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DEAN MEAD
ATTORNEYS AT LAW

Dean, Mead, Egerton, Bloodworth, Capouano & Bozarth, P.A.
420 South Orange Avenue, Suite 700
P.O. Box 2346 (ZIP 32802-2346)
Orlando, FL 32801

(407) 841-1200
(407) 423-1831 Fax
www.deanmead.com

Attorneys and Counselors at Law
Orlando
Fort Pierce
Tallahassee
Tampa
Viera/Melbourne

MARTIN FRIEDMAN
407-310-2077
mfriedman@deanmead.com

August 20, 2019
VIA E-FILING

Adam Teitzman, Commission Clerk
Office of Commission Clerk
Florida Public Service Commission
2540 Shumard Oak Blvd.
Tallahassee, FL 32399-0850

RE: Re: Docket No. 20190031-WU - Application for increase in water rates in Highlands County, by Placid Lakes Utilities, Inc.
<u>Our Matter No.: 070336</u>

Dear Mr. Teitzman:

On behalf of Placid Lakes Utilities, Inc. ("Utility") the following are the responses to Staff's Second Data Request dated August 9, 2019.

1. Please refer to Placid Lakes' response to staff's first data request, question 8a.

    a. The utility stated that "[t]he water treatment plant (WTP) system was failing for unknown reasons." Please provide a detailed explanation of the system failure, including when the failure occurred and any causes for the failure that have since been identified.
    ***Response****: The Utility knew the old Square D computer system, which controlled the wells, was not working properly. The computer kept regularly showing errors over the last 7 years. The nature of the problem was that the Square D would not properly send signals for the wells to turn on. The water system demand would then use up most of the water in the storage tanks. An employee would then have to override the automatic system and manually turn on the wells. These errors over the last 7 years were resolved by replacing the Square D with spare Square D parts existing at the plant. A*

*failure occurred in September 2018 which required two Square D's to be replaced. A major failure occurred November 2018, which used the last Square D spare left in the plant. At that point the Utility decided to find a replacement contractor to resolve the problem. Data Flow Systems timely responded to the Utility's request for help. They identified a solution and provided the Utility with a quote dated January 28, 2019 (typo on quote said 2018), contained in Volume III, Schedule XI, Part C, 7 pages (see Attachment 4). The new control system was operational around May 1, 2019, and has been working to expectation ever since. To gain a more detailed description of the history of this problem, please feel free to contact Nathan Brewer, water system Supervisor, directly on his cell phone (863-441-1090).*

b. When and how many companies were contacted to obtain bids for the Control System Project?
***Response**: As stated in our prior response to staff's First Data Request, only one bid was obtained. The Utility tried to address this issue for over 7 years with its prior contractor, J.H. Ham Engineering. They were never able to resolve the problem, and were never willing to give the Utility a quote. After the major failure in November 2018, the Utility contacted a new contractor, Data Flow Systems. They were able to provide a plan to solve the issue, and give the Utility a quote. See Attachment 4.*

c. When and how many companies were contacted to obtain bids for the Variable Flow Pumps Project?
***Response**: In April 2019, the Utility contacted two contractors for bids on changing its existing pumps to variable flow pumps. One contractor, Amp Electric, never responded back. The second, Hudson Pump & Equipment, provided the Utility with the quote contained in Volume III, Schedule XI, Part D, 1 page (see Attachment 1).*

2. Please refer to Placid Lakes' response to staff's first data request, question 8b. Please provide the plan designed by the Florida Rural Water Association for the installation of the hydrogen peroxide treatment system.
***Response**: Please see Attachment 2.*

3. Please refer to Placid Lakes' response to staff's first data request, question 8b.

   a. Please provide the invoice for the "Source Names" of J. H. Ham Engineering, Inc. as listed on the Hydrogen Peroxide Project Transaction Report.
   ***Response**: Please see Attachment 3a.*

   b. The amount listed on the Hydrogen Peroxide Project Transaction Report for pump and blower is $2,610.99; however, the invoice provided from Pat's

Pump & Blower, LLC dated 11/30/2018 is for the amount of $2,430.99. Please explain the discrepancy between these amounts.
***Response**: See Attachment 3b. The $180.00 difference relates to Excavation Point, Inc. invoice for fill dirt that was posted twice into the accounting system; once by check and once by credit card. The source name for the $2,610.99 posting is Heartland Visa (credit card), and includes both the EPI invoice and the Pat's Pump & Blower invoice. The 3rd page of Attachment 3b is a copy of the check to EPI, which they never cashed, wrote VOID on front, and mailed back to the Utility. The bill that posted the $180.00 will be reversed in 2019, and removed from Account # 320.3, Water Treatment Equipment.*

c. The amount listed on the Hydrogen Peroxide Project Transaction Report for Home Depot on 4/21/2019 is $382.57; however, the provided invoice dated 4/4/2019 is for the amount of $263.32. Please explain the discrepancy between these amounts.
***Response**: See Attachment 3c. The first page of the Home Depot invoice was erroneously not provided on our original response. Page 1 of the attachment is this missing page. The total of $382.57 for several items purchased rolls into the top of page 2. The information at the bottom of page 2 (now X'ed out), totaling 263.32, is unrelated to the Hydrogen Peroxide Project.*

d. The amount listed on the Hydrogen Peroxide Project Transaction Report for Heartland Visa on 4/4/2019 is $585.90. Please provide a description of the item(s) purchased.
***Response**: See Attachment 3d. The Utility purchased Discharge Tubing 500' Roll from vendor USABlueBook (invoice attached). The Utility paid for it with the Heartland Visa credit card, which was the payee. The source name should have been shown as USABlueBook.*

4. Please refer to Placid Lakes’ response to staff’s first data request, question 8b. Please provide the invoice for the amount of $30,000 listed on the Control System Project Transaction Report. If no invoice is available, please explain why.
***Response:** See Attachment 4. DFS invoice # 75313 dated Feb. 21, 2019 in the amount of $30,000. The attached quote was dated January 28, 2019 (typo on document said 2018). The Utility entered a bill for $30,000 (one half down payment) into its accounting system dated January 31, 2019. The Utility cut a check (#22419) dated February 1, 2019 in payment of this Invoice, and delivered it to DFS on that date. Because of the serious ongoing potential failure of our Square D computer water pump control system, the Utility wanted to entice DFS to put its needs in front of their many other customers. The Utility’s plan was rewarded by DFS, and the new control system was operational around May 1, 2019.*

5. Please refer to Placid Lakes’ response to staff’s first data request, question 12.

a. What is the estimated monthly Chemicals expense for the new hydrogen peroxide treatment system, including the quantity purchased, unit price, and dosage rate?
***Response****: One 55 gallon drum of hydrogen peroxide is approximately a one month supply, and costs $305.10, plus $25.00 delivery.*

b. What basis was used to estimate the monthly Chemicals expense for the new hydrogen peroxide treatment system?
***Response****: Based on the Utility's limited experience with the new hydrogen peroxide system (approximately 3 months), at its normal monthly water demand, one 55 gallon drum seems to be sufficient to provide hydrogen peroxide into the new system for a month.*

c. The utility stated that the existing gas chlorination treatment system will be used to supplement the hydrogen peroxide in the water towers. Does the utility anticipate a decrease in the amount of chlorine and sequestall used? If so, please provide an updated MFR Volume III, Schedule I - Chemicals Used.
***Response****: The Utility is still using gas chlorination to supplement the hydrogen peroxide treatment. There will be a significant decrease in the amount of gas chlorination compared to what was used in the past. Based on the Utility's limited experience (approximately 3 months), it is using about 20 lbs./mo vs. 693 lbs./mo (3 yr avg) in 2018 of gas chlorine ($1.04/lb). This gas chlorine is used in the water towers to fight algae. However, the Utility is now using liquid chlorine (sodium hypochlorite) to treat water at the point of entry in the distribution system. The Utility estimates that approximately 500 gallons ($1.30/gal + $25 delivery) of liquid chlorine will be used each month. There will not be any change in the amount of Sequestall it uses. Volume III, Schedule II, Chemicals Used (page 2, bottom right; excess over 2018) has been adjusted for the above changes (see Attachment 5). This changes the normalization for chemicals on Volume I, Schedule B-3, line 17 from $3,317 to $2,743.*

6. Please refer to MFR Volume III, page 265. The utility estimated a total cost of $1,080 for parts related to the meter replacements. Please provide a description of the general types of parts that the utility anticipates will be needed.
***Response****: The "parts" referred to on Volume III, Schedule XI, Part A relating to the meter replacement program are for couplings, valves, PVC pipe, etc. All these miscellaneous parts are not needed on every meter replacement. The Utility used one-half the time as an estimate.*

7. Please advise if there were any unusual circumstances such as fires or flushing for the following dates: 10/20/2018, 10/26/2018, 10/28/2018, 11/01/2018, and 11/04/2018. If an unusual event occurred, please describe it, provide the amount of water used or lost, and the date it happened.

> ***Response****: See Attachment 7, containing four water usage graphs for the weeks beginning 10/8/18, 10/15/18, 10/22/18 & 11/5/18. These four graphs cover all the above dates. Also in the Attachment are the October & November 2018 Monthly Operating Reports. Neither the graphs or MORs indicate any unusual spikes in water usage for 10/20, 10/26, 10/28, or 11/1. Both the graph and MOR indicate a spike on 11/4 at approximately 8 pm. The Utility has no reason to believe this was due to a fire. It was most likely caused by automatic blow off activity. If staff needs any further information regarding this question, please feel free to call the water system Supervisor, Nathan Brewer, directly (863-441-1090) to discuss.*

8. Were there any line breaks or water leaks in the system during the calendar year 2018 (test year), aside from the water line break on Farrell? If yes, were the leaks fixed? Please describe the incidents and provide the dates of the leaks.
   ***Response****: As indicated in the response to the Staff's First Data Request, Question 3b, the following water line breaks occurred in 2018: 3/26 on Ferrell (4" line), 5/17 on Washington (8" line), 8/1 on Lincoln (6" line), 8/10 at fire department (2" line). See Attachment 8, containing 3 water usage graphs. These three graphs show the water usage spikes that occurred on the line break dates. Any and all water line breaks or leaks are repaired as soon as detected. If staff needs any further information regarding this question, please feel free to call the water system Supervisor, Nathan Brewer, directly (863-441-1090) to discuss.*

Should you or Staff have any questions regarding this filing, please do not hesitate to give me a call.

Very truly yours,

*<u>/s/ Martin S. Friedman</u>*
For the Firm

cc: Larry King (via e-mail)
Marie McKinney (via e-mail)

# ATTACHMENT 1

VARIABLE FLOW PUMPS SCH. XI, PART D, 1 PAGE

**Hudson**
**Pump & Equipment**
**A Division of Tencarva Machinery Company**

3524 Craftsman Boulevard • Lakeland, FL • 33803
**Tel:** (863) 665-7867 • **Fax:** (863) 666-5649
**Municipal Division**

| | | | |
|---|---|---|---|
| Quote No: | 041219RB2 | Date: | 04/12/19 |
| Customer: | Placid Lakes | No. Pages: | 1 |
| Location: | | Your No.: | |
| Attn: | Nate Brewer | e-mail: | ndbrewer@embarqmail.com |
| Phone: | (863) 441-1090 | Terms: | N30 |
| Fax: | | F.O.B.: | Destination |
| From: | Roger Burna/Scott Chisholm | | Freight Included |

**Conditions of Service:** 1,100 GPM @ 125 ft TDH

We are pleased to quote as follows:

| qty | Description | Price Each | Extension |
|---|---|---|---|
| 3 | Horizontal Split-Case Pump, Weinman-Deming Model 5L1, NSF61/372, Cast Iron Casing, Aluminum Bronze Impeller, 316SS Shaft Sleeves, Carbon/Ceramic/Buna Mechanical Seal, on a Fabricated Steel Baseplate, with Coupling, Guard, and a 50 HP, 1800 RPM, 3 Ph, 60 Hz, 230/460V, ODP, Premium Efficient, Motor, Suitable for Inverter Use per NEMA MG-1.4.4.2, Part 31. | $11,872.00 | $35,616.00 |
| 3 | Optional HI 2B Performance Test | $1,711.00 | $5,133.00 |
| 1 | Control Panel for Above (Please see separate Data Sheets) | $44,714.00 | $44,714.00 |
| | **Quote Valid thru 12/31/19** | | |

## With the following notes:

1. Freight is included.
2. Delivery: 8-10 weeks & add 2 weeks if performance test is needed.
3. Removal & Installation to be quoted later after evaluation of current installation.

**Best Regards,**

*Roger Burna*

Quoted By: Roger Burna

ATTACHMENT 2

**FLORIDA RURAL WATER ASSOCIATION**
2970 WELLINGTON CIRCLE• TALLAHASSEE, FL 32309-7813
(850) 668-2746

EMAIL
frwa@frwa.net

WEBSITE
www.frwa.net

August 20, 2018

Ms. Pam Brewer
Placid Lakes Utilities, Inc. Water Treatment Plant
410 Washington Blvd, NW
Lake Placid FL 33852
Phone: (863) 465-0345
Email: pambrewer@embarqmail.com

**Re: Permit Application for Hydrogen Peroxide as a Preoxidant to Improve Water Quality and Decrease Disinfection By-Product Precursors**
**Placid Lakes Utilities, Inc., Highland Co., PWS: 6280223**

Dear Ms. Brewer;

Please accept this Permit Application for Hydrogen Peroxide for use as a Preoxidant to Improve Water Quality and Decrease Disinfection By-Product Precursors.

Sign the Permit Application for Construction in 3 places and forward to Mr. James Oni, P.E. at the FDEP South District along with a check for $650 per Rule 62-4.050(4)(n), F.A.C.

After the installation is complete you will need approval of the installation from the FDEP. CAUTION! Do not start using these new facilities until AFTER you receive the Final Clearance from FDEP – *otherwise your system may be subject to fines up to $5,000 and other enforcement action.*

Florida Rural Water Association has enjoyed serving you and wishes your water system the best.

Sincerely,

Robert E. Holmden

Robert E. Holmden, P.E.
Engineer, In Association with FRWA
Phone: 850-264-7218
Email: rholmden@gmail.com

Copy: Stan Epperly, FRWA Circuit Rider

**FLORIDA RURAL WATER ASSOCIATION**
2970 WELLINGTON CIRCLE • TALLAHASSEE, FL 32309-7813
(850) 668-2746

EMAIL
frwa@frwa.net

WEBSITE
www.frwa.net

August 20, 2018

Mr. James Oni, P.E.
Drinking Water Program Admisistrator
Fort Myers Office
Florida Department of Environmental Protection
South District
P.O. Box 2549
Phone: (239) 344-5679
Email: James.Oni@FloridaDEP.gov

**Re: Permit Application for Hydrogen Peroxide as a Preoxidant to Improve Water Quality and Decrease Disinfection By-Product Precursors**
**Placid Lakes Utilities, Inc., Highland Co., PWS: 6280223**

Dear Mr. Oni,

Please accept this Permit Application for Hydrogen Peroxide as a Preoxidant to Improve Water Quality and Decrease Disinfection By-Product Precursors.

Peroxide is a well-known oxidant more frequently used in wastewater treatment to control hydrogen sulfide odors. $H_2O_2$ is one of the recognized alternative preoxidants recommended by EPA in water pre-treatment in lieu of chlorination for lowering disinfection by-product formation. [1]

Please contact me if you have any questions.

Sincerely,

Robert E. Holmden

Robert E. Holmden, P.E.
FL PE# 54814
Engineer, In Association with FRWA
Phone: 850-264-7218
Email: rholmden@gmail.com

Copy: Pam Brewer, Vice President Placid Lakes Utilities, Inc.
Nathan Brewer, Operator Placid Lakes Utilities, Inc.
410 Washington Blvd, NW, Lake Placid, FL 33852
Stan Epperly, FRWA Circuit Rider

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[1] EPA (1999), Alternative Disinfectants and Oxidants Guidance Manual, Doc No. 815-R-99-014]

# Table of Contents

# ENCLOSURE ~ 1

## Hydrogen Peroxide Permit Application

Florida Department of Environmental Protection

# APPLICATION FOR A SPECIFIC PERMIT TO CONSTRUCT PWS COMPONENTS

See page 4 for instructions.

## I. General Project Information

A. Name of Project: Placid Lakes Utilities Inc - Hydrogen Peroxide as a Preoxidant at WTP

B. Description of Project and Its Purpose:

This permit seeks to add a hydrogen peroxide system at the Placid Lakes Utilities, Inc. Water Treatment Plant. The peroxide will be injected at the point where the three wells join into a single pipe prior to entering the storage tanks. The ortho/polyphosphate and chlorine injection points will be relocated downstream to just prior to the point of entry into the distribution system. The project will involve the following components: Chemical feed pump, injection point, and 55-gallon drum of 35% Hydrogen Peroxide and relocation of the ortho/polyphosphate and chlorine lines and injection point..

C. Does project create a "new system" as described under subsection 62-555.525(1), F.A.C.? ☐ Yes, and a completed copy of Form 62-555.900(20), New Water System Capacity Development Financial and Managerial Operations Plan, is attached. ☒ No.

D. Location of Project

1. County Where Project Located: Highland County
2. Description of Project Location:

410 Washington Blvd NW
Lake Placid, FL 33852

3. Latitude and Longitude of Each New Treatment Plant and Each New Raw Water Source (attach additional sheets if necessary):

| Name of New Treatment Plant or Raw Water Source | Latitude | Longitude |
|---|---|---|
| None | ° ' "N | ° ' "W |
| | ° ' "N | ° ' "W |
| | ° ' 'N | ° ' "W |
| | ° ' "N | ° ' "W |
| | ° ' N | ° ' "W |

E. Estimate of Cost to Construct Project:

F. Estimate of Dates for Starting and Completing Construction of Project: Within 90 days of permit issuance

G. Applicant

| | | |
|---|---|---|
| PWS/Company Name: Placid Lakes Utilities Inc | | PWS Identification No.:*6280223 |
| PWS Type:* ☒ Community ☐ Non-Transient Non-Community ☐ Transient Non-Community ☐ Consecutive | | |
| Contact Person: Nathan Brewer | Contact Person's Title: Operator | |
| Contact Person's Mailing Address: 410Washington Blvd NW | | |
| City: Lake Placid | State: FL | Zip Code: 33852 |
| Contact Person's Telephone Number: 863-441-1090 | Contact Person's Fax Number: | |
| Contact Person's E-Mail Address: ndbrewer@embarqmail.com | | |

** This information is required only if the applicant is a public water system (PWS).*

H. Public Water System (PWS) Supplying Water to Project

| | | |
|---|---|---|
| PWS Name: Placid Lakes Utilities, Inc | | PWS Identification No.: 6280223 |
| PWS Type: ☒ Community ☒ Non-Transient Non-Community ☐ Transient Non-Community ☐ Consecutive | | |
| PWS Owner: Lake Placid Holding Company | | |
| Contact Person: Ms. Pam Brewer | Contact Person's Title: Vice President | |
| Contact Person's Mailing Address: 410 Washington Blvd NW | | |
| City: Lake Placid | State: FL | Zip Code: 33852 |
| Contact Person's Telephone Number: 863-465-0345 | Contact Person's Fax Number: | |
| Contact Person's E-Mail Address: pambrewer@embarqmail.com | | |

# APPLICATION FOR A SPECIFIC PERMIT TO CONSTRUCT PWS COMPONENTS

| | |
|---|---|
| Project Name: Placid Lakes Utilities Inc - Hydrogen Peroxide as a Preoxidant at WTP | Applicant: Placid Lakes Utilities nc |

I. Public Water System (PWS) that Will Own Project after It Is Placed into Permanent Operation

| | | |
|---|---|---|
| PWS Name: Placid Lakes Utilities Inc | | PWS Identification No.:*6280223 |
| PWS Type:* ☒ Community ☐ Non-Transient Non-Community ☐ Transient Non-Community ☐ Consecutive | | |
| PWS Owner: Lake Placid Holding Company | | |
| Contact Person: Ms. Pam Brewer | Contact Person's Title: Vice President | |
| Contact Person's Mailing Address: 410 Washington Blvd NW | | |
| City: Lake Placid | State: FL | Zip Code: 33852 |
| Contact Person's Telephone Number: 863-465-0345 | Contact Person's Fax Number: | |
| Contact Person's E-Mail Address: pambrewer@embarqmail.com | | |

* *This information is required only if the owner/operator is an existing PWS.*

J. Professional Engineer(s) or Other Person(s) in Responsible Charge of Designing Project*

| | | |
|---|---|---|
| Company Name: Florida Rural Water Association | | |
| Designer(s): Robert E. Holmden, P.E. | Title(s) of Designer(s): Professional Engineer | |
| Qualifications of Designer(s):<br>☒ Professional Engineer(s) Licensed in Florida – License Number(s): 54814<br>☐ Public Officer(s) Employed by State, County, Municipal, or Other Governmental Unit of State†<br>☐ Plumbing Contractor(s) Licensed in Florida – License Number(s):^ | | |
| Mailing Address of Designer(s): 2970 Wellington Circle | | |
| City: Tallahassee | State:FL | Zip Code: 32309 |
| Telephone Number of Designer(s): 850-264-7218 | Fax Number of Designer(s): | |
| E-Mail Address(es) of Designer(s): rholmden@gmail.com | | |

* *Except as noted in paragraphs 62-555.520(3)(a) and (b), F.A.C., projects shall be designed under the responsible charge of one or more professional engineers licensed in Florida.*

† *Attach a detailed construction cost estimate showing that the cost to construct this project is $10,000 or less.*

^ *Attach documentation showing that this project will be installed by the plumbing contractor(s) designing this project, documentation showing that this project involves a public water system serving a single property and fewer than 250 fixture units, and a detailed construction cost estimate showing that the cost to construct this project is $50,000 or less.*

## II Certifications

A. Certification by Applicant

I am duly authorized to sign this application on behalf of the applicant identified in Part I.G of this application. I certify that, to the best of my knowledge and belief, this project complies with Chapter 62-555, F.A.C., and provides assurance of compliance with Chapter 62-550, F.A.C. I also certify that construction of this project has not begun yet.

| | | |
|---|---|---|
| | Pam Brewer | Vice President |
| Signature and Date | Printed or Typed Name | Title |

B. Certification by PWS Supplying Water to Project

I am duly authorized to sign this application on behalf of the PWS identified in Part I.H of this application. I certify that said PWS will supply the water necessary to meet the design water demands for this project. I certify that, to the best of my knowledge and belief, said PWS's connection to this project will not cause said PWS to be, or contribute to said PWS being, in noncompliance with Chapter 62-550 or 62-555, F.A.C. I also certify that said PWS has reviewed the preliminary design report or drawings, specifications, and design data for this project and that said PWS considers the connection(s) between this project and said PWS acceptable as designed.

- Name(s) of Water Treatment Plant(s) to Which this Project Will Be Connected: Lake Placid Utilities Inc WTP
- Total Permitted Maximum Day Operating Capacity of Plant(s), gpd: 1140000 gpd
- Total Maximum Day Flow at Plant(s) as Recorded on Monthly Operating Reports During Past 12 Months, gpd: 583,000gpd

| | | |
|---|---|---|
| | Pam Brewer | Vice President |
| Signature and Date | Printed or Typed Name | Title |

# APPLICATION FOR A SPECIFIC PERMIT TO CONSTRUCT PWS COMPONENTS

| | |
|---|---|
| Project Name: Placid Lakes Utilities Inc - Hydrogen Peroxide as a Preoxidant at WTP | Applicant: Placid Lakes Utilities Inc |

C. Certification by PWS that Will Own Project after It Is Placed into Permanent Operation

I am duly authorized to sign this application on behalf of the PWS identified in Part I.I of this application. I certify that said PWS will own this project after it is placed into permanent operation. I also certify that said PWS has reviewed the preliminary design report or drawings, specifications, and design data for this project and that said PWS considers this project acceptable as designed.

| Signature and Date | Printed or Typed Name | Title |
|---|---|---|
| | Pam Brewer | Vice President |

D. Certification by Professional Engineer(s) in Responsible Charge of Designing Project*

I, the undersigned professional engineer licensed in Florida, am in responsible charge of preparing the preliminary design report or drawings, specifications, and design data for this project. I certify that, to the best of my knowledge and belief, the design of this project complies with Chapter 62-555, F.A.C., and provides assurance of compliance with Chapter 62-550, F.A.C.

| | |
|---|---|
| Signature, Seal, and Date:<br>Affix Seal<br>Robert E. Holmden<br>Aug 20, 2018 | Signature, Seal, and Date:<br>Affix Seal |
| Printed/Typed Name: Robert E. Holmden, P.E. | Printed/Typed Name: |
| License Number: 54814 | License Number: |
| Portion of Engineering Document(s) for Which Responsible: all | Portion of Engineering Document(s) for Which Responsible: |
| Signature, Seal, and Date:<br>Affix Seal | Signature, Seal, and Date:<br>Affix Seal |
| Printed/Typed Name: | Printed/Typed Name: |
| License Number: | License Number: |
| Portion of Engineering Document(s) for Which Responsible: | Portion of Engineering Document(s) for Which Responsible: |

* *Except as noted in paragraphs 62-555.520(3) (a) and (b), F.A.C., projects shall be designed under the responsible charge of one or more professional engineers (PEs) licensed in Florida. If this project is being designed under the responsible charge of one or more PEs licensed in Florida, Part II.D of this application shall be completed by the PE(s) in responsible charge. If this project is not being designed under the responsible charge of one or more PEs licensed in Florida, Part II.D does not have to be completed.*

# APPLICATION FOR A SPECIFIC PERMIT TO CONSTRUCT PWS COMPONENTS

INSTRUCTIONS: This application shall be completed and submitted by persons proposing to construct or alter public water system components unless such proposed construction or alteration is permitted under the Department of Environmental Protection's (DEP's) "General Permit for Construction of Water Main Extensions for Public Water Systems," in which case Form 62-555.900(7) is to be completed and submitted, or under the DEP's "General Permit for Construction of Lead or Copper Corrosion Control, or Iron or Manganese Sequestration, Treatment Facilities for Small or Medium Public Water Systems," in which case Form 62-555.900(18) is to be completed and submitted. Complete and submit one copy of this application to the appropriate DEP District Office or Approved County Health Department (ACHD) along with payment of the proper application processing fee and one copy of the following information:

- either a preliminary design report or drawings, specifications, and design data (the preliminary design report or drawings, specifications, and design data shall contain all pertinent information required under subsection 62-555.520(4), F.A.C.); and
- the Florida Public Service Commission (FPSC) certificate of authorization to provide water service if the project involves construction of a new public water system subject to the jurisdiction of the FPSC.

All information provided on this application shall be typed or printed in ink. Application processing fees are listed in paragraph 62-4.050(4) (n), F.A.C. Checks for application processing fees shall be made payable to the Department of Environmental Protection or to the appropriate ACHD. Preliminary design reports, drawings, specifications, and design data prepared under the responsible charge of one or more professional engineers licensed in Florida shall be signed, sealed, and dated by the professional engineer(s) in responsible charge. NOTE THAT A SEPARATE APPLICATION AND A SEPARATE APPLICATION PROCESSING FEE ARE REQUIRED FOR EACH NON-CONTIGUOUS PROJECT.*

* *Non-contiguous projects are projects that are neither interconnected nor located nearby one another (i.e., on the same site, on adjacent streets, or in the same neighborhood).*

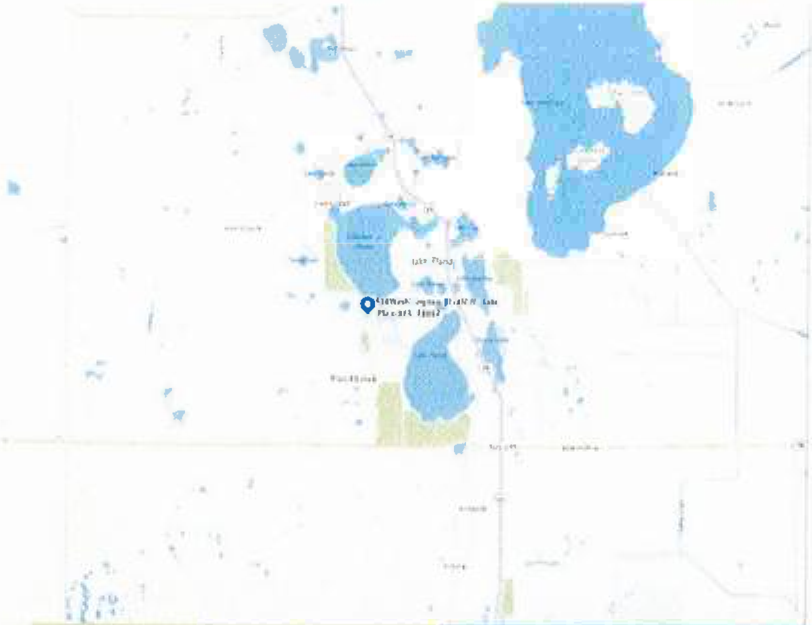
# ENCLOSURE ~ 2

## Engineering Documents & Photographs

2.1 Location Map, Proposed WTP Plan View, and Proposed WTP Schematic
2.2 Preliminary Engineering Report
2.3 Jar Tests
2.4 FRWA Recommended Treatment Techniques
2.5 $H_2O_2$ Safety Data Sheet
2.6 US Peroxide Hydrogen Peroxide Application, Safety and Handling Guidelines, Field Mehods and Test Kits, and Solution Properties
2.7 Photographs

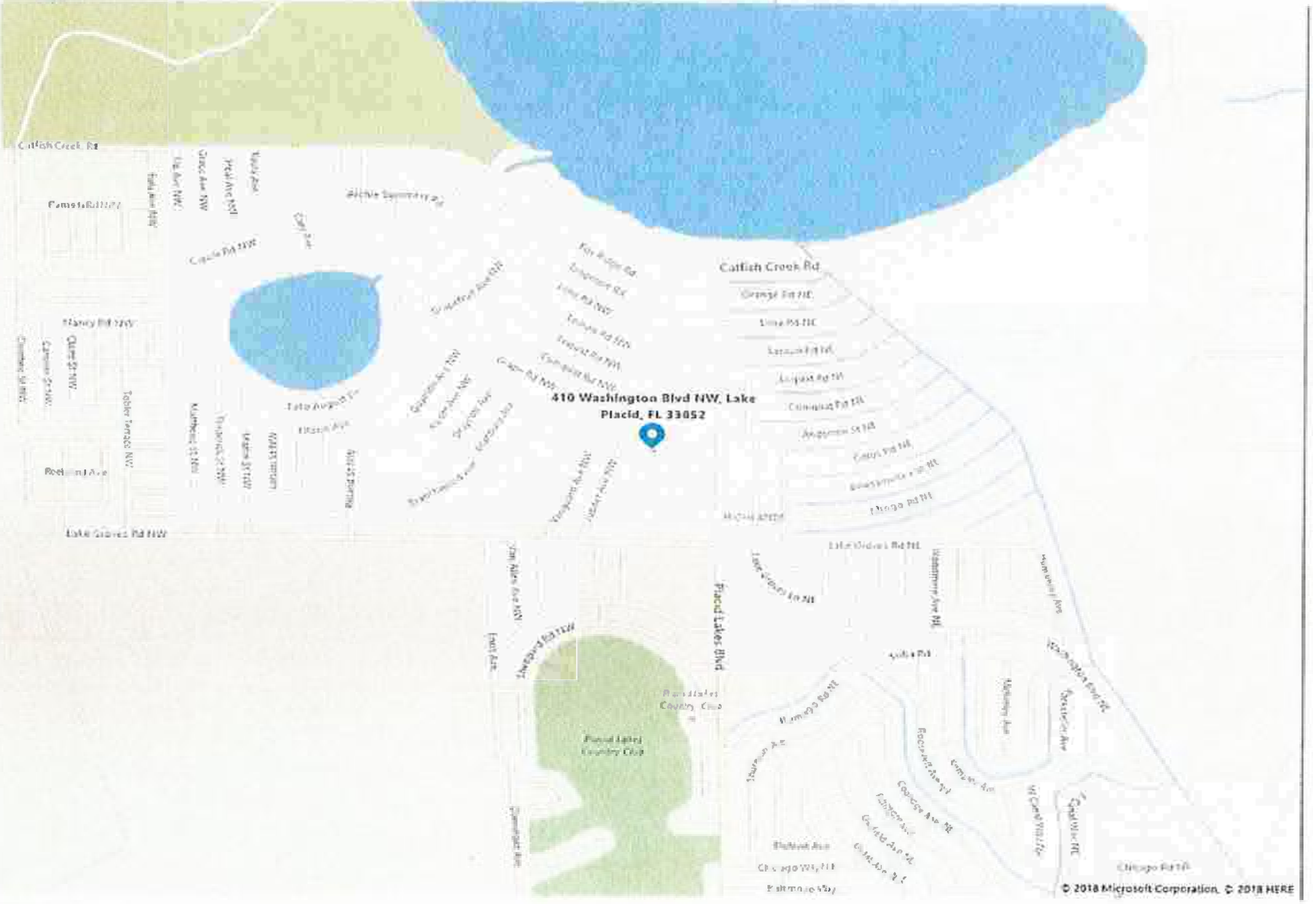
# ENCLOSURE ~ 2.1

## Location Map, Proposed WTP Plan View, and Proposed WTP Schematic



# Placid Lakes Utilities, Inc.
# Water Treatment Plant
# 410 Washington Blvd, NW
# Lake Placid, FL 33852

## Project: Use Hydrogen Peroxide as a Preoxidant to Improve Water Quality and Decrease Disinfection By-Product Precursors



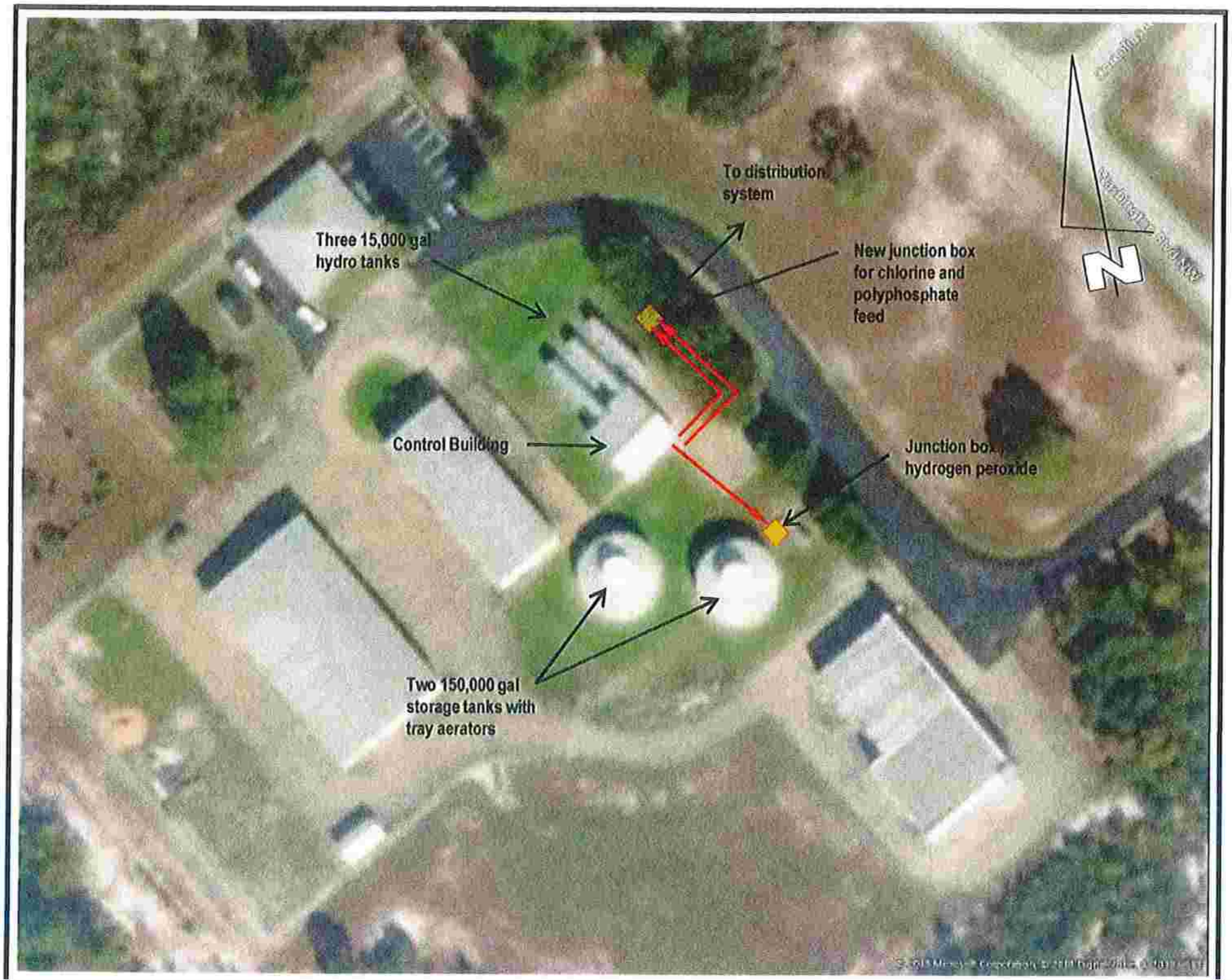
**ROBERT E. HOLMDEN, P.E.**
Phone: 850-264-7218
Email: rholmden@gmail.com
P.E. #54814

**IN ASSOCIATION WITH:**

**FLORIDA RURAL WATER ASSOCIATION**
2970 Wellington Circle, Tallahassee, FL 32309
Phone: 850-668-2746 ~ Fax: 850-893-4581
Certificate of Authorization: 29291

**PLACID LAKES UTILITIES, INC.**
Ms. Pam Brewer
410 Washington Blvd NW
Lake Placid, FL 33852

Highlands County
PWS: 6280223
Phone: (863) 465-0345



# Proposed Water Treatment Plant Plan

## Hydrogen Peroxide as a Preoxidant to Improve Water Quality at Water Treatment Plant and Decrease Disinfection By-Product Precursors

Scale (feet)
0 10 20 30 40 50

**ROBERT E. HOLMDEN, P.E.**
Email: rholmden@gmail.com
Phone: 850-264-7218
P.E. #54814

Robert E Holmden
Aug 30, 2018

**IN ASSOCIATION WITH**

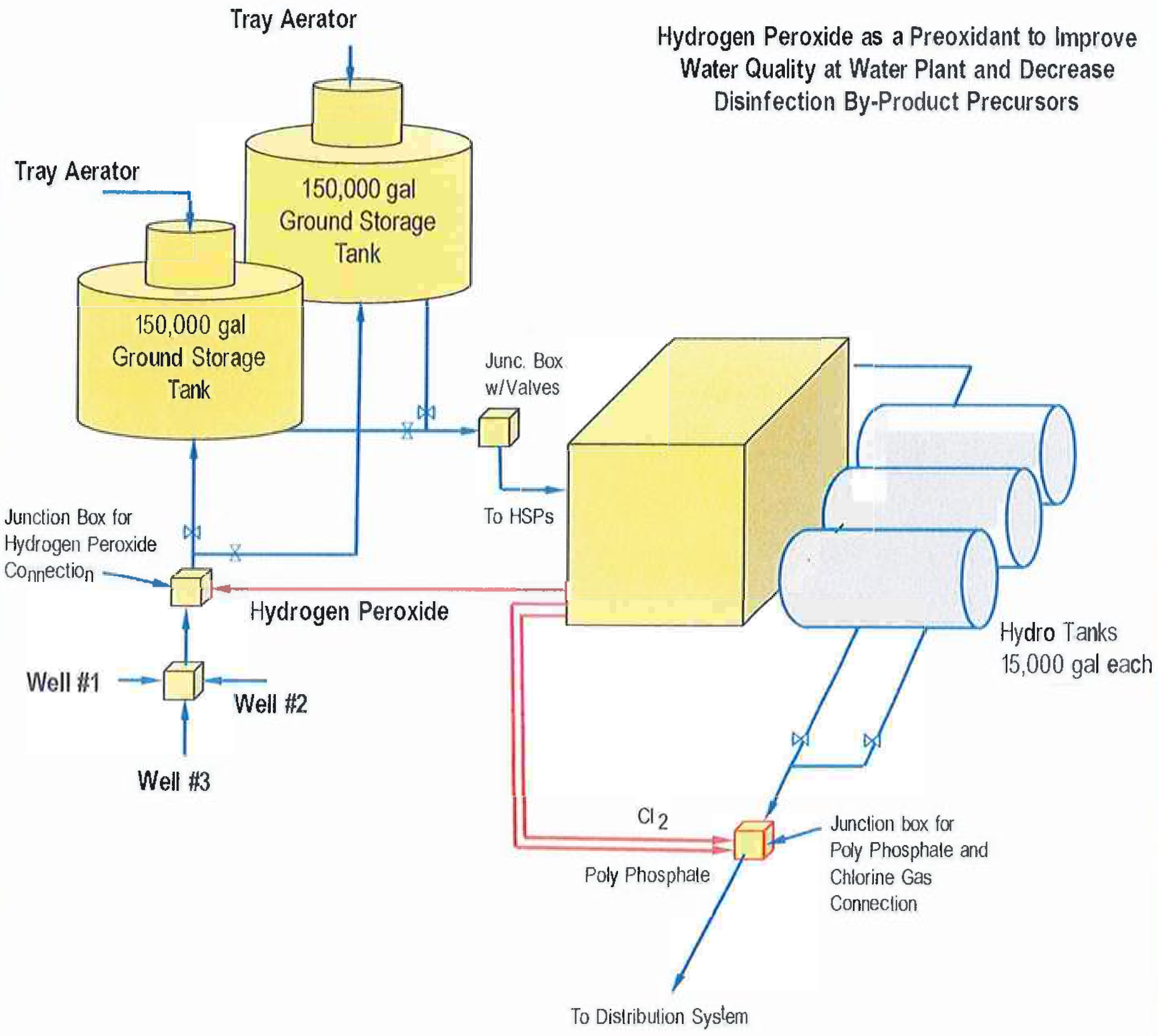
**FLORIDA RURAL WATER ASSOCIATION**
2970 Wellington Circle, Tallahassee, FL 32309
Phone: 850-668-2746 ~ Fax: 850-893-4581
Certificate of Authorization: 29291

**PLACID LAKES UTILITIES, INC. WTP**
Ms. Pam Brewer
410 Washington Blvd NW
Lake Placid, FL 33852

Highlands Co.,
PWS: 6280223
Phone: (863) 465-0345

# Proposed Water Treatment Plant Schematic

Hydrogen Peroxide as a Preoxidant to Improve Water Quality at Water Plant and Decrease Disinfection By-Product Precursors



**ROBERTE.HOLMDEN,P.E**
Email: rholmden@gmail.com
Phone: 850-264-7218
P.E. #54814

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Ms. Pam Brewer
410 Washington Blvd
Lake Placid, FL 33852

Highlands Co.,
PWS: 6280223
Phone: (863) 465-0345

# ENCLOSURE ~ 2.2

## Preliminary Engineering Report

# *Preliminary Engineering Report*
*for*

# *Placild Lakes Utilities Water Treatment Plant*

*for*

# Addition of Hydrogen Peroxide as a Preoxidant to Improve Water Quality at Water Plant and Decrease Disinfection By-Product Precursors

**Robert E. Holmden, P.E.**
Telephone: 850-264-7218
Email: rholmden@gmail.com

In Association with

**Florida Rural Water Association**
2970 Wellington Circle ~ Tallahassee FL 32309
Telephone: 850-668-2746 ~ Fax: 850-893-4581
Certificate of Authorization: 29291

Robert E. Holmden

August 20, 2018
Robert E. Holmden, P.E.
FL PE #54814

## Section 1 ~ General Discussion & Background

### 1.1 ~ Problem Statement.

Placid Lakes Utilities, Inc. has been having problems with disinfection by-product (DBP) formation. Raw water impurities (such as hardness, odor, color, iron, sulfides/sulfates, and natural occurring organics such as tannins as measured by total organic carbon) increase the amount of chlorine needed to disinfect the water and maintain residual and as a result, increases the amount of disinfection by-products produced.

### 1.2~ Hydrogen Peroxide ($H_2O_2$).

The use of Hydrogen Peroxide ($H_2O_2$) as a pre-oxidant in municipal water treatment is well documented and has been practiced for about two decades. Historically hydrogen peroxide drinking water applications include taste and odor control, hydrogen sulfide removal, iron removal and ozone enhancement/destruction.[1]

Hydrogen Peroxide ($H_2O_2$) is chemically water ($H_2O$) with an additional oxygen molecule (O). Unlike chlorine, hydrogen peroxide produces no harmful disinfection by-products. During the reaction the oxygen molecule is liberated and chemically oxidizes (reduces) impurities in the raw water. These impurities include iron, sulfur, organics, tannins, color, odor, taste, etc. As a result, hydrogen peroxide can be an effective pre-oxidant of disinfection by-product precursors and lower secondary contaminants.[2]

### 1.3 ~ Oxidants and Particulates.

Impurities in raw groundwater are generally in the soluble, reduced, divalent state. When they are oxidized by any of the reagents listed below, these impurities change and discolor the water from turbid yellow to black, depending on their concentration and the presence or absence of other contaminants.

**Oxidation Potential of Various Reagents**

| Oxidant | Oxidation Potential, V |
|---|---|
| Fluorine (F) | 3.06 |
| Hydroxyl Radical (• HO) | 2.85 |
| Ozone ($O_3$) | 2.07 |
| Hydrogen Peroxide ($H_2O_2$) | 1.77 |
| Potassium Permanganate ($KMnO_4$) | 1.67 |
| Chlorine Dioxide ($CO_2$) | 1.57 |
| Hypochlorous Acid (HClO) | 1.49 |
| Chlorine Gas ($Cl_2$) | 1.36 |
| Oxygen ($O_2$) | 1.23 |
| Hypochlorite (ClO) | 0.94 |
| Chlorite ($ClO_2-$) | 0.76 |

Compare

---

[1] Source U.S. Peroxide, MKG-C03 Drinking Water Treatment Application - MUNI. www.h2o2.com.

[2] EPA (1999), Alternative Disinfectants and Oxidants Guidance Manual, Doc No. 815-R-99-014)

Oxidized impurities form very fine particles that are mostly colloidal in nature. Groundwater systems typically using chlorine do not provide additional treatment or filtration to remove particulates; the same can be said about most reagents listed above (including hydrogen peroxide). It is not practical or cost effective to capture and remove these particulates since they account for about one (1) ounce per day per 1,000 gallons of treated water.[3] The particulates are very small and tend to pass through most filters.

Particulates formed after chlorination tend to collect in storage tanks, the distribution system, hot water heaters, and any other quiescent zones. In low flow and low chlorine residual areas iron and sulfur bacteria can thrive resulting in odor, taste, and color issues. Sulfur bacteria can cause black water or rotten egg odor problems. Iron bacteria can cause grey or red water problems in the system.

### 1.4 ~ Hydrogen Peroxide Systems.

The use of $H_2O_2$ for disinfection by-product reduction does not require expensive capital so it can be easily integrated into existing water plant operations. FRWA carefully performs onsite jar tests of raw water to determine if peroxide is appropriate for each system. Following successful jar tests, full-scale pilot studies are performed.

The typical hydrogen peroxide system consists of a chemical injection pump and solution tank – usually a 55-gallon drum. This allows $H_2O_2$ to be full-scale pilot tested so that its benefits can be documented under a plant's specific conditions. This is a critical step since all source water varies in organics make-up and therefore individual plant results with the use of $H_2O_2$ may vary from plant to plant.

The plant configuration that works best is one that allows for 15 to 20 minutes of contact time to allow for oxidation of iron, manganese, tannins, etc.(hydrogen sulfide is reduced much quicker). Hydrogen peroxide replaces chlorine as a chemical preoxidant. Often the plant configuration might include aeration, storage, high service pumps, and filters, but we have had success with different plant flow schemes.

Florida ground waters often contain objectionable taste and odor compounds. Many of these can be treated with hydrogen peroxide. In a study conducted in the late 1980's[4], hydrogen peroxide was equally or more effective than potassium permanganate ($KMnO_4$) for the removal of various taste and odor compounds.

### 1.5 ~ Hydrogen Peroxide use is uncommon in Florida.

Use of hydrogen peroxide as an oxidant or pre-oxidant is fairly uncommon in Florida. Here is a list of systems that FRWA has assisted, engineered, and permitted with Hydrogen Peroxide to lower DBPs and improve water quality.

1. Okeechobee Youth Development Center (PWS 4470472)
    - Quinn Campbell, Superintendent, (863) 763-2174, quinn.campbell@djj.state.fl.us
2. City of Perry (PWS: 2620208)
    - Philip Maddox or Chester McAfee, (850) 838-2326, wtp2@fairpoint.net

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[3] Assumes that the total oxidized impurities are about 10 mg/L

[4] Evaluating Oxidants for the Removal of Model Taste and Odor Compounds from a Municipal Water Supply",W.H. Glaze, R. Shep, W. Chauncey, E.C. Ruth, J.J. Zarnoch, E.M. Aieta, C.H. Tate, and M.J. McGuire, Journal of AWWA, May 1990.

3. High Springs, City of (2010201)
    - Edwrin Booth or Rodney Hoffman, (386) 454-1416 or (386) 454-2134, ebooth@highsprings.us
4. Eastpoint Water & Sewer District (1190236)
    - Billy Fuentes, Office Manager, 850-670-8177, epwsd.1@gmail.com
5. Inlet Beach Water System, Inc. (PWS: 1660370)
    - Robin Hayes or Carol Anderson, (850) 231-4498, IBWS@mchsi.com
6. First Baptist Church Dowling Park, Iron Filter & $H_2O_2$ (PWS: 2614257)
    - Pastor Shawn Johnson, (386) 658-2360 / Cell: (386) 249-1359, fbcdp@hotmail.com, or kpert1@hotmail.com
7. Hidden Acres Estates Water System, GAC Filters & $H_2O_2$ (PWS: 5280129)
    - James Rowland, President, (863) 763-8266, shortutility@embarqmail.com
8. Parry Village MHP, GAC Filters & $H_2O_2$ (PWS: 4501075)
    - Frank Dunn, (561) 236-5553, dunnfj@hotmail.com
9. Bratt-Davisville Water System, Inc. Jar Test (PWS: 1170085)
    - Wesley Scott, Manager of Corporate Services, (850) 675-4521, wesley@erec.com
10. Big Bend Water Authority (fka Steinhatchee Water Assn., Inc.) 2621102
    - Mark Reblin, General Manager, 352-498-3576, bbwa@bellsouth.net, mreblin@msn.com
11. Carrabelle, City of (1190118)
    - Keith Mock, Water Superintendent, 850-697-3618, cbelwwtp@gtcom.net
12. East Marion Utilities, LLC (aka Lakeview Woods/ Trails East Subd) 3424789
    - Mike Smallridge, (352) 302-7406, mike@fus1llc.com

## 1.6 ~ Examples of Hydrogen Peroxide Results.

FRWA designed the Hydrogen Peroxide system for Okeechobee Youth Development Center, see results attached. The system includes liquid hydrogen peroxide (30% $H_2O_2$), multi-media filters, greatly lowered water age, lower chlorine feed rates, poly/orthophosphate, and chloramines, see Figure 1 below. Please note the reduction in DBPs using a combination of best available technology and treatment changes. TTHMs dropped from 220 µg/L to **18 µg/L** and HAA5s dropped from 70 µg/L to **10 µg/L**.

The Okeechobee Youth Development Center system startup was Jan 12, 2013. Peroxide is demonstrated as an effective and inexpensive alternative to chlorination as a chemical preoxidant for iron, sulfur, manganese, organics, and other secondary/ aesthetic impurities.

River Grove Mobile Home Village has been using $H_2O_2$ since 2009 to reduce $H_2S$, Fe & DBPs with mixed success, see Figure 2. The system initially saw a reduction in chlorine demand to less that 20% of its original dose with a comparable disinfection by-product reduction of 80%. They have experienced problems with maintaining a chlorine residual because of over feeding $H_2O_2$ and frequently need to replenish the carbon in the GAC filters.

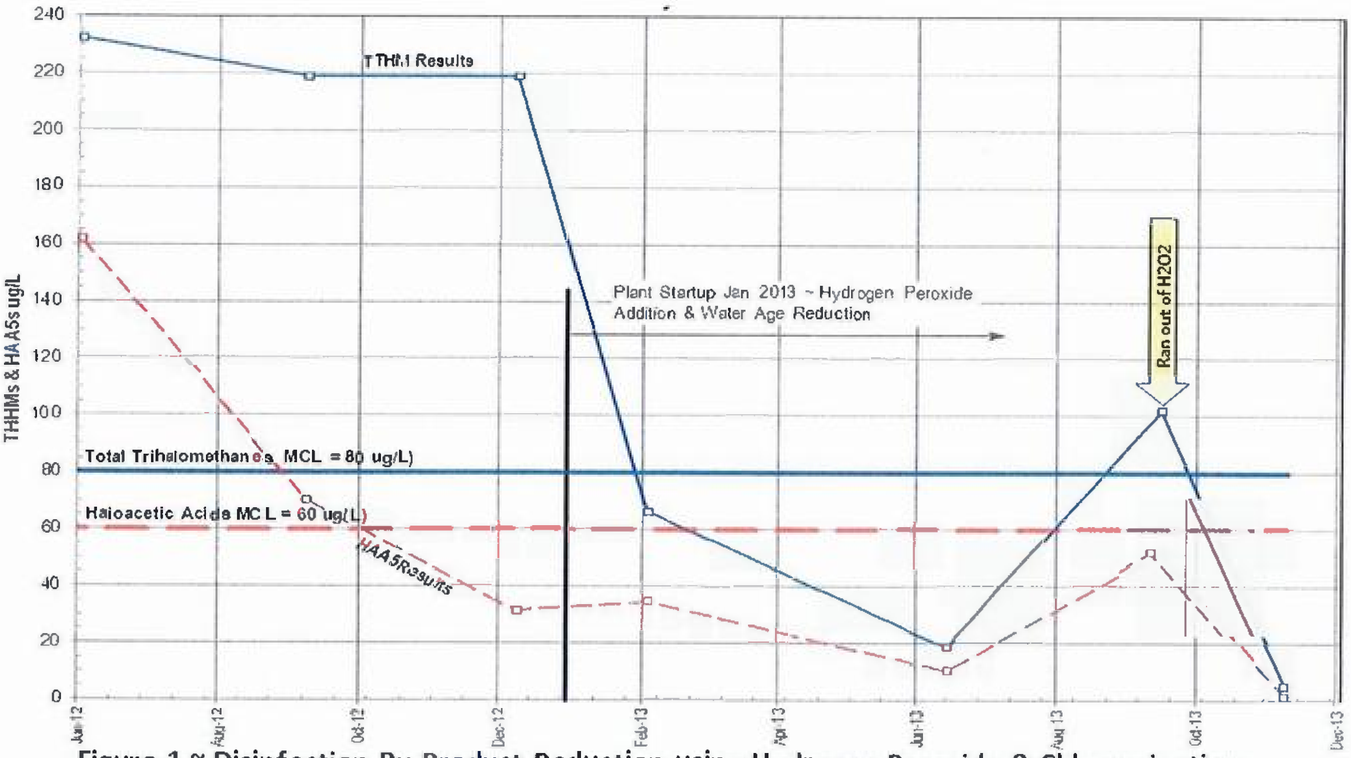

Figure 1 ~ Disinfection By-Product Reduction using Hydrogen Peroxide & Chloramination
Okeechobee Youth Development Center

During the third quarter of 2013 the operator ran out of hydrogen peroxide and ammonia.

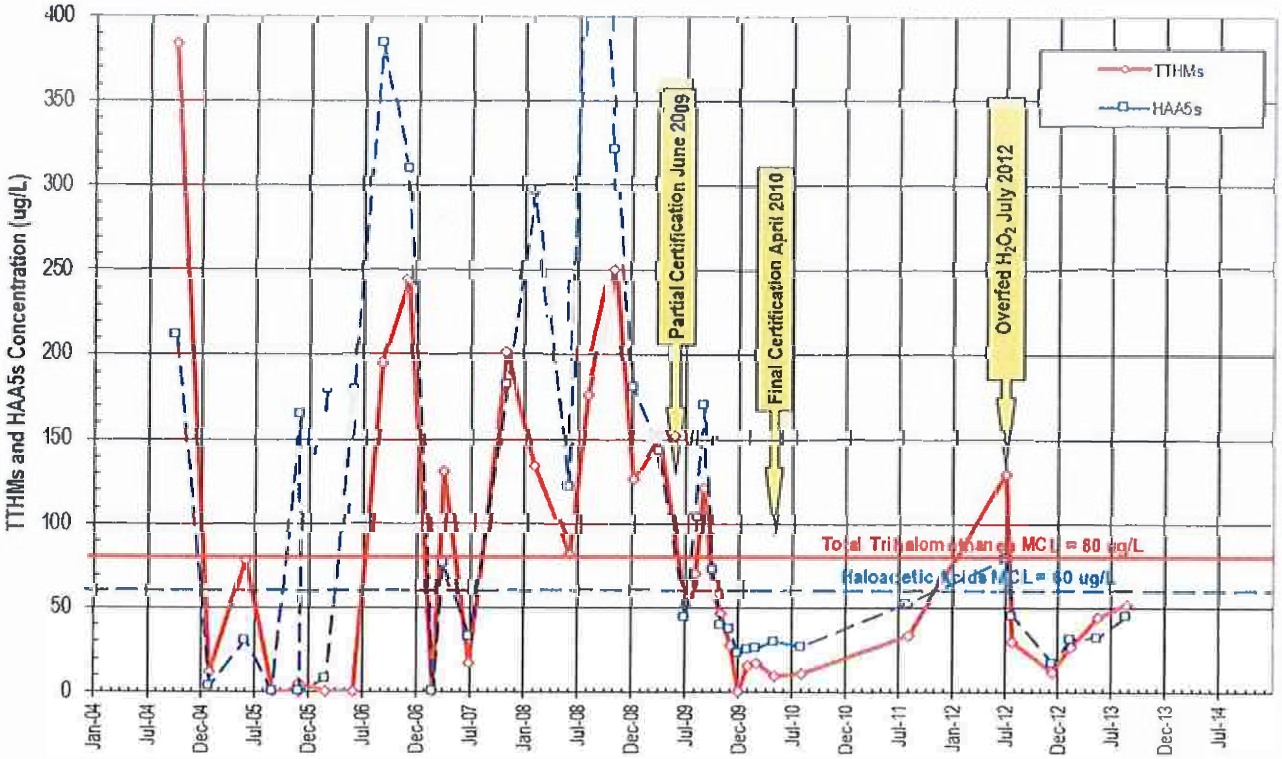

Figure 2 ~ Disinfection By-Product Reduction using Hydrogen Peroxide
River Grove Mobile Home Village

Partial Certification June 2009, Final Certification April 2010, Overfed H2O2 July 2012, plus GAC filters needed replenishing

Hydrogen peroxide is a de-chlorinating agent so dosing of $H_2O_2$ must be carefully controlled or the system will have problems with maintaining a chlorine residual.

### 1.7 ~ Hydrogen Sulfide Treatment using Hydrogen Peroxide.

Hydrogen sulfide reacts with oxidants such as chlorine ($Cl_2$), ozone ($O_3$), chlorine dioxide ($ClO_2$) and hydrogen peroxide ($H_2O_2$) to form polysulfides ($HS_m$) and hydrogen polysulfide ($H_2S_m$).[5] The formation of polysulfides is unavoidable under pH of 9.[6] These compounds can cause a milky blue suspension of colloidal sulfur getting a "musty or earthy" taste or an odor similar to a rubber tire and a taste similar to drinking from a rubber garden hose.

Polysulfides tend to complex with metals in the water and distribution system leading to the formation of blackwater. This odor may not become apparent until the water is heated and the polysulfide odor is released.

Few systems actually attempt to reduce polysulfides because the treatment scheme involves oxidation and the addition of sulfur dioxide ($SO_2$). The sulfur dioxide promotes the conversion of polysulfides and elemental sulfur to thiosulfate. Oxidation of sulfides in the treatment process is extremely important in the removal of iron and manganese.

The following factors affect peroxide effectiveness:

- At pH above 7.6 pH iron, manganese, calcium and sulfur ions are not readily available for oxidation.
- Free elemental iron, manganese, calcium, sulfur, etc. (minerals) are first oxidized. Hard waters have a higher oxidation demand and reduce effectiveness of treatment.
- If the source water is high in humic or naturally occurring organic matter, elemental components such as iron, manganese, sulfur, etc. are not easily oxidized. The organic complexes must be oxidized / reduced before the oxidant can effectively oxidize the minerals.
- Sulfide and iron oxidation must be complete or taste and odor problems will persist in the distribution system.
- Even with the use of hydrogen peroxide a small dose of chlorine is recommended for water storage tanks on the water treatment plant site to control bacterial regrowth.
- Chlorine is still required for finished water disinfection. An excess of **0.5 mg/L of oxidant (chlorine) is recommended** in finished water storage and distribution system to inhibit any growth of sulfur bacteria.

During a literature search, we were unable to find a system or text that recommended coagulation, flocculation, or filtration to remove elemental sulfur formed by aeration and/or chemical oxidation. Sulfide concentrations at 1 mg/L with flows of 1.0 MGD produce less than eight (8) pounds of elemental sulfur daily – this amount varies by pH. This elemental sulfur flows into the distribution system with or without peroxide treatment.

In a July 2010 Florida Water Resources Journal article entitled *"Innovative Hydrogen Sulfide Treatment*

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[5] See http://www.filtronics.com/literature/technical/electromedia-systems/em-1-technical.pdf, p 6.

[6] Water Treatment: Principles and Design, Second Edition/ MWH. (2005) revised by John Critienden, et al, pp. 512-513.

*Methods: Moving Beyond Packed Tower Aeration"* [7] several options were discussed – including hydrogen peroxide.

> *"For conversion of hydrogen sulfide to sulfate using hydrogen peroxide oxidation, a stoichiometric ratio of 4.0 to 1.0 is required for water having a pH greater than 8.0 units, but the treatment method has not been demonstrated effectively for treatment of hydrogen sulfide in groundwater. Approximately 12.4 mg/L of potassium permanganate is required to oxidize 1.0 mg/L of hydrogen sulfide. Both peroxide and permanganate have been shown to provide complete removal of sulfide but yield both sulfate and colloidal sulfur as reaction products (Dohnalek 1983)."* [8] [emphasis added]

In the article the stoichiometric ratio hydrogen peroxide dose for the oxidation of sulfide is 0.25 mg $H_2O_2$ / mg $H_2S$ for water having a pH greater than 8.0 units. According to MWH *"Water Treatment Principles and Design"*[9] the required hydrogen peroxide dose for the oxidation of sulfide is 1.0 mg $H_2O_2$ / mg $H_2S$. The higher dose tends to match what we observed during jar tests.

We assume that the intention of the comment *"hydrogen peroxide oxidation... has not been demonstrated effectively for treatment of hydrogen sulfide in groundwater,"* is to urge for more research and experimentation, not to rule out peroxide as a viable option. While it may be undemanding on the designer to choose a treatment scheme based on frequency of use or even relative popularity this is not a reason to exclude unusual methods from consideration.

It still remains important to demonstrate the peroxide treatment scheme's effectiveness to each raw water application. Chemistries of raw waters vary from source to source. Water treatment chemistries and reactions are complex. As a consequence jar testing and chemical analysis of the raw water are essential to the decision making process. Selecting an appropriate treatment scheme must include all of these factors.

The Florida Water Resources Journal article evaluates the advantage and disadvantages of hydrogen peroxide as well as other treatment schemes.

**Treatment by Hydrogen Peroxide** [10]

| Advantages | Disadvantages |
|---|---|
| 1. Controllable process | 1. Optimum mixing and long reaction/ contact times |
| 2. Inexpensive capital installation | 2. Incomplete oxidation |
| 3. Inexpensive chemical cost | 3. Large dosages needed |
| | 4. Turbidity– requires filtration |

The four listed disadvantages are not a ringing endorsement for hydrogen peroxide use. We agree with the first two listed disadvantages.

First, the reaction/ contact time is in the range of 20 to 30 minutes.

Second, oxidation is dependent on pH, the LOWER the pH the better oxidation result. There is a strong

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[7] Duranceau,S.J., Trupiano, V.M., Lowenstine, M. Whidden, S., and Hopp, J. (July 2010) "Innovative Hydrogen Sulfide Treatment Methods: Moving Beyond Packed Tower Aeration." *Florida Water Resources Journal*, pp. 4-12

[8] ibid. p.12

[9] MWH, Crittenden, J., Trussell, R., Hand, D., Howe, K., and Tchobanoglous, G. (2005) *Water Treatment: Principles and Design, 2nd Edition*, John Wiley & Sons, New York. pp. 552-553.

[10] Duranceau, et. al. p.10

relationship between pH and the three species of sulfur (hydrogen sulfide gas [$H_2S$], bisulfide [$HS1^-$], and elemental sulfur [$S_2$]). The pH of the raw water is a vital factor in the treatment of raw water. At the neutral pH of 7.0 half of the dissolved sulfide species is hydrogen sulfide (gas) and the other half is bisulfide – typical for most of Florida's ground waters. So removal by peroxide is dependent on pH, see Figure 3.

The third and fourth listed disadvantages did not hold up to jar testing.

Third, peroxide dosage is low – usually less than 5 mg/L.

Fourth, typically the resulting turbidity is marginally raised (about 10%) using peroxide feed rates under 4 mg/L; even considering the formation of micro-bubbles produced by the peroxide reaction.

Hydrogen sulfide gas is frequently found in groundwater that contains iron and manganese. It is easily identified by its "rotten egg" odor. In addition to causing serious taste and odor problems, sulfide also promotes the growth of sulfur bacteria.[11]

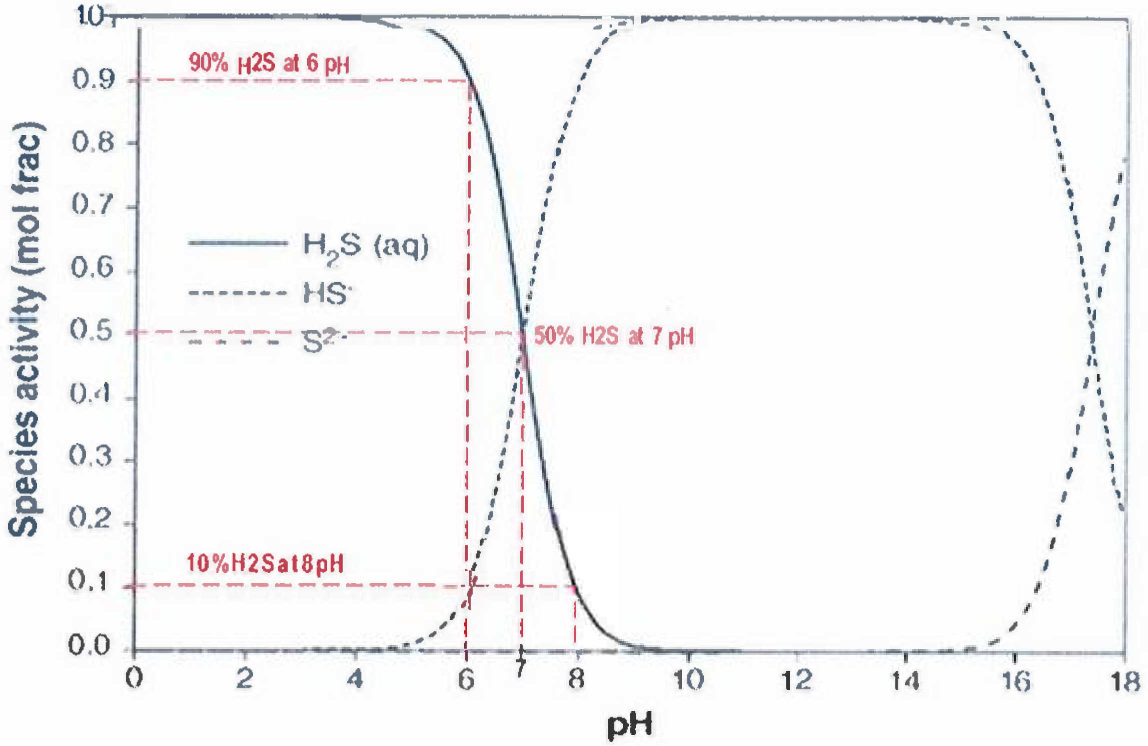

Figure 3 ~ Sulfide Species Distribution by pH Diagram[12]

Standard treatment for hydrogen sulfide has been aeration and degasification or oxidation with chlorine to form elemental sulfur. Hydrogen sulfide reacts with most oxidants such as chlorine, ozone, chlorine dioxide, and peroxide to form polysulfides ($HS_m$) and hydrogen polysulfide ($H_2S_m$). These compounds cause a milky blue suspension of colloidal sulfur getting a "musty or earthy" taste or an odor similar to a rubber tire and a taste similar to drinking from a rubber garden hose. This odor may not become apparent until the water is heated and the polysulfide odor is released.

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[11] Iron and Manganese Filtration Systems, Filtronics, http://www.filtronics.com/literature/technical/electromedia-systems/em-1-technical.pdf

[12] Sawyer, et. al. Parkin, G.F. (2003) Chemistry for Environmental Engineering and Science, 5th Ed, McGraw-Hill, New York, pp. 476-481

Hydrogen peroxide, potassium permanganate and chlorine can form colloidal sulfur – a milky blue suspension or the Tyndall Effect. The Tyndall Effect occurs when light is scattered by colloidal particles suspended in water that intensifies blue light waves over other colors, see figure 4 below. All chemical oxidizers listed above require excess oxidizer and a basic pH to avoid colloidal sulfur formation/ Tyndall Effect.

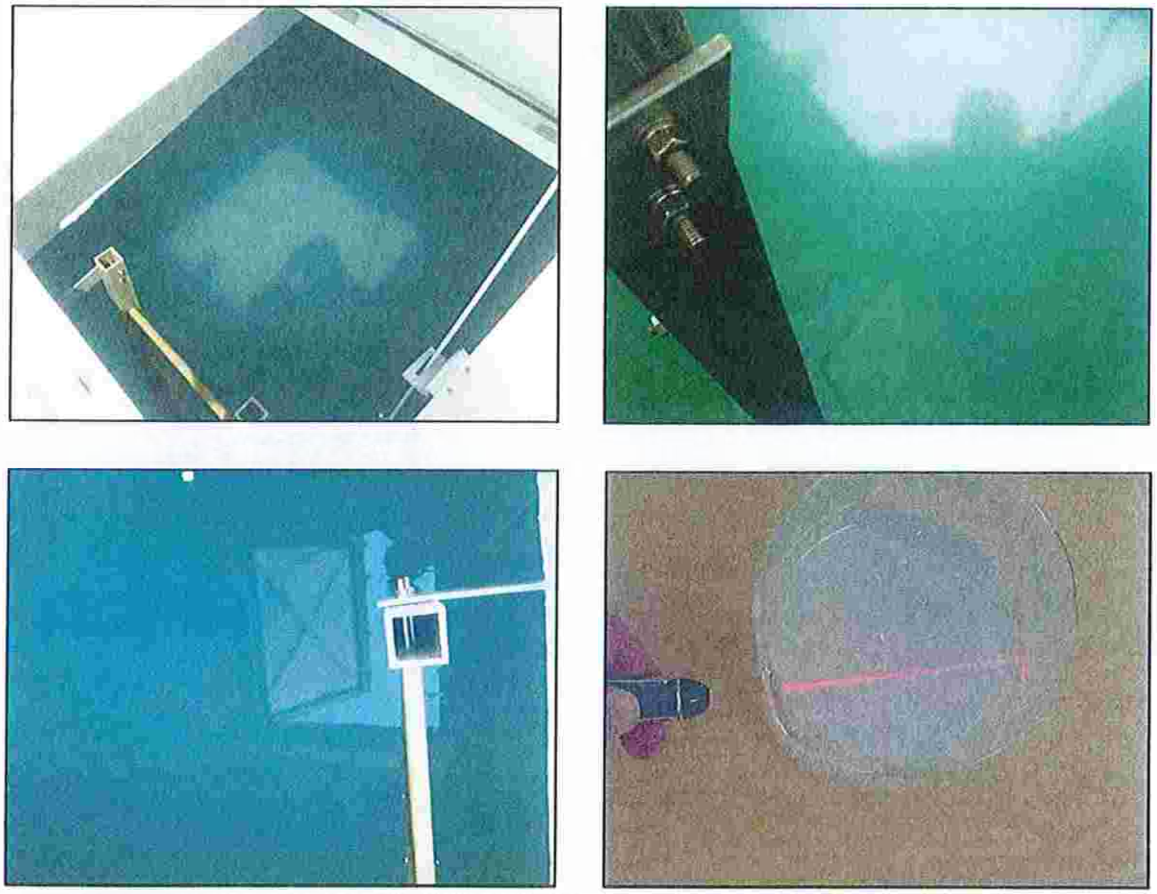


**Figure 4 ~ Colloidal Sulfur Formation / Tyndall Effect**

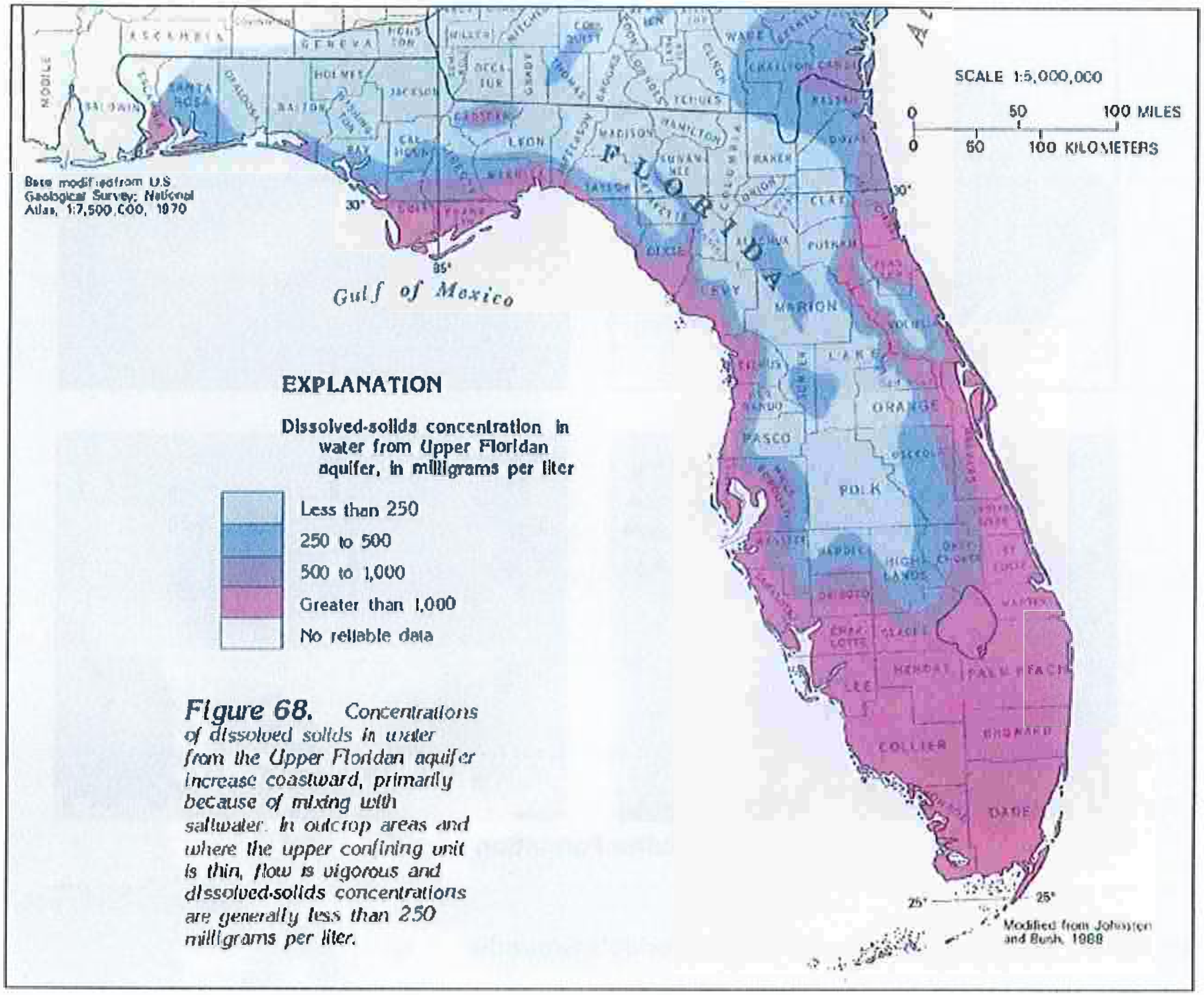
**1.8 ~ Sulfide, Iron, and TOC are common in Florida's Groundwaters.**

Hydrogen sulfide, iron, and total organic carbon (TOC) are much more common in groundwater supplies throughout Florida than the rest of the United States. Figure 5 above shows areas with high total dissolved solids. There is a strong correlation of groundwaters having high total dissolved solids and those with high sulfide, iron, and total organic carbon.

High dissolved-solids concentrations in the Floridan aquifer system are related to: (1) the ground-water flow system, and (2) the proximity to saltwater. In places where the aquifer system is unconfined or thinly confined, ground-water flow is vigorous. Large volumes of water move quickly in and out of the aquifer system, and dissolved-solids concentrations are minimal.

Areas with high dissolved-solids concentrations are near the east and west coasts of Florida. In western panhandle Florida and in the southern one-third of the State, large concentrations of dissolved solids result from the ground water mixing with residual saltwater that a sluggish flow system has left unflushed from the aquifer. The band of large dissolved-solids concentrations along the St. Johns River in east-central Florida likewise reflects unflushed, residual saltwater.

When hydrogen sulfide, iron, and total organic carbon levels are high this usually results in discolored water, laundry, and plumbing fixtures. This, in turn, results in consumer complaints and a general dissatisfaction with the water utility.



Base modified from U.S. Geological Survey, National Atlas, 1:7,500,000, 1970

Modified from Johnston and Bush, 1988

**EXPLANATION**

**Dissolved-solids concentration in water from Upper Floridan aquifer, in milligrams per liter**

- Less than 250
- 250 to 500
- 500 to 1,000
- Greater than 1,000
- No reliable data

***Figure 68.*** *Concentrations of dissolved solids in water from the Upper Floridan aquifer increase coastward, primarily because of mixing with saltwater. In outcrop areas and where the upper confining unit is thin, flow is vigorous and dissolved-solids concentrations are generally less than 250 milligrams per liter.*

Figure 5 ~ Groundwaters in Florida with High Total Dissolved Solids[13]

## 1.8 ~ Total Organic Carbon & Tannins.

There are no water quality standards for Total Organic Carbons (TOCs), however there are secondary/ aesthetic MCLs for color and odor which are related to TOCs. More importantly Total Organic Carbons are precursors to Disinfection By-Products – the DBPs have a Primary Drinking Water Standards and accounted for over 43% of ALL FDEP compliance violations for 2013.

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[13] From the USGS, Ground Water Atlas of the United States, Alabama, Florida, Georgia, South Carolina, HA 730-G. see http://pubs.usgs.gov/ha/ha730/ch_g/G-text6.html and http://pubs.usgs.gov/ha/ha730/ch_g/jpeg/G068.jpeg

Tannin chemistry is complex, not well understood, and varies from site to site. Tannins comprise a broad family of organic compounds leached from the decomposition of plants, leaves and humus materials. Tannins are believed to be a natural plant defense against plant predators (i.e. insects, birds, pests) and inhibits microbial attack – this is a reason it is so persistent in the environment.

There are two major families of tannins: Hydrolysable and Condensed.

- Hydrolysable tannins are very soluble and easily broken down by water treatment processes – hydrolyzed by weak acids or weak bases to produce carbohydrate and phenolic acids.
- Condensed tannins are the tough guys (proanthocyanidins) mostly soluble – polymers of 2 to 50 (or more) flavonoid units that are joined by carbon-carbon bonds (these are hard to break), which are not susceptible to being cleaved by hydrolysis. Some very large condensed tannins are insoluble.

Floridian waters are uniquely hard to treat because of complex tannin chemistries, varying admixtures of background elements, and pH. FRWA has postulated that iron, manganese, and other metals are commonly tied up with organic molecules – resulting in Florida's high levels of disinfection by-products.

### 1.9 ~ TOCs and Disinfection By-Products.

Numerous studies have been conducted that illustrate the reaction of chlorine with organic material. In Figure 6 we can also see that the formation of Total Trihalomethanes (TTHMs) rises significantly with high concentrations of TOC that are typically found. Also note that the formation of Haloacetic Acids(HAA5) do not increase as rapidly as organic carbon concentration increases.

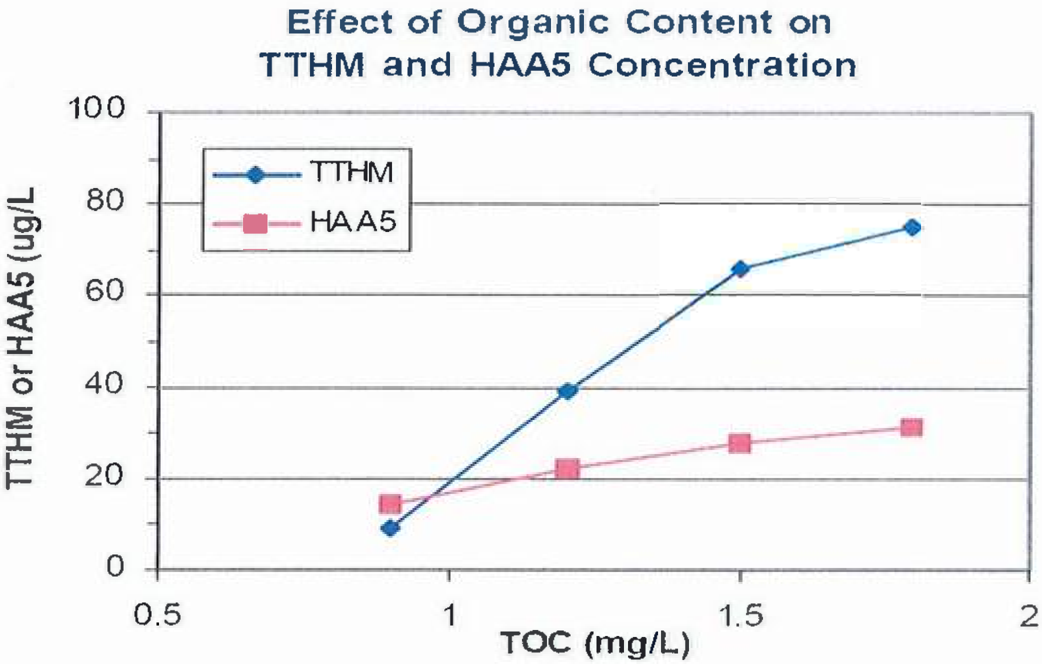

**Figure 6 ~ Effect of Organic Content on TTHM and HAA5 Concentration[14]**

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[14] US EPA. (2003). *"Stage 2 Disinfectants and Disinfection Byproducts Rule, Significant Excursion Guidance Manual."* Quoted source A. Franchi and C. Hill (2002) chlorine dose 4.3 mg/L. EPA Document 815-D-03-004. p 2-3. Franchi, A. and C. Hill. 2002. *Factors Affecting DBP Formation in the Distribution*

Most groundwaters contain less than 2 mg/L, although Florida is an exception to this rule, see Figure 7. In Florida, FRWA has seen groundwaters in the ranges of 12 to 15 mg/L. Surface water generally ranges from 1 to 20 mg/L, although as much as 300 mg/L have been reported for swamp and bog waters.

- Groundwater greater than 5 mg/L TOC exhibit significant DBP formation.
- When total organic carbon is less than 9 mg/L systems can meet the DBP MCLs by lowering water age, lowering chlorine feed, aggressive flushing, and installing automatic flushing valves.
- Even for systems with TOC greater than 12 mg/L FRWA has had success with chloramine treatment that also exhibit moderate hardness, iron and sulfides.
- Other treatment schemes are required above 9 mg/L TOC if the raw water is very hard or has high iron and/or sulfides.

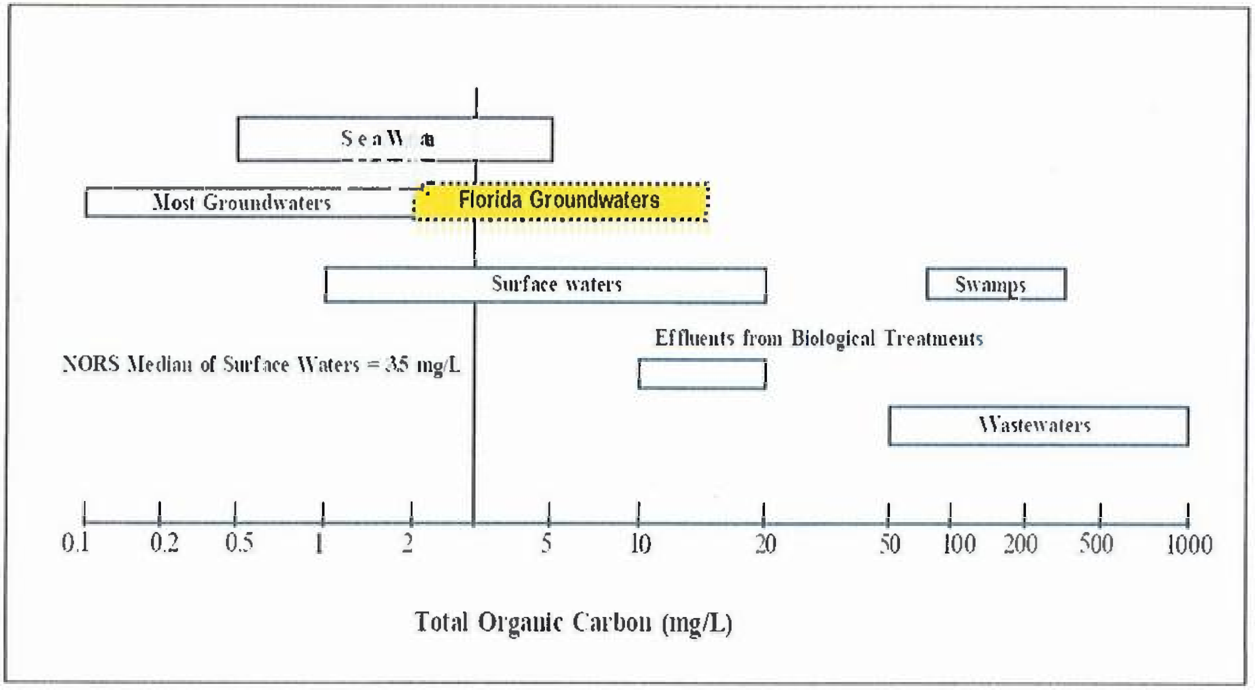

**Figure 7 ~ Typical Total Organic Carbon (TOC) Concentrations**[15]
The bar showing Florida's Groundwater TOCs is based on statewide FRWA experience

High Total Trihalomethanes are a result of water age and are heavily influenced by poor raw water quality and high chlorination. This is supported by our statewide experience with DBPs.

## 2.0 ~ Theory of Sulfide Removal using Hydrogen Peroxide.

According to MHW *"Water Treatment Principles and Design"*[16] the required hydrogen peroxide dose for the oxidation of sulfide is **1.0 mg $H_2O_2$ / mg $H_2S$** and the required hydrogen peroxide dose for the

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*System. Paper Presented at the Water Quality from Source To Tap,* AWWA Chesapeake Section Seminar.

[15] Kavanaugh, M. C., 1978. "Modified Coagulation for Improved Removal of THM Precursors." Journal AWWA, Vol. 70, No. 12, pp. 613 - 620.

[16] MWH, Crittenden, J., Trussell, R., Hand, D., Howe, K., and Tchobanoglous, G. (2005) *Water Treatment: Principles and Design, 2nd Edition,* John Wiley & Sons, New York. pp. 552-553.

oxidation of iron is **0.30 mg $H_2O_2$ / mg $Fe_2^+$**. The reaction between sulfides and hydrogen peroxide depends greatly on the pH and temperature of the raw water. The raw water is slightly alkaline, well buffered, pH is 7.6, and will tend to calcify.

The redox reactions are as follows:

$$\mathbf{H_2S + H_2O_2 \rightarrow S_0 + 2\ H_2O}$$

$$\mathbf{2\ Fe_2^+ + H_2O_2 + 2H^+ \rightarrow 2\ Fe^{3+} + 2\ H_2O}$$

The $H_2O_2$ Dosage Rates are estimated as follows.

$$H_2O_2 \text{ Dose for } H_2S = \frac{1.5 \text{ mg/L Sulfide x } 1.0 \text{ mg } H_2O_2}{\text{mg } H_2S} = 1.5 \text{ mg/L } H_2O_2$$

$$H_2O_2 \text{ Dose for } Fe_2^+ = \frac{0.62 \text{ mg/L } Fe_2^+ \text{ x } 0.3 \text{ mg } H_2O_2}{\text{mg } Fe^{2+}} = 0.186 \text{ mg/L } H_2O_2$$

So: **$H_2O_2$ Dose for $H_2S$ + $Fe_2^+$ = 1.69 mg/L $H_2O_2$**

To account for the oxidation effects of other constituents in the raw water the hydrogen peroxide dose should be increased by 50% until field conditions, ORP meter jar tests, or operations shows a lower dose is appropriate.

For this application we started with a 30% $H_2O_2$ dose between **3 to 4 mg/L $H_2O_2$**

## 2.1 ~ Monitoring of Hydrogen Peroxide.

Standard Methods[17] does not list procedures for measuring hydrogen peroxide. USEPA[18] suggests several methods for hydrogen peroxide analysis including: titration methods; colorimetric methods; and horseradish peroxidase methods – each with limited working range, varying accuracy and precision, operator skill level required, and possible interferences.

The Brenntag representative recommended the use of an ORP meter to measure oxidation-reduction potential. This would directly notify us when the oxidation process is complete during jar tests. The ORP millivolt reading of plus 400 MV demonstrates a true oxidant reaction. The literature states that the estimated reaction time for hydrogen peroxide to convert sulfide to elemental sulfur is in the range of 20 to 30 minutes and we'll try to provide for this reaction/ contact time within the water treatment plant. Since the resulting solids are almost negligible and will be filtered prior to the point of entry filtering and reaction time is not a primary design concern (as will be demonstrated by the jar tests).

FRWA recommends the use of a Field Test Kit for measuring $H_2O_2$ residuals sold by LaMotte, Hach, or CHEMetrics.

---

[17] APHA, AWWA, WEF. (1995). *"Standard Methods for the Examination of Water and Wastewater"* (Standard Methods), 19th edition, Washington, DC. Franson, et. Al. (editors). APHA (American Public Health Association), AWWA, and Water Environment Federation

[18] USEPA. (1999). Alternative Disinfectants and Oxidants Guidance Manual. p. 7-10.

## 2.2 ~ Sample Hydrogen Peroxide Feed Rate Calculations.

Calculate monthly hydrogen peroxide usage and storage needs assuming the Hydrogen Peroxide feed rate is approximately 4.0 mg/L $H_2O_2$. The hydrogen peroxide feed is proportional to raw water flow.

**Given:**

- Average Daily Demand (ADD) ..........................................50 gpm = 71,830 gpd
- Maximum Daily Demand (MDD) .......................................181 gpm = 260,850 gpd
- Well Pump Capacity@ 50 psi ...........................................250 gpm = 360,000 gpd

**Feed Rate** = ADD $_{MGD}$ x Hydrogen Peroxide $_{ppm}$ x Conversion Factor =

- Average Daily Demand (ADD)= 71,830 gpd = 0.0718 MGD
- 0.0718 MGD x 4.0 ppm x 8.34 lbs/gal = 2.40 lbs / day of $H_2O_2$
- Given: 30% $H_2O_2$ Solution (by weight) from Brenntag = 2.50 lb $H_2O_2$ / gallon

$$\text{ADD } H_2O_2 \text{ Usage} = \frac{2.40 \text{ lbs / day of } H_2O_2}{2.50 \text{ lb } H_2O_2 \text{ / gallon}} = \mathbf{0.96 \text{ gpd } H_2O_2 \text{ Solution}}$$

- However the actual dosage will have to be adjusted to account for oxidation of color, total organic carbon, and other oxidizable species in the raw water.
- 30 day storage of 30% Hydrogen Peroxide= **29 gallons per month.**
- 55 gallon drums cost about $550/drum (or $10 / gal). Deliveries come at 2 to 4 drums at a time. The estimated cost for peroxide is approximately **$290 per month= $3,500per year.**
- 55-gallon drum provides about **2 months storage.**

| Hydrogen Peroxide Feed Rate | Estimated Annual Chemical Costs |
|---|---|
| 2.0 mg/L $H_2O_2$ | $19 per year per 1,000 gpd |
| 3.0 mg/L $H_2O_2$ | $28 per year per 1,000 gpd |
| 4.0 mg/L $H_2O_2$ | $37 per year per 1,000 gpd |
| 5.0 mg/L $H_2O_2$ | $46 per year per 1,000 gpd |

**Calculate Feed Rates for Well Pump Capacity:**

- Assuming well pump runs all day to obtain feed pump setting
- Feed Rate= WellPump $_{MGD}$ x Hydrogen Peroxide $_{ppm}$ x Conversion Factor
- Feed Rate= 0.360 MGD x 4 mg/L x 8.34 lbs/gal = **12.0 lbs/day of $H_2O_2$**

$$H_2O_2 \text{ Usage} = \frac{12.0 \text{ lbs / day of } H_2O_2}{2.50 \text{ lb } H_2O_2 \text{ / gallon}} = \mathbf{4.80 \text{ gpd } H_2O_2 \text{ Solution}}$$

**Initial Feed Pump Setting**

- System will furnish and install a positive displacement, peristaltic-metering pump for chemical feed
- Stenner Chemical Feed Pumps Model:

45MHP2 = 3 gpd @ 100 psi

45MHP10 = 10 gpd @ 100 psi ←**Use this pump**

45MHP22 = 22 gpd@ 100 psi

$$\text{Feed Pump Setting(\%)} = \frac{\text{4.80 gpd of } H_2O_2 \text{ Solution}}{\text{10 gpd Stenner Pump}} = \textbf{48\% Pump Setting}$$

**Hydrogen Peroxide Installation** includes (1) 45MHP10 = 10 gpd with 55-gal Drum of 30% Hydrogen Peroxide. Approximately $1,500 for initial installation.

### 3.0 ~ Placid Lakes Utilities.

### 3.1 ~ The Problem.

In disinfection, gaseous chlorine ($Cl_2$) is added to and reacts with, water to form hypochlorous acid. Hypochlorous acid forms a strong oxidizing agent and reacts with a wide variety of compounds, which is why it is such an effective disinfectant. The problem is that hypochlorous acid also reacts with naturally occurring organic and inorganic matter to create many water disinfection byproducts, like trihalomethanes (TTHMs) and haloacetic acids (HAAs).

Overall, the raw water quality is fairly good. See test results shown below:

| | Well #1 | Well#2 | Well#3 |
|---|---|---|---|
| Temperature | 24.6°C | 24.8°C | 25.4°C |
| pH | 7.85 | 7.86 | 7.82 |
| Conductivity | 123 | 123 | 126 |
| Total Organic Carbon (TOC) | 1.3 | 1.1 | 1.1 |
| Alkalinity | 140 | 144 | 146 |
| Total Dissolved Solids (TDS) | 80 | 80 | 82 |
| Sulfate | 5.4 | 6.2 | 2.0 |
| Sulfide | 1.0 | 1.0 | 0.5 |
| Iron | 0.04 | 0.04 | 0.14 |

Residual chlorine and other disinfectants may also react further within the distribution system, both by further reactions with dissolved natural organic matter and with biofilms present in the pipes. In addition to being highly influenced by the types of organic and inorganic matter in the source water, the different species and concentrations of DBPs vary according to the type of disinfectant used, the dose of disinfectant, the concentration of natural organic matter, water age, temperature, and pH of the water.

Studies have looked at the association between exposure to DBPs in drinking water with cancers, adverse birth outcomes and birth defects. As a result, the maximum contaminant has been set by the United States Environmental Protection Agency (EPA). The level for TTHMs has been set at 80 micrograms per liter and the level for HAAs has been set at 60 micrograms per liter.

### 3.2 ~ Historical Results

As shown in figure 8 below, Placid Lakes Utilities has been having problems with both TTHMs and HAAs for the last several years. Exceedances are attributed to the types of organic and inorganic matter in the source water. Water age is also a contributing factor. The water age is just over one day before leaving the plant. TTHMs and HAAs are at elevated levels before even before entering the distribution system.

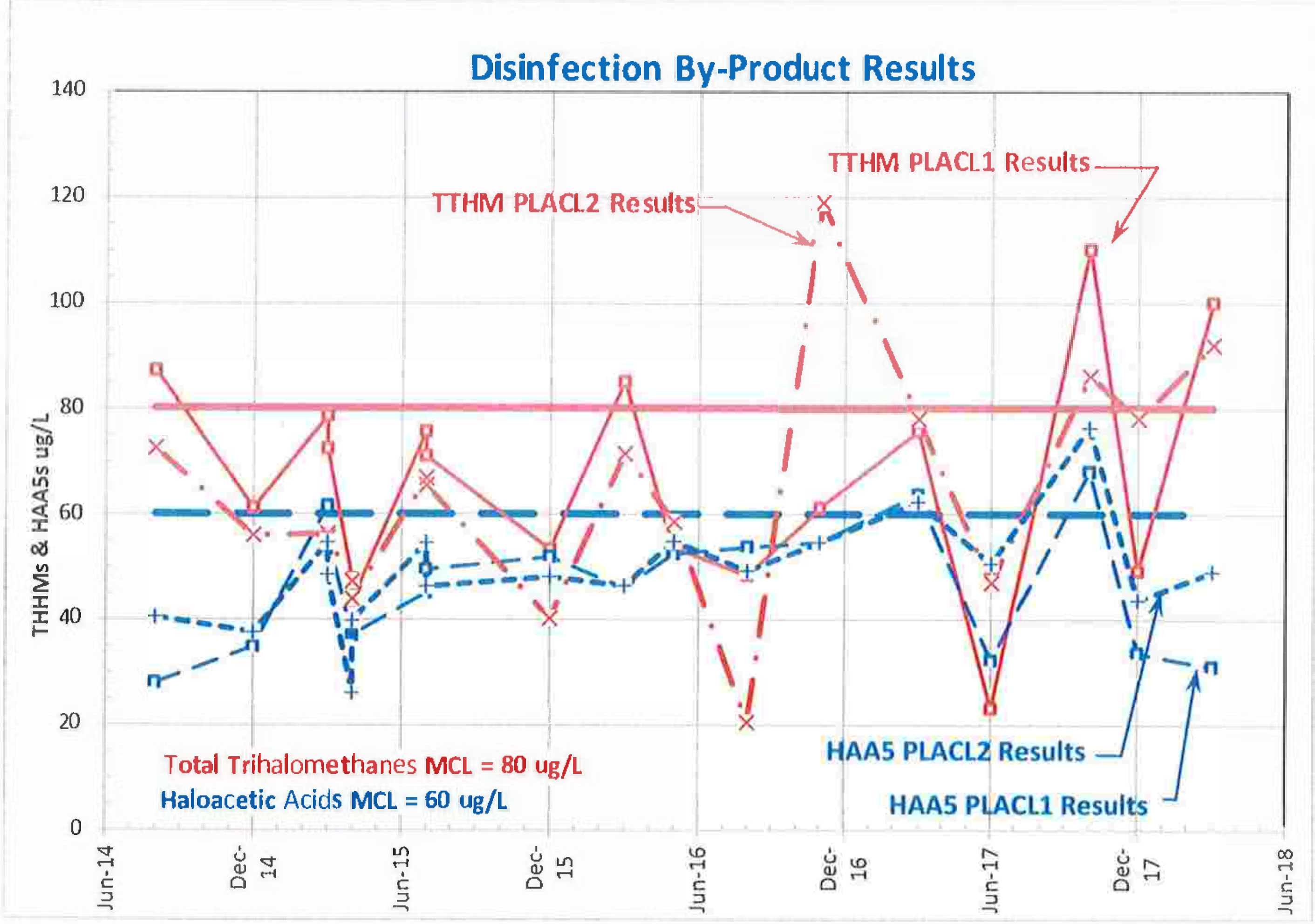


Figure 8 ~ Placid Lakes Utilities, Inc. Disinfection By-Product Results

### 3.1 ~ Jar Test Results.

The raw water is slightly alkaline, well buffered, pH is 7.8, and will tend to calcify. There is a slight sulfur odor initially but after about 2 minutes the smell has dissipated. There is also trace amounts of iron.

The required hydrogen peroxide dose for the oxidation of sulfide is 1.0 mg $H_2O_2$ / mg $H_2S$ and the required hydrogen peroxide dose for the oxidation of iron is 0.30 mg $H_2O_2$ / mg Fe2+. The reaction between sulfides and hydrogen peroxide depends greatly on the pH and temperature of the raw water.

Based on the jar test results, see tab 2.3, the dosage for the sulfide and iron in the water is 1.04 mgl/l. To account for the oxidation effects of other constituents in the raw water the hydrogen peroxide dose should be increased by 50% (or even doubled) until field conditions or operations shows a lower dose is appropriate.

### 3.2 ~ Recommendation

Hydrogen peroxide is an alternative oxidant (see tab 2.4 FRWA Recommended Treatment Techniques) that can be substituted for chlorine for pre-chlorination and thus minimize the formation of disinfection by-products within the water treatment plant. See Figure 9 for a drawing of the proposed changes. The injection point for hydrogen peroxide should be located in the existing junction box at a point where all three wells join together prior to entering the storage tanks. The chlorine and ortho/polyphosphate should have new lines run to a new junction box located to a point just prior to entry into the distribution system. By using hydrogen peroxide and moving the chlorine feed point other systems using this process have been able to reduce their chlorine injection by 33%-50%.

Dosing should be as follows:

Hydrogen Peroxide $H_2O_2$.

a. It is recommended that the initial dosing be 2.00 mg/l. This equates to feed rate of 4.84 lbs/day of $H_2O_2$.
b. Use a 35% $H_2O_2$ solution from Dumont. This equates to 1.44 gpd of $H_2O_2$ solution.
c. System to install a positive displacement, peristaltic-metering pump for chemical feed.
d. Use a Stenner Chemical Feed Pump Model: 85MHP17 #2
e. Use a feed pump setting(%): 23.1%

Chlorine $Cl_2$: Cut initial chlorine feed rate by 33% to prevent over dosing. Test results may dictate even lower settings.

Ortho/polyphosphate – no change to dosage.

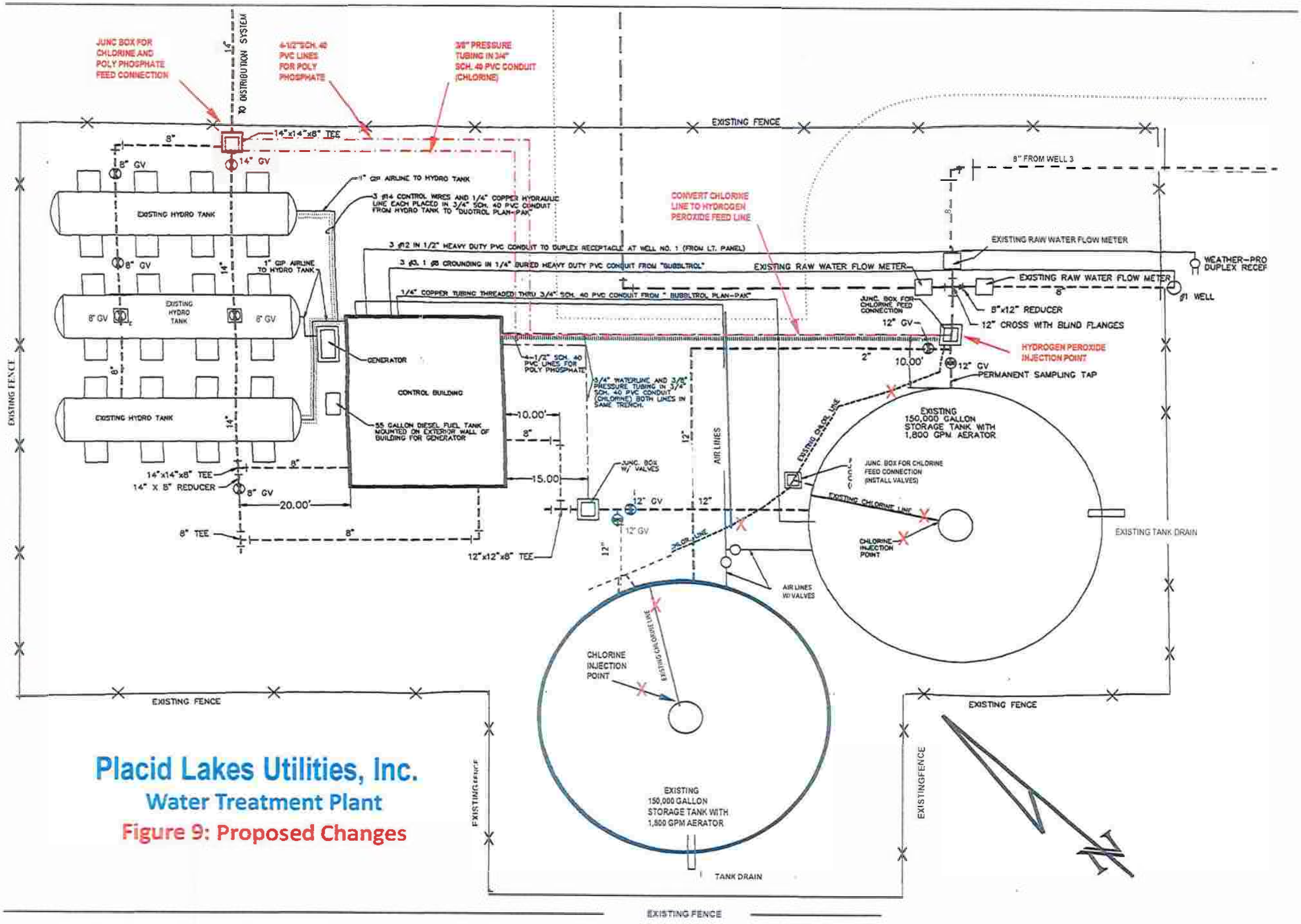
### 3.3 ~ Procedures for Bringing Hydrogen Peroxide System Online

1. Flush the peroxide, chlorine, and ortho/polyphosphate feed systems, pump lines, valves and fittings before putting them into service.
2. Disinfect the peroxide, chlorine, and ortho/polyphosphate feed systems, pump, lines, valves, and fittings prior to connecting to the existing system.
3. Take two (2) bacteriological samples on consecutive days at the point of connection (or finished water sampling tap) to determine if the system is clean to operate.
4. Send the bacteriological results to FDEP and FRWA.
5. Mark up (redline) the design drawings to show how the improvements were built (as-builts) –

show any changes that were made during construction. *Note which were installed and those that were not!*

6. Please take at least 12 photographs of the installed feed system and send a CD, flash drive, or email the photos.
7. Send the Final Certification of Construction in 3 places (see enclosure 3).
8. Please send the original Final Certification form back to me and attach:
    a. Copies of the as-built drawings
    b. Photo CD/flash drive or email photos
    c. Bacteriological Results
    d. Final Certification form
9. I will then prepare a Final Certification to FDEP to obtain clearance and gain approval to put system into service

Myself and FRWA will work closely with Placid Lakes Utilities to ensure proper installation and dosing setup.



Placid Lakes Utilities, Inc.

Water Treatment Plant

Figure 9: Proposed Changes

# ENCLOSURE ~ 2.3

## Jar Tests

# Hydrogen Peroxide
# JAR TEST

*FRWA Member:* **Placid Lakes Utilities**

Address: 410 Washington Blvd
Lake Placid, FL 33852

Telephone: (863)465-0345

County: Highlands

Date: **July 13, 2018**

Contact: Nathan Brewer

E-mail: ndbrewer@embarqmail.com

Population: 4,100

Connections: 1,800

PWS: **6280223**

Capacity: **1.104 MGD**

Prepared by: ***Stan Epperly***

**Florida Rural Water Association**

2970 Wellington Circle
Tallahassee, Florida 32309-6885
Phone: 850-668-2746

## Florida Rural Water Association

Member: Placid Lakes Utilities
Contact: Nathan Brewer
By: Stan Epperly

Date: 13-Jul-18
PWS: 6280223
County: Highlands

## Hydrogen Peroxide Jar Tests

Sulfides= 1.000 mg/L
pH= 7.85-7.86-7.82
Iron= 0.04-0.04-0.14
5 - 10 minutes contact time

| Jar | Jar Volume (L) | $H_2O_2$ Dose (mg/L) | Standard $H_2O_2$ Solution (mL) | $H_2O_2$ Residual (mg/L) | Beginning Odor | Ending Odor |
|---|---|---|---|---|---|---|
| | | | **Well# 1** | | | **30 seconds** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | YES | YES |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | YES | YES |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | | YES | NO |
| | | | **Well# 1** | | | **2 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | YES | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | YES | NO |
| 3 | 1 L | 1.10mg/L | 3.0 mL | | NO | NO |
| | | | **Well# 1** | | | **5 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | 0.15 mg/L | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | 0.50 mg/L | NO | NO |
| 3 | 1 L | 1.10mg/L | 3.0 mL | 0.60 mg/L | NO | NO |
| | | | **Well# 1** | | | **10 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | 0.10mg/L | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | 0.25 mg/L | NO | NO |
| 3 | 1 L | 1.10mg/L | 3.0 mL | | NO | NO |
| | | | **Well# 1** | | | **15 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | NO | NO |
| 3 | 1 L | 1.10mg/L | 3.0 mL | | NO | NO |
| | | | **Well# 2** | | | **30 seconds** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | YES | YES |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | YES | YES |
| 3 | 1 L | 1.10mg/L | 3.0 mL | | YES | NO |
| | | | **Well# 2** | | | **2 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | YES | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | YES | NO |
| 3 | 1 L | 1.10mg/L | 3.0 mL | | NO | NO |
| | | | **Well# 2** | | | **5 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | 0.10 mg/L | YES | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | 0.40 mg/L | NO | NO |
| 3 | 1 L | 1.10mg/L | 3.0 mL | 0.60 mg/L | NO | NO |
| | | | **Well# 2** | | | **10 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | 0.05 mg/L | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | 0.15 mg/L | NO | NO |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | | NO | NO |
| | | | **Well# 2** | | | **15 minutes** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | NO | NO |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | | NO | NO |
| | | | **Well # 3** | | | **30 seconds** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | YES | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | YES | NO |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | | YES | NO |
| | | | **Well # 3** | | | **2 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | 0.20 mg/L | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | 0.40 mg/L | NO | NO |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | 0.70 mg/L | NO | NO |
| | | | **Well # 3** | | | **5 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | 0.10 mg/L | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | 0.30 mg/L | NO | NO |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | | NO | NO |
| | | | **Well# 3** | | | **10 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | NO | NO |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | | NO | NO |
| | | | **Well# 3** | | | **15 minutes** |
| 1 | 1 L | 0.40 mg/L | 1.0 mL | | NO | NO |
| 2 | 1 L | 0.70 mg/L | 2.0 mL | | NO | NO |
| 3 | 1 L | 1.10 mg/L | 3.0 mL | | NO | NO |

## Florida Rural Water Association

| | | | |
|---|---|---|---|
| Member: | Placid Lakes Utilities | Date: | 13-Jul-18 |
| Contact: | Nathan Brewer | PWS: | 6280223 |
| By: | Stan Epperly | County: | Highlands |

## Hydrogen Peroxide Standard Solution

Given: 35% H2O2 Solution= 35% (1ppm / 0.0001%) = 350,000 ppm $H_2O_2$ Solution

Set up Standard $H_2O_2$ =

$$\frac{350{,}000\ \text{ppm}}{H_2O_2\ \text{Solution}} \Bigg| \frac{1\ \text{mL}}{1{,}000\ \text{mL}} = 350\ \text{mg/L}\ H_2O_2\ \text{Std Soln}$$

$H_2O_2$ Dose Calculation =

$$\frac{350\ \text{ppm}}{H_2O_2\ \text{Std Soln}} \Bigg| \frac{1\ \text{mL}}{1{,}000\ \text{mL}} = 0.4\ \text{mg/L}\ H_2O_2\ \text{Solution}$$

| $H_2O_2$ Dose (mg/L) | Standard $H_2O_2$ Solution (mL) | $H_2O_2$ Dose (mg/L) | Standard $H_2O_2$ Solution (mL) | $H_2O_2$ Dose (mg/L) | Standard $H_2O_2$ Solution (mL) |
|---|---|---|---|---|---|
| | | | | | |
| 0.4 mg/L | 1 mL | 7.4 mg/L | 21 mL | 14.4 mg/L | 41 mL |
| 0.7 mg/L | 2 mL | 7.7 mg/L | 22 mL | 14.7 mg/L | 42 mL |
| 1.1 mg/L | 3 mL | 8.1 mg/L | 23 mL | 15.1 mg/L | 43 mL |
| 1.4mg/L | 4 mL | 8.4 mg/L | 24 mL | 15.4 mg/L | 44 mL |
| **1.8 mg/L** | **5 mL** | **8.8 mg/L** | **25 mL** | **15.8 mg/L** | **45 mL** |
| 2.1 mg/L | 6 mL | 9.1 mg/L | 26 mL | 16.1 mg/L | 46 mL |
| 2.5 mg/L | 7 mL | 9.5 mg/L | 27 mL | 16.5 mg/L | 47 mL |
| 2.8 mg/L | 8 mL | 9.8 mg/L | 28 mL | 16.8 mg/L | 48 mL |
| 3.2 mg/L | 9 mL | 10.2 mg/L | 29 mL | 17.2 mg/L | 49 mL |
| **3.5 mg/L** | **10 mL** | **10.5 mg/L** | **30 mL** | **17.5 mg/L** | **50 mL** |
| 3.9 mg/L | 11 mL | 10.9 mg/L | 31 mL | 17.9 mg/L | 51 mL |
| 4.2 mg/L | 12 mL | 11.2 mg/L | 32 mL | 18.2 mg/L | 52 mL |
| 4.6 mg/L | 13 mL | 11.6 mg/L | 33 mL | 18.6 mg/L | 53 mL |
| 4.9mg/L | 14 mL | 11.9 mg/L | 34 mL | 18.9 mg/L | 54 mL |
| **5.3 mg/L** | **15 mL** | **12.3 mg/L** | **35 mL** | **19.3 mg/L** | **55 mL** |
| 5.6 mg/L | 16 mL | 12.6mg/L | 36 mL | 19.6 mg/L | 56 mL |
| 6.0 mg/L | 17 mL | 13.0 mg/L | 37 mL | 20.0 mg/L | 57 mL |
| 6.3 mg/L | 18 mL | 13.3 mg/L | 38 mL | 20.3 mg/L | 58 mL |
| 6.7 mg/L | 19 mL | 13.7 mg/L | 39 mL | 20.7 mg/L | 59 mL |
| **7.0 mg/L** | **20 mL** | **14.0 mg/L** | **40 mL** | **21.0 mg/L** | **60 mL** |

## Florida Rural Water Association

| | | | |
|---|---|---|---|
| Member: | Placid Lakes Utilities | Date: | 13-Jul-18 |
| Contact: | Nathan Brewer | PWS: | 6280223 |
| By: | | County: | Highlands |

## Hydrogen Peroxide Dosing Calculations

| Raw Water Quality Data | | WELL1-WELL2-WELL3 |
|---|---|---|
| Temperature | | 24.6-24.8-25.4 C |
| pH | | 7.85-7.86-7.82 |
| Conductivity | | 123-123-126 |
| Dissolved Oxygen | | |
| Total Organic Carbon (TOC) | | 1.3-1.1-1.1 |
| Turbidity | | |
| Alkalinity | | 140-144-146 |
| Total Dissolved Solids (TDS) | | 80-80-82 |
| Sulfate | | 5.4-6.2-2.0 |
| Sulfide | *1.0-1.0-0.5* | 1.00 mg/L |
| Iron | | 0.04-0.04-0.14 |

It is a good idea to obtain these raw water parameters & TOC to better understand how $H_2O_2$ reacts and DBP Forms - TOC is $20

FRWA STRONGLY Recommends taking DBPs at point of entry before and after **H2O2** pilot testing

### Redox Reactions

According to "Water Treatment Principles and Design" (MHW, 2005), pp. 552-553 the required hydrogen peroxide dose for the oxidation of sulfide is 1.0 mg $H_2O_2$ / mg $H_2S$ and the required hydrogen peroxide dose for the oxidation of iron is 0.30 mg $H_2O_2$ / mg Fe2+. The reaction between sulfides and hydrogen peroxide depends greatly on the pH and temperature of the raw water. The raw water is slightly alkaline, well buffered, pH is 7.6, and will tend to calcify.

$$H_2S + H_2O_2 \Rightarrow S_0 + 2\,H_2O$$

$$2\,Fe^{2+} + H_2O_2 + 2H^{+} \Rightarrow 2\,Fe^{3+} + 2\,H_2O$$

The $H_2O_2$ Dosage Rates are estimated as follows.

$H_2O_2$ Dose for $H_2S$ = $\dfrac{1.0\text{ mg/L Sulfide} \times}{} \Big| \dfrac{1.0\text{ mg } H_2O_2}{\text{mg } H_2S}$ = 1.00 mg/L $H_2O_2$

$H_2O_2$ Dose for $Fe^{2+}$ = $\dfrac{0.140\text{ mg/L } Fe^{2+} \times}{} \Big| \dfrac{0.3\text{ mg } H_2O_2}{\text{mg } Fe^{2+}}$ = 0.04 mg/L $H_2O_2$

So: $H_2O_2$ Dose for $H_2S + Fe^{2+}$ = **1.04 mg/L** $H_2O_2$

### Initial Dosing Concentration

To account for the oxidation effects of other constituents in the raw water the hydrogen peroxide dose should be increased by 50% (or even doubled) until field conditions or operations shows a lower dose is appropriate. For this application we'll start with:

So: 150% $H_2O_2$ Dose for $H_2S + Fe^{2+}$ + other constituents in the raw water 1.56 mg/L $H_2O_2$

Use 2.0 mg/L $H_2O_2$

### Initial Feed Rate Calculations

Existing System & Water Demand from 12-2017 MOR

| | | | |
|---|---|---|---|
| Average Daily Demand | 290,290 gpd | 0.290 MGD | 202 gpm |
| Estimated Sulfide produced daily | | | 2.42 ppd |
| Maximum Daily Demand | 349,000 gpd | 0.349 MGD | 242 gpm |
| Well #1 Pump Capacity | 792,000 gpd | 0.792 MGD | 550 gpm |

Feed Rate Equation at Average Daily Demand:

Feed Rate= ADD $_{MGD}$ x Hydrogen Peroxide $_{ppm}$ x Conversion Factor

Feed Rate= 0.290 MGD 2.00 mg/L 8.34 lbs/gal **4.84 lbs/day** of $H_2O_2$

Assume: Purchase 35% $H_2O_2$ Solution from Dumont

Given: 35% $H_2O_2$ Solution (by weight) = 3.3 lb $H_2O_2$ / gallon 35%

Average Daily Demand $H_2O_2$ Usage= $$\frac{4.84\ \text{lbs/day of } H_2O_2}{3.36\ \text{lbs/gal } H_2O_2}$$ 1.44 gpd $H_2O_2$ Solution

30 day storage of 35% Hydrogen Peroxide = 43.27 gal $H_2O_2$ Solution

55-gallon drum provides about 1.27 months storage.

$5.00 /gal

Hydrogen Peroxide Chem Cost per month **$216**

Hydrogen Peroxide Chem Cost per year **$2,596**

**Initial Feed Pump Setting** **Well #1 Pump Capacity**

Feed Rate Equation at Well Pump Capacity:

Assume: Well pump runs all day to obtain feed pump setting

Feed Rate= Well Pump $_{MGD}$ x Hydrogen Peroxide $_{ppm}$ x Conversion Factor

Feed Rate= 0.792 MGD 2.00 mg/L 8.34 lbs/gal 13.21 lbs/day of $H_2O_2$

Average Daily Demand $H_2O_2$ Usage = $$\frac{13.21\ \text{lbs/day of } H_2O_2}{3.36\ \text{lbs/gal } H_2O_2}$$ 3.94 gpd $H_2O_2$ Solution

Assume: System will furnish and install a positive displacement, peristaltic-metering pump for chemical feed

| Stenner Chemical Feed Pump Model: | | | | |
|---|---|---|---|---|
| | 85MHP5, #1 | 3 gpd | @ 100 psi | |
| | **85MHP17, #2** | **17 gpd** | **@ 100 psi** | Use this one |
| | 85MHP40, #7 | 40 gpd | @ 100 psi | |

Feed Pump Setting (%) = $$\frac{3.94\ \text{gpd } H_2O_2\ \text{Solution}}{17.00\ \text{gpd Stenner Pump}} =$$ 23.1% Pump Setting

# ENCLOSURE ~ 2.4

## FRWA Recommended Treatment Techniques

**FLORIDA RURAL WATER ASSOCIATION**
2970 Wellington Circle • Tallahassee, FL 32309-6885
Telephone: 850-668-2746 ~ Fax: 850-893-4581

# RECOMMENDED TREATMENT TECHNIQUES

## for Improving Water Quality & Controlling Disinfection By-Products

We recommend these treatment techniques to small & medium sized water systems for controlling / reducing the formation of disinfection by-products (DBPs). The best actions and treatment techniques are have been included and systematized into a stepwise approach -- starting with the most effective steps and lowest cost alternatives. It is hoped that systems might avoid common pitfalls, expensive engineering studies, and benefit from FRWA experience.

First, it is vital to understand how disinfection by-products are formed so the operator understands why these recommendations are effective. The formation of total trihalomethanes (TTHMs) and haloacetic acids (HAA5s) is a function of many factors. All organic DBPs are formed by the reaction between organic substances, inorganic compounds such as bromide, and oxidizing agents that are added to water during treatment (e.g., chlorine). The table below is a brief summary of those factors that affect the formation of disinfection by-products in water treatment processes and distribution systems.

### Factors Affecting DBP Formation & Possible Options[1]

| Factors | Affects | Controllable? | Possible Actions |
|---|---|---|---|
| **Time** | ▪ Higher water age → higher DBPs | **Yes** | ▪ Lower residence time in tanks[2]<br>▪ Install automatic flushing devices |
| **Temperature** | ▪ Higher temps → higher DBPs | No | N/A |
| **pH** | ▪ Higher pH → higher TTHMs<br>▪ Lower pH → higher HAA5s | Marginally Yes | ▪ Lower pH only if TTHMs are high and HAA5s are low |
| **Water Quality** | ▪ Poor water quality → higher chlorine demand → higher DBPs<br>▪ Higher Organics → higher DBPs | **Yes** | ▪ Remove impurities / TOC with treatment<br>▪ Oxidize TOCs, Fe & $H_2S$ |
| **Disinfectants** | ▪ More free chlorine available for reactions → higher DBPs | **Yes** | ▪ Lower chlorine feed<br>▪ Use alternative preoxidant in WTP and move chlorine injection near point of entry<br>▪ Recommend AGAINST using chloramines |

**Begin with these proven actions to control and reduce DBPs:**

**Where to start**

- ✓ Clean and flush tanks / distribution system,
- ✓ Lower water age in the tanks/ distribution system,
- ✓ Lower chlorine feed and minimize chlorine contact time, and
- ✓ Treat to improve water quality (remove or oxidize impurities).

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[1] USEPA. (2008). *Stage 2 Disinfectants and Disinfection Byproducts Rule – Operational Evaluation Guidance Manual.*

[2] USEPA (2002). *Effects of Water Age on Distribution System Water Quality.*

## Aggressive Cleaning, Flushing & Chlorine Reduction Program

Many systems could make higher quality water if they were operated with cleaner tanks and water mains. Positive results have been repeatedly demonstrated with this aggressive cleaning, flushing and chlorine reduction program. When systems actually implement the program there is an expected 30% reduction in TTHMs & HAA5s – often enough to bring the system back into compliance. Several systems reduced disinfection by-products by as much as two-thirds.

<table>
<tr><th>Steps</th><th>Recommended Action</th><th>Description of Recommended Actions</th></tr>
<tr><td>1</td><td><b>Aggressive Tank Cleaning Program[3]</b></td><td>It is essential to remove any and ALL accumulated sludge, biogrowth, sediment, and biological matter from tanks in order to improve water quality and lower chlorine demand and feed rates.</td></tr>
<tr><td>2</td><td><b>Systematic Water System Flushing & Cleaning[4]</b></td><td>Start a systematic and regular water main flushing program to remove biofilm and deposits in the distribution system. Begin at the water plant / source and move out to system extremities. Consider unidirectional flushing in problem areas. It is better and different than conventional flushing. It employs targeted and high-velocity water flow (2 - 6 feet per second) to scour the mains.</td></tr>
<tr><td>3</td><td><b>Reduce Water Age[5] & Install Automatic Flushing Devices</b></td><td>Increase tank turnover rate to every 72-hrs – turnover at least one-third of the tank volume daily. Liberally install automatic flushing devices at water system extremities. The operational goal is to lower residence age. The valves can be set to run 3 or more times a week at night for 15-30 minutes. Although it is not always practical, try to keep water age to 2 to 3-days in the water system. Systems may purchase commercially available devices for $2,500 or construct their own for under $500, design is attached.</td></tr>
<tr><td>4</td><td><b>Minimize Chlorine Contact Time in the WTP</b></td><td>Move the chlorine feed point in the water plant closer toward the point of entry. Substitute chlorine feed in other points in the water plant with an alternative pre-oxidant to lower total chlorine dosage.[6]</td></tr>
<tr><td>5</td><td><b>Reduce Total Disinfection Dosage</b></td><td>Reduce total chlorine dosage, but maintain minimum free residual. We recommend chlorine booster station for systems with large services areas. This allows chlorine dose reduction at the water plant, in the overall system, and fewer DBPs formed.</td></tr>
<tr><td colspan="3"><b>The first five steps must be completed before results should be expected. In other words, if chlorine feed isn't (or can't be) lowered don't expect positive results!</b></td></tr>
<tr><td>6</td><td><b>Install Treatment to Improve Water Quality</b></td><td>If the first five steps don't work for your system then treatment may be needed to improve water quality and remove disinfection by-product precursors. Recommended treatment technologies are expanded herein.</td></tr>
</table>

The five-step aggressive cleaning, flushing and chlorine reduction program is a mitigation technique to reduce the amount of disinfection by-products formed in the water system. It also manages the remaining DBP formation potential and total organic carbon interaction with chlorine. Warmer temperatures contribute to biofilm regrowth in drinking water distribution systems and water storage facilities. Chlorine residuals are kept higher to manage regrowth, but increase DBP formation. It's common for chlorine levels to be kept artificially high due to operator convenience, to avoid low residuals/ bacteriological hits, and for a margin of safety.

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[3] AwwaRF (2000b). Water Quality Modeling of Distribution System Storage Facilities. Grayman et al.

[4] Reiss, R. et al (2010, March). Unidirectional Flushing: Enhance Water Quality and Improve Customer Relations. Opflow, AWWA. 36:3, pp. 10-14

[5] Carroll, S. et al. (2012, Spring). Water Age and Water Quality Deterioration. The Floridan. Florida Department of Environmental Protection. 4:10, pp. 7, 12-13. & USEPA (2002). *Effects of Water Age on Distribution System Water Quality.*

[6] USEPA. (1999a). *Alternative Disinfectants and Oxidants Guidance Manual.* EPA #815-R-99-014.

# Step 6 ~ Install Treatment to Improve Water Quality

## Recommended Treatment Techniques
## for Oxidizing or Removing Disinfection By-Product Precursors

**Follow the money.** Solutions used for larger systems do not always work for smaller systems – scaled down technologies are not as cost effective nor workable. Smaller water systems may be of little interest to the engineering design consultant as there may be few financial rewards for working with these systems; nevertheless unique approaches are needed. These less known innovative solutions for medium /small systems are being played out that are of interest for all drinking water professionals.

If you hire an engineer it is likely that they will start with Step 6. Don't let your consultant jump to treatment. Whatever you do, don't skip the first five steps and miss out very effective operational changes, improved water quality, and lower DBP formation.

Engineering firms don't get a lot of fees for helping you with operational fine-tuning. Firstly they may not understand those issues and secondly the profit motive is low. So it is easy to understand why consultants tend to focus on larger construction projects.

**There is NO Silver Bullet.** Medium and small water systems are hard pressed to conduct their own research and hire experienced design professionals to wade through the myriad of choices. FRWA has performed the research and fieldwork to isolate the best treatment techniques (TTs) for oxidizing or removing disinfection by-product precursors. FRWA has eliminated options that don't make sense for most medium and small systems.

Treatment techniques are ranked according to installation cost, ease of operation, and effectiveness. Installed cost and operator skill metrics are provided as a general guidance in your decision-making process for selecting a treatment technique best for your system. Some treatment techniques have been intentionally excluded from the recommendations for a variety of reasons, some which tend to be much too expensive to install or complex to operate.

There is still work to do. Water professionals must choose the best treatment options for their own system. Each system and raw water is unique – solutions for each system will be unique and tailored for its distinctive circumstances.

### Installed Costs & Operator Attention Scale

| Scale | Installed Costs | Operator Attention |
|---|---|---|
| 1 | Low cost/ easy to install - often under $5,000 for a small system | Low attention & ease of operation |
| 2 | Affordable cost / easy to install | Periodic attention & operator expertise needed |
| 3 | Moderate cost | Regular / close monitoring & fine-tuning |
| 4 | High cost | Involved monitoring & treatment adjustments |
| 5 | Expensive – often $15 to $20 per gal capital cost | Complex chemistries, controls & attention |

Installed costs are rated 1 through 5 – a rating of 1 equates to low costs (under $5,000 for a small system), while reverse osmosis which has a complex arrangement of chemical feed and controls is rated 5 for high costs.

Most treatment schemes have a degree of automatic control to limit the amount of operator attention. Operator attention for each technologies is rated based from 1 through 5 on the complexity of the method – a simple system with few mechanical elements, is rated 1 for low attention, while reverse osmosis which has a complex arrangement of chemical feed and controls, is rated 5 for high attention.

# Summary of FRWA Recommended Treatment Techniques

| RANK | Recommended Treatment Technique for DBPs | Installed Costs | Operator Attention | General Comments |
|---|---|---|---|---|
| **1** | **Aeration** | --- | --- | Includes cascade trays, forced draft towers, bubble diffusers, spray, or air induction. Little operator skill is needed. |
| **1A** | Cascade Tray Aerators | 2 | 1 | Requires a storage tank and high service pumps. Trays must be cleaned regularly. |
| **1B** | Air Stripping Towers (Packed Tower Aeration) | 3 to 4 | 2 | More effective and much more expensive than tray aerators. Regular / annual cleaning of the plastic packing material with a citric acid is required to remove deposits. |
| **1C** | Venturi Induction with air filter | 1 | 1 | Air entrainment system for systems without aerators - less effective / expensive. Requires a storage tank and high service pumps. |
| **2** | **Chemical Oxidation** | --- | --- | Includes ozone, chlorine dioxide, permanganate, or hydrogen peroxide |
| **2A** | Hydrogen Peroxide ($H_2O_2$) | 1 | 1 to 2 | $H_2O_2$ is inexpensive and easy to install – feed pump and drum. Jar testing is a MUST to determine effectiveness. Requires adequate contact time before chlorination. $H_2O_2$ is an alternative oxidant that can be substituted for chlorine at the aerator or pre-oxidation. $H_2O_2$ must be used up before chlorination as $H_2O_2$ is a dechlorinating agent. Watch for the Tyndall effect. |
| --- | Chlorine Dioxide (ClO2) | 1 | 2 to 3 | Under pilot study and review - TwinOxide |
| **2B** | Sodium Permanganate with Greensand Filtration ($NaMnO_4$ solution) | 3 | 2 | $NaMnO_4$ is moderately expensive to install and much easier to use than $KMnO_4$. $NaMnO_4$ is suspended in a brine solution and is fed neat. $NaMnO_4$ chemical costs for are more expensive. Can be overfed turning water pink or purple.<br>Both permanganates must be followed by 15 to 20 minute reaction / mixing / contact zones then greensand filters. The greensand media pulls any remaining soluble Fe and Mn from solution by ion exchange properties. Periodic backwashing to remove the Fe and Mn is required. |
| **2C** | Potassium Permanganate with Greensand Filtration ($KMnO_4$ solid granules) | 3 to 4 | 3 | $KMnO_4$ is moderately expensive and is followed by rapid rate pressure filters. $KMnO_4$ is a strong oxidizer and should be carefully handled when preparing the feed solution. Granules must be dissolved. Can be overfed turning water pink or purple. See $NaMnO_4$ for greensand filter discussion. |
| **2D** | Ozone ($O_3$) | 4 | 4 | Ozone capital costs are high and O&M relatively complex – power A bench scale pilot study is important. Ozone MUST be followed with GAC to remove organic molecules that pose a problem for regrowth in the distribution system. |
| **2E** | Peroxone ($O_3$+ $H_2O_2$) | 4 | 4 to 5 | Peroxone is applied at points similar to ozone for oxidation. This advanced oxidation process generates highly reactive hydroxyl free radicals to oxidize various compounds in the water. MUST be followed with CAC. Peroxone is used for oxidation of taste and odor compounds, and oxidation of synthetic organic compounds (herbicides, pesticides, and VOCs). |

| RANK | Recommended Treatment Technique for DBPs | Installed Costs | Operator Attention | General Comments |
|---|---|---|---|---|
| **3** | **Adsorption and Filtration** | | | |
| **3A** | Granular Activated Carbon (GAC) Filters | 3 | 4 | GAC absorption is an EPA recommended technology for DBP precursors. Design of filters includes using a min. empty bed contact time of 10 minutes (GAC$_{10}$). Pilot studies are recommended to predict specific media life for each site and raw water characteristics. Prudent design dictates that the expected GAC life to last at least six months. The GAC regular replacement on is often costly. Monitoring TOC before and after filters can indicate when GAC is spent. Refilling GAC in filters requires specialized expertise to avoid media channeling. This TT also includes powdered activated carbon. |
| **3B** | Biologically Active GAC Filters (BAC) | 3 | 4 | Any GAC Filter following chemical oxidants (e.g. ozone, hydrogen peroxide) will become biologically active. GAC offers an excellent surface for biological activity. The rough surface provides numerous good places for attachment. Amount of organic carbon removed is far beyond that which can be removed by adsorption alone. |
| **3C** | Biologically Active Slow Sand Filtration (BAF) | 3 | 2 | Advantages of slow sand filtration include its low maintenance requirements (since it does not require backwashing and requires less frequent cleaning) and the fact that its efficiency does not depend on actions of the operator. However, slow sand filters do require time for the schmutzdecke to develop after each cleaning; during this "ripening period," however, filter performance steadily improves. |
| **4** | **Anion Exchange** | | | |
| **4A** | Anion Exchange | 3 | 2 | Strong base anion exchange resin is specially designed to remove tannins and naturally occurring organic matter. Pre-filtration is recommended if source water turbidity is >0.3 NTU. Contaminant breakthrough can be avoided by careful monitoring and by running several columns in series, keeping the most recently regenerated column last. Can include mixed beds with ion & anion resins in same vessel – also TT for arsenic, radon, & uranium removal. |
| **4B** | MIEX Treatment (Suspended Magnetic Anion Exchange) | 3 to 4 | 3 to 4 | MIEX® can specifically remove dissolved organic carbon (DOC) from natural water. MIEX has been successfully installed in a dozen Florida systems. The magnetic ion exchange resin has traditional anion exchange resin properties – is smaller and has a magnetic core. The resin is suspended in a stirred tank reactor with the raw water fed upwards. Resin is removed from the treatment stream to be recharged in a brine bath – producing only 20% brine as compared to ion exchange. Pre-filtration is recommended if source water turbidity is >0.3 NTU. |

| RANK | Recommended Treatment Technique for DBPs | Installed Costs | Operator Attention | General Comments |
|---|---|---|---|---|
| **5** | **Corrosion Control & Sequestration** with Poly / Orthophosphates – 70% / 30% Blend | 1 | 1 | Phosphates are inexpensive and easy to install – feed pump and drum. Small water plants may choose to either sequestrate with polyphosphates or remove iron and manganese. Sequestration only works for Fe and Mn. If the water contains less than 1.0 mg/L iron and less than 0.3 mg/L manganese, using polyphosphates followed by chlorination can be an effective and inexpensive method for mitigating iron and manganese problems. Below these concentrations, the polyphosphates combine with the iron and manganese preventing them from being oxidized. Orthophosphates inhibit control corrosion in water distribution systems. Blended phosphates rely on hydrolysis to maintain orthophosphate residual in system – actual phosphate concentration will increase with time in system and build up a protective coating on pipe walls which tends to lower chlorine demand. **Expect a 10% reduction in DBPs.** Phosphates are added to groundwater at the well head or at the pump intake before the water has a chance to come in contact with air or chlorine. This ensures that the iron and manganese stays in a soluble form. No sludge is generated in this method. |
| **6** | **Enhanced Coagulation** Conventional Water Treatment Involves coagulation, flocculation, and clarification followed by filtration | 4 | 3 | Enhanced coagulation is an applicable treatment technique ONLY if the source water is surface water or ground water under the direct influence (Subpart H system); and the utility uses conventional treatment (i.e., flocculation, coagulation or precipitative softening, sedimentation, and filtration). The coagulants effective for removing TOC include: Regular Grade Alum (Aluminum Sulfate) $Al_2[SO_4]_3{}^{*}{}_{14H_2O}$, reagent grade alum $Al_2[SO_4]_3{*}18H_2O$, Polyaluminum Chloride (PACl), cationic polymers, Ferric Chloride $FeCl_3{*}6H_2O$, Ferric Chloride $FeCl_3$, Ferric Sulfate $Fe_2(SO_4)_3{*}9H_2O$, and Ferrous Sulfate $FeSO_4{*}7H_2O$. For TOC removal high coagulant doses requires significant coagulant doses. Required Treatment Technique for some systems once LT2SWTR Rule is in effect. |
| **7** | **Membrane Filtration** includes Nanofiltration (NF) & Reverse Osmosis (RO) | 5 | 4 | Membrane processes are the most expensive to construct and operate. Requires chemical addition, pre-treatment acidification / conditioning, and post-treatment re-stabilization. Reject water has high TDS and must be carefully disposed using expensive measures such as deep well injection. |
| **8** | **LAST CHOICE OPTION Chloramines** (monochloramine NH2Cl) | 1 | 2 | Chloramination Is NOT RECOMMENDED. Although chloramines are inexpensive and easy to install (feed pump and drum) their by-products may be ultimately more health adverse and subject to future regulation. Chloramines have been shown to pose simultaneous compliance problems such as nitrification, biofilm regrowth and degraded water quality. Chloramine is a mixture of ammonia and chlorine, and is more persistent but less potent in distribution systems. Chloramine is generated onsite using Ammonium Hydroxide $NH_3$ or Ammonium Sulfate $(NH_4)2SO_4$ (is preferred). Min allowed residual is 0.6 mg/L |

# Details of FRWA Recommended Treatment Techniques

## Recommendation 1 ~ Aeration.

**Includes Cascade Trays, Forced Draft Towers, Bubble Diffusers, Spray, or Air Induction.** Oxidation via aeration is frequently used for surface waters, sometimes groundwaters high in odors, iron and manganese. Contaminants are oxidized, such as iron and manganese, causing them to form solids, which can then be removed by filters. Aeration is relatively inexpensive and easy use. Aerators require frequent cleaning.

### Recommendation 1A ~ Cascade Tray Aerators.

Cascade aeration is accomplished by natural draft units that mix cascading water with air that is naturally inducted into the water flow. Raw water is pumped to the top of the aerator, and cascades over a series of trays. Air is naturally inducted into the water flow to accomplish iron oxidation and some reduction in dissolved gasses. Design of cascade tray aeration is dependent on aeration contact time, aeration transfer efficiency, and the nature of raw water.

Tray aerators can significantly reduce $CO_2$, $H_2S$, iron, manganese, color and odor in raw waters. Tray aerators are not as effective with oxidizing tannins.

Cascade aerators have no moving parts and are constructed of non-corroding materials – fiberglass, redwood, aluminum, or stainless steel.

**Installed Costs: 2.** Tray aerators cost as little as $15,000 and as much as $50,000. Installation requires a storage tank and high service pumps. Aerators are typically mounted on top of the storage tank.

**Operation and Maintenance Issues and Costs: 1.** Very little operator skill is needed. Regular removal of bioslime buildup on trays is required. The storage tank is in essence a reaction vessel where the oxidation process is completed and oxidized metals and organics can stabilize and settle. The storage tank must be cleaned regularly to reduce sludge/ bioslime buildup and chlorine demands.

**References:** MWH. (2005). pp. 1176-1182; USACE. (1999). p. 6-10

### Recommendation 1B ~ Air Stripping Towers (Packed Tower Aeration - PTA).

Air strippers provide contact between air and water that encourage volatile material to move from the water to the air. A packed column air stripper consists of a cylindrical column that contains a water distribution system above engineered (structured or dumped) packing with an air distributor below.

Raw water is distributed at the top of the column and flows generally downward through the packing material. At the same time, air, introduced at the bottom of the column, flows upward through the packing (countercurrent flow). The packing provides an extended surface area and impedes the flow of both fluids, extending the contact and to increase the gas-liquid interface. As water and air contact, VOCs and $H_2S$, move from the water to the air. Iron, manganese, color, $CO_2$, and organics are also reduced by oxidation in the packed tower.

The VOCs transferred to the air exit the top of the column in the air stream. Off- gas (air) is released to the atmosphere or treated if necessary to meet emission limits. pH adjustment / acidification is often used to enhance $H_2S$ stripping.

**Installed Costs: 3.** Packed towers start at about $150,000

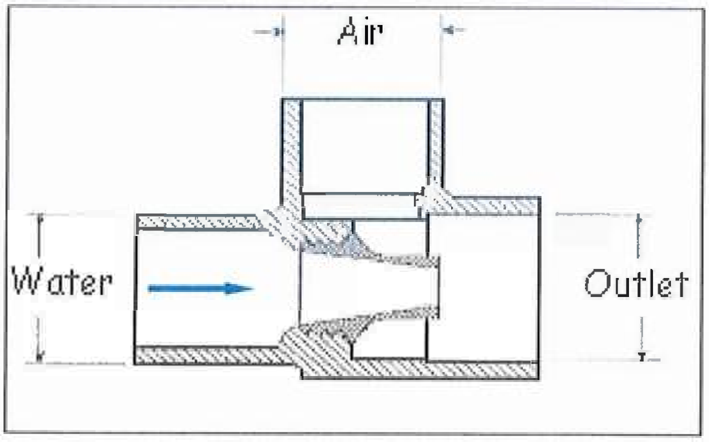
**Operation and Maintenance Issues and Costs: 2.** Packed towers are much more effective than tray aerators. Annual (or more frequent) cleaning of the plastic packing material with a potable acid solution is required to remove deposits.

**References:** MWH. (2005). pp. 1176-1182; USACE. (1999). p. 6-10, USACE. (2001).

## Recommendation 1C ~ Venturi Induction with Air Filter

The simplest aeration system is air entrainment accomplished by induction Venturi. This is a passive system that requires no outside power. It pulls air into the water line by means of an induction device called a Venturi. The Venturi (sometimes called a "Micronizer" or an educer) is installed in the water line to enhance a cascade tray, spray aerator, or alone. As water is forced through the venturi while the pump operates, air is sucked into the water line.

The improved the air-water ratios facilitate oxidation of impurities and DBP precursors. The main advantages of the Venturi system are its low cost, its economy of operation, and its simplicity. The main disadvantage is that the Venturi itself restricts water flow.



**Installed Costs: 1.** Construction is under $500 with a fabricated air filter.

**Operation and Maintenance Issues and Costs: 1.** Air filter needs periodic cleaning / replacement.

References: N/A

## Recommendation 2 ~ Chemical Oxidation.

**Includes Ozone, Chlorine Dioxide, Permanganate, Hydrogen Peroxide, or UV Radiation.** Chemical oxidation improves the aesthetic characterizes and quality of most raw waters. Oxygen, chlorine and permanganate are the most frequently used oxidizing agents. Oxidation is used for many purposes to reduce taste, odor, color, iron, manganese, and natural organic materials, all are DBPs precursors. Chemical oxidation is relatively inexpensive and easy to perform. Chlorine is the most frequently used chemical oxidant in water treatment – but increases DBPs. For this reason alternative chemical oxidants are recommended.

## Recommendation 2A ~ Hydrogen Peroxide.

Hydrogen peroxide ($H_2O_2$) is an alternative oxidant that can be substituted for chlorine for pre-oxidation or at the aerator. During the reaction the oxygen molecule is liberated and chemically oxidizes (reduces) impurities in the raw water, including iron, sulfur, organics, tannins, and TOC – all contribute to color, odor, and taste.

Partial oxidation with $H_2O_2$ gives rise to lower molecular weight organics that are more easily biodegradable – food for the bioslime in water distribution systems. High TOC waters may require biological filtration, a systematic flushing program, and continual chlorine residual above 0.5 mg/L.

**Installed Costs: 1.** Peroxide is fed as a 30% to 35% solution with a chemical feed pump (peristaltic pumps required because of $H_2O_2$ off gassing. Cost starts under $1,000.

**Operation and Maintenance Issues and Costs: 1 to 2.** $H_2O_2$ is inexpensive and easy to install – chemical feed pump and drum. Dosing is determined by jar testing and pilot study. $H_2O_2$ costs marginally more than sodium hypochlorite to use. Do NOT overfeed as peroxide is a dechlorinating agent and reacts with other oxidants, such as chlorine, chlorine dioxide, and monochloramines.

**References:** USACE. (1999)., p. 6-13; USEPA. (1999a).

## Under Review and Pilot Studies ~ Chlorine Dioxide

FRWA is working with TwinOxide to test a binary powder formation of chlorine dioxide – it's a 99.9% pure chlorine dioxide solution in a 0.3% concentration. TwinOxide works on the biocidal component chlorine dioxide. Although chlorine can be found in the name, it is NOT a chlorine type of disinfectant. TwinOxide does not release free chlorine (hypochlorous acid) to provide a biocidal function. When TwinOxide 0.3% solution is applied, the active substance has a full spectrum of efficiency against bacteria, algae, fungi, protozoan, yeast, methanogens and viruses.

Very efficient dosage and water disinfection Main advantage of TwinOxide compared to other chloring dioxide delivery systems are its ease of storage, distribution and shelf life. In general, 1 gallon of TwinOxide 0.3% solution, with a dosage rate between 0.05 to 2.0 ppm will produce up to 60,000 gallons of potable water. Deviations of these dosage rates are likely.

### Microbiological Advantages

- Stronger, efficacious and faster biocidal function;
- Independant working within a wide range of pH-Value (pH 4-10);
- Significantly more disinfection power compared to chlorine products;
- Many times more oxidizing power compared to chlorine products;
- Effective removal of biofilms and no resistance building by micro organisms.

### Environmental Advantages

- Limited sewage load compared to other water disinfection agents;
- No strange taste occurrences – improved taste and improved color of water.

### Economical Advantages

- Low volume and low concentration of chlorine dioxide;
- No investment cost in production equipment;

- No construction modifications or certifications;
- No highly educated & trained employees required;
- Cost of operation concerns a dosage pump with maintenance.

**Advantages of TwinOxide as water disinfectant**

- Effective against all water related micro organisms (bacteria, viruses, protozoan, fungi, yeast);
- High performance as disinfectant and biocide;
- No resistance building by micro organisms;
- Removal of Prophylaxis on Bio Films;
- Fully operational on pH-levels between 4 and 10;
- Negligible corrosive effects compared to the corrosive damages of drinking water-> no material application limitations;
- The bactericidal performance is at pH-levels between 4 and 10 very steady-> as a consequence addition of acids (industrial or citric) is not necessary;
- Due to a continuous addition of chlorine dioxide for disinfection to the recycled water all pipes and places in the circuit can be reached and disinfected.

## Recommendation 2B~ Sodium Permanganate with Greensand Filtration (NaMnO4) solution

$NaMnO_4$ is 2 to 3 times more effective / reactive than $KMnO_4$ – can be used to oxidize organic precursors, iron, and manganese at the head of the treatment plant, thus minimizing the formation of DBPs at the downstream disinfection stage of the plant. No mixing required.

Very effective as a primary disinfectant to control DBP precursors, TOC, iron, manganese, color, odor, and taste. Not efficient for raw waters high in sulfides. Greensand is a naturally occurring mineral that consists largely of dark greenish grains of glauconite (green clay), and a natural ion exchange mineral capable of softening water and removing iron and manganese. Greensand filters follow $KMnO_4$ / $NaMnO_4$. The media pulls any remaining soluble Fe and Mn from solution by the ion exchange properties.

**Installed Costs: 3.** Capital cost for a permanganate and greensand filter system is high. Permanganate requires 20-minutes of contact and MUST be followed with filters.

**Operation and Maintenance Issues and Costs: 2 to 3.** O&M is somewhat complex. $NaMnO_4$ is fed as a solution with a chemical feed pump. A bench scale pilot study on the raw water is important. Periodic backwashing of the media to remove the Fe and Mn is required. Sludge disposal is required. Can be overfed turning water pink or purple.

**References:** USEPA. (1999a). pp. 6-10; Carus Corp, www.caruscorporation.com

## Recommendation 2C ~ Potassium Permanganate with Greensand Filtration (KMnO4)

$NaMnO_4$ is 2 to 3 times more effective / reactive than $KMnO_4$ – can be used to oxidize organic precursors, iron, and manganese at the head of the treatment plant, thus minimizing the formation of DBPs at the downstream disinfection stage of the plant. See $NaMnO_4$ for greensand filter discussion.

**Installed Costs: 3.** Capital costs for a permanganate and greensand filter system is high. Permanganate requires 20-minutes of contact and MUST be followed with filters.

**Operation and Maintenance Issues and Costs: 3.** $KMnO_4$ mixing is required, messy and problematic. O&M is somewhat complex. A bench scale pilot study on the raw water is important. Periodic backwashing of the media to remove the Fe and Mn is required. Sludge disposal is required. $KMnO_4$ is more easily overfed turning water pink or purple.

**References:** USEPA. (1999a). pp. 5-1– 5-12

## Recommendation 2D ~ Ozone (O3).

Ozone is a most powerful oxidizing and disinfecting agent formed by passing dry air through a system of high voltage electrodes. Requiring shorter contact time and a smaller dosage than chlorine, ozone is widely used as a primary disinfectant. Ozone is often combined with peroxide to more completely oxidize organics.

Ozone eeduces DBP precursors, TOC, color, odor, and taste. Ozone does not directly produce halogenated organic materials unless a bromide ion is present. Partially oxidizes organics into biodegradable compounds that may need to be removed by biological filtration – food for the bioslime in water distribution systems.

**Installed Costs: 4.** Capital costs of ozonation systems are relatively high. Ozone requires a contact chamber and MUST be followed with GAC filters to remove organic molecules that pose a problem for regrowth in the distribution system.

**Operation and Maintenance Issues and Costs: 4.** O&M is relatively complex – with high power and GAC media replacement costs. A bench scale pilot study on the raw water is important.

**References:** USEPA. (1999A). pp. 3-1– 3-43

## Recommendation 2E ~ Peroxone (Ozone/Hydrogen Peroxide).

Advanced oxidation processes generate highly reactive hydroxyl free radicals to oxidize various compounds in the water. Peroxone is used for oxidation of taste and odor compounds, and oxidation of synthetic organic compounds (herbicides, pesticides, and VOCs). Several methods have been used to increase ozone decomposition and produce high concentrations of hydroxyl radicals. One of the most common of these processes involves adding hydrogen peroxide to ozonated water, a process commonly referred to as peroxone.

The two oxidation reactions compete for substrate (i.e., compounds to oxidize). The ratio of direct oxidation with molecular ozone is relatively slow compared to hydroxyl radical oxidation, but the concentration of ozone is relatively high. On the other hand, the hydroxyl radical reactions are very fast, but the concentration of hydroxyl radicals under normal ozonation conditions is relatively small. A key difference between the ozone and peroxone processes is that the ozone process relies heavily on the direct oxidation of aqueous ozone while peroxone relies primarily on oxidation with hydroxyl radical. In the peroxone process, the ozone residual is short lived because the added peroxide greatly accelerates the ozone decomposition.

However, the increased oxidation achieved by the hydroxyl radical greatly outweighs the reduction in direct ozone oxidation because the hydroxyl radical is much more reactive. The net result is that oxidation is more reactive and much faster in the peroxone process compared to the ozone molecular process. However, because an ozone residual is required for determining disinfection CT credit, peroxone may not be appropriate as a pre-disinfectant. The peroxone process utilizes oxidation by hydroxyl radicals. The oxidation potential of the hydroxyl radical and ozone are as follows:

**Installed Costs: 4**. Capital costs are similar to ozone.

**Operation and Maintenance Issues and Costs: 4 to 5.** Peroxone is applied at points similar to ozone for oxidation. Addition of ozone first and hydrogen peroxide second is the better way to operate – MUST be followed with GAC.

References: USEPA. (1999a). pp. 7-1 – 7-16

# Recommendation 3 ~Adsorption and Filtration.

Filtration methods include **Slow and Rapid Sand Filtration, Diatomaceous Earth Filtration, Direct Filtration, Membrane Filtration, and Cartridge Filtration**. Federal and state laws require all surface water systems and systems under the influence of surface water to filter their water. Filtration alone does not reduce DBP precursors – **GAC Absorption, Biologically Active GAC,** and **Biologically Active Slow Sand Filtration** are the only devices that can effectively lower disinfection by-products.

**Recommendation 3A ~ Granular Activated Carbon (GAC) Filters.**

GAC absorption is an EPA recommended technology for DBP precursors. Design of filters includes using a min. empty bed contact time of 10 minutes ($GAC_{10}$). Pilot studies are recommended to predict specific media life for each site and raw water characteristics. Prudent design dictates that the expected GAC life to last at least six months. The GAC regular replacement on is often costly. Monitoring TOC before and after filters can indicate when GAC is spent. Refilling GAC in filters requires specialized expertise to avoid media channeling. This TT also includes powdered activated carbon.

GAC installations are expected to increase since they provide a passive, broad-spectrum barrier against many emerging contaminants, such as endocrine disrupting compounds. The list of organic contaminants targeted for removal continues to expand due to increasing sensitivity of analytical method at trace levels, advancing knowledge of adverse effects, and growing threats of deliberate contamination.

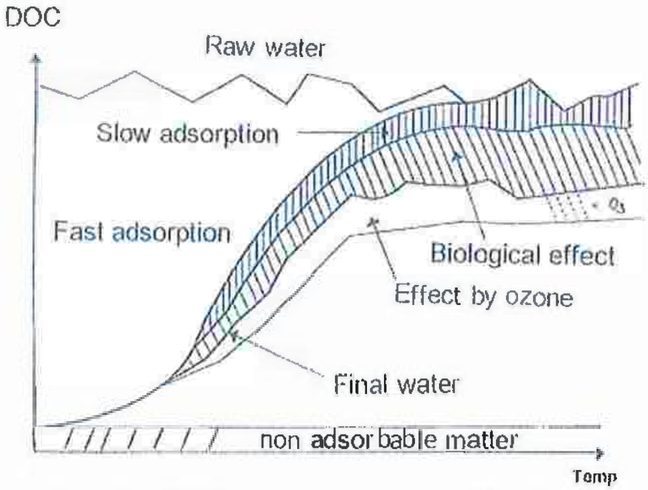
**Installed Costs: 3.** Capital costs for GAC Filters are high.

**Operation and Maintenance Issues and Costs: 4.** The GAC regular replacement on is often costly. Monitoring TOC before and after filters can indicate when GAC is spent. Refilling GAC in filters requires specialized expertise to avoid media channeling.

**References:** MWH. (2005). pp. 1309-1347; AWWA. (1999). pp. 13.16 - 13.62

## Recommendation 3B ~ Biologically Active GAC Filters (BAC)

Any GAC Filter following chemical oxidants (e.g. ozone, hydrogen peroxide) will become biologically active in 4 to 6 weeks – there is no need to "seed" the filters. GAC offers an excellent surface for biological activity. The rough surface provides numerous good places for attachment. Amount of organic carbon removed is far beyond that which can be removed by adsorption alone.



Biological activity is commonly expected to extend the lifetime of GAC filters now termed BAC filters. When contaminants are removed by BAC, two main parallel mechanisms are involved: adsorption due to the presence of adsorption sites on the activated carbon, and biodegradation due to microbial activity developing in the crevices of the media.

Biologically Active Filters are used downstream of ozone, perozone, or peroxide. Filter media may be GAC, anthracite, or sand, or some combination. TOC removals in the 20-70 percent range possible, dependent on the nature of the organics present, ozone: TOC dose, and filter contact time.

TOC removals in the 20-70 percent range possible, dependent on the nature of the organics present, ozone: TOC dose, and filter contact time. Also reduces $NO_3$, Fe, Mn.

**Installed Costs:** 3. Same high capital costs as GAC Filters.

**Operation and Maintenance Issues and Costs: 2.** In addition to O&M for GAC, monitoring TOC before and after filters, replacing GAC, and biological monitoring.

A biological baseline must be established so that if changes in operations cause detrimental impacts to the filter, the impact can be assessed. Changes in biological parameters may not directly correlate to changes in removal of specific compounds of interest, but they have more subtle impacts/correlations such as relationships with resiliency during upset conditions or colder temperatures. The baseline should be developed over the period of at least one year to assess seasonal impacts on water quality and treatment efficacy.

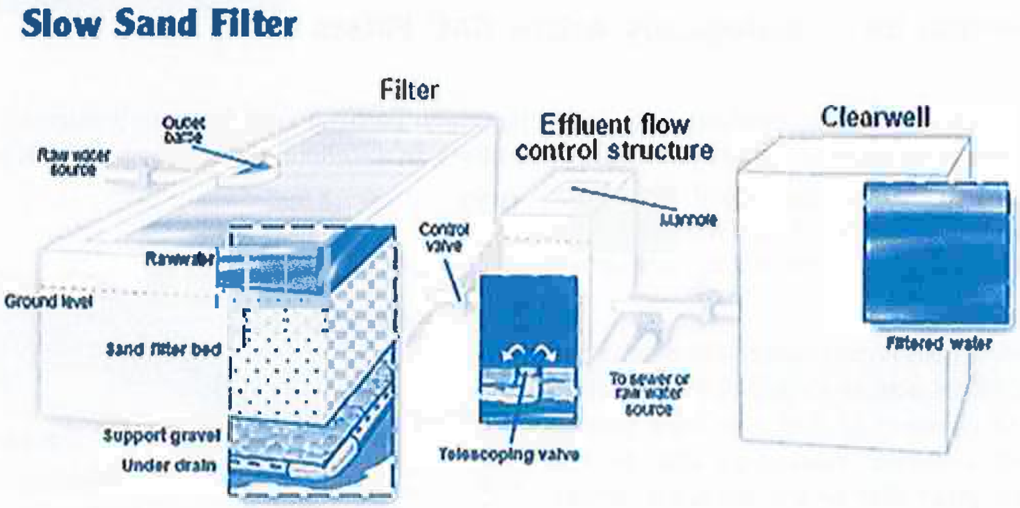
This baseline should include one or more biological parameters (e.g., ATP or hydrolase activity on media and online LDO consumption across the filter), organic carbon parameters (e.g., TOC, DOC, AOC, and carboxylic acids), water quality parameters (e.g., turbidity, temperature, pH, nutrients and DBP formation potential), operational parameters (head loss accumulation rate and oxidant residual on top of the filter), and control parameters (e.g., pre-oxidant type(s) and dose(s), nutrients, and contact time).

**References:** USEPA. (1999a). pp. 3-19 – 3-20; 9-5 – 9-6

## Recommendation 3C ~ Biologically Active Slow Sand Filters

Slow sand filters are simple, are easily used by small systems, and have been adapted to package plant construction. The schmutzdecke, the top-most, biologically active layer of filter, removes suspended organic materials and microorganisms by biodegradation and other processes, rather than relying solely on simple filter straining or physico-chemical sorption.

Slow sand filtration has demonstrated removal efficiencies in the 90 to 99.9999% range for viruses and greater than 99.99% for Giardia lamblia. Standard slow sand filtration expected to remove 5-25% of TOC.



Biological filters remove contaminants by three main mechanisms: biodegradation, adsorption of micropollutants, and filtration of suspended solids. The microbial growth attached to the filter media (biofilm) consumes the organic matter that would otherwise flow through the treatment plant and ultimately into the distribution system. The end products are carbon dioxide, water, biomass, and simpler organic molecules. Particle filtration takes place on the bare filter media as well as the biofilm. In biofilters used for biological denitrification, nitrate is converted to nitrogen. In this case, microorganisms are fed a form of carbon, and they use nitrate as an electron acceptor in place of oxygen. Granular activated carbon (GAC) is often used to provide the necessary surface to promote the development of the biofilm.

**Installed Costs: 3.** Open bed filters are fairly expensive to install.

**Operation and Maintenance Issues and Costs: 2.** Advantages of slow sand filtration include its low maintenance requirements (since it does not require backwashing and requires less frequent cleaning) and the fact that its efficiency does not depend on actions of the operator. However, slow sand filters do require time for the schmutzdecke to develop after each cleaning: during this "ripening period," however, filter performance steadily improves.

**References:** USEPA. (1999a). pp. 3-21; AwwaRF. (1993).

## Recommendation 4 ~ Anion Exchange

A physical-chemical process in which ions are swapped between a solution phase and a solid resin phase. The solid resin adsorbs anions and releases chloride into the water. pH 6.5 to 9.0 is optimal.

### Recommendation 4A ~ Anion Exchange.

Strong base anion exchange resin is specially designed to remove tannins and naturally occurring organic matter. Breakthrough can be avoided by careful monitoring and by running several columns in series, keeping the most recently regenerated column last. Can include mixed beds with ion & anion resins in same vessel.

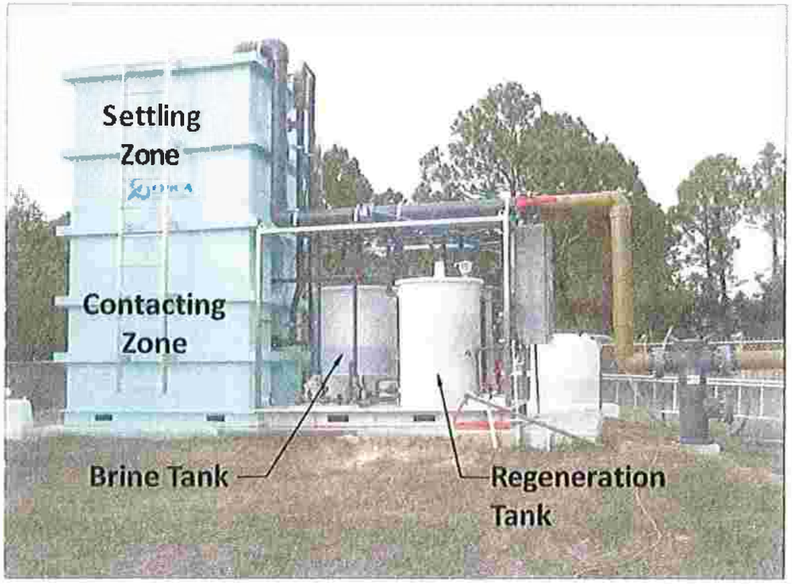
Most of the color in raw water is weakly acidic and thus can be exchanged with basic functionality of the resin. The non-ionic constituents get adsorbed on the resin beads due to Van-Der-Waal's attraction and because of the large surface area and macroporosity of the resin. The resin performs dual functions of chemical and physical adsorption of naturally occurring organic matter. The matter is stripped off by passing brine or alkaline brine solution through the resin.

**Installed Costs: 3.** Very effective to remove DBP precurors, TOC, iron, manganese, arsenic, nitrates, uranium, color, odor, and taste. Sulfates, nitrates, and other ions compete for adsorption sites.

**Operation and Maintenance Issues and Costs: 2.** Pre-filtration is recommended if source water turbidity is >0.3 NTU. Contaminant breakthrough can be avoided by careful monitoring and by running several columns in series, keeping the most recently regenerated column last. Brine disposal is a major concern.

**References:** AWWA. (1999). pp. 9.68 - 9.88

### Recommendation 4B ~ MIEX Treatment (Suspended Magnetic Anion Exchange).



MIEX® can specifically remove dissolved organic carbon (DOC) from natural water. This product has been installed in several Florida systems. The magnetic ion exchange resin has traditional ion exchange resin properties – is smaller and has a magnetic core. However, the resin is suspended in a stirred tank reactor and the raw water is fed upwards. Pre-filtration is recommended if source water turbidity is >0.3 NTU. Only 20% brine is produced as compared to ion exchange.

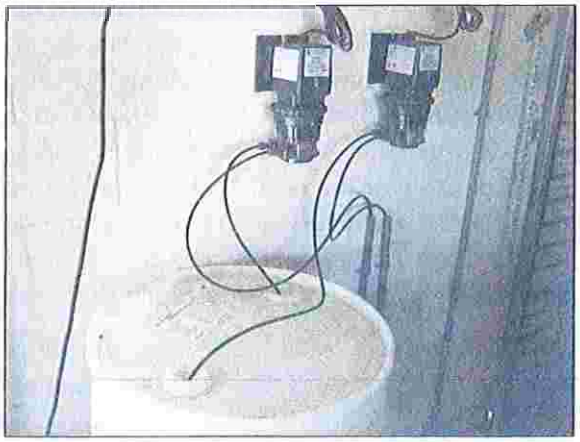
**Installed Costs: 3 to 4.** This is an excellent treatment scheme using anion resin coated over magnetic particles suspended in the water. Just introduced to Florida with high success rate from Australia mining industry.

**Operation and Maintenance Issues and Costs: 3 to 4.** Unique treatment scheme can be difficult to start up and adjust settings. Very effective to remove DBP precursors, TOC, iron, manganese, arsenic, nitrates, uranium, color, odor, and taste. Sulfates, nitrates, and other ions compete for adsorption sites.

**References:** USEPA. (2007a).; miexresin.com

## Recommendation 5 ~ Corrosion Control & Sequestration with Poly / Orthophosphates – 70% / 30% Blend

Poly / Orthophosphates have been found to improve disinfection efficiency of free chlorine for biofilm bacteria in iron pipes. Polyphosphate is used as a sequestering agent that formed soluble complexes with metallic ions. Orthophosphate is used to control corrosion for the Lead and Copper Rule as a 'best available technology' (BAT) to minimize the leaching of lead from water lines and brass fixtures into the drinking water.



Phosphates are inexpensive and easy to install – feed pump and drum. Small water plants may choose to either sequestrate with polyphosphates or remove iron and manganese. Sequestration only works for Fe and Mn. If the water contains less than 1.0 mg/L iron and less than 0.3 mg/L manganese, using polyphosphates followed by chlorination can be an effective and inexpensive method for mitigating iron and manganese problems. Below these concentrations, the polyphosphates combine with the iron and manganese preventing them from being oxidized. Orthophosphates inhibit control corrosion in water distribution systems. Blended phosphates rely on hydrolysis to maintain orthophosphate residual in system – actual phosphate concentration will increase with time in system and build up a protective coating on pipe walls which tends to lower chlorine demand. Expect a 10% reduction in DBPs.

Phosphates are added to groundwater at the well head or at the pump intake before the water has a chance to come in contact with air or chlorine. This ensures that the iron and manganese stays in a soluble form. No sludge is generated in this method.

**Installed Costs: 1.** Simple installation uses a chemical feed pump and drum storage. Corrosion in a system can be reduced by adjusting pH and alkalinity, softening the water, and changing the level of dissolved oxygen. Expected DBP 10% reduction.

**Operation and Maintenance Issues and Costs: 1.** Any corrosion adjustment program should include monitoring as water characteristics change over time

**References:** USACE. (1999). p. 6-13 –6-14

## Recommendation 6 ~ Enhanced Coagulation

### Conventional Water Treatment involves coagulation, flocculation, and clarification followed by filtration

Enhanced coagulation is an applicable treatment technique ONLY if the source water is surface water or ground water under the direct influence (Subpart H system); and the utility uses conventional treatment (i.e., flocculation, coagulation or precipitative softening, sedimentation, and filtration). Enhanced coagulation is the term used to define the process of obtaining improved removal of DBP precursors by conventional treatment. Enhanced softening refers to the process of obtaining improved removal of DBP precursors by precipitative softening.

Chemical coagulation and flocculation consists of adding a chemical coagulant combined with mechanical flocculation (rapid mix) to allow fine suspended and some dissolved solids to clump together (floc). Clarification allows the flocs to settle and then the water is filtered. The conventional chemical and physical treatment process removes suspended solids removal in surface waters – this includes turbidity, silt, odor, color and other particulates including bacteria. Routine check of chemical feed equipment is necessary several times during each work period to prevent clogging and equipment wear, and to ensure adequate chemical supply. Routine checks of contaminant buildup in the filter is required, as well as filter backwash. Recharging or clean installation of media is periodically required.

The coagulants effective for removing TOC include:

- Regular Grade Alum (Aluminum Sulfate) $Al_2[SO_4]_3*14H_2O$,
- Reagent Grade Alum $Al_2[SO_4]_3*18H_2O$,
- Polyaluminum Chloride (PACl), cationic polymers,
- Ferric Chloride $FeCl_3*6H_2O$,
- Ferric Chloride $FeCl_3$,
- Ferric Sulfate $Fe_2(SO_4)_3*9H_2O$, and
- Ferrous Sulfate $FeSO_4*7H_2O$.

For TOC removal high coagulant doses requires significant coagulant doses. Required Treatment Technique for some systems once LT2SWTR Rule is in effect.

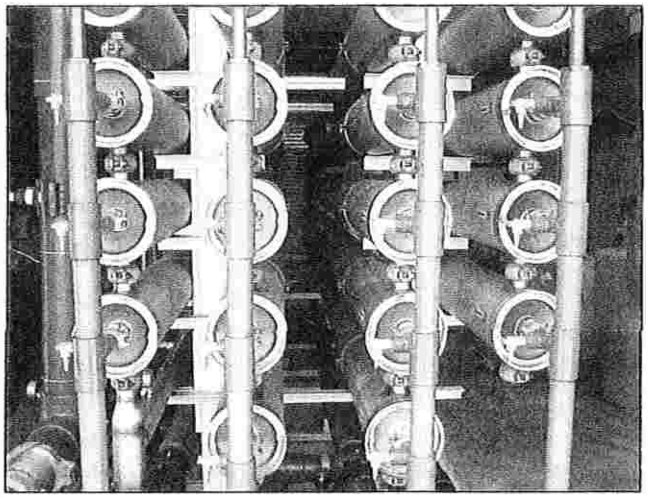
Alum (aluminum sulfate) is one of the most widely used coagulants in water treatment. Alum is commercially available in dry powder, granule, or lump form, and as a liquid. For small water plants, liquid alum is usually most practical. When alum is added to water, insoluble precipitates such as aluminum hydroxide $Al(HO)_3$ are formed. Alum is used suspended solids removal in surface waters – this includes turbidity, silt, odor, color and other particulates including bacteria.

**Installed Costs: 4.** Suitable primarily for conventional surface water plants. Nature of source water organic material, treatment conditions (coagulation pH) and background alkalinity control effectiveness.

**Operation and Maintenance Issues and Costs: 3.** Requires significant coagulant doses. Required Treatment Technique for some systems once LT2SWTR Rule is in effect.

**References:** USEPA (1999b)., MWH. (2005). pp. 247-258; AWWA. (1999). 6.2 - 6.62

## Recommendation 7 ~ Membrane Filtration
### including Nanofiltration (NF) and Reverse Osmosis (RO)



Membrane Filtration is the process for separating larger size solutes from aqueous solutions by means of a semi-permeable membrane.

Membranes remove a high variety of contaminants depending on the membrane type – arsenic, fluoride, iron, calcium, manganese, nitrates, odor, color, DBP precursors, etc. More stringent water quality regulations and inadequate water resources are making membrane technology increasingly popular as an alternative treatment technology for drinking water. Membranes are some of the more expensive processes to install and operate. Post treatment corrosion control may be required, high operational cost, concentrate disposal issues must be evaluated.

NF employs a spiral membrane configuration with larger pore size than RO, down to 0.001 micron. NF employs pressures between 100 to 200 psi for operation. Softening. 60-80% of all ions are rejected, 90-95% of divalent ions (sodium chloride) are removed, and organic compounds in the 300 to 1000 molecular weight range are eliminated, the technology is also very effective for removing color and DBP precursors.

**Installed Costs: 5.** Membrane processes are the most expensive to construct and operate. This alternative may make sense for larger systems but the cost puts them out of reach for smaller systems – typically $15 to $20 per gallon. Requires chemical addition, pre-treatment acidification / conditioning, and post-treatment re-stabilization.

A large cost component of membrane systems is the disposal of reject / brine with high TDS that require expensive deep wells or rapid infiltration basins. In Florida deep injection wells start at $3.5M.

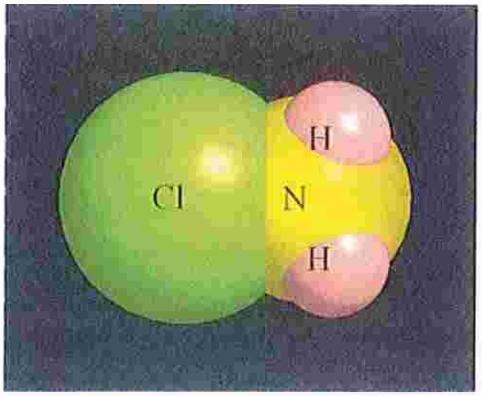
**Operation and Maintenance Issues and Costs: 4.** NF is an expensive membrane processes to construct and operate. Requires chemical addition and post treatment stabilization. Reject water has high TDS and must be carefully disposed using expensive measures such as deep well injection.

**References:** MWH. (2005). pp. 1429-1506

## Recommendation 8 ~ Last Choice ~ CHLORAMINES
### (monochloramine $NH_2Cl$)

Chloramination is NOT RECOMMENDED by FRWA. Although chloramines are inexpensive and easy to install (feed pump and drum) their by-products may be ultimately more health adverse and subject to future regulation. Chloramines have been shown to pose simultaneous compliance problems such as nitrification, biofilm regrowth and degraded water quality. Chloramine is a mixture of ammonia and chlorine, and is more persistent but less potent in distribution systems. Chloramine is generated onsite using Ammonium Hydroxide $NH_3$ or Ammonium Sulfate $(NH_4)2SO_4$ (is preferred). Minimum allowed residual is 0.6 mg/L

The very stable monodichloramine is produced by combining by weight, approximately 4.5 parts of chlorine to 1 part of ammonia. FRWA recommends against adding ammonia (a by-product of waste) to drinking water. Chloramine is an effective bactericide that produces fewer disinfection by-products.



**Installed Costs: 1.** Chloramine is inexpensive and relatively easy to generate onsite using Ammonium Hydroxide $NH_3$ or Ammonium Sulfate $(NH_4)2SO_4$ (is preferred). Installation includes a chemical feed pump and drum.

**Operation and Maintenance Issues and Costs: 2.** Minimum allowed residual is 0.6 mg/L. Chloramine residual can drop without warning – recommend the use of ORP meters[7] to monitor for nitrification. Chloramines may pose simultaneous compliance problems such as nitrification, biofilm regrowth and degraded water quality.

**References:** USEPA. (1999). pp. 6-1– 6-29

## Treatment Techniques not included in DBP Recommendations.

The following treatment techniques have not been included with recommended alternatives mostly because of their ineffectiveness with DBP reduction and/or problematic operation. Potassium and Sodium Permanganate were close to be placing on this list due to problematic operation alone.

- Activated Alumina Adsorption
- Bag / Cartridge Filtration
- Bubble Diffusers
- Chlorine Dioxide
- Diatomaceous Earth Filtration
- Direct Filtration
- Electrodialysis (ED)
- Ion Exchange
- Lime Softening
- Microfiltration (MF)
- pH Adjustment
- Silicates
- Spray Aeration
- Ultrafiltration (UF)
- UV Radiation

## References:

AWWA. (1999). *Water Quality & Treatment–A Handbook of Community Water Supplies*. Fifth edition. McGraw-Hill, Inc.

AwwaRF. (1993). Eighmy, T.T., et al, *Biologically Enhanced Slow Sand Filtration for Removal of Natural Organic Matter*, Denver Colo.: AwwaRF

AwwaRF. (1996). Anselme, C & Jacobs, E.P, *Water Treatment Membrane Processes*, Chapter 10, American Water Works Research Foundation, McGraw Hill,

AwwaRF. (1999). Maintaining and Operating Finished Water Storage Facilities to Prevent Water Quality Deterioration.

AwwaRF (2000a). Guidance Manual for Maintaining Distribution System Water Quality.

AwwaRF (2000b). Water Quality Modeling of Distribution System Storage Facilities. Grayman et al.

Carroll, S. et al. (2012, Spring). Water Age and Water Quality Deterioration. The Floridan. Florida Department of Environmental Protection. 4:10, pp. 7, 12-13.

MWH. (2005). *Water Treatment Principles and Design*. Second Edition. John Wiley & Sons.

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[7] Oxidation Reduction Potential meters are the most accurate way of tracking nitrification and nitrifying bacteria growth in the distribution system. See http://www.hach.com/hqdguide?gclid=Cley6OS3v5wCFUdM5QodMi29nQ

NRWA. (1992). *Training Guide: Filters and Filtration.* National Rural Water Association. TGR-24-92

Reiss, R. et al (2010, March). *Unidirectional Flushing: Enhance Water Quality and Improve Customer Relations.* Opflow, AWWA. 36:3, pp. 10-14

USACE. (1999). *Design of Small Water Systems*, Engineer Manual 1110-2-503,

USACE. (2001). *Engineering and Design, Air Stripping.* Design Guide. 1110-1-3.

USEPA. (1998). *Small System Compliance Technology List for the Surface Water Treatment Rule and Total Coliform Rule.* EPA #815-R-98-001.

USEPA. (1999a). *Alternative Disinfectants and Oxidants Guidance Manual.* EPA #815-R-99-014. Available online at: http://www.epa.gov/safewater/mdbp/implement.html

USEPA. (1999b). *Enhanced Coagulation and Enhanced Precipitative Softening Guidance Manual.* EPA #815-R-99-012. Available online at: http://www.epa.gov/safewater/mdbp/implement.html

USEPA. (2001). *Controlling Disinfection By-Products and Microbial Contaminants in Drinking Water.* EPA #600-R-01-110. Available online at: http://www.epa.gov/nrmrl/pubs0199.html

USEPA (2002). *Effects of Water Age on Distribution System Water Quality.* Prepared by AWWA with assistance from Economic and Engineering Services, Inc. Available online at: http://www.epa.gov/safewater/disinfection/tcr/regulation_revisions.html

USEPA. (2006). *Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule.* EPA #815-R-06-007. Available online at: http://www.epa.gov/safewater/disinfection/lt2/compliance.html.

USEPA. (2007a). *Simultaneous Compliance Guidance Manual for the Long Term 2 and Stage 2 DBP Rules.* EPA #815-R-07-017. Available online at: http://www.epa.gov/safewater/disinfection/stage2/compliance.html

USEPA. (2007b). *Removing Multiple Contaminants from Drinking Water: Issues to Consider*[8]. EPA #816-H-07-004, Available online at: http://www.epa.gov/OGWDW/treatment/pdfs/poster_treatment_technologies.pdf

USEPA. (2008). *Stage 2 Disinfectants and Disinfection Byproducts Rule– Operational Evaluation Guidance Manual.* EPA# 815-R-08-018, Available online at: http://www.epa.gov/ogwdw/disinfection/stage2/pdfs/draft_guide_stage2_operationalevaluation.pdf

## Abbreviations/ Acronyms:

| | |
|---|---|
| AOC | Assimilable organic carbon |
| ASDWA | Association of State Drinking Water Administrators |
| AWWA | American Water Works Association |
| AWWARF | AWWA Research Foundation |
| BAC | Biologically active carbon |
| BAF | Biologically active filtration |
| BAT | Best Available Technology |
| BDOC | Biological dissolved organic carbon |
| BMP | Best management practice |

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[8] USEPA. (2007). *Removing Multiple Contaminants from Drinking Water: Issues to Consider.* EPA 816-H-07-004, http://www.epa.gov/OGWDW/treatment/pdfs/poster_treatment_technologies.pdf

| | |
|---|---|
| BOM | Biodegradable organic matter (BOM = BDOC + AOC) |
| $Cl_2$ | Chlorine |
| $ClO_2$ | Chlorine Dioxide |
| CT | Concentration-Time |
| CT | Disinfectant residual × contact time |
| DBPs | Disinfection By-Products |
| DOC | Dissolved Organic Carbon |
| EBCT | Empty bed contact time |
| EPA | Environmental Protection Agency |
| ESWTR | Enhanced Surface Water Treatment Rule |
| FBR | Filter Backwash Rule |
| Fe | Iron |
| GAC | Granular Activated Carbon Adsorption / Filtration (can include powdered activated carbon) |
| GWR | Ground Water Rule |
| $H_2O_2$ | Hydrogen Peroxide |
| $H_2S$ | Hydrogen Sulfide |
| HAASs | Haloacetic Acids |
| MCL | Maximum Contaminant Level |
| MCLG | Maximum Contaminant Level Goal |
| mg/L | milligrams per liter |
| MGD | Million Gallons per Day |
| MRDL | Maximum Residual Disinfectant Level (as mg/l) |
| MRL | Minimum Reporting Level |
| NOM | Natural Organic Matter |
| $O_2$ | Oxygen |
| $O_3$ | Ozone |
| POE | Point-of-Entry Technologies |
| POU | Point-of-Use Technologies |
| ppm | parts per million |
| PTA | Packed Tower Aeration |
| SDWA | Safe Drinking Water Act, or the "Act," as amended in 1996 |
| Stage 2 DBPR | Stage 2 Disinfectants and Disinfection Byproducts Rule |
| SWTR | Surface Water Treatment Rule |
| TOCs | Total Organic Carbon |
| TT | EPA has established specific treatment techniques (standards and removal processes) for certain contaminants underthe SDWA. |
| TTHMs | Total Trihalomethanes |
| UV | Ultraviolet |
| VOC | Volatile Organic Chemical |

# ENCLOSURE ~ 2.5

## $H_2O_2$ Safety Data Sheet

# SAFETY DATA SHEET

North American Version

# HYDROGEN PEROXIDE (35% =< Conc. < 50%)

## 1. PRODUCT AND COMPANY IDENTIFICATION

### 1.1. Identification of the substance or mixture

*Product name* : *HYDROGEN PEROXIDE (35% =< Conc. < 50%)*

Product grade(s) :
Interox® PFP 35% Hydrogen Peroxide
Interox® HP Food 35% Hydrogen Peroxide
Interox® Chem Grade 35%
Interox® Cosmetic Grade 35%
Interox® Food Grade 35% Hydrogen Peroxide
Interox® Universal Food Grade 35% Hydrogen Peroxide
Interox® Standard 35% Hydrogen Peroxide
Interox® Storage Grade 35% Hydrogen Peroxide
Interox® Technical Grade 35% Hydrogen Peroxide
Interox®Technical Grade 35/D Hydrogen Peroxide
Interox®Technical Grade 40% Hydrogen Peroxide
Interox® Crude Grade 40% Hydrogen Peroxide
Interox® SG 35 Hydrogen Peroxide

Chemical Name : Hydrogen peroxide
Synonyms : Hydroperoxide, Hydrogen dioxide
Molecular formula : $H_2O_2$
Molecular Weight : 34 g/mol

### 1.2. Use of the Substance/Mixture

Recommended use :
- Bleaching agent
- Chemical industry
- Electronic industry
- Metal treatment
- Odour agents
- Oxidising Agents
- Textile industry
- Water treatment
- Pulp and paper

Recommended use
- Food additive

### 1.3. Company/Undertaking Identification

Address :
SOLVAY CHEMICALS, INC.
3333 RICHMOND AVENUE
HOUSTON TX 77098-3099
United States

### 1.4. Emergency and contact telephone numbers

**Emergency telephone** : **1 (800) 424-9300 CHEMTREC ® (USA & Canada)**
**01-800-00-214-00 (MEX. REPUBLIC)**

**Contact telephone number (product information):** : **US: +1-800-765-8292 (Product Information)**
**US: +1-713-525-6500 (Product Information)**

P 16414/USA
Issuing date 05/23/2010/ Report version 1.4

www.solvaychemicals.us

SOLVAY
Chemicals

SOLVAY

## 2. HAZARDS IDENTIFICATION

### 2.1. Emergency Overview:

NFPA : H= 3 F= 0 I= 1 S=OX
HMIS : H= 3 F= 0 R= 1 PPE = Supplied by User; dependent on local conditions

*General Information*

Appearance : liquid
Colour : colourless
Odour : pungent

*Main effects*

- Oxidizing properties
- Harmful if swallowed.
- Irritating to respiratory system and skin.
- Risk of serious damage to eyes.

### 2.2. Potential Health Effects:

*Inhalation*

- Inhalation of vapours is irritating to the respiratory system, may cause throat pain and cough.
- Repeated or prolonged exposure: Risk of sore throat, nose bleeds, chronic bronchitis.

*Eye contact*

- Severe eye irritation
- Redness
- Lachrymation
- Swelling of tissue
- Risk of serious damage to eyes.

*Skin contact*

- Irritation
- Risk of: Causes burns..

*Ingestion*

- Severe irritation
- Ingestion causes burns of the upper digestive and respiratory tracts.
- Nausea
- Vomiting
- Bloating of stomach, belching.
- Risk of chemical pneumonitis from product inhalation.

*Other toxicity effects*

- See section 11: Toxicological Information

### 2.3. Environmental Effects:

- See section 12: Ecological Information

## 3. COMPOSITION/INFORMATION ON INGREDIENTS

**Hydrogen peroxide**

CAS-No. : 7722-84-1
**Concentration : >= 35.0 - < 50.0 %**

## 4. FIRST AID MEASURES

**4.1. Inhalation**

- Remove to fresh air.
- If symptoms persist, call a physician.

**4.2. Eye contact**

- Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
- In the case of difficulty of opening the lids, administer an analgesic eye wash (oxybuprocaine).
- Consult with an ophthalmologist immediately in all cases.

**4.3. Skin contact**

- Remove and wash contaminated clothing before re-use.
- *Wash off with plenty of water.*
- Keepwarm and in a quiet place.
- Consult a physician.

**4.4. Ingestion**

- Call a physician immediately.
- Take victim immediately to hospital.

***If victim is conscious:***

- If swallowed, rinse mouth with water (only if the person is conscious).
- Do NOT induce vomiting.

***If victim is unconscious but breathing:***

- Artificial respiration and/or oxygen may be necessary.

## 5. FIRE-FIGHTING MEASURES

**5.1. Suitable extinguishing media**

- Water
- Water spray

**5.2. Extinguishing media which shall not be used for safety reasons**

- None.

**5.3. Special exposure hazards in a fire**

- Oxygen released in thermal decomposition may support combustion
- Contact with combustible material may cause fire.
- Contact with flammables may cause fire or explosions.
- Risk of explosion if heated under confinement.

**5.4. Hazardous decomposition products**

- Oxygen
- The release of other hazardous decomposition products is possible.

**5.5. Special protective equipment for fire-fighters**

- Evacuate personnel to safe areas.
- In the event of fire, wear self-contained breathing apparatus.
- When intervention in close proximity wear acid resistant over suit.
- Clean contaminated surface thoroughly.

**5.6. Other information**

- Keep product and empty container away from heat and sources of ignition.
- Keep containers and surroundings cool with water spray.
- Approach from upwind.

## 6. ACCIDENTAL RELEASE MEASURES

### 6.1. Personal precautions

- Refer to protective measures listed in sections 7 and 8.
- Isolate the area.
- Keep away from incompatible products.
- Prevent further leakage or spillage if safe to do so.
- In case of contact with combustible material, keep material wet with plenty of water.

### 6.2. Environmental precautions

- In case of accidental release or spill, immediately notify the appropriate authorities if required by Federal, State/Provincial and local laws and regulations.
- Do not dump into any sewers, on the ground, or into any body of water. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations.

### 6.3. Methods for cleaning up

- Dam up.
- Soak up with inert absorbent material.
- Dilute with plenty of water.
- Do not add chemical products.
- Treat recovered material as described in the section "Disposal considerations".
- Never return spills in original containers for re-use.

## 7. HANDLING AND STORAGE

### 7.1. Handling

- Use only in well-ventilated areas.
- Keep away from heat.
- Keep away from incompatible products.
- May not get in touch with:
- Organic materials
- Use only equipment and materials which are compatible with the product.
- Before all operations, passivate the piping circuits and vessels according to the procedure recommended by the producer.
- Never return unused material to storage receptacle.
- Use only in an area with adequate water supply
- Containers and equipment used to handle the product should be used exclusively for that product.

### 7.2. Storage

- Keep in a cool, well-ventilated place.
- Keep away from heat.
- Keep away from incompatible products.
- Keep away from combustible material.
- Store in a receptacle equipped with a vent.
- Store in original container.
- Keep container closed.
- Keep in a bunded area.
- Regularly check the condition and temperature of the containers.
- Information about special precautions needed for bulk handling is available on request.

### 7.3. Packaging material

- aluminium 99,5 %
- stainless steel 304L / 316L
- Approved grades of HDPE.

### 7.4. Other information

- Refer to protective measures listed in sections 7 and 8.
- Do not confine the product in a circuit, between closed valves, or in a container without a vent.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

### 8.1. Exposure Limit Values

**Hydrogen peroxide**

- US. ACGIH Threshold Limit Values 2009
  time weighted average = 1 ppm
- US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) 02 2006
  *Permissible exposure limit = 1 ppm*
  Permissible exposure limit = 1.4 mg/m3
- US. OSHA Table Z-1-A (29 CFR 1910.1000) 1989
  time weighted average = 1 ppm
  time weighted average = 1.4 mg/m3
- US. Tennessee. OELs. Occupational Exposure Limits. Table Z1A 06 2008
  time weighted average = 1 ppm
  time weighted average = 1.4 mg/m3

ACGIH® and TLV® are registered trademarks of the American Conference of Governmental Industrial Hygienists.
SAEL = Solvay Acceptable Exposure Limit. Time Weighted Average for 8 hour workdays. No Specific TLV STEL (Short Term Exposure Level) has been set. Excursions in exposure level may exceed 3times the TLV TWA for no more thana totalof30minutes during a workday and under no circumstances should they exceed 5 times the TLV TWA.

### 8.2. Engineering controls

- Ensure adequate ventilation.
- Apply technical measures to comply with the occupational exposure limits.
- Refer to protective measures listed in sections 7 and 8.

### 8.3. Personal protective equipment

#### *8.3.1. Respiratory protection*

- Self-contained breathing *apparatus in medium confinement/insufficient oxygen/in case of large uncontrolled* emissions/in all circumstances when the mask and cartridge do not give adequate protection.
- Use only respiratory protection that conforms to international/ national standards.
- Use NIOSH approved respiratory protection.
- Wear an approved full-face air supplied respirator for excessive or unknown concentrations. Selected chemical cartridges for respirators, i.e. OV, OV/AG, GME have been tested successfully under lab conditions to remove hydrogen peroxide and peracetic acid vapors in concentrations exceeding the applicable exposure limits. Further information is available in a Solvay Chemicals, Inc. Technical Communication, located at http://www.solvaychemicals.us/resource.htm in the Peractic Acid section.

#### *8.3.2. Hand protection*

- Protective gloves - Impervious chemical resistant:
- PVC
- Rubber gloves
- Take note of the information given by the producer concerning permeability and break through times, and of special workplace conditions (mechanical strain, duration of contact).

#### *8.3.3. Eye protection*

- Chemical resistant goggles must be worn.
- If splashes are likely to occur, wear:
- Tightly fitting safety goggles
- Face-shield

#### *8.3.4. Skin and body protection*

- Protective suit
- If splashes are likely to occur, wear:
- Apron
- Boots
- Suitable material
- PVC
- Rubber products

#### *8.3.5. Hygiene measures*

- Use only in an area equipped with a safety shower.
- Eye wash bottle with pure water
- When using do not eat, drink or smoke.
- Handle in accordance with good industrial hygiene and safety practice.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

### 9.1. General information

| | | |
|---|---|---|
| **Appearance** | : | liquid |
| **Colour** | : | colourless |
| **Odour** | : | pungent |

### 9.2. Important health safety and environmental information

| | | |
|---|---|---|
| **pH** | : | 1 - 4<br>*Remarks*: Apparent pH |
| **Boiling point/boiling range** | :<br>: | 108 °C ( 226 °F) ($H_2O_2$ 35 %)<br>115 °C ( 239 °F )($H_2O_2$ 50 %) |
| **Flash point** | : | *Remarks*: The product is not flammable. |
| **Flammability** | : | *Lower explosion limit*:<br>*Remarks*: The product is not flammable. |
| **Explosive properties** | : | *Explosion danger*:<br>*Remarks*: With certain materials (see section 10).<br>*Remarks*: In case of heating: |
| **Oxidizing properties** | : | *Remarks*: yes |
| **Vapour pressure** | :<br><br>:<br><br><br>: | 1 mbar ($H_2O_2$ 50 %)<br>*Temperature*: 30 °C ( 86 °F )<br>12 mbar ($H_2O_2$ 50 %)<br>*Remarks*: Total pressure ($H_2O_2$ + $H_2O$)<br>*Temperature*: 20 °C ( 68 °F)<br>72 mbar ($H_2O_2$ 50 %)<br>*Remarks*: Total pressure ($H_2O_2$ + $H_2O$)<br>*Temperature*: 50 °C ( 122 °F ) |
| **Relative density / Density** | : | 1.1 ($H_2O_2$ 27,5 %)1.2 ($H_2O_2$ 50 %) |
| **Solubility** | :<br>:<br>: | Soluble in:<br>Water<br>Polar organic solvents |
| **Partition coefficient:** | : | *log Pow*: |

**n-octanol/water** -1.1

**Viscosity** : 1.17 mPa.s ($H_2O_2$ 50 %)
*Temperature*: 20 °C ( 68 °F )
: 1.07 mPa.s ($H_2O_2$ 27,5 %)

**Vapour density** : 1 ($H_2O_2$ 50 %)

**9.3. Other data**

**Freezing point:** : -33 °C ( -27 °F) ($H_2O_2$ 35 % )
: -52 °C ( -62 °F) ($H_2O_2$ 50 % )

**Auto-flammability** : *Remarks*: The product is not flammable.

**Surface tension** : 75.6 mN/m ($H_2O_2$ 50 %)
*Temperature*: 20 °C ( 68 °F )
: 74 mN/m ($H_2O_2$ 27,5 %)

**Decomposition temperature** : >=60°C(140°F)
*Remarks*: Self-Accelerating decomposition temperature (SADT)
: <60°C( 140°F)
*Remarks*: Slow decomposition

## 10. STABILITY AND REACTIVITY

**10.1. Stability**

- Potential for exothermic hazard
- Stable under recommended storage conditions.

**10.2. Conditions to avoid**

- Contamination
- To avoid thermal decomposition, do not overheat.
- Keep at temperature not exceeding: 60 °C ( 140 °F )
- Keep at temperature not exceeding: 60 °C ( 140 °F )

**10.3. Materials to avoid**

- Acids, Bases, Metals, Salts of metals, Reducing agents, Organic materials, Flammable materials

**10.4. Hazardous decomposition products**

- Oxygen
- The release of other hazardous decomposition products is possible.

## 11. TOXICOLOGICAL INFORMATION

**Toxicological data**

***Acute oral toxicity***

- LD50, rat, 1,232 mg/kg ($H_2O_2$ 35 %)

***Acute inhalation toxicity***

- LC50, 4 h, rat, 2,000 mg/m3 (Hydrogen peroxide)

***Acute dermal irritation/corrosion***

- LD50, rabbit, > 2,000 mg/kg ($H_2O_2$ 35 %)

***Skin irritation***

- rabbit, Skin irritation ($H_2O_2$ 35 %)

*Eye irritation*
- Risk of serious damage to eyes. ($H_2O_2$ 35 %)

*Irritation (other route)*
- Inhalation, mouse, Irritating to respiratory system., RD 50= 665 mg/m3 (Hydrogen peroxide)

*Sensitisation*
- guinea pig, Did not cause sensitization on laboratory animals.

*Chronic toxicity*
- Oral, Prolonged exposure, Various species, Target Organs: Gastrointestinal tract, observed effect
- Inhalation, Repeated exposure, dog, Lowest observable effect level: 14.6 mg/m3, irritant effects

*Carcinogenicity*
- Oral, Prolonged exposure, mouse, Target Organs: duodenum, carcinogenic effects
- Dermal, Prolonged exposure, mouse, Animal testing did not show any carcinogenic effects.

*Genetic toxicity in vitro*
- In vitro tests have shown mutagenic effects.

*Genetic toxicity in vivo*
- Animal testing did not show any mutagenic effects.

*Remarks*
- Irritating to eyes, respiratory system and skin.
- Risk of serious damage to eyes.
- Carcinogenic effect not applicable to human
- Irritating to skin and mucous membranes
- Risk of serious damage to eyes.

## 12. ECOLOGICAL INFORMATION

### 12.1. Ecotoxicity effects

*Acute toxicity*
- Fishes, Pimephales promelas, LC50, 96 h, 16.4 mg/l
- Fishes, Pimephales promelas, NOEC, 96 h, 5 mg/l
- Crustaceans, EC50, 48 h, 2.4 mg/l
- Crustaceans, NOEC, 48 h, 1 mg/l

*Chronic toxicity*
- Molluscs, NOEC, 56 Days, 2 mg/l
- Algae, Chlorella vulgaris, EC50, growth rate, 72 h, 4.3 mg/l
- Algae, Chlorella vulgaris, NOEC, 72 h, 0.1 mg/l

### 12.2. Mobility

- Air, Volatility, Henry's law constant (H) = 1 Pa.m³/mol
  Conditions: 20 °C
  Remarks: not significant
- Air, condensation on contact with water droplets
  Remarks: rain washout
- Water
  Remarks: The product evaporates slowly.
- Soil/sediments
  Remarks: non-significant evaporation and adsorption

### 12.3. Persistence and degradability

*Abiotic degradation*

- Air, indirect photo-oxidation, t 1/2 from 16 - 20 h
  Conditions: sensitizer: OH radicals
- Water, redox reaction, t 1/2 from 25 - 100 h
  Conditions: mineral and enzymatic catalysis, fresh water
- Water, redox reaction, t 1/2 from 50 - 70 h
  Conditions: mineral and enzymatic catalysis, salt water
- Soil, redox reaction, t 1/2 from 0.05 - 15 h
  Conditions: mineral catalysis

*Biodegradation*

- aerobic, t 1/2 < 2 min
  Conditions: biological treatment sludge
  Remarks: Readily biodegradable.
- aerobic, t 1/2 from 0.3 - 5 d
  Conditions: fresh water
  Remarks: Readily biodegradable.
- anaerobic
  Remarks: not applicable
- Effects on waste water treatment plants, inhibitor > 30 mg/l
  Remarks: Inhibitory action

### 12.4. Bioaccumulative potential

- Bioaccumulative potential
  Result: Does not bioaccumulate.

### 12.5. Other adverse effects

- no data available

### 12.6. Remarks

- Toxic to aquatic organisms.
- Nevertheless, hazard for the environment is limited due to product properties:
- . no toxicity of degradation products ($H_2O$ and $O_2$).
- Inherently biodegradable.
- Does not bioaccumulate.

## 13. DISPOSAL CONSIDERATIONS

### 13.1. Waste from residues / unused products

- In accordance with local and national regulations.
- Limited quantity
- Dilute with plenty of water.
- Flush into sewer with plenty of water.
- Large quantities:
- Contact manufacturer.

### 13.2. Packaging treatment

- Empty containers.
- Clean container with water.
- Dispose of rinse water in accordance with local and national regulations.
- Do not rinse the dedicated containers.
- The empty and clean containers are to be reused in conformity with regulations.

### 13.3. RCRA Hazardous Waste

- Listed RCRA Hazardous Waste (40 CFR 302) - No
- Unlisted RCRA Hazardous Waste (40 CFR 302) - Yes
- D001 (ignitable waste)

- D002 (corrosive waste)

## 14. TRANSPORT INFORMATION

| | |
|---|---|
| **UN-Number** | **2014** |

**IATA-DGR**

| | |
|---|---|
| Class | 5.1 |
| Sub-risks | CORROSIVE |
| Packing group | II |
| ICAO-Labels | 5.1 + 8 |

Proper shipping name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION

**IMDG**

| | |
|---|---|
| Class | 5.1 |
| Sub-risks | Corrosive |
| Packing group | II |
| ICAO-Labels | 5.1 + 8 |
| HI/UNNo. | 2014 |

Proper shipping name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION

**U.S. Dept of Transportation**

| | |
|---|---|
| Class (Subsidiary) | 5.1 (8) |
| Packing group | II |
| Label (Subsidiary) | Oxidising agent (Corrosive) |
| Marine pollutant: | no |
| Emergency Info: | ERG: 140 |

Proper shipping name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION

**Canada (TDG)**

| | |
|---|---|
| Class (Subsidiary) | 5.1 (8) |
| Packing group | II |
| Label (Subsidiary) | Oxidizer (Corrosive) |
| Marine pollutant: | no |
| Emergency Info: | ERG: 140 |

Proper shipping name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION

- IATA: forbidden over 40 %

## 15. REGULATORY INFORMATION

### 15.1. Inventory Information

| | | |
|---|---|---|
| **Toxic Substance Control Act list (TSCA)** | : - | In compliance with inventory. |
| **Australian Inventory of Chemical Substances (AICS)** | : - | In compliance with inventory. |
| **Canadian Domestic Substances** | : - | In compliance with Inventory. |

| | | |
|---|---|---|
| **List (DSL)** | | |
| **Korean Existing Chemicals List (ECL)** | : - | In compliance with inventory. |
| **EU list of existing chemical substances (EINECS)** | : - | In compliance with inventory. |
| **Japanese Existing and New Chemical Substances (MITI List) (ENCS)** | : - | One or more components not listed on inventory. |
| **Inventory of Existing Chemical Substances (China) (IECS)** | : - | One or more components not listed on inventory. |
| **Philippine Inventory of Chemicals and Chemical Substances (PICCS)** | : - | One or more components not listed on inventory. |
| **New Zealand Inventory of Chemicals (NZIOC)** | : - | One or more components not listed on inventory. |

### 15.2. Other regulations

*US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 302 Extremely Hazardous Substance (40 CFR 355, Appendix A)*
- not regulated.

*SARA Hazard Designation (SARA 311/312)*
- Acute Health Hazard: Yes.
- Fire Hazard: Yes.

*US. EPA Emergency Planning and Community Right-To-Know Act(EPCRA) SARA Title III Section 313 Toxic Chemicals (40 CFR 372.65) - Supplier Notification Required*
- not regulated.

*US. EPA CERCLA Hazardous Substances (40 CFR 302)*
- not regulated.

*US. New Jersey Worker and Community Right-to-Know Act (New Jersey Statute Annotated Section 34:5A-5)*
- yes.

*US. Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)*
- yes.

*US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)*
- WARNING! This product contains a chemical known to the State or California to cause cancer..

### 15.3. Classification and labelling

*Canada. Canadian Environmental Protection Act (CEPA). WHMIS Ingredient Disclosure List (Can. Gaz., Part II, Vol. 122, No. 2)*
- Oxidizing Material
- Corrosive Material
- Dangerously Reactive Material
- Toxic Material Causing Immediate and Serious Toxic Effects

Remarks: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

***EC Label***

- The product is classified and labelled in accordance with Directive 1999/45/EC.

| | | |
|---|---|---|
| Symbol(s) | Xn | Harmful |
| R-phrase(s) | R22 | Harmful if swallowed. |
| | R37/38 | Irritating to respiratory system and skin. |
| | R41 | Risk of serious damage to eyes. |
| S-phrase(s) | S 1/2 | Keep locked up and out of the reach of children. |
| | S26 | In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. |
| | S28 | After contact with skin, wash immediately with plenty of water. |
| | S36/37/39 | Wear suitable protective clothing, gloves and eye/face protection. |
| | S45 | In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). |

## 16. OTHER INFORMATION

**Ratings :**

**NFPA (National Fire Protection Association)**
Health = 3 Flammability = o Instability= 1 Special =OX

**HMIS (Hazardous Material Information System)**
Health = 3 Fire= o Reactivity = 1 PPE : Supplied by User; dependent on local conditions

**Further Information**

- The National Transportation Safety Board (NTSB) and Federal Aviation Administration (FAA) have requested the following information be provided:
- Combustible materials exposed to hydrogen peroxide should be immediately submerged in or rinsed with large amounts of water to ensure that all hydrogen peroxide is removed.
- Residual hydrogen peroxide that is allowed to dry (upon evaporation hydrogen peroxide can concentrate) on organic materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in a fire.
- Wear an approved full-face air supplied respirator for excessive or unknown concentrations. Selected chemical cartridges for respirators, i.e. OV, OV/AG, GME have been tested successfully under lab conditions to remove hydrogen peroxide and peracetic acid vapors in concentrations exceeding the applicable exposure limits. Further information is available in a Solvay Chemicals, Inc. Technical Communication, located at http://www.solvaychemicals.us/resource.htm in the Peracid Acid section.

Material Safety Data Sheets contain country specific regulatory information; therefore, the MSDS's provided are for use only by customers of the company mentioned in section 1 in North America. If you are located in a country other than Canada, Mexico or the United States, please contact the Solvay Group company in your country for MSDS information applicable to your location.

The previous information is based upon our current knowledge and experience of our product and is not exhaustive. It applies to the product as defined by the specifications. In case of combinations or mixtures, one must confirm that no new hazards are likely to exist. In any case, the user is not exempt from observing all legal, administrative and regulatory procedures relating to the product, personal hygiene, and integrity of the work environment. (Unless noted to the contrary, the technical information applies only to pure product).

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# ENCLOSURE ~ 2.6

## US Peroxide: Hydrogen Peroxide Application, Safety and Handling Guidelines, Field Methods and Test Kits, and Solution Properties

**USPeroxide**™

A TROJAN TECHNOLOGIES BUSINESS

# DRINKING WATER TREATMENT

## Hydrogen Peroxide Pre-Oxidant Application

## Features

### TTHM and HAA5 Reduction

- Recent water plant applications have demonstrated positive results in reducing TTHM and HAA5
- The use of $H_2O_2$ for TTHM and HAA5 reduction does not require expensive capital projects

### Taste and Odor Control

- $H_2O_2$ is equally or more effective than $KMnO_4$ for the removal of various taste and odor compounds

### Hydrogen Sulfide Removal

- $H_2O_2$ can effectively oxidize $H_2S$ to remove the taste and odor as well as corrosion associated with sulfides
- $H_2O_2$ is more economical than KMnO4 or chlorine and has no harmful by-products.

### Iron Removal

- $H_2O_2$ is very effective in the oxidation and precipitation of iron

NSF

$H_2O_2$ provided for this application by US Peroxide is certified under the ANSI/NSF Standard 60: Drinking Water Treatment Chemicals – Health Effects for use in the treatment of drinking water. The required dose rates will vary depending on the application and the individual characteristics of the municipal water plant.

The use of Hydrogen Peroxide ($H_2O_2$) as a pre-oxidant in municipal water treatment is well documented and has been practiced for over 15 years. Historical applications of $H_2O_2$ in drinking water have been for taste and odor control, hydrogen sulfide removal, iron removal and ozone enhancement/destruction. With the EPA Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) coming into effect, more recent emphasis has been on the reduction of the formation of total trihalomethanes (TTHM) and haloacetic acids (HAA5).

## TTHM and HAA5 Reduction

Stage 2 DBPR is put into effect to reduce potential cancer, reproductive and developmental health risks from disinfection byproducts (DBP's) in drinking water. Research on the use of $H_2O_2$ for this application is documented as early as the 1970's, with actual implementation in North American municipalities over the past several years. Recent water plant applications have demonstrated positive results in reducing TTHM and HAA5 as well as improving TOC reduction. In addition, some water plants have recently documented significant reductions in TTHM and HAA5 by the use of $H_2O_2$ in doses as low as 0.5 mg/L. Other benefits such as algae control and taste and odor improvement have also been documented.

The use of $H_2O_2$ for TTHM and HAA5 reduction does not require expensive capital projects so it can be easily integrated into existing water plant operations. This allows $H_2O_2$ to be full-scale pilot tested so that its benefits can be documented under a plant's specific conditions. This is a critical step since all source water varies in organics make-up and therefore individual plant results with the use of $H_2O_2$ may vary from plant to plant.

## Taste and Odor Control

Surface waters often contain objectionable taste and odor compounds. Many of these can be treated with $H_2O_2$. In a study conducted in the late 1980's*, $H_2O_2$ was equally or more effective than $KMnO_4$ for the removal of various taste and odor compounds. While $H_2O_2$ is successful in treating many taste and odor occurrences, in some instances it cannot control higher levels of geosmin and MIB. In these cases, an advanced oxidation process that involves the generation of hydroxyl radicals such as UV / $H_2O_2$ or Ozone / $H_2O_2$ is the recommended alternative.

## Ozone Enhancement/Ozone Residual Quenching

$H_2O_2$ can be used to enhance the performance of ozone systems for organic oxidation (e.g. taste & odor compounds, THM precursors) or for quenching of ozone residuals near the end of the contactors.

## Hydrogen Sulfide Removal

Hydrogen sulfide ($H_2S$) is a common taste and odor compound found in underground potable water sources characterized by a rotten egg odor and metallic taste. $H_2O_2$ can effectively oxidize $H_2S$ to remove the taste and odor as well as corrosion associated with sulfides. The oxidation reaction can be controlled under alkaline conditions to produce soluble sulfate and a minimal amount of colloidal sulfur; hence, turbidity is minimized. For this application $H_2O_2$ is more economical than $KMnO_4$ or chlorine and has no harmful by-products.

* *"Evaluating Oxidants for the Removal of Model Taste and Odor Compounds from a Municipal Water Supply", W.H. Glaze, R. Shep, W. Chauncey, E.C. Ruth, J.J. Zarnoch, E.M. Aieta, C.H. Tate, and M.J. McGuire, Journal of AWWA, May 1990.*

## Iron Removal

The removal of iron from potable water sources is aesthetically advantageous, since iron can discolor the water, spot laundry and stain plumbing fixtures. In addition, the growth of iron-oxidizing bacteria can result in abnormal taste and odor as well as contribute to biofouling in water distribution systems. $H_2O_2$ is very effective in the oxidation and precipitation of iron as it rapidly oxidizes iron to a ferric state to form dense, easily settled solids, which are then removed through conventional flocculation/ precipitation/filtration systems. $H_2O_2$ has a fast reaction rate and is also more economical for this application than $KMnO_4$ or chlorine.

## Safety

$H_2O_2$ stored and handled in a safe manner can be integrated into almost any environment, including raw water lift stations at water plant intakes or in the water plant itself. Compared to other chemicals typically used in water plants, $H_2O_2$ has a lower oxidizer class rating (see table below) making it easy to integrate into existing and new plants.

### NFPA Hazard Code of Common Chemicals

| Chemical | Health | Flammability | Reactivity |
|---|---|---|---|
| Ozone | 4 | 0 | 3 |
| Chlorine | 4 | 0 | 2 |
| Sodium Hypochlorite (12-15%) | 2 | 0 | 1 |
| Potassium Permanganate | 3 | 0 | 2 |
| Hydrogen Peroxide (35% & 50%) | 3 | 0 | 1 |

## About US Peroxide

US Peroxide is the leading supplier of hydrogen peroxide based technologies and services for environmental applications. We have been serving the Municipal market for over 15 years and have offices and field service locations throughout North America.

Our consultative approach to problem solving includes performing objective customer "needs" assessments, application modeling and development of chemical treatment programs tailored to a customer's specific requirements.

Use of full-service programs successfully integrates storage and dosing equipment systems, chemical supply, inventory and logistics management as well as ongoing field and technical support. This comprehensive operations and program management approach provides cost effective turn-key solutions to our customers.

Please contact one of our water specialists for assistance on your particular application.

### Hydrogen Sulfide Removal

$$H_2S + 4\,H_2O_2 \rightarrow SO_4^{2-} + 4\,H_2O + 2\,H^+$$

(for pH> 8)

### Ozone Enhancement & Residual Ozone Quenching

$$H_2O_2 + O_3 \rightarrow 2 \bullet OH + {}^3/_2\,O_2 \rightarrow H_2O + 2\,O_2$$

### Iron Removal

$$2\,Fe^{2+} + H_2O_2 + 2\,H^+ \rightarrow 2\,Fe{+}3 + H_2O{-}$$

## Treatment Benefits

US Peroxide treatment provides benefits over other oxidative technologies:

- **Economical**
- **Fast reaction rate**
- **Easily settled solids**
- **Minimal equipment requirements**

USPeroxide™
A TROJAN TECHNOLOGIES BUSINESS

U.S. Peroxide, LLC
900 Circle 75 Parkway, Suite 1330
Atlanta, GA 30339
www.h2o2.com

Inquiries call 877-346-4262 or
email: info@h2o2.com

# Safety and Handling Guidelines

Hydrogen peroxide is well-established as an environmentally-friendly, deodorizing and bleaching agent. Its uses include organic and inorganic chemical processing, textile and pulp bleaching, metal treating, cosmetic applications, catalysis of polymerization reactions, municipal odor control, industrial waste treatment (detoxification), and control of bulking in wastewaters. These uses are continually expanding, making it a necessity not only to understand the mode of hydrogen peroxide application but the safe handling of the chemical as well.

## Properties of Hydrogen Peroxide

A basic understanding of the properties of hydrogen peroxide is essential to the safe handling of this chemical. Hydrogen peroxide is clear, colorless, water like in appearance, and has a characteristic pungent odor. Nonflammable, it is miscible with water in all proportions and is sold as a water solution.

The amount of hydrogen peroxide in commercial solutions is expressed as a percentage of the solution's weight. Thus, a 35% solution contains 35% hydrogen peroxide and 65% water by weight. Most municipal and industrial applications call for 35% or 50% concentrations.

## Delivery and Storage

The methods available for delivery to bulk storage installations accommodate shipments of 70% hydrogen peroxide for dilution to the 35% or 50% storage concentrations. Solutions containing more than 8% hydrogen peroxide are classified by the U.S. Department of Transportation (DOT) as an oxidizer.

Under normal conditions hydrogen peroxide is extremely stable when properly stored. Rate loss in large containers such as tanks is less than 1% per year at normal ambient temperatures; in small containers, such as drums, rate loss is less than 2% per year. The larger the ratio of the storage container surface areas to the volume of hydrogen peroxide, the greater the rate loss.

Decomposition of hydrogen peroxide liberates oxygen and heat. In dilute solutions the heat evolved is readily absorbed by the water present. In more concentrated solutions, the heat raises the temperature of the solution and accelerates the decomposition rate. Special stabilizers are added during the manufacture of all grades of hydrogen peroxide to inhibit the catalytic decomposition effect of metals and other impurities that may accidentally contaminate the chemical during shipment, storage, and handling.

However, since no additive will prevent decomposition if excessive contamination occurs, the best practice is to prevent contamination through proper handling. All handling procedures must, therefore, be directed towards maintaining the same degree of purity and freedom from contamination as is maintained during the manufacturing process:

> Storage of hydrogen peroxide should be restricted to its original shipping container or to properly designed containers made of compatible materials which have been thoroughly passivated.
>
> Hydrogen peroxide that has been removed from the original shipping container should not be returned to it.
>
> All containers must be properly vented, and preferably stored away from sources of direct heat and combustible materials.
>
> Adequate ventilation and ample water supply for thorough flushing of accidental spillage on personnel and property should be provided.
>
> Hydrogen peroxide itself will not burn, but its decomposition liberates oxygen which supports combustion. Fires involving hydrogen peroxide are best controlled by using large quantities of water.

Hydrogen peroxide is not considered an explosive. However, when it is mixed with organic substances at significant concentrations, hazardous impact-sensitive compounds may result. Small amounts of other materials

### About US Peroxide

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that contain catalysts (silver, lead, copper, chromium, mercury, and iron oxide rust) can cause rapid decomposition and an explosive pressure rupture of the containing vessel if it is not properly vented.

In addition to accelerated decomposition through contamination, the decomposition rate of hydrogen peroxide is increased with alkalinity, contact with certain materials of construction, and increasing temperatures. The rate of decomposition increases approximately 2.2 times for each 10 degrees C rise in temperature in the range from 20 degrees C to 100 degrees C, or 1.5 times for each 10 degrees F rise from 68 degrees F to 212 degrees F.

Decreasing temperatures have little effect on hydrogen peroxide until they drop substantially below 0 degrees C. Crystals do not begin to appear in 35% and 50% solutions until -33C (-27.4F) and -52.2C (-62F), respectively.

## Eye Protection

Hydrogen peroxide and its decomposition products are not systematic poisons but contact with hydrogen peroxide can be irritating. Concentrated vapors cause discomfort in the mucous membranes and the eyes. Contact of the eyes with hydrogen peroxide is particularly dangerous because corneal burns can occur very rapidly. Therefore, safety glasses or, preferably, goggles should always be worn when handling concentrated hydrogen peroxide. If, however, any hydrogen peroxide does get in the eyes, flush eyes thoroughly with water and consult a physician promptly.

## Protective Clothing

In addition to eye protection, rubber gloves and suitable protective clothing such as aprons or cover alls made of polyester acrylic fiber, polyvinyl chloride, polyethylene, or neoprene should be worn when handling concentrated hydrogen peroxide. Protective clothing, which lacks fire resistance, must be washed thoroughly with water should it come in contact with hydrogen peroxide. If allowed to dry in the fabric, the chemical may cause fire, particularly if the clothing is soiled.

Contact with moderate concentrations of hydrogen peroxide will cause whitening of the skin and stinging sensations. The whitening is due to the formation of gas bubbles in the epidermal layer of the skin. The stinging, in most cases, subsides quickly after thorough washing, and the skin gradually returns to normal without any damage. Highly concentrated hydrogen peroxide can cause blistering if left on skin surfaces for any length of time.

Inhalation of hydrogen peroxide vapors can cause irritation and inflammation of the respiratory tract. For this reason, the American Conference or Government Industrial Hygienists has determined a Threshold Limit Value (LTV) or 1 ppm (1.4mg/m3) of hydrogen peroxide vapor in air as a maximum exposure limit for any eight-hour workday of a normal 40-hour work week. If hydrogen peroxide vapor is inhaled, fresh air should be sought at once; if the inhalation has been prolonged, a physician should be consulted immediately.

## Accidental Swallowing

Hydrogen peroxide, a mild disinfectant, is useful in counteracting various microorganisms. Because of their antiseptic action, dilute hydrogen peroxide solutions (3% or less) are frequently used to treat open wounds and can be used as a gargle or mouthwash. However, contact or concentrated solutions (over 3%) with the members of the mouth is to be avoided. Under no circumstances should hydrogen peroxide be taken internally. If hydrogen peroxide is swallowed, drink water immediately to dilute, and contact a physician but do not attempt to cause vomiting.

In using hydrogen peroxide, safety should be first in the minds of everyone, and as with any other chemical, initial steps should be taken to familiarize all personnel with its safe and proper handling. Acceptance of hydrogen peroxide in a wide variety of industrial applications is a reflection of its simplicity in use.

Maximum safety in handling hydrogen peroxide is assured through the use of proper materials of construction, recognition or the need for venting in storage, and overall avoidance of contamination. The oxygen and water by-products of decomposition are innocuous, but splashing, inhaling vapor, and ingesting hydrogen peroxide must be avoided. If by unusual circumstances an accident should take place, flushing with large quantities of plain water is the simple corrective action needed. By adhering to straight-forward common sense procedures, every aspect of your operation will be aimed toward safety and a clean environment.

*-FMC Pollution Control Release No. 24*

USPeroxide

[illegible] Circle 75 Parkway, Suite [illegible], Atlanta, GA [illegible]
Phone (404) [illegible] • Toll-free U.S. (877) [illegible] • Fax (404) [illegible]

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*Full-Service Wastewater Treatment Programs for Municipal, Industrial and Refinery Applications*

Home Technical Library Field Methods and Test Kits

Methods for Product Assay

Permanganate Titration
Ceric Sulfate Titration

Methods for Residual Peroxide Determination

Iodometric Titration
Titanium Oxalate (Spectrophotometric)
Cobalt - Bicarbonate
Peroxidase Enzyme

Additional Information

Field Methods and Test Kits
Analytical interferences Caused by Residual Peroxide

# Field Methods and Test Kits

The table below lists several easy-to-use products for measuring H2O2 residuals in the field. The more appropriate selection will depend on a number of factors including the concentration of H2O2 expected, the potential for interfering substances in the water, and the frequency of analysis. Note that the upper limit of each detection range is somewhat artificial, since higher concentrations of H2O2 may be determined by diluting the sample.

| | Test Strips | | | Test Kits | |
|---|---|---|---|---|---|
| **Manufacturer** | EM Science | Macherey-Nagel | CHEMetrics | La Motte | Hach |
| **Source** | Lab Safety Supply | Scientific Products | CHEMetrics | LaMotte | Hach |
| **Basis** | Peroxidase enzyme | Starch-Iodide | Iron Thiocyanate | DPD | Starch-Iodide, Thiosulfate |
| **Method** | Color comparison | Color comparison | Ampule color comparator titration | Disk color | Drop count colorimetric comparator |
| **Range, mg/L** | o 5-25 | 3-100 | 0 05-10 | 0 1-40 | 0 2-10 |
| **Interferences** | None likely or reducing agents | Oxidizing or reducing agents | Oxidizing or reducing agents | Oxidizing or reducing agents | Oxidizing or reducing agents |
| **Ease of Operation** | Very easy | Very easy | Easy | Moderate | Moderate |
| **Product Name** | Merckoquant Peroxide Test | Quantofix Peroxide | Peroxide Test Kit | Peroxide DPD Tablet | Model HYP-1 |
| **Manufacturer No.** | 10011-1 | 91312 | K-5510 | 3138 | 22917-00 |
| **Unit** | Tube of 100 strips | Tube or 100 strips | 30 ampules | Kit of 50 tests, refills available | Kit of 100 tests |
| **Cost** | $41.65 | $22.40 | $50.30 | $32.25 | $40.50 |
| **Comments** | Semi-quantitative, loses accuracy with age - must be refrigerated | Semi-quantitative, interferences may cause problems | Quantitative, poor sensitivity in lower ranges, interferences are common | Quantitative, poor sensitivity in lower ranges, interferences are common | Quantitative, interferences may cause problems |

Manufacturers and Sources

**EM Science** (division of EM Industries, Inc.). 480 N. Democrat Road, Gibbstown, NJ 08027. (856) 423-6300.

**Lab Safety Supply.** P.O. Box 1368, Janesville, WI 53547-1368. (800) 356-0783.

**Scientific Products** (division of Baxter Diagnostics). 1430 Waukegan Road, McGaw Park, IL 60085-6787. (800) 234-5227.

**CHEMetrics, Inc.** 4295 Catlett Road, Calverton, VA 22016. (800) 356-3072.

**Hach Company**, P.O. Box 608, Loveland, CO 80539-0608. (800) 227-4224.

**LaMotte, Inc.** Chestertown, MD 21620. (410) 778-3100.

## About US Peroxide

US Peroxide is a leading provider of hydrogen peroxide and peroxide based, performance-driven, full-service environmental treatment programs to help purify water, wastewater, soil and air. We specialize in turn-key solutions for municipal wastewater and drinking water treatment; refinery, gas, oil and petrochemical applications; industrial wastewater and air quality treatment; remediation; and UV-Oxidation.

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US Peroxide

[illegible] Circle 75 Parkway, Suite [illegible], Atlanta, GA [illegible]
Phone: [illegible] • Toll free U.S.: [illegible] • Fax: [illegible]
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*Full-Service Wastewater Treatment Programs for Municipal, Industrial and Refinery Applications*

Home Technical Library $H_2O_2$ Physical & Chemical Properties

H2O2 Physical & Chemical Properties

- H2O2 Physical Properties
- H2O2 Thermodynamic Properties
- H2O2 Electrical Properties
- H2O2 Radiation Properties

# Hydrogen Peroxide ($H_2O_2$) Solution Properties (CAS 7722-84-1)

Standard Grade hydrogen peroxide is formulated with an inorganic tin-based stabilizer system for high stability and long-term storage.

The 70% concentration can be diluted to 27%, 35% or 50% concentration with most ordinary tap water found in North America. This permits a customer to achieve maximum economy by purchasing hydrogen peroxide at 70% concentration and diluting it to 27%, 35% or 50% for storage. This hydrogen peroxide product is suitable for storage at 70% concentration if desired. Product diluted and drummed at terminal locations meets the stringent assay and stability specifications below.

Standard Grade Hydrogen Peroxide is used extensively for pulp, textile, and environmental applications. It is the most suitable grade available for industrial purposes and should be used whenever possible.

H2O2 has a molecular weight of 34.02 and is nonflammable at any concentration.

## Standard $H_2O_2$ Industrial Strengths

| **Specifications** | **27%** | **35%** | **50%** | **70%** |
|---|---|---|---|---|
| H2O2 content, % by weight | | | | |
| Product diluted at terminals | 26.6 - 27.4 | 35.0 - 35.8 | 50.0 - 50.8 | 70.0 - 70.8 |
| Stability, 24 hours @100° C | >96.0% | >96.0% | >96.0% | >96.0% |
| | | | | |
| **Typical Properties** | **27%** | **35%** | **50%** | **70%** |
| Loss in% assay, 1 yr, 25° C | <0.5 | <0.7 | <1.0 | <1.4 |
| Apparent pH | <3.7 | <3.7 | <3.0 | 0-1.0 |
| Sn, ppm | 19-27 | 25-35 | 36-50 | 50-70 |
| Active oxygen content, % | 12.7 | 16.5 | 23.5 | 32.9 |
| Specific gravity (20° C/4° C) | 1.10 | 1.13 | 1.20 | 1.29 |
| Lbs/gal (kg/$M^3$ or g/L) @ 20° C | 9.2(1102) | 9.4( 1126) | 10.0(1198) | 10.8(1294) |
| Boiling point, ° C (° F) | 105(222) | 108(226) | 114(237) | 126(259) |
| Freezing point, ° C (° F) | -23(-9) | -33(-27) | -52(-62) | -40(-40) |

Polyethylene drums: 15 gallon (56.6 liter), 30 gallon (113.6 liter), 55 gallon (208.2 liter). Bulk shipments are available in tank trucks and tank cars.

Hydrogen peroxide above 8% concentration is classified as an "Oxidizer" by the Department of Transportation and all containers must carry the yellow DOT label.

### About US Peroxide

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Phone: (404) 352-6070 • Toll-free U.S.: (877) 346-4262 • Fax: (404) 352-6077

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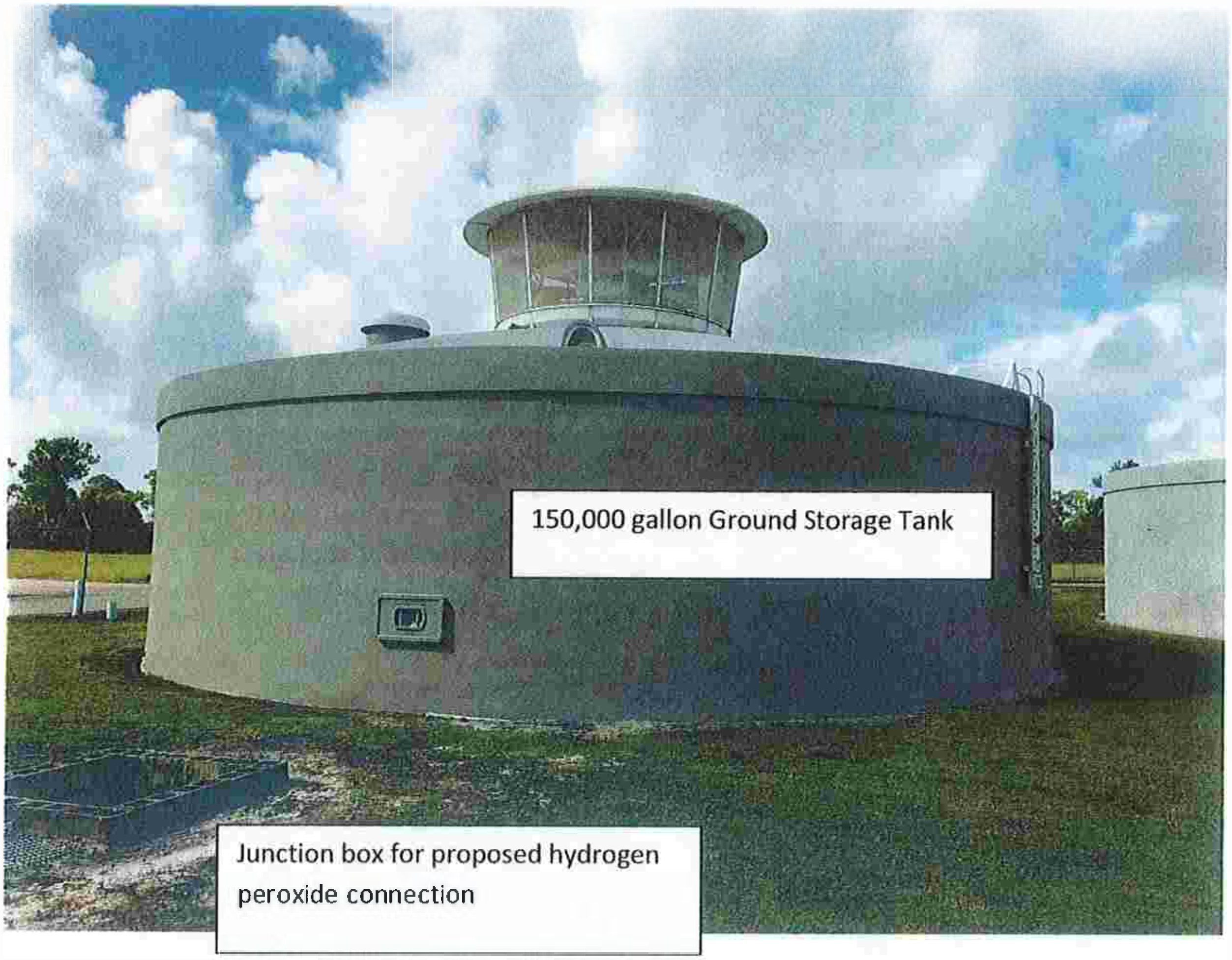
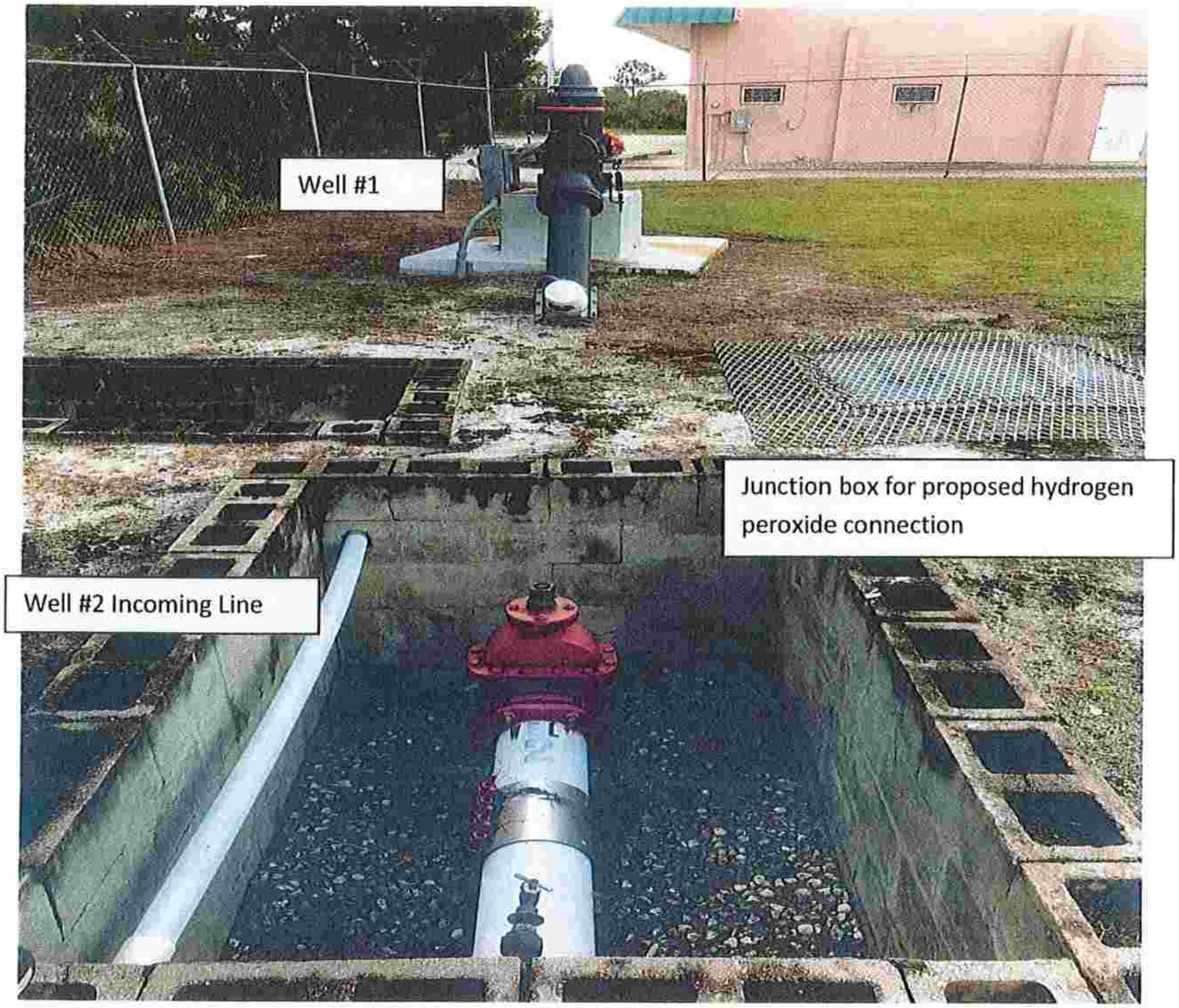
# ENCLOSURE ~ 2.7

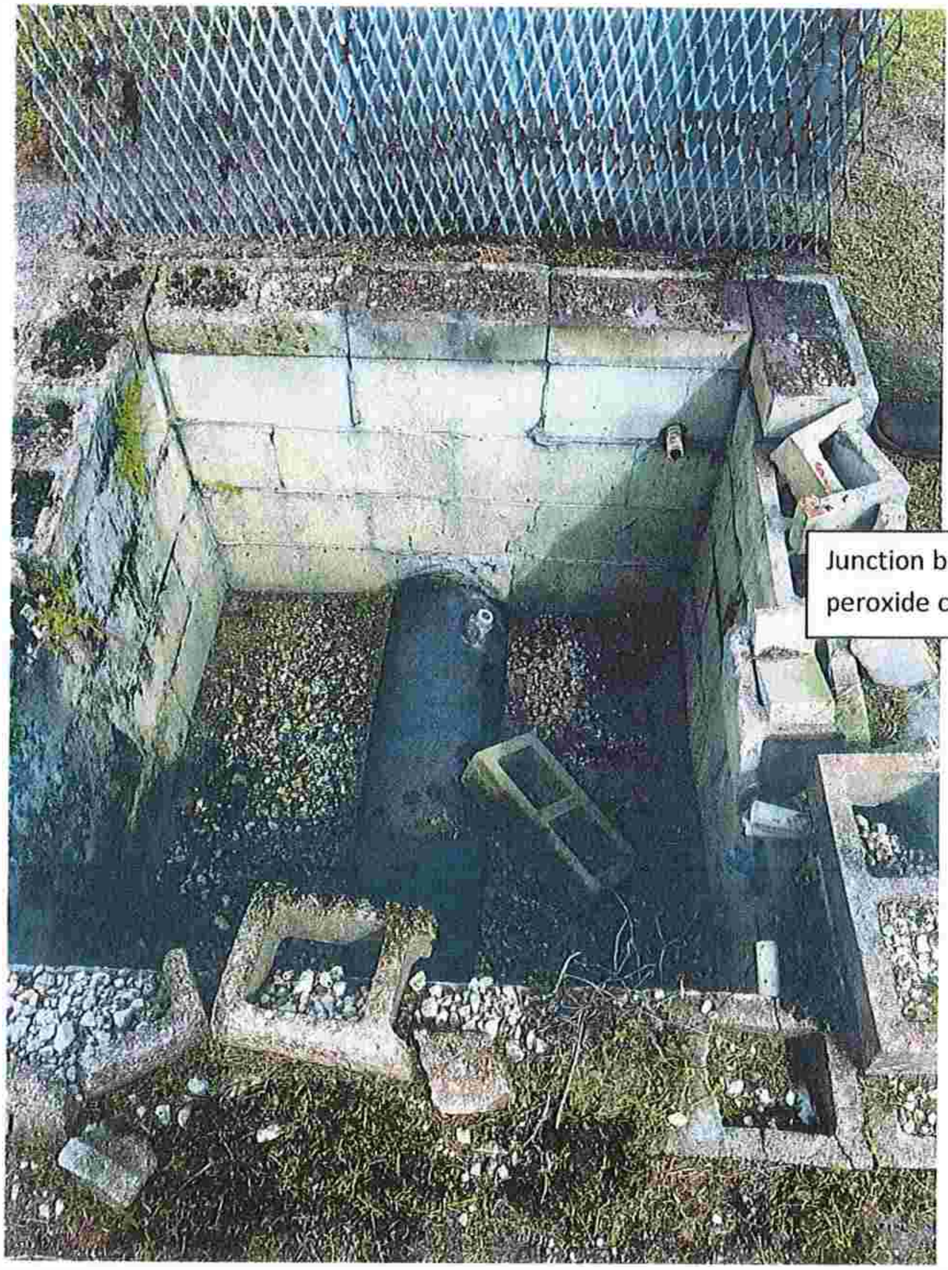
## Photographs



150,000 gallon Ground Storage Tank

Junction box for proposed hydrogen peroxide connection


Well #1
Junction box for proposed hydrogen peroxide connection
Well #2 Incoming Line



Junction box for proposed hydrogen peroxide connection

Approximate location for proposed chlorine and phosphate junction box

# ENCLOSURE ~ 3

## Final Certification Package

**FLORIDA RURAL WATER ASSOCIATION**
2970 WELLINGTON CIRCLE• TALLAHASSEE, FL 32309-7813
(850) 668-2746

August20,2018

**Save this letter for FINAL Certification**

Ms. Pam Brewer
Placid Lakes Utilities, Inc. Water Treatment Plant
410 Washington Blvd, NW
Lake Placid FL 33852
Phone: (863) 465-0345
Email: pambrewer@embarqmail.com

**Re: Final Certification for Hydrogen Peroxide as a Preoxidant to Improve Water Quality and Decrease Disinfection By-Product Precursors**
**Placid Lakes Utilities, Inc., Highland Co., PWS: 6280223**

Dear Ms. Brewer;

After the installation is complete you will need approval of the installation from the FDEP. CAUTION! Do not start using these new facilities until AFTER you receive the Final Clearance from FDEP – *otherwise your system may be subject to fines up to $5,000 and other enforcement action.*

Procedures for bringing the hydrogen peroxide system improvements online: Please carefully follow the instructions below once the hydrogen peroxide system is installed, bacteriological tested, and ready for service.

Please call your FRWA Circuit Rider, Stan Epperly, or me if you have any questions.

1. Flush the peroxide, chlorine, and ortho/polyphosphate feed systems, pump lines, valves and fittings before putting them into service.
2. Disinfect the peroxide, chlorine, and ortho/polyphosphate feed systems, pump, lines, valves, and fittings prior to connecting to the existing system.
3. Take two (2) bacteriological samples on consecutive days at the point of connection (or finished water sampling tap) to determine if the system is clean to operate.
4. Send the bacteriological results to myself, FDEP and FRWA.
5. Mark up (redline) the design drawings to show how the improvements were built (as-builts) – show any changes that were made during construction. *Note which were installed and those that were not!*
6. Please take at least 12 photographs of the installed feed system and

EMAIL
frwa@frwa.net

WEBSITE
www.frwa.net

send a CD, flash drive, or email the photos.

7. Send the Final Certification of Construction in 3 places (see enclosure 3).
8. Please send the original Final Certification form back to me and attach:
    a. Copies of the as-built drawings
    b. Photo CD/flash drive or email photos
    c. Bacteriological Results
    d. Final Certification Form
9. Please take at least 12 photographs of the installed feed system and send a CD, flash drive, or email the photos.
10. Sign the Final Certification of Construction Completion in <u>3 places</u> (see the appendix).
11. Please send the original Final Certification form back to me and attach:
    - Copies of the as-built drawings
    - Photo CD / flash drive or email photos
    - Bacteriological Results
    - Final Certification form
12. Keep one copy for your files.

On behave of myself and the Florida Rural Water Association we have enjoyed serving you and wish your water system the best.

Sincerely,

Robert E. Holmden

Robert E. Holmden, P.E.
In Association with FRWA
Phone: 850-264-7218
Email: rholmden@gmail.com

Copy: Stan Epperly, FRWA Circuit Rider

ATTACHMENT 3a

# INVOICE

34

**M ENGINEERING, INC.** Electrical & Instrumentation - Engineering & Construction

ANNEN ROAD P.O. BOX 5106
ELAND, FLORIDA 33807-5106

OFFICE: (863) 646-1448
FAX: (863) 644-0784

INVOICE NO
**26515**

SOLD TO
PLACID LAKES UTILITIES
410 WASHINGTON BLVD NW
LAKE PLACID, FL 33852

SHIP TO
MISC T&M SERVICES/PLACID LAKES
300 WASHINGTON BLVD, NW
LAKE PLACID, FL 33852-9015

| ACCOUNT NO | PO NUMBER | SHIP VIA | SHIPPED | TERMS | INVOICE DATE | PAGE |
|---|---|---|---|---|---|---|
| PLAC | NATHAN BREWER | | | Net 15 | 1/31/2019 | 1 |

JOB#46009

MATERIAL PER ATTACHED

| ITEM NO | QUANTITY | DESCRIPTION | UNIT PRICE | EXTENDED |
|---|---|---|---|---|
| | 1 | SI-190203-A | 2,023.43 | 2,023.43 |

**TOTAL AMOUNT** **2,023.43**

ATTACHMENT 3b

36

(863) 471-1997 FAX (863) 386-1997 mail@excavationpoint.com

**EXCAVATION POINT INC.**

7944 S. George Blvd. Sebring, Florida 33875

Job Description:

DELIVERED 1 LOAD OF FILL TO
410 WASHINGTON BLVD N W

| EPI Number | Invoice |
|---|---|
| DEL18 | 00041308 |

Responsible Customer:

Placid Lakes Utilities
410 Washington Blvd NW
Lake Placid, FL 33852

| PG. | Invoice Date |
|---|---|
| 1 | 11/29/2018 |

| Quantity | Unit Type | Description | Value | Extended |
|---|---|---|---|---|
| 1 | Load | Fill Dirt Delivered | $167.442 | $167.44 |

Adding DEP - Hydrogen Peroxide

163

Paid In Full. We Appreciate Your Payment!

CC

| | |
|---|---|
| Sub Total | $167.44 |
| Tax | $12.56 |
| Deposits | $0.00 |
| Invoice Total | $180.00 |

For Superior Service & Quality Performance
Get To The Point!

36

Pat's Pump & Blower, LLC

2141 West Church Street
Orlando, FL 32805
(407)841-7867
FEIN: 04-3769717

PAT'S PUMP + BLOWER

# Invoice

| Date | Invoice # |
|---|---|
| 11/30/2018 | 99554 |

| Bill To | Ship To |
|---|---|
| Placid Lakes Utilities<br>410 Washington Blvd NW<br>Lake Placid, FL 33852 | Placid Lakes Utilities<br>410 Washington Blvd NW<br>Lake Placid, FL 33852 |

| S.O. No. | P.O. No. | Rep | Ship Date | Ship Via | Terms |
|---|---|---|---|---|---|
|  | STAN | LLC | 11/30/2018 | SAIA | Prepaid |

| Description | Qty | Rate | Amount |
|---|---|---|---|
| Roots 45 U-RAI; 65109021 | 1 | 2,048.00 | 2,048.00T |
| Shipping & Handling Charge | 1 | 249.87 | 249.87 |

| | |
|---|---|
| **Subtotal** | $2,297.87 |
| **Sales Tax (6.5%)** | $133.12 |
| **Total** | $2,430.99 |

Look for Pat's Pump and Blower on Facebook

Please note our NEW ADDRESS:
2141 West Church Street, Orlando FL 32805

3b

CASH ONLY IF ALL *CheckLock™* SECURITY FEATURES LISTED ON BACK INDICATE NO TAMPERING OR COPYING

**Placid Lakes Utilities, Inc**
410 Washington Blvd NW
Lake Placid, FL 33852
(863) 465-0345

**Wauchula State Bank**
WAUCHULA, FL 33873
63-492/631

22222

12/6/2018

VOID

PAY TO THE ORDER OF Excavation Point, Inc. $ **180.00

One Hundred Eighty and 00/100*************************************************************************** DOLLARS

Excavation Point, Inc.
7944 S. George Blvd.
Sebring, FL 33875

MEMO invoice# 00028924 EPI # 16P036

Pres

MP

Details on Back

Intuit® CheckLock™ Secure Check

⑈022222⑈ [redacted] [redacted]

---

**Placid Lakes Utilities, Inc**

Excavation Point, Inc. 12/6/2018 22222

| Date | Type | Reference | Original Amt. | Balance Due | Discount | Payment |
|---|---|---|---|---|---|---|
| 11/29/2018 | Bill | | 180.00 | 180.00 | | 180.00 |
| | | | | | Check Amount | 180.00 |

12/11/18 Per Nathan write void & Mail back.
PAID by Credit
Card 11/29/18
Beverly.

Cash in Bank-Operati invoice# 00028924 EPI # 16P036 180.00

ATTACHMENT 3c

3C

BILL TO:
Acct: [redacted]
PLACID LAKES UTILITIE

| Amount Due: | Trans Date: | DUE DATE: | Invoice #: |
|---|---|---|---|
| $199.05 | 03/26/19 | 05/11/19 | 8090051 |
| PO: | Store: 6340, SEBRING, FL | | |

| PRODUCT | SKU # | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|
| CHARMIN ESSENTIALS SFT 24 GIANT | 1003140464000040002 2 | 1.0000 EA | $12.97 | $12.97 |
| HDX TERRY TOWELS 20PK | 000039081400004000 20 | 1.0000 EA | $8.97 | $8.97 |
| HDX TERRY TOWELS 20PK | 000039081400004000 20 | 1.0000 EA | $8.97 | $8.97 |
| 357-3PK WATCH/ELECTRONIC BATTERY | 000031356700005000 10 | 1.0000 EA | $6.46 | $6.46 |
| MAX AAA30 | 100258988300005000 10 | 1.0000 EA | $15.98 | $15.98 |
| SCOTT COMFORT PLUS 18 DR | 100404533300004000 22 | 1.0000 EA | $8.97 | $8.97 |
| AA 36 PACK | 000055347100005000 10 | 1.0000 PK | $15.98 | $15.98 |
| 19-1/2"X4" ALUMINUM PLACER | 000095968700009000 06 | 1.0000 EA | $24.00 | $24.00 |
| KRYSTAL KLEER +32DEG SUMMER 1 GAL | 100233942900031000 10 | 1.0000 EA | $1.97 | $1.97 |
| KRYSTAL KLEER +32DEG SUMMER 1 GAL | 100233942900031000 10 | 1.0000 EA | $1.97 | $1.97 |
| KRYSTAL KLEER +32DEG SUMMER 1 GAL | 100233942900031000 10 | 1.0000 EA | $1.97 | $1.97 |
| KRYSTAL KLEER +32DEG SUMMER 1 GAL | 100233942900031000 10 | 1.0000 EA | $1.97 | $1.97 |
| 3" CHLORINATING TABS 35 LB | 100276053700027000 02 | 1.0000 EA | $74.98 | $74.98 |

**Purchased by:** BREWER NATHAN
**Customer #:** 00001

| | |
|---|---|
| SUBTOTAL | $185.16 |
| TAX | $13.89 |
| TOTAL | $199.05 |

BILL TO:
Acct: [redacted]
PLACID LAKES UTILITIE

| Amount Due: | Trans Date: | DUE DATE: | Invoice #: |
|---|---|---|---|
| $382.57 | 04/01/19 | 05/11/19 | 2011734 |
| PO: | Store: 6878, OKEECHOBEE, FL | | |

| PRODUCT | SKU # | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|
| HOMER BUCKET | 00001312270001000008 | 1.0000 EA | $3.25 | $3.25 |
| 5/16"X1-1/4" GALV CARRIAGE BOLT 20PK | 00004147350001300002 | 1.0000 BG | $6.64 | $6.64 |
| 5/16"X1-1/4" GALV CARRIAGE BOLT 20PK | 00004147350001300002 | 1.0000 BG | $6.64 | $6.64 |
| 5/16"X1-1/4" GALV CARRIAGE BOLT 20PK | 00004147350001300002 | 1.0000 BG | $6.64 | $6.64 |
| MILWAUKEE 1/4" HEX OFFSET DR ADAPTER | 00001052690000700009 | 1.0000 EA | $19.97 | $19.97 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| 1-5/8" LINE POST EYE TOP | 00005755500001300002 | 1.0000 EA | $1.98 | $1.98 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| RYB 15 AMP 12" SLIDE MITER SAW | 10011907730000900022 | 1.0000 EA | $269.00 | $269.00 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| 2-3/8" GALVANIZED STEEL TENSION BAND | 00001654090001300002 | 1.0000 EA | $1.52 | $1.52 |
| MILWAUKEE SHOCKWAVE 5PC NUT DRVER | 00007246440000700009 | 1.0000 EA | $14.97 | $14.97 |
| 48" GALVANIZED TENSION BAR | 00005755180001300002 | 1.0000 EA | $5.43 | $5.43 |
| 48" GALVANIZED TENSION BAR | 00005755180001300002 | 1.0000 EA | $5.43 | $5.43 |

continued ⇨

# INVOICE DETAIL

Invoice #:
**2011734**
continued

| PRODUCT | SKU # | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|
| 48" GALVANIZED TENSION BAR | 000057551800001300002 | 1.0000 EA | $5.43 | $5.43 |

**Purchased by:** BREWER NATHAN
**Customer #:** 00001

| | |
|---|---|
| **SUBTOTAL** | $357.54 |
| **TAX** | $25.03 |
| **TOTAL** | $382.57 |

BILL TO:
Acct: [redacted]
PLACID LAKES UTILITIE

| **Amount Due:** | **Trans Date:** | **DUE DATE:** |
|---|---|---|
| $263.32 | 04/04/19 | 05/11/19 |

Invoice #:
**9091162**

**PO:**
**Store:** 6340, SEBRING, FL

| PRODUCT | SKU # | QUANTITY | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|
| ARCTULT | 100404062400002000017 | 1.0000 EA | $39.97 | $39.97 |
| MAX AAA30 | 100258088300005000010 | 1.0000 EA | $15.98 | $15.98 |
| MAX AAA30 | 100258088300005000010 | 1.0000 EA | $15.98 | $15.98 |
| MAX AAA30 | 100258088300005000010 | 1.0000 EA | $15.98 | $15.98 |
| AA 36 PACK | 000055347100000500010 | 1.0000 PK | $15.98 | $15.98 |
| 9 IN TABLE TOP AIR CIRCULATOR | 100278601500001700004 | 1.0000 EA | $15.96 | $15.96 |
| AA 36 PACK | 000055347100000500010 | 1.0000 PK | $15.98 | $15.98 |
| DISCOUNT | 000000000000000000005 | 1.0000 EA | -$6.00 | -$6.00 |
| LINE POST 16G 1-5/8"X 8' SWAGE | 100402809600001300002 | 1.0000 EA | $17.25 | $17.25 |
| 72"GALVANIZED TENSION BAR | 000042381500001300002 | 8.0000 EA | $7.24 | $57.92 |
| BOUNTY 12 DOUBLE ROLL SAS | 100311236500000400022 | 1.0000 EA | $22.97 | $22.97 |
| BOUNTY 12 DOUBLE ROLL SAS | 100311236500000400022 | 1.0000 EA | $22.97 | $22.97 |
| DISCOUNT | 000000000000000000005 | 1.0000 EA | -$3.00 | -$3.00 |
| DISCOUNT | 000000000000000000005 | 1.0000 EA | -$3.00 | -$3.00 |

**Purchased by:** BREWER NATHAN
**Customer #:** 00001

| | |
|---|---|
| **SUBTOTAL** | $244.94 |
| **TAX** | $18.38 |
| **TOTAL** | $263.32 |

# ATTACHMENT 3d

**USABlueBook**®
***Get the Best Treatment***™

Remit To:
P.O. Box 9004
Gurnee, IL 60031-9004

TEL: (847) 689-3000
FAX: (847) 689-3001
TOLL FREE: 1-800-493-9876
F.E.I.N.: 52-2418852

3d

# INVOICE

**Paid in full by Credit Card**

| INVOICE NO. | PAGE NO. |
|---|---|
| 839549 | 1 of 1 |
| **CUSTOMER NO.** | **DATE** |
| [redacted] | 03/15/19 |

View online at: http://usabluebook.billtrust.com
Web Enrollment Token: HMW FHQ TRB

**BILL TO:** [redacted]

PLACID LAKE UTILITIES
410 WASHINGTON BLVD NW
LAKE PLACID FL 33852
USA

**SHIP TO:** 1

PLACID LAKE UTILITIES
410 WASHINGTON BLVD NW
LAKE PLACID FL 33852-6779
USA

Ordered by: 0002 NATHAN BREWER

Attention: 0002 NATHAN BREWER

| CUSTOMER P.O. NO. | SHIP DATE | SLP | TERMS | TAX CODE | SALES ORDER NO. | W/H | FREIGHT | SHIP VIA |
|---|---|---|---|---|---|---|---|---|
| CC-ONLINE | 03/15/19 | www | VISA | FL | 515845 | 50 | FXD/PPD | UPSRED |

| USA STOCK NO. | DESCRIPTION | ORDERED | SHIPPED | BACKORDER | U/M | PRICE | PER | EXTENSION |
|---|---|---|---|---|---|---|---|---|
| A | CR Released<br>** ESTIMATED TAX AMOUNT $31.34 | 1 | 1 | 0 | EA | 0.00 | EA | 0.00 |
| 3464 | 3/8'OD x 1/4'ID Black HDPE<br>Discharge Tubing 500' Roll | 1 | 1 | 0 | RL | 489.95 | RL | 489.95 |

**THANK YOU for your business!**
**1.5% MONTHLY FINANCE CHARGE**
**ON AMOUNTS 30 DAYS PAST DUE**
**Discounts Apply to Merchandise Only**

| MERCHANDISE | MISCELLANEOUS | DISCOUNT | TAX | FREIGHT | TOTAL |
|---|---|---|---|---|---|
| 489.95 | 0.00 | 0.00 | 29.40 | 66.55 | 585.90 |

Should it become necessary to refer your unpaid balance to a collection agency, [redacted]le[redacted]ion fee, not to exceed 25% of the balance referred; plus reasonable attorney's fees; and court costs when neces[redacted] w[redacted] e added to the balance due.

**Please Detach and Return Bottom Portion to Insure Proper [redacted]it [redacted]Your Account**

---

**USABlueBook**®
***Get the Best Treatment***™

## Paid i[redacted] [redacted]ull by Credit Card

****IMPORTANT****
Please include this customer #
on the face of your remittance check.

| INVOICE NO. | CUSTOMER NO. | DATE | TOTAL |
|---|---|---|---|
| 839549 | [redacted] | 03/15/19 | 585.90 |

PLACID LAKE UTILITIES
410 WASHINGTON BLVD NW
LAKE PLACID FL 33852
USA

**REMIT[redacted]E ADDRESS**
USAB[redacted]k
P.O. B[redacted]4
Gurn [redacted] 031-9004

ATTACHMENT 4

**Data Flow Systems, Inc.**
605 N. John Rodes Blvd.
Melbourne, FL 32934

# INVOICE

Invoice Number: **75313**
Date: **2/21/2019**
Page Number: **1**
Order Number: **57094-SE**
F.O.B: **DESTINATION**

| Sold To | Ship To |
|---|---|
| PLACID LAKES UTILIITES, INC.<br>410WASHINGTON BLVD. NW<br>LAKE PLACID, FL 33852 | PLACID LAKES UTILIITES, INC.<br>410WASHINGTON BLVD. NW<br>LAKE PLACID, FL 33852 |

| CUSTOMER ID | CUSTOMER PO | PAYMENT TERMS | FREIGHT TERMS |
|---|---|---|---|
| PLALAK | SALES AGREEMENT | Net 30 | Freight: Billed |

| SALES REP ID | SHIPPING METHOD | SHIP DATE | INVOICE DUE DATE |
|---|---|---|---|
| | DFS DELIVERY | 2/20/2019 | 3/23/2019 |

**ORDER SPECIFICATIONS**

| QUANTITY ORD | QUANTITY SHP | QUANTITY BCK | PART | DESCRIPTION | TX | UNIT PRICE | EXTENDED PRICE |
|---|---|---|---|---|---|---|---|
| 1.00 | 0.00 | 1.00 | | WTP SCADA INTERIM SOLUTION<br>THIS GOES WITH 57095-SE AND 57096-SO, 57097-TO | T | (0.00) | $0.00 |
| 1.00 | 1.00 | 0.00 | | 25% MOBILIZATION UPON SUBMITTAL A<br>prepaid | T | 14,254.01 | $14,254.01 |
| 1.00 | 1.00 | 0.00 | | 55% DELIVERY OF PRODUCT<br>prepaid | T | 13,977.12 | $13,977.12 |
| 1.00 | 0.00 | 1.00 | STARTUP SERVI | 15% STARTUP SERVICES | T | (0.00) | $0.00 |
| 1.00 | 0.00 | 1.00 | | 5% COMPLETION OF PUNCH LIST ITEM | T | (0.00) | $0.00 |
| 1.00 | 0.00 | 1.00 | | balance of 55% delivery of product | T | (0.00) | $0.00 |
| | | 0.00 | | FL 1.5% | T | (0.00) | $75.00 |
| | | 0.00 | | FL6% | T | (0.00) | $1,693.87 |

**SUBTOTAL: $30,000.00**

**TOTAL AMOUNT DUE: $30,000.00**

PAID
FEB 2 1 2019
CK# 22419
Dated 2/1/19

IF YOU HAVE QUESTIONS ON HOW THIS INVOICE WAS CALCULATED, OR QUESTIONS ABOUT ANY OF OUR OTHER PRODUCTS, PLEASE CONTACT OUR SALES OFFICE.

PLEASE REFERENCE THIS INVOICE NUMBER ON YOUR CHECK AND REMIT TO:
**Data Flow Systems, Inc.**
605 N. John Rodes Blvd.
Melbourne, FL 32934

CONTROL SYSTEM

SCHEDULE XI, PART C
7 Pages

DFS
Data Flow Systems

**QUOTE NO. 190128-03-ES**
**WTP SCADA INTERIM SOLUTION**
**PLACID LAKES UTILITIES, INC.**
**JANUARY 28, 2018**

## SUMMARY OF SCOPE

DFS will provide an interim control system solution for the Placid Lakes Utility. The current system at Placid Lakes WTP is failing for unknow reasons. The ability to identify and correct the issues with the current automation controller cannot be identified by the Utility's Vendor. As such, DFS is proposing an interim solution to provide basic and reliable functionality of the WTP.

DFS is recommending an interim solution to install an HSS to monitor two (2) DFS TCUs in "pump up" mode that will provide automation operation for the HSPs and Well Pumps. The TCUs would be integrated to the existing control panel and would not provide all current functionality however, this system will provide stabile functionality for the Pumps. With additional integration, included in this proposal, the DFS panel will provide the minimum functionality required for the Chemical Feed system as well. DFS, under a separate proposal, is proposing a separate DFS PLC based control panel that will provide full functionality. It should be noted many elements of this proposal will be repurposed with the PLC Control Panel proposal and this will minimize duplication of efforts, and costs.

Within the Scope of this proposal will be the running of PVC Conduit(s) between the DFS TCU Enclosure, CP and HSS enclosures, wire will be provided.

## SEQUENCE OF INSTALLATION

- Submittal/Mobilization
- Construction and testing of the TCU enclosure at our facility.
- Installation of HSS and RTU.
- Integration and Wiring services.
- Final Startup and Commissioning services.
- Close out and Final Documentation delivery.

**Understanding of Installation** - The understanding is the current control panel (CP) will remain in place and the DFS TCUs will be installed in a new enclosure to be mounted on the wall near the Office door. This enclosure will be integrated into the CP via conduit and wires provide between the two enclosures. The HSS will be mounted on a wall in the Office with the Client Work Station located on the desk. The HSS, Client Work Station and RTU will all be on the same network and will communicate with each other on this network.

The existing CP is remaining and the current controller will be removed and surrendered to the Utility. The wiring to this controller will be terminated to blocks added into the CP by DFS for the new RTU to integrate with this panel. The existing field connections and surge suppression will remain in place as will all Pressure and Probe Switches. The system being provided, in the future, could be reconfigured to use Pressure Transducers in place of the current Pressure Switches when the Utility is ready to make the switch over.

## DETAILS OF REQUIREMENTS

### SCADA Server/System

The proposed TAC II SCADA System is designed specifically for water and wastewater applications. Highlights include ease-of-use and obsolescence-proof engineering. Each and every improvement we make to our system hardware and software is downward compatible with every one of our TAC II SCADA Systems, including those installed nearly 30 years ago. Even our oldest customers are able to take full advantage of our latest innovations and improvements. No other manufacturer who has taken such extreme measures to assure the support of their systems and to prevent obsolescence.

Please keep in mind that many of the features and services offered free of charge by DFS are either line item cost and/or reoccurring cost with other SCADA system providers. Such DFS features and services include but are not necessarily limited to:

- No access limits or charges for additional HMI user seats
- No annual user fees
- No annual software license fees
- No incremental group rates for future points or tags
- No annual maintenance or annual service contract required
- No cost for SCADA software and/or module firmware revisions for life - All revisions and updates are free of charge
- No cost for "call-in" customer service technical support (during normal business hours) for system life
- No cost for DFS customer service department to the utility. Central Site remote access permits our technicians to troubleshoot in real-time alongside your technicians
- No cost for radio path studies and FCC license renewal services
- No cost for 911 alarm dialer, multiple communication/protocol drivers and system/user partitioning
- Three (3) year warranty on DFS hardware (including radio) against lightning and surge damage.

When comparing SCADA systems, it is of the utmost importance to consider the life cycle. The life cycle of a SCADA system is determined by manufacture and provider support for software version issues, system durability and availability, and compatibility of replacement parts. In most cases, the life cycle of other SCADA systems is only 7 to 10 years. On the other hand, DFS has yet to define our SCADA system's life expectancy. Many of our SCADA systems have been in continuous use for well over 20 years and are still running strong.

We ask that you consider what other SCADA system providers charge per year for the above-mentioned features and services, and extrapolate such cost over the life cycle expectancy of the system. We believe that when you compare the extrapolated value of others SCADA systems to that of DFS, you will conclude that we provide the most economical and durable SCADA system in the industry.

### SCADA SOFTWARE & FREE SERVICES FOR LIFE OF SYSTEM:

The proposed HT3 SCADA Software is manufactured by DFS and operates on a wall-mounted Hyper SCADA Server. A typical off-the-shelf "Windows PC" is utilized for HMI operator interface. Great attention has been paid to ease-of-use. The HMI platform is the familiar Internet Browser

Distinct benefits and savings are unlimited RTU I/O points, unlimited user access seats, built-in reports and trending programs, integrated 911 alarm dial-out modem, 411 remote access, mobile phone access, and the MariaDB open source database. It's important to note there are no on-going costs associated with the use of DFS' HT3 SCADA Software. All updates, revisions, and future releases of the HT3 SCADA software are available free of charge for the life of your system. NO MAINTENANCE CONTRACT REQUIRED! Detailed information is also available at www.scadaserver.com.

HT3 MOBILE: This system includes the HT3 Mobile software. With the emergence of smart phones that can browse the Internet, system access via a cell phone browser is now possible. HT3 Mobile is an application developed by DFS for today's smart phones. Please note that HT3 Mobile requires Internet access by the HSS. The Internet connection, along with a secure VPN router access to the Internet, are the responsibility of the Owner. The smartphone(s) and cell service are the responsibility of the Owner.

## WARRANTY AND CUSTOMER SUPPORT: (INCLUDES 3 YEAR SURGE/LIGHTNING WARRANTY)

DFS warrants the proposed system to be free from defects in materials and workmanship for a period of one year. All DFS plug-in modules, radios, power supplies and RTU pump-controllers, carry an additional two-year return-to-factory warranty and are covered against damage due to surge/lightning the entire 3-year period.

Our Service Department operates 24/7/365 to administer all service related issues. Service personnel are full-time DFS employees based in our Melbourne, Florida office. DFS telephone tech support is offered free of charge during normal business hours for the life of the system. NO MAINTENANCE CONTRACT REQUIRED!

The proposed Hyper SCADA Server (HSS) incorporates remote maintenance access, which will allow DFS to perform remote diagnostics and troubleshooting free of charge during normal business hours for the life of the system. We have found that most service issues can be resolved remotely, resulting in immediate resolution. The UTILITY will be required to provide a telephone line (standard dial-up) connection, or a preferably secure VPN network connection, that permits DFS remote access to the HSS for the maintenance/warranty support, updates and software upgrades.

The system also incorporates a "911" alarm dial-out feature. The UTILITY will be required to provide one (1) telephone line (standard dial-up) to the HSS that is dedicated for the system's 911 feature (a modem). Alternatively, a Verizon Wireless T2000 phone line to cellular link adapter can be purchased and utilized for an additional cost and associated cellular data plan.

## WTP RTU/Control Panel Detail

The RTU being supplied under this proposal will contain two (2) DFS TCUs that will operate the I/O as outlined below. The control will be similar to the current system and integrated through the existing CP. The Wells, High Service Pump (HS or HSP) and Chemical Feed systems will operate in a manner similar to their current operation, except as noted below.

### Well and HSP Operations

The Wells will alternate and fill the Ground Storage Tank (GST) using the existing Pressure Switches. Likewise, the HSP will alternate and provide water/pressure to the Hydrostatic Tanks. With each system being integrated to a separate TCU. The systems will operate as two independent systems. Each will be monitored by the HSS which will provide for alarm functionality, similar to an auto-dialer alarm system. The HSP TCU will require additional integration with programmable relays to provide for the single Pressure Switch that handle both the PUMPS OFF and LEAD HSP CALL signals.

### RTU Chemical Feed Processes

This system will provide limited operation as follows. The Well currently turn on the Polymer pumps which are keyed to the Wells via the IR relay in the CP. As the Well TCU will be integrated to these IR the Polymer Pumps will turn on with its assigned well, the relays used will be TPDT. To energize the Booster Water Solenoid for the Polymer system the second NO contact on the Well run IR within the RTU will be paralleled connect to a Programmable Timer Relay PTR which will be programmed as a Time Delay Relay (TDR) OFF. The output of this TDR will be used to active the currently WPCHEM relay, and the TDR OFF function providing for Flushing the Line after the Well Pump Stops. As the WPCHEM IR also activates the CL2 solenoid that feeds the Non-Pan feed, CL2 will also be provided as well. Any additional operation as is currently provided will not be available with this solution.

### Hydro Tank Air System

The Aux Input on the HSP TCU will be used to attempt to control this function. The probe will be wired to the AUX Input (inverted signal) and the Output will be wire to the Compressor control. A built-in timer that can hold 8 minutes delay will be set accordingly. Additional time can be captured by the programmable relay being installed.

### Air System Purge

No control or automation for this system is provided under this proposal.

## GENERAL SYSTEM OPERATIONAL ASPECTS

The General System Operational Aspects are outlined in the DFS TCU Manual.

## GRAPHICAL DISPLAYS

Custom graphical displays of telemetry/project data can take many forms. The graphical displays provided for under the proposal are P&ID type in nature. The screen/displays will show the basics of the process flow and instrumentation placement in this flow. They will also provide for control of the devices using a standardized set of control objects used by DFS. The control operators have color coded meaning and are used consistently across all DFS customer platforms. Other forms of graphical displays that more closely represent a pictorial view, or physical presence of a customer site, are available and can be ordered in addition to the P&ID type screen displays provided for in this proposal.

## ADDITIONAL DETAILS

The Utility will be required to provide personnel to make the site available when work is scheduled. Any instrumentation installation is to be performed by the Utility/Contractor.

It should be noted that only elements addressed within the Proposal will be accomplished. If an operation or element of the WTP systems are missing, they are not included and needs to be addressed with DFS prior the DFS coming on site.

Please feel free to contact DFS with any questions concerning this project or changes in your telemetry system.

Eric Stord
Systems Engineering
Data Flow Systems

## BILL OF MATERIAL & SERVICES

1. **TAC II CENTRAL SITE PACKAGE:**

   HYPER SCADA SERVER (HSS002-2):

   - (1) Enclosure Assembly w/Door Window (NEMA 12 Steel, 24"W x 30"H x 8"D)
   - (2) Modular Backplane
   - (2) Hyper Server Module
   - (2) Network Switch Module
   - (1) Fiber Interface Module
   - (2) Power Supply Module
   - (1) 7.0 Ah Backup Battery (UPS)
   - (1) Debian, Linux Operating System
   - (1) Maria DB, Open Source Database
   - (1) HT3 SCADA Software

(1) HT3 Mobile (smartphone & service by UTILITY)

ONSITE OPERATOR TRAINING:

Operator Training covers basic material for the HSS/HMI and RTU, and includes a follow-up refresher course. The first session will be taught over a 2-day period. The second session is a 1-day refresher of the initial training, which will be conducted approximately six months later. Please note the maximum number of attendees is eight (8) people due to material presentation and effective instructor/student ratio.

## 2. PRIMARY WORKSTATION COMPUTER (PROVIDED WITH HSS IF REQUIRED)

Lenovo ThinkCentre M910z "All-in-one" Computer (23" Monitor) – per specs below:
Intel Core i7 Processor
3.6 GHz Processor Speed
16 GB RAM
256 Solid State Drive
Intel HD Graphics Controller
DVD Recordable
Windows 10 Pro 64 Operating System
23 Inch Display Diagonal Size, Flat Panel
USB Keyboard & Mouse, Web Camera

## 3. WTP, TCU1101 (WELLS) AND TCU1102(HSP)

This site includes the following:

- RTU Panel
  - (1) Enclosure SS, 48" x 36" x 10" (to mount both TCU, later to be used for PLC RTU)
  - (1) Inner Panel, 48" x 36"
  - (2) TCU Backplane assemblies
  - (2) TCU Network Connections (TCU001-IP)
  - (2) 7.0 Ah Battery w/shelf
  - (10) 120V TPDT Octal Relay w/Base
  - (4) Programmable Relays
  - (4) Edco PC642C-036 Surge Protector w Base
  - (1) RTU Surge Protection (TFS & SPS)
- Hardwired I/O List TCU 1101 (WELLS)

| DIGITAL INPUT (DI) | DIGITAL OUTPUT (DO) | ANALOG INPUT (AI) | ANALOG OUTPUT (AO) |
|---|---|---|---|
| (3) WELL STATUS<br>(1) TANK HIGH LEVEL<br>(1) WELL STOP PRESS<br>(1) WELL LEAD LEVEL<br>(1) WELL LAG LEVEL<br>(1) WELL LAG 2 LEVEL<br>(1) GST LOW TANK LEVEL | (3) WELL PMP CMD | (2) SPARE<br>(3) PHASE VOLTAGE | (0) INSTALL |

- Hardwired I/O List TCU 1102 (HSP)

| DIGITAL INPUT (DI) | DIGITAL OUTPUT (DO) | ANALOG INPUT (AI) | ANALOG OUTPUT (AO) |
|---|---|---|---|
| (3) HSP STATUS<br>(1) GST LOW TANK | (3) HSP CMD<br>(1) COMPRESSOR CMD (TDOFF) | (2) SPARE<br>(3) PHASE VOLTAGE | (0) INSTALL |

| | | | |
|---|---|---|---|
| LEVEL/HIGH PRESSURE<br>(1) HSP STOP PRESS<br>(1) HSP LEAD PRESS<br>(1) DIST LAG PRESS<br>(1) HSP LAG 2 PRESS<br>(1) HSP LOW PRESS<br>(1) HYDRO TANK PROBE | | | |

- Onsite Services

  This site includes up to the following trips and on-site services:
  Survey
  Delivery/Install/pre-wiring
  Final Wiring/Start-up
  Commissioning/Punch List /Training

4. **SPARE PARTS - NONE**

5. **INSTRUMENTATION – NONE**

**HARDWIRED I/O REQUIREMENTS**

a) All digital inputs to the DFS RTU will be of a dry contact type, terminal connections to be provided by the MCC manufacture/contractor/customer.
b) Mixing of multiple sources of power will not be permitted.
c) All digital outputs from DFS RTU will be dry contacts and provide for 120VAC at 10amp capacity.
d) All analog inputs signals will be 4-20mA, or 0-5VDC, and use Shielded Cable.
e) 4-20 mA signals at minimum to provide 500 ohm impedance drive.
f) All pulse input to be dry contact, and mechanically operated.
g) The field terminal blocks in the DFS RTU provide for stranded wire with a maximum size of 12AWG.

**DFS SCOPE OF WORK**

DFS will assemble and test the RTU and SCADA Server with any applicable programming in our facility. After testing is complete, DFS will deliver the RTU to the location designated by the customer. Any conduit provided by DFS will be PVC rigid and/or flexible, unless otherwise noted. DFS will complete all configurations and provide on-site start-up services.

DFS will provide on-site operator training.

**WORK TO BE PERFORMED BY THE UTILITY**

1. Ensure 120 VAC power is near the location of the DFS RTU for connection to power.
2. Clear the Wall of outlet and switch by the Office door so RTU may be mounted at that location.
3. If the Well Flow are to be on Telemetry, the Utility will be required to replace the Flow Meter displays in the office with a type that can produce a 4-20mA signal to be monitored.
4. Make site available when work is scheduled.
5. Make personnel available to operate system as needed when work is scheduled.

- **LEAD TIME:**

  Submittal: 60 days (TBD), after acceptance of order and any required documentation.
  Equipment: 150 days (TBD), after receipt of approved submittal.

- **PRICING & TERMS:**

  This quotation totals 60,512.00. Please review the Quotation Notes listed below. DFS payment terms are NET 30 with approved credit. This proposal will be honored for 90 days. DFS will submit an invoice for each activity and payment schedule is as follows:

  25% Mobilization (upon submittal approval)
  55% Delivery of Product
  15% Start Up
  5% Completion of Punch List items

- **QUOTATION NOTES:**

1. Only those items and services specifically listed above are included in this quotation.
2. Pricing is based on NET 30 Payment Terms with approved credit. Pricing can be adjusted upon request for payment terms other than NET 30.
3. This quote includes 5 copies of the Submittal, and 5 copies of the O & M Manuals for each RTU. Additional copies are available at $35.00 each.
4. Any conduit provided by DFS will be PVC rigid and/or flexible, unless otherwise noted.
5. All required panel mounting structures and related hardware are to be provided and installed by others.
6. Ensuring the site is ready when services are requested is the responsibility of the customer/contractor. Additional trips and site services beyond those listed above will be billed on a time and material basis via change order. If cause of the additional activity is responsibility of DFS, a change order will not be required.
7. DFS employees will not enter "Confined Spaces" and/or "Permit-Required Confined Spaces" as defined by OSHA. Any such requirement will be performed by others.
8. All electrical equipment to be accessed by DFS employees must be temporarily removed from service during the performance of our scope of work.
9. This quotation does not include any required permitting, sealed drawings, or associated fees.
10. DFS' Standard Warranty applies to this project. www.dataflowsys.com/products/warranty-statement.php
11. All DFS-supplied stainless-steel enclosures for outdoor applications are powder-coated white to meet internal heat requirements. Sun-shields and/or air conditioning is not required by the DFS warranty and shall not be supplied under this scope regardless of enclosure specification requirements.
12. This quotation stipulates that DFS existing insurance provider(s) and policy coverage are acceptable. In the event that you require a change to insurance provider(s), additional coverage, and/or amending the terms of our existing policies, we reserve the right to void and withdraw this quote and replace it with an amended quote which contemplates and provides for the recovery of the cost associated with analyzing and complying with different insurance requirements. Policy information can be found at http://www.dataflowsys.com/company/documents/insurance-coverage.pdf
13. This quotation is formatted and priced for a direct purchase from the utility. If this scope is to be purchased by others, a revised quote is required to cover additional project administration charges. These additional charges cover routine contractor/developer requirements such as contract management, submittal preparation, project coordination, owner notices, etc.

ATTACHMENT 5

Chemicals Used Schedule

Company: Placid Lakes Utilities, Inc.
Docket No.: 130025-WU
Test Year Ended: 12/31/18
Interim [ ] Final [ X ]
Historical [ X ] Projected [ ]

| CHLORINE | 2016 | | | | 2017 | | |
|---|---|---|---|---|---|---|---|
| | QUANTITY LBS | $AMOUNT | UNIT PRICE | DOSAGE RATE | QUANTITY LBS | $AMOUNT | UNIT PRICE |
| JAN | 750 | $731.00 | $0.97 | 9 ppm | 750 | $731.00 | $0.97 |
| FEB | 1050 | $1,013.40 | $0.97 | 9 ppm | 750 | $731.00 | $0.97 |
| MAR | 0 | $- | #DIV/0! | 9 ppm | 750 | $731.00 | $0.97 |
| APR | 750 | $731.00 | $0.97 | 9 ppm | 750 | $731.00 | $0.97 |
| MAY | 900 | $872.20 | $0.97 | 9 ppm | 750 | $731.00 | $0.97 |
| JUNE | 750 | $731.00 | $0.97 | 9 ppm | 750 | $731.00 | $0.97 |
| JULY | 750 | $731.00 | $0.97 | 9 ppm | 750 | $731.00 | $0.97 |
| AUG | 0 | $- | #DIV/0! | 9 ppm | 750 | $781.00 | $1.04 |
| SEPT | 750 | $731.00 | $0.97 | 9 ppm | 950 | $957.20 | $1.01 |
| OCT | 750 | $731.00 | $0.97 | 9 ppm | 750 | $781.00 | $1.04 |
| NOV | 750 | $731.00 | $0.97 | 9 ppm | 750 | $781.00 | $1.04 |
| DEC | 750 | $731.00 | $0.97 | 9 ppm | 750 | $781.00 | $1.04 |
| Total | 7950 | $7,733.60 | $0.97 | 9 ppm | 9200 | $9,198.20 | $1.00 |

| SEQUESTALL | 2016 | | | | 2017 | | |
|---|---|---|---|---|---|---|---|
| | QUANTITY GALLONS | $AMOUNT | UNIT PRICE | DOSAGE RATE | QUANTITY GALLONS | $AMOUNT | UNIT PRICE |
| JAN | 120 | $1,755.06 | $14.63 | 6.67 gpm | 0 | $- | #DIV/0! |
| FEB | 0 | $- | #DIV/0! | 6.67 gpm | 0 | $- | #DIV/0! |
| MAR | 0 | $- | #DIV/0! | 6.67 gpm | 120 | $3,511.75 | $29.26 |
| APR | 120 | $1,758.59 | $14.65 | 6.67 gpm | 0 | $- | #DIV/0! |
| MAY | 0 | $- | #DIV/0! | 6.67 gpm | 120 | $1,761.21 | $14.68 |
| JUNE | 120 | $1,763.78 | $14.70 | 6.67 gpm | 0 | $- | #DIV/0! |
| JULY | 0 | $- | #DIV/0! | 6.67 gpm | 120 | $1,760.80 | $14.67 |
| AUG | 0 | $- | #DIV/0! | 6.67 gpm | 0 | $- | #DIV/0! |
| SEPT | 120 | $1,765.47 | $14.71 | 6.67 gpm | 120 | $1,761.96 | $14.68 |
| OCT | 0 | $- | #DIV/0! | 6.67 gpm | 0 | $- | #DIV/0! |
| NOV | 120 | $1,748.85 | $14.57 | 6.67 gpm | 120 | $1,652.22 | $13.77 |
| DEC | 0 | $- | #DIV/0! | 6.67 gpm | 0 | $- | #DIV/0! |
| | 600 | $8,791.75 | $14.65 | 6.67 gpm | 600 | $10,447.94 | $17.41 |
| Totals | | $16,525 | | | | $19,646 | Total C |
| | | | | | | 414 | Prepaid |
| | | | | | | 20,060 | Balan |

Rule 25-30.440(2), F.A.C.

Florida Public Service Commission

Schedule II
1 Page
Preparer: Larry P. King, Treasurer

| | 2018 | | | |
|---|---|---|---|---|
| DOSAGE RATE | QUANTITY LBS | $AMOUNT | UNIT PRICE | DOSAGE RATE |
| 9 ppm | 600 | $629.80 | $1.05 | 9 ppm |
| 9 ppm | 600 | $629.80 | $1.05 | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 0 | $- | #DIV/0! | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 600 | $629.80 | $1.05 | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 750 | $781.00 | $1.04 | 9 ppm |
| 9 ppm | 7800 | $8,137.40 | $1.04 | 9 ppm |

Per discussion with Nathan Brewer, Plant Operator,
target Dosage Rates are calculated as follows:

Chlorine: The target is 9 ppm:
The plant uses on average 24 lbs Chlorine / day
(gas – 150 lbs canister)
The plant produces approx. 300,000 gals water / day
This coverts to 2.5 million lbs of water produced / day
(300,000 x 8.34 lbs / gal water)
Thus the Dosage Rate is 24 lbs Chlorine / 2.5 lbs water
Is 9 lbs Chlorine / million lbs water

| | 2018 | | | |
|---|---|---|---|---|
| DOSAGE RATE | QUANTITY GALLONS | $AMOUNT | UNIT PRICE | DOSAGE RATE |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 120 | $1,762.83 | $14.69 | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 120 | $1,763.12 | $14.69 | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 120 | $1,763.30 | $14.69 | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 0 | $- | #DIV/0! | 6.67 gpm |
| 6.67 gpm | 360 | $5,289.25 | $14.69 | 6.67 gpm |

Sequestall: The target Dosage Rate is 6.67 gpm:
The plant uses on average 2 gals Sequestall / day
(liquid – 30 gal drums)
The plant produces approx. 300,000 gals water / day
Thus the Dosage Rate is 2 gals Sequestall / 300,000
gal. x 1,000,000 = 6.67 gals Sequestall / million gal.
water.

| | |
|---|---|
| Chemicals Purchased | $13,427 |
| Chemicals Acct. # 162 | 0 |
| ce Account # 618.3 | 13,427 |

| Grand Total | 2 Year Average | Excess over 2018 |
|---|---|---|
| $49,598 | $16,744 | $3,317 |

**Hydrogen Peroxide Project:**

| | | |
|---|---|---|
| **Gas chlorine reduction** | (-673 lbs x 12 mo x $1.04/lb) | -$8,399 |
| **Liquid chlorine increase** | (500 gal x 12 mo x 1.30/gal + 25) | $7,825 |
| **Hydrogen Peroxide new** | (55 gal drm x 12 mo x 305.10 + 25) | $3,686 |
| | Total Net Change | $2,743 |

Sch. B-3

ATTACHMENT 7

OCT 18

# Monthly Operation Report for PWSs Treating Raw Ground Water or Purchased Finished Water

PWS Identification Number: 5280223 | Plant Name: Placid Lakes Utilities

III. Daily Data for the Month/Year of:

Means of Achieving Four-Log Virus Inactivation/Removal: * ______Free Chlorine ______Chlorine Dioxide ______Ozone ______Combined Chlorine (Chloramines) ______Ultraviolet Radiation ______Other (Describe):

Type of Disinfectant Residual Maintained in Distribution System: Free Chlorine Combined Chlorine (Chloramines) Chlorine Dioxide

| | Days of Month | Days Plant Staffed Or Visited By Oper. | Hours Plant In oper. | Net quantity Of finished Water Produced, gal | CT Calculations, or UV Dose, to Demonstrate Four-Log Virus Inactivation, if applicable* | | | | | | | | | Lowest residual disinfectant concentration at remote point in distribution system, mg/L | Emergency or abnormal operating conditions, repair or maintenance work that involves taking water system component out of operation. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | CT Calculations | | | | | | | UV Dose | | | |
| | | | | | Peak Flow Rate, gpd | Lowest residual s\disinfectant Concentration (C) Before or at First customer During peak Flow, mg/L | Disinfectant Contact time (T) At C Measurement Point during Peak flow, Minutes | Lowest CT Provided Before or At first Customer During Peak flow, mg-min/L | Temp Of Water, C | PH of Water, If appl. | Minimum CT req. mg-min/L | Lowest operating UV dose, mW-sec/cm2 | Minimum UV dose req. mW-sec/cm2 | | |
| | 1 | X | 24 | 327000 | 288 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 2 | X | 24 | 298000 | 219 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 3 | X | 24 | 265000 | 244 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | 4 | X | 24 | 289000 | 227 | 1.2 | – | – | 25 | 7.3 | – | – | – | .9 | |
| | 5 | X | 24 | 268000 | 257 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 6 | X | 24 | 304000 | 281 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 7 | X | 24 | 338000 | 277 | 1.5 | – | – | 25 | 7.3 | – | – | – | 1.2 | |
| | 8 | X | 24 | 333000 | 247 | 1.5 | – | – | 25 | 7.3 | – | – | – | 1.2 | |
| | 9 | X | 24 | 288000 | 214 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| 3017 | 10 | X | 24 | 307000 | 207 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 11 | X | 24 | 269000 | 244 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 12 | X | 24 | 264000 | 156 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 13 | X | 24 | 290000 | 209 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | 14 | X | 24 | 319000 | 364 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 15 | X | 24 | 294000 | 189 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | 16 | X | 24 | 317000 | 248 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 17 | X | 24 | 293000 | 262 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 18 | X | 24 | 321000 | 359 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 19 | X | 24 | 316000 | 223 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| 6046 | 20 | X | 24 | 341000 | 347 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 21 | X | 24 | 337000 | 313 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | 22 | X | 24 | 334000 | 350 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 23 | X | 24 | 302000 | 274 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | 24 | X | 24 | 330000 | 260 | 1.3 | – | – | 25 | 7.3 | – | – | – | .9 | |
| | 25 | X | 24 | 324000 | 197 | 1.2 | – | – | 25 | 7.3 | – | – | – | .9 | |
| | 26 | X | 24 | 316000 | 227 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 27 | X | 24 | 330000 | 264 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | 28 | X | 24 | 358000 | 409 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | 29 | X | 24 | 342000 | 211 | 1.4 | – | – | 25 | 7.3 | – | – | – | 1.1 | |
| | 30 | X | 24 | 327000 | 217 | 1.3 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| 7685 | 31 | X | 24 | 309000 | 250 | 1.5 | – | – | 25 | 7.3 | – | – | – | 1.0 | |
| | Total | | | | | | | | | | | | | | |
| | Average | | | | | | | | | | | | | | |
| | Maximum | | | | | | | | | | | | | | |

NOV 18

# Monthly Operation Report for PWSs Treating Raw Ground Water or Purchased Finished Water

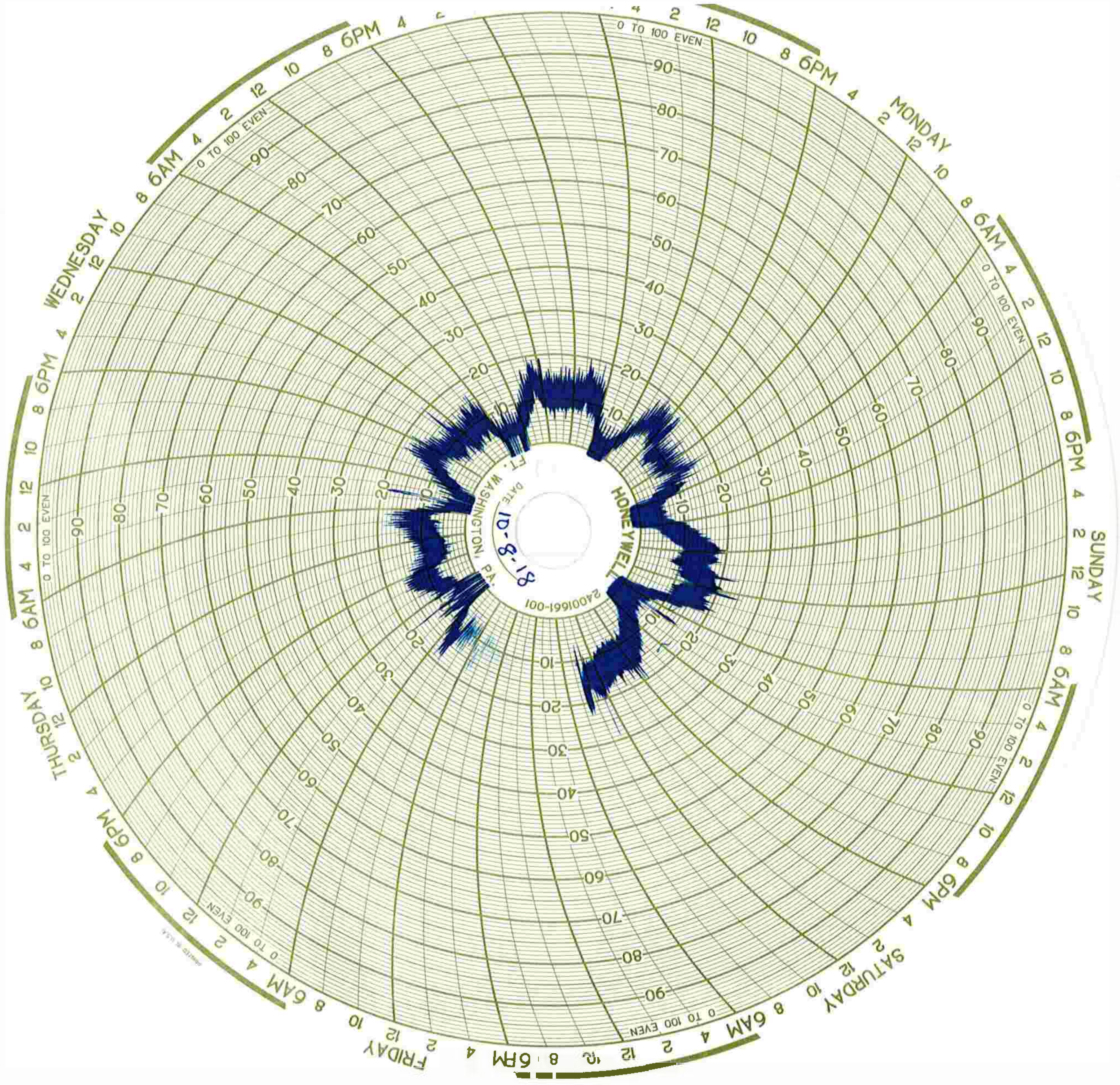
PWS Identification Number: 5280223 Plant Name: Placid Lakes Utilities

III. Daily Data for the Month/Year of:

Means of Achieving Four-Log Virus Inactivation/Removal: * _____ Free Chlorine _____ Chlorine Dioxide _____ Ozone _____ Combined Chlorine (Chloramines) _____ Ultraviolet Radiation _____ Other (Describe):

Type of Disinfectant Residual Maintained in Distribution System: Free Chlorine Combined Chlorine (Chloramines) Chlorine Dioxide

| | | | | CT Calculations, or UV Dose, to Demonstrate Four-Log Virus Inactivation, if applicable* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CT Calculations | | | | | | | UV Dose | | | |
| Days of Month | Days Plant Staffed Or Visited By Oper. | Hours Plant In oper. | Net quantity Of finished Water Produced, gal | Peak Flow Rate, gpd | Lowest residual s\disinfectant Concentration (C) Before or at First customer During peak Flow, mg/L | Disinfectant Contact time (T) At C Measurement Point during Peak flow, Minutes | Lowest CT Provided Before or At first Customer During Peak flow, mg-min/L | Temp Of Water, C | PH of Water, If appl. | Minimum CT req. mg-min/L | Lowest operating UV dose, mW-sec/cm2 | Minimum UV dose req. mW-sec/cm2 | Lowest residual disinfectant concentration at remote point in distribution system, mg/L | Emergency or abnormal operating conditions, repair or maintenance work that involves taking water system component out of operation. |
| 1 | X | 24 | 331000 | 233 | 1.5 | - | - | 25 | 7.3 | - | - | - | 1.2 | |
| 2 | X | 24 | 314000 | 204 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 3 | X | 24 | 294000 | 309 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 4 | X | 24 | 351000 | 426 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 5 | X | 24 | 302000 | 389 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 6 | X | 24 | 252000 | 179 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 7 | X | 24 | 281000 | 246 | 1.0 | - | - | 25 | 7.3 | - | - | - | .7 | |
| 8 | X | 24 | 290000 | 247 | 1.1 | - | - | 25 | 7.3 | - | - | - | .8 | |
| 9 | X | 24 | 309000 | 262 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 10 | X | 24 | 327000 | 319 | 1.2 | - | - | 25 | 7.3 | - | - | - | .9 | |
| 11 | X | 24 | 303000 | 235 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 12 | X | 24 | 315000 | 219 | 1.1 | - | - | 25 | 7.3 | - | - | - | 1.8 | |
| 13 | X | 24 | 286000 | 263 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 14 | X | 24 | 285000 | 323 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 15 | X | 24 | 275000 | 280 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 16 | X | 24 | 251000 | 180 | 1.2 | - | - | 25 | 7.3 | - | - | - | .9 | |
| 17 | X | 24 | 264000 | 339 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 18 | X | 24 | 261000 | 382 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 19 | X | 24 | 320000 | 276 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 20 | X | 24 | 300000 | 316 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 21 | X | 24 | 260000 | 272 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 22 | X | 24 | 281000 | 312 | 1.1 | - | - | 25 | 7.3 | - | - | - | 1.8 | |
| 23 | X | 24 | 310000 | 249 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 24 | X | 24 | 254000 | 238 | 1.5 | - | - | 25 | 7.3 | - | - | - | 1.2 | |
| 25 | X | 24 | 286000 | 335 | 1.2 | - | - | 25 | 7.3 | - | - | - | .9 | |
| 26 | X | 24 | 270000 | 310 | 1.3 | - | - | 25 | 7.3 | - | - | - | 1.0 | |
| 27 | X | 24 | 278000 | 193 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 28 | X | 24 | 250000 | 239 | 1.4 | - | - | 25 | 7.3 | - | - | - | 1.1 | |
| 29 | X | 24 | 258000 | 230 | .5 | - | - | 25 | 7.3 | - | - | - | .5 | |
| 30 | X | 24 | 262000 | 273 | .5 | - | - | 25 | 7.3 | - | - | - | .5 | |
| 31 | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | | |
| Average | | | | | | | | | | | | | | |
| Maximum | | | | | | | | | | | | | | |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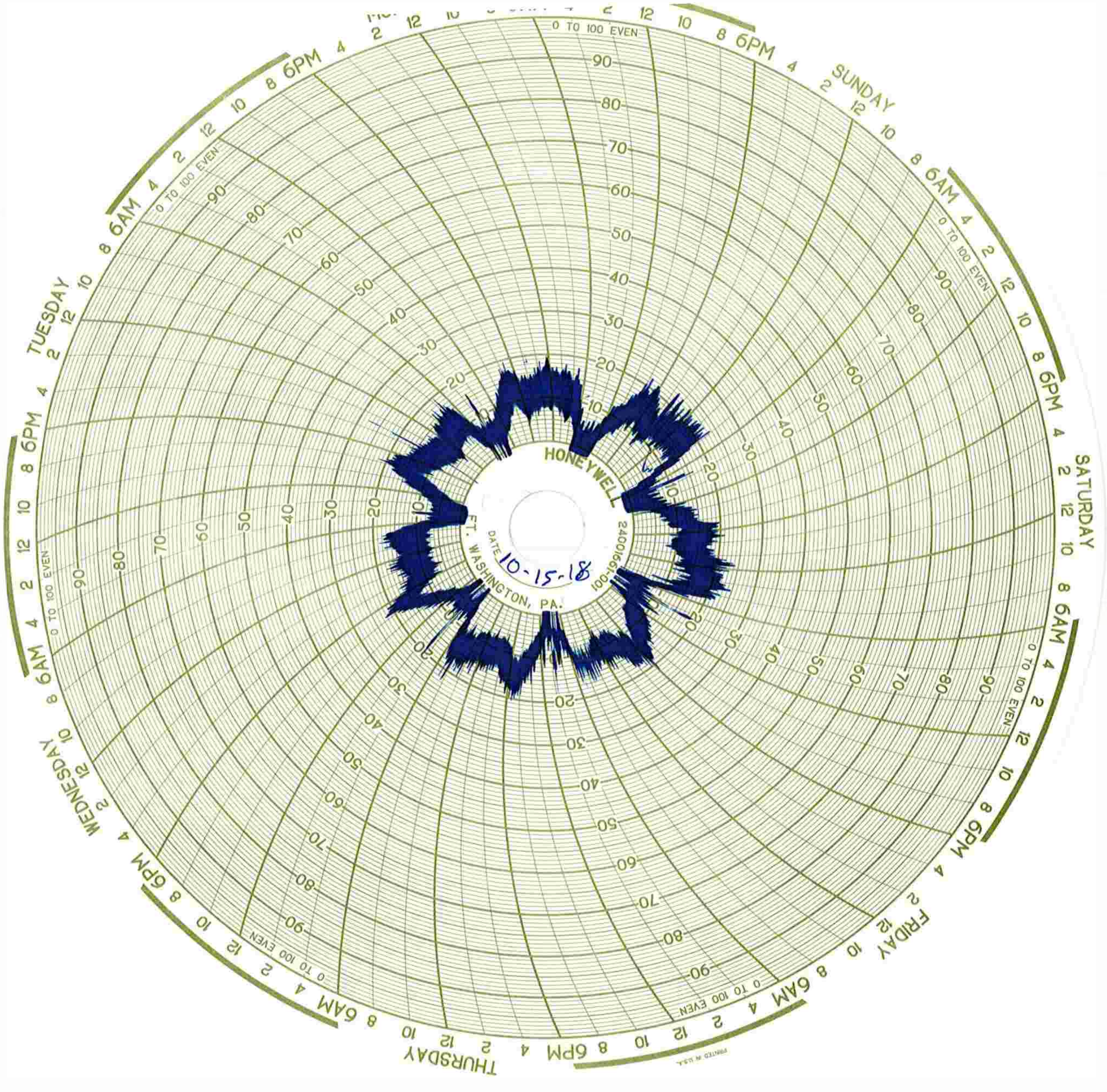
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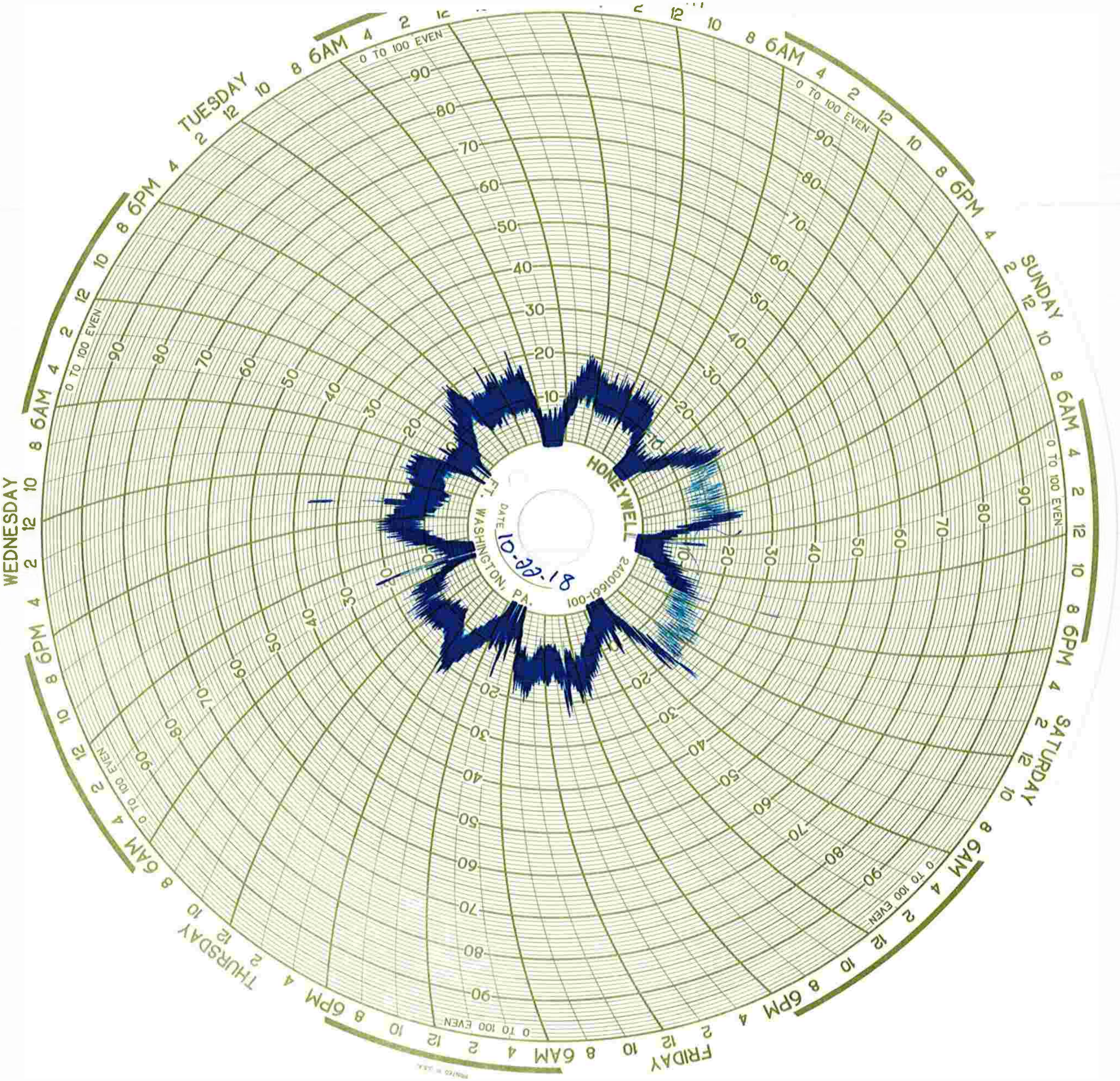
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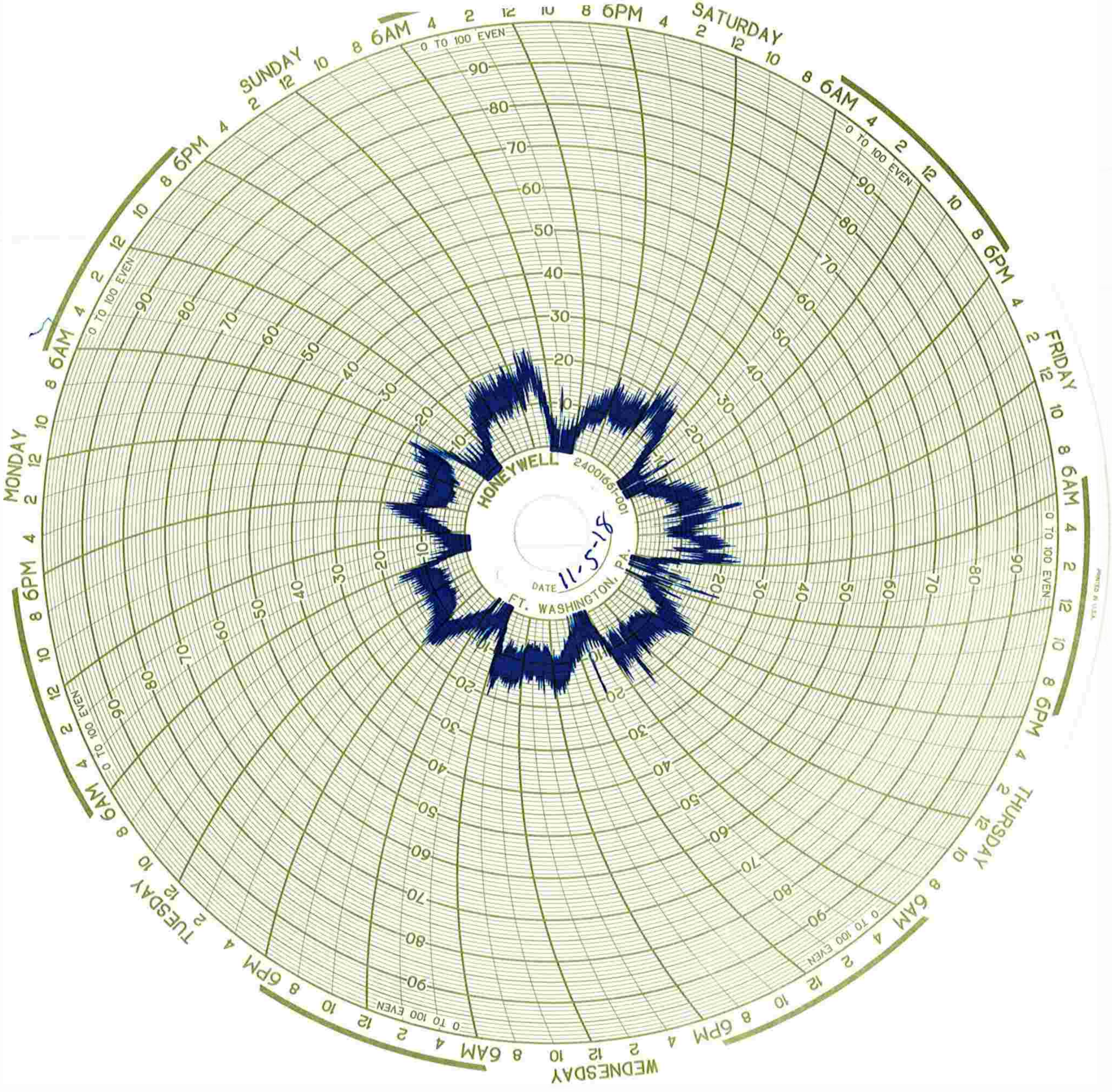
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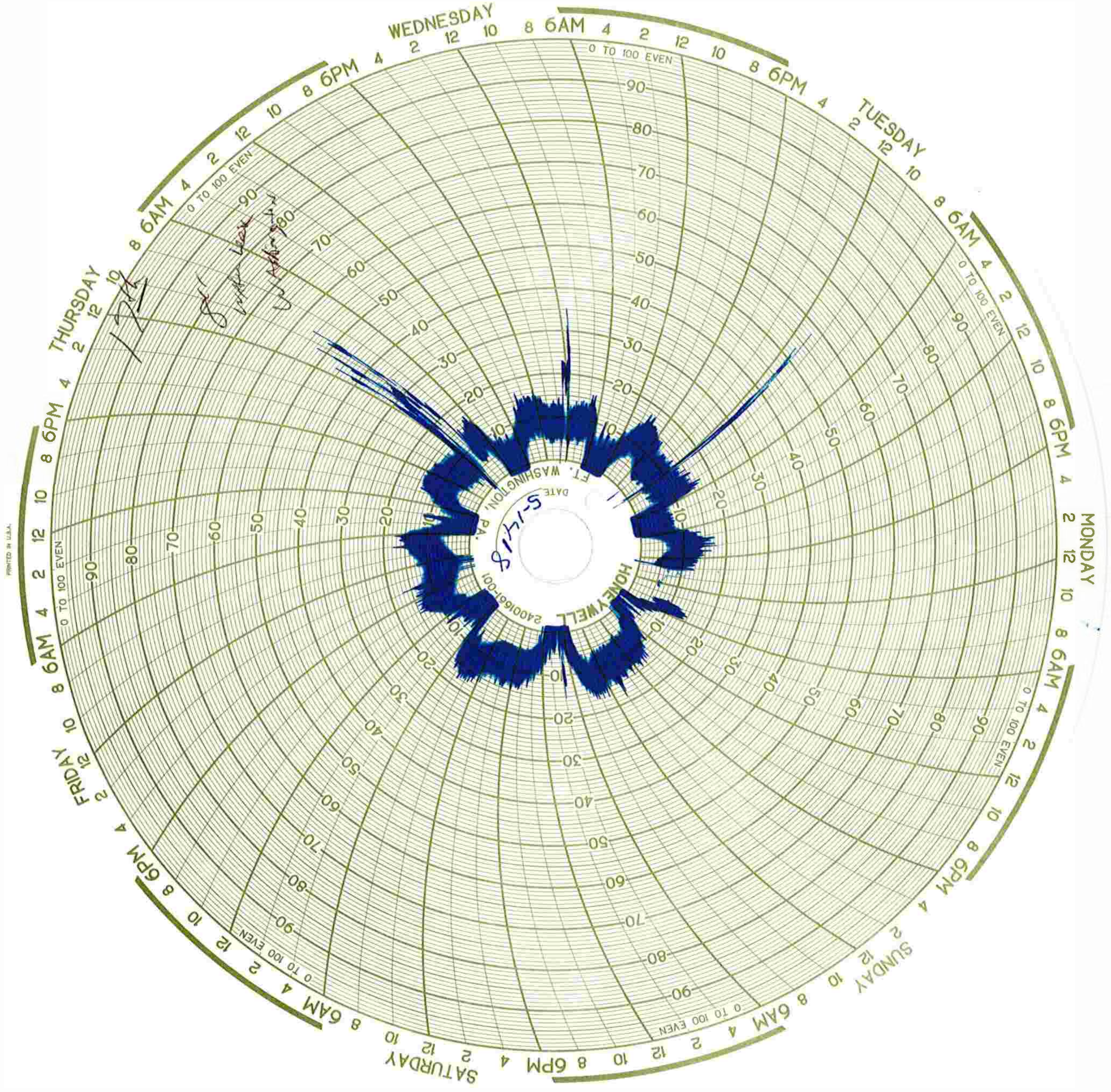
ATTACHMENT 8



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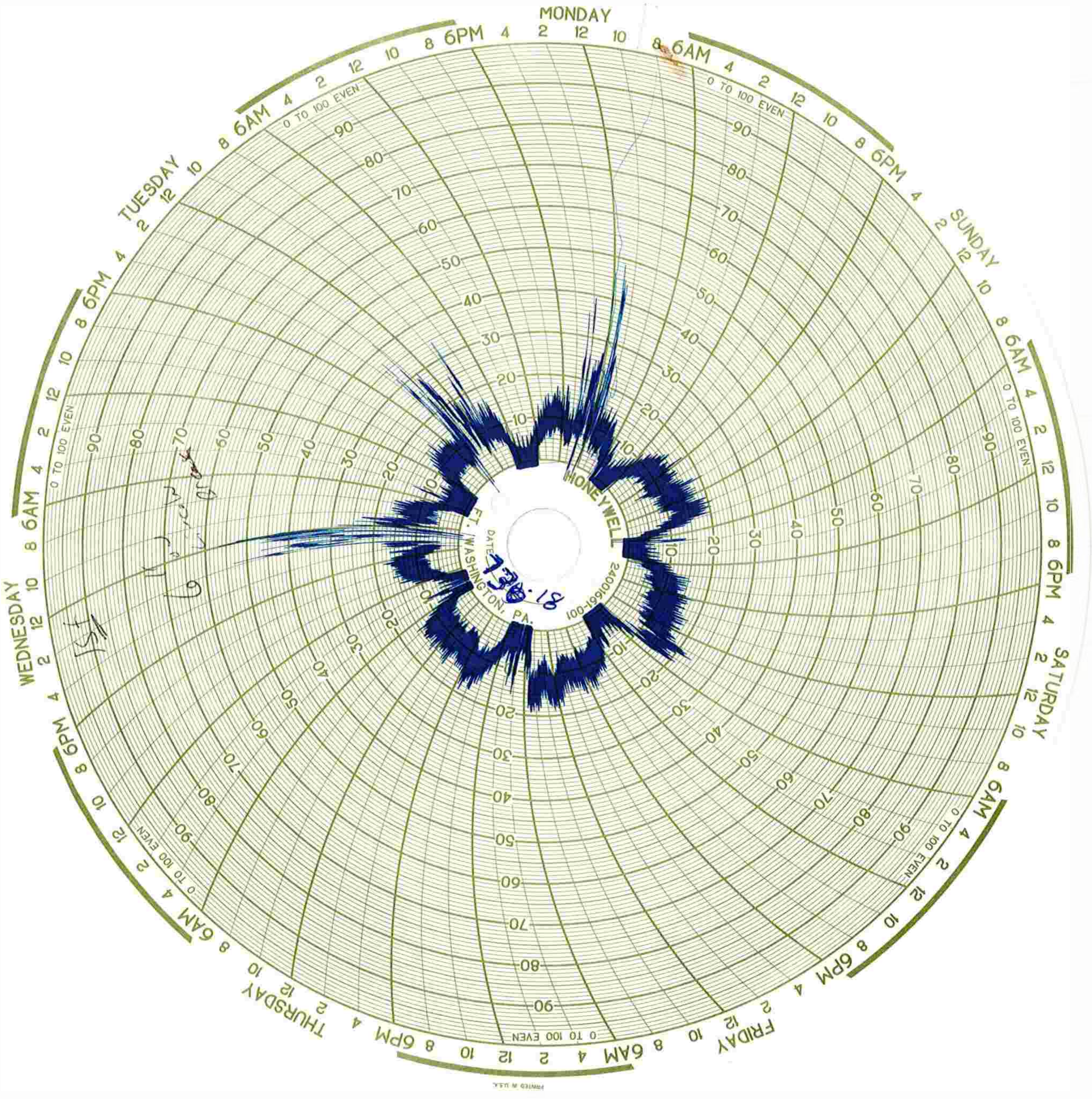MONDAY
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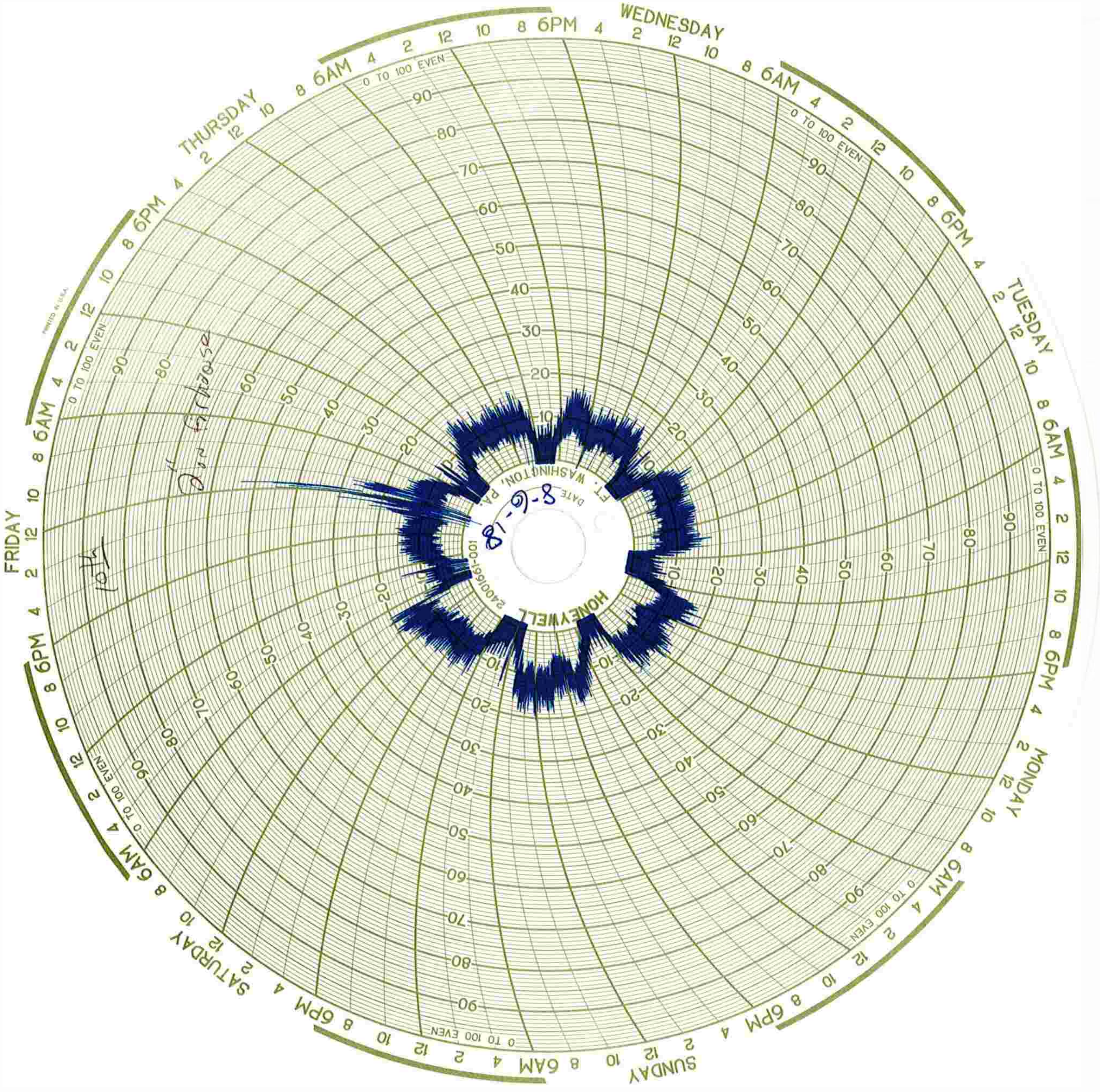
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