



**Department of Public Utilities
Policy and Procedure**

NUMBER: 20.01
EFFECTIVE DATE: 09/01/00
SUPERCEDES: N/A
SUBJECT: FLUSHING AND DISINFECTION OF WATER DISTRIBUTION LINES

I. Purpose and Application

The purpose of this policy is to establish a uniform framework for flushing and disinfection of City water distribution lines. It is to be used as a reference for contractors and City employees when laying new water lines or when repairing existing water lines.

II. General

- A. All flushing, pressure testing and disinfection procedures shall conform to the applicable sections of the Chesapeake Public Facilities Manual and AWWA/ANISI C651.
- B. The Contractor shall make a request for water through his or her inspector to the Water Distribution Superintendent at Maintenance & Operations Division 24 hours in advance of use. Requests for a quantity of water in excess of 100,000 gallons requires a 48-hour notice.
- C. The Contractor shall provide at least 48 hours notice to the appropriate City inspector to witness a connection for flushing or disinfection, pressure test, etc.
- D. Only properly functioning and clean equipment shall be used for flushing and disinfecting a water pipeline.
- E. Only Public Utilities personnel shall operate valves in the existing system (City Code Section 18-58).
- F. The Contractor will be charged for all water used for flushing and disinfection based on the rates in the City Code. Quantity of water used will be calculated from information provided on the Utility System Flushing Work Order (Attachment 1) by the City project inspector which has been

signed off by the contractor. Inspectors will forward the work order to Public Utilities within 30 days of water usage.

1. DPU will calculate the quantity of water used based on the information on the flushing request form.
 2. Bills will be processed within 60 days after the completed form is received by DPU.
- G. Water used for pressure testing and disinfection shall be only from an approved potable water source. The inspector shall verify the source.
- H. The Contractor is responsible for meeting all safety requirements pertaining to construction.

III. Open End Flushing

- A. Connection to the existing system for water during flushing is subject to the conditions noted below:
1. Request for water for flushing and disinfection is outlined in Attachment 1.
 2. City inspector will be on site during the flushing operation.
 3. Taps to existing mains will be performed as specified on related project construction drawings and as defined on the "Tapping Procedure for Tapping Water Main."
 4. New pipelines near tie-in points shall be terminated as shown on Appendix A - Figure 1.
- B. Contractor shall install a temporary full pipe size blow off on all branches and loops of the extension as shown on Appendix A - Figure 2.
1. New loops shall not be closed until after flushing has been completed.
 2. The ends of all temporary blow offs shall be elevated to prevent the contaminated water from re-entering the pipe.
- C. Flushing shall proceed in a logical progression from the water supply to the end of the extension and shall include all pipes within the project, including service laterals. Procedure to be used in flushing will be

discussed and agreed to by the inspector prior to beginning the flushing operation.

- D. Mains containing reducers will be flushed at the rate for the largest main.
- E. Flushing velocity shall be at least 2.5 feet per second.

| Size (inches) | Flow Required (gpm) |
|---------------|---------------------|
| 4 | 98 |
| 6 | 221 |
| 8 | 392 |
| 10 | 612 |
| 12 | 882 |
| 16 | 1,560 |

Appendix C - Table 1 and Figure 1 provide discharge velocity information.

- F. Mains shall be flushed until the water is clear or until at least two pipe volumes have passed through each branch, whichever is greater.

- 1. Volume of water in 100 feet of pipe

| Size (inches) | Volume Required (gallons) |
|---------------|---------------------------|
| 4 | 66 |
| 6 | 147 |
| 8 | 262 |
| 10 | 408 |
| 12 | 588 |
| 16 | 1,045 |

- 2. To obtain the required volume use the following formula to obtain minimum required flushing volume:

$$\begin{array}{r} \text{Volume} \\ \text{in} \\ \text{100 ft.} \\ \text{of Pipe} \end{array} \times \frac{\text{Length of Pipe}}{100} \times 2 = \begin{array}{r} \text{Volume of} \\ \text{Water} \\ \text{Required} \end{array}$$

- G. The inspector shall check the clarity of the water prior to conducting the pressure test.

- 1. The water shall be allowed to flow for at least 5 minutes before the sample is taken.

2. At least 25% of the branch lines blow-offs shall be sampled.
3. Samples shall be collected in a clear 1-quart container.
 - a. No visible particles or cloudiness shall be allowed.
 - b. If any sample is found to be unacceptable, then, all lines shall be checked for clarity.
 - c. Any mains found to be unacceptable shall be refushed using the procedures noted above.

H. Connection between new main and existing system will be broken when flushing is completed or when requested by inspector.

IV. Pressure Test

- A. The contractor shall test the line prior to the arrival of the inspector to witness the formal pressure test.
- B. Water for the pressure test shall be obtained through a fully valved manifold (Appendix A - Figure 3) including a proper backflow preventer. Upon completion of the filling of the line the connection shall be severed during the pressure test.
- C. The contractor shall request to schedule an inspector at least 48 hours prior to the time he desires to conduct the formal pressure test.
 1. If the line is not pressurized when the inspector arrives, the test must be rescheduled.
- D. The inspector or contractor (in the presence of the inspector) shall check each new hydrant valve and new mainline valve to insure that all valves are open. The contractor shall not operate any existing system valves.
- E. The inspector shall check the pressure gauge after the test to insure that it registers zero.
- F. The inspector shall check the pressure gauge at least every 20 minutes and the pressure noted.
- G. Water used for pressure testing and disinfection shall be from an approved or potable water source that is verified by the Inspector.

V. Disinfection of Installed Pipe

- A. All chlorination practices for disinfecting the mains shall be in accordance with the Public Facilities Manual, and AWWA/ANSI C651 (latest revision), and the Virginia Health Department, Water Works Regulation.
- B. Water for disinfection shall be obtained as shown in Appendix A - Figure 3. If the contractor does not install a proper backflow preventer, the City inspector will shut down the water pipeline work. Connection shall be made with the inspector present.
- C. All equipment to be used shall be provided by the contractor and checked for cleanliness and disinfected prior to beginning chlorination.
 - 1. Solution for disinfecting pipe and fittings and containers may be prepared by adding 1 gallon of bleach (5.25% available chlorine) to 4 gallons of water (total volume 5 gallons).
 - 2. Equipment shall be immersed in solution, or swabbed and flushed out with the solution.
 - 3. After disinfection do not place equipment directly on the ground or where it will be recontaminated.
- D. The chlorine solution shall be introduced into the main at a constant rate using a properly functioning chlorinator.
 - 1. Proportioned method - chlorine solution shall be pumped into the fill pipe, at a rate proportional to the flow of water in the fill line.
 - a. The contractor shall provide detailed calculations to the inspector to show the strength of the solution to be used, the resulting concentration, and the flow rates. This is to be submitted at the time of the request to disinfect the pipeline.
 - (1) Inspector shall review calculations to insure that the correct dosages & mixtures are to be used.
 - b. The solution feed pump shall have been calibrated by the contractor prior to using and may be checked by the inspector.

2. Additional chlorine above 25 mg/l may be required to provide the necessary residual at the end of the holding period depending on project location, cleanliness of the installation, and the holding time. The calculations of dosages shall also consider that the City water system utilizes chloramines to provide the system chlorine residual.
3. The chlorine residual shall be measured at each dead end and loop by the contractor at the beginning of the holding period. This information shall be provided to the inspector. The inspector will spot check these residuals, and if the information is wrong, the situation will be corrected at the contractor's expense.
 - a. Only free chlorine residuals shall be determined.
4. Solution shall remain in the main for at least 24 hours but should not remain longer than 48 hours.
 - a. Contractor shall not flush out solution until inspector has checked residual. The residual must be below 20 ppm and no flushing will begin until this level is measured.
5. The inspector shall randomly check chlorine residual.
 - a. If any residual is below 10 mg/l., then, the inspector shall check the residual on each line.
 - b. If more than 25% of the lines do not have the required residual the disinfection procedure shall be repeated.
6. The main shall be flushed until the residual in the extension is equal to the system residual. (0.5 -2.0 mg/l.)
 - a. All valves and hydrants shall be operated during flushing.
7. The inspector as required by the Public Facilities Manual shall collect samples. The contractor will assist if requested by the inspector.
 - a. Samples shall be collected only from suitable sampling set-ups. (See Appendix A - Figure 4.) The set-up will be installed by the contractor at locations shown on construction drawings or as directed by the inspector.

- b. Samples shall be collected using sterilized sample bags with dechlorinating agent (white tablet) and sample record cards that are available from the Water Laboratory at the Northwest River Water Treatment Plant.
- c. Sampling procedure.
 - (1) Water shall be allowed to run for 20 seconds wide open.
 - (2) Water is turned off and faucet carefully flamed using an alcohol flame, sterno, or small lighter (matches are not suitable).
 - (3) Water shall be allowed to run for 2 to 4 minutes full open, then, reduced to a slow, even flow.
 - (4) Open sample bag carefully, not touching top of bag, and fill to the fill line, which is at least 100 ml. required for testing
 - (5) Close bag by holding wire tabs and whirling rapidly to wind the top of the bag around the tabs. Fold tabs together and twist securely. Shake bag to dissolve tablet.
 - (6) Measure chlorine residual using approved methods. Test equipment is to be provided by the contractor. Call Lab for information.
 - (7) Complete sample record card (Attachment 2) including the following information:
 - (a) Location sample was taken
 - (b) Time and date sample was taken
 - (c) Chlorine residual when sample was taken
 - (d) Person collecting sample
 - (8) The inspector shall transport samples in a cooler with ice within 24 hours of collection to the Water Laboratory at the Northwest River Water Treatment

Plant. The Water Laboratory will accept contractor samples Monday to Thursday from 8:30 a.m. to 3 p.m. Bacteriological tests are complete in 24 hours **after analysis** for negative (no bacteria) results and up to 48 hours for positive (bacteria present) results. Copies of the sample results must be provided to the contractor.

- (9) Water Laboratory will reject samples for the following reasons:
- Sample is dirty or turbid.
 - Sample bag leaks.
 - Sample bag is not properly sterilized.
 - Sample transit time exceeds 24 hours.
 - Sample is not transported on ice.
 - Sample is not properly identified.
 - Sample bag does not have air space to mix the sample.
 - Reasonable doubt of contamination of the sample.
 - Bag top is not torn off correctly.
 - Not enough sample volume collected.
 - Chlorine odor detected when bag is opened at the Lab.
 - Chlorine residual not recorded on card.
- (10) If samples indicate the presence of coliform bacteria, then, the inspector and contractor shall:
- (a) Review sampling and disinfection procedures used to determine possible source of contamination.
 - (b) Resample points that indicated contamination.
 - (c) If repeat samples indicate contamination the main shall be re-disinfected.
- (11) Two consecutive passing samples are required at each sample point as per the PFM.
- (12) If water line is not activated within 21 days of bacteria sampling, the line shall be re-disinfected and tested for two consecutive passing bacteria samples.

- (13) Sample risers are to be secured or removed to prevent vandalism after each sample is taken.

VI. Sleeve in and final sampling

- A. This step will complete the flushing, chlorination, sampling, and tie-in procedures. Note that valves to the new system cannot be turned on until activated by Public Utilities.
- B. The procedure to be followed is defined in "Sleeve in Connections & Repairs".

Tapping Water Main

I. Pipe Preparation

A. Location of Tap

1. Pipe shall be uncovered on either side of the proposed tap location to insure that the following set back distances from joints are maintained:
 - a. 3.5 feet for mains 8 inches or smaller.
 - b. 5.5 feet for mains 10 inches or larger.

Measurement shall be from the "homeline" at the joint to the centerline of the outlet of the tapping sleeve.

2. Line and grade for tie-in shall also be determined at this time.
3. If proposed tap location is closer to a joint than noted above, a tee shall be cut into the line or the tap locations moved. The inspector shall make this decision.
 - a. Work shall be coordinated with inspector.
 - b. In those cases where the main is not to be tapped under pressure, then that shutoff shall be scheduled at least 48 hours in advance. Contact the Public Utilities Water Distribution Superintendent to establish the time frame. **The Superintendent will review and approve all notices that the contractor delivers to the affected customers.**

B. Excavation shall extend at least 12 inches below the pipe being tapped to allow adequate work area.

C. The existing pipe shall be cleaned prior to placing the tapping sleeve on the pipe:

1. Wash off pipe with potable water to remove dirt.

2. Swab pipe and interior of tapping sleeve with 1% chlorine solution.
 - a. Prepare solution by adding 1 gallon of bleach (5.25% available chlorine) to 4 gallons of water for total volume of 5 gallons.

II. Tapping of Main

- A. All taps shall be made full size.
- B. Tapping sleeves shall be assembled and installed in accordance with the manufacturers recommended procedures.
- C. Sleeves to be used:
 1. Cast iron, mechanical joint tapping sleeves shall be used for all taps. Size on size taps on ductile iron pipe or cast iron pipe only.
 2. Tapping saddles are not allowed.
 3. Materials used shall conform to the Chesapeake Public Facilities Manual.
- D. Special care shall be taken to insure coupon is removed from the pipe. Coupon shall be shown to the inspector.
- E. Tapping sleeves shall be pressure tested with the valve in place and open.
 1. Test pressure shall be 125 psi.
 2. Test duration shall be 1 hour.
 3. No leakage will be allowed.

III. Pipeline Extension

- A. Following the tapping sleeve installation pipe shall be swabbed and installed from the tap to a distance of approximately 4 feet outside the edge of the existing pavement as shown on the construction drawings. Distance may be adjusted for site and safety considerations.

- B. A short nipple of the length noted below shall be installed. This is to facilitate removal following flushing of the line:
 - 1. For 8 inch and smaller use 3 foot nipple minimum.
 - 2. For 12 inch and larger use 5 foot nipple minimum.
- C. All pipe from the tap shall be swabbed with a 1% chlorine solution prior to reinstallation.
- D. Tapped caps or plugs should be used to close the ends of the lines and to facilitate filling of the pipeline extension for the pressure testing and disinfecting.

IV. Final Tie-In

- A. The Standard Procedures for sleeve-in shall be followed when the nipple is installed following disinfection and pressure testing of the main.

Sleeve-In Connections and Repairs

I. Connections

- A. Connections for subdivisions shall be made after all samples have passed and just prior to activation and acceptance of section by Public Utilities.
- B. Connection for large meters on customer side shall be made only after City forces have installed the meter.

II. Excavation and Dewatering

- A. Excavate hole to a depth of at least 18 inches below the pipe to provide sump to pump out water and to prevent it from re-entering the pipe.
- B. If pipe must be drained:
 - 1. Turn off all services in the area of the shutoff.
 - 2. Sprinkle HTH powder or crystals on sides and bottom of the excavation.
 - 3. Make cuts on pipe to remove damaged section (for repairs) or remove caps or plugs on ends of lines (for sleeve-ins).
 - 4. If water leaving pipe is discolored, flush until clear.
 - 5. Maintain water level below the bottom of the pipe using pump.
- C. If repair or tie-in can be made without draining existing pipe, then services are not normally shutdown or hole sprinkled with HTH.

III. Material Preparation and Installation

- A. The interior of all pipes, sleeves, clamps and gaskets shall be swabbed with a chlorine solution.
 - 1. Prepare solution by adding 1 gallon of bleach (5.25% available chlorine) to 4 gallons of water (total volume – 5 gallons).
 - 2. Use only clean rags for swabbing.

3. After materials have been swabbed **do not lay directly on ground.**
- B. Clean and swab ends of existing water pipeline (inside and outside) for at least 12 inches from end of the pipe.
- C. Install sleeves, clamps, pipe, etc. Take care not to contaminate the disinfected materials.

IV. Flushing and Sampling

- A. Upon completion of the installation – open a hydrant, blow-off or install a service blow-off (See Appendix B - Figure 1) as close as possible to the end of the shutoff section closest to the sleeve-in.
 1. Flush pipeline from end of shutoff until the water is clear and the chlorine residual is at least one mg/l. In no case flush the section less than 30 minutes.
 2. If closest flushing and sampling point is more than 50 feet from the end of the shutoff, flush the water from both ends of the shutoff to the hydrant or blow-off.
- B. Collect Bacteriological Samples (after flushing)
 1. For sleeve-in connections – collect two samples at the nearest blow-off or hydrant 24 hours apart. If there is a sample failure, it is necessary to disinfect the line again and collect two additional samples.
 2. For repairs – use a service blow-off or hydrant as close as possible to the repair location. Flush for five minutes then collect two samples 24 hours apart. If there is a sample failure, it is necessary to disinfect the line again and collect two additional samples.
- C. If necessary flush all service connections to remove cloudy water.

Note: If substantial contamination is suspected (broken sewer main in hole, sewage smell, etc.) follow procedures in Alternate Repair Procedures.

Alternate Repair Procedure

- I. Notification - If possible contamination from sewer waste or other waste presents itself, then notification to the Water Distribution Superintendent must be immediate.

- II. Excavation
 - A. Excavate hole as noted in Standard Procedure.
 1. Sprinkle HTH Powder or Crystals around sides and bottom of excavation and on the source of possible contamination.

 - B. Prepare and install material as noted in Standard Procedure.

 - C. Disinfection and Sampling
 1. Use service blow-off, fire hydrant, or new tap to introduce chlorine into line.
 - a. Use whichever is farthest from the location of the repair and in shutoff section.

 - b. Add bleach to line – See Appendix B - Figure 2 for amount required.
 - (1) Determine length of shutoff and pipe diameter.
 - (2) Find length on bottom of graph.
 - (3) Draw line straight up to the appropriate line for pipe size needed.
 - (4) Extend line to left to determine gallons of bleach needed. Use only full gallon quantities.
 - (5) If section is longer than 500 feet, divide length as necessary for length to be less than 500 feet. Use graph, then multiply quantity times the number you used to divide length.

2. Attach jumper from service or hydrant outside shutoff section to the one in the shutoff. Monitor residual at opposite end of section using service blow-off or hydrant.
3. Determine free chlorine residual:
 - a. If residual is 300 mg/l or greater then the contact time is 15 minutes.
 - b. If residual is at least 100 mg/l but less than 300 mg/l then determine contact time using Appendix B - Figure 3.
 - c. If residual is less than 100 mg/l, disinfection procedure should be repeated.
4. At end of contact time the high chlorine residual shall be flushed out until the chlorine residual at the sampling point is 2-3 mg/l.
5. Two bacteriological samples collected 24 hours apart shall then be taken at the flushing discharge point. If there is a sample failure, it is necessary to disinfect the line again and collect two additional samples.
6. Place main back in service.

**Original signed by
Amar Dwarkanath**

7-20-2000

Director, Public Utilities

Date

Attachment 1

**City of Chesapeake
Department of Public Utilities
Utility System Flushing Work Order**

Authorization # _____ AC # _____

Requesting Inspector _____ Date of Request ___/___/___

Subdivision or Street Name _____

Date of Flushing ___/___/___

Description of System to be Flushed:

| System Components | A Length of Pipe | B Diameter of Pipe | C Duration of Flushing | D Dia. of Flow-Thru Device | DPU Use Only |
|-------------------|---------------------|-----------------------|---------------------------|-------------------------------|--------------|
| 1 | L.F. | | | | |
| 2 | L.F. | | | | |
| 3 | L.F. | | | | |
| 4 | L.F. | | | | |
| 5 | L.F. | | | | |

Other Water Usage _____

Feed Valve Size, Turns and Location* _____

Submitted by Inspector _____

Contractor Company and Representative _____

Data Needed for :
 Filling/Chlorination - A + B
 Flushing - B + C + D
 Sampling - C + D + # of D

Notification of Department of Public Utilities - 382-6189 (8:00 a.m. - 4:00 p.m.) or 382-3550 (after hours)

*Location should be intersection street names or number or nearest hydrant number.

Top copy to DPU - Administrative Division
 Middle Copy to Inspector
 Bottom copy to Contractor

CG-16,139/R96

Attachment 2

BACTERIOLOGICAL EXAMINATION OF WATER

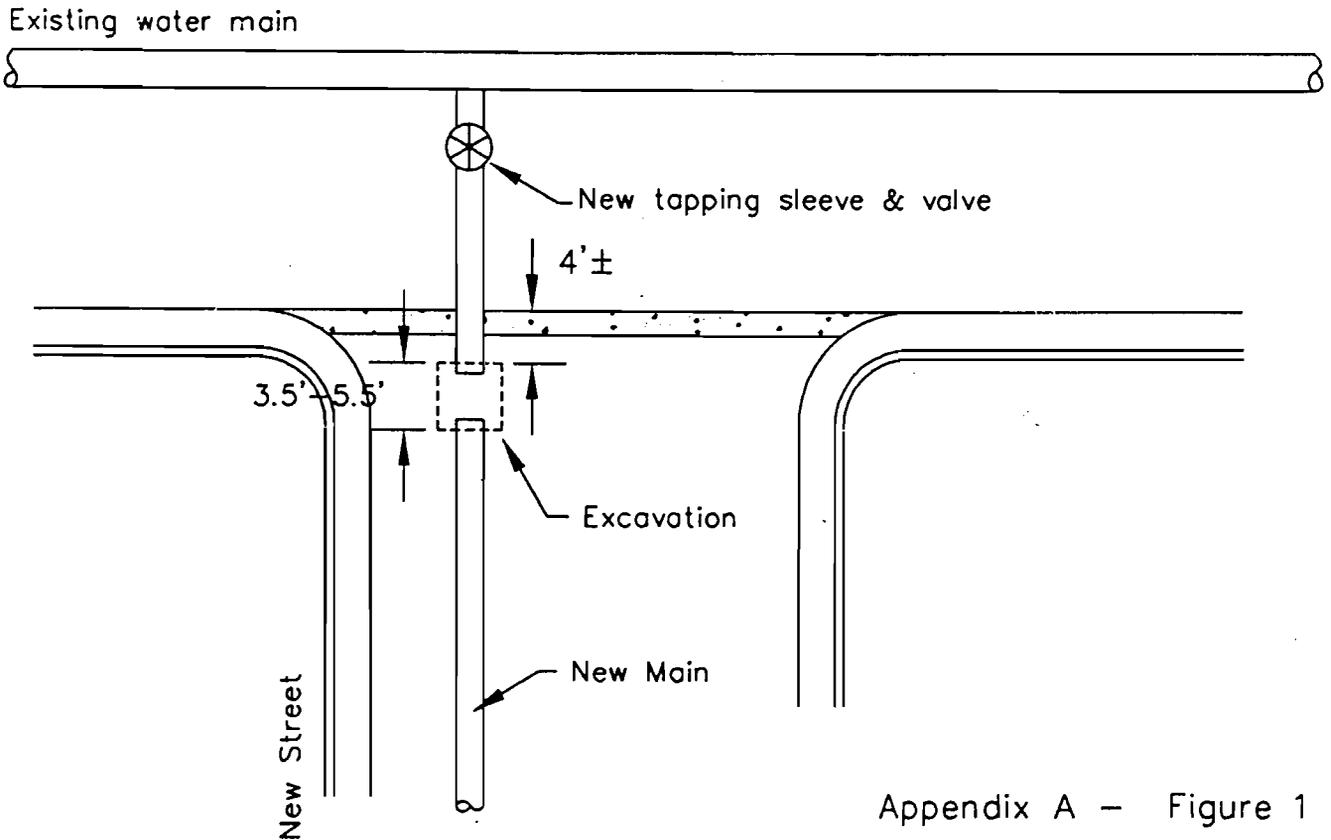
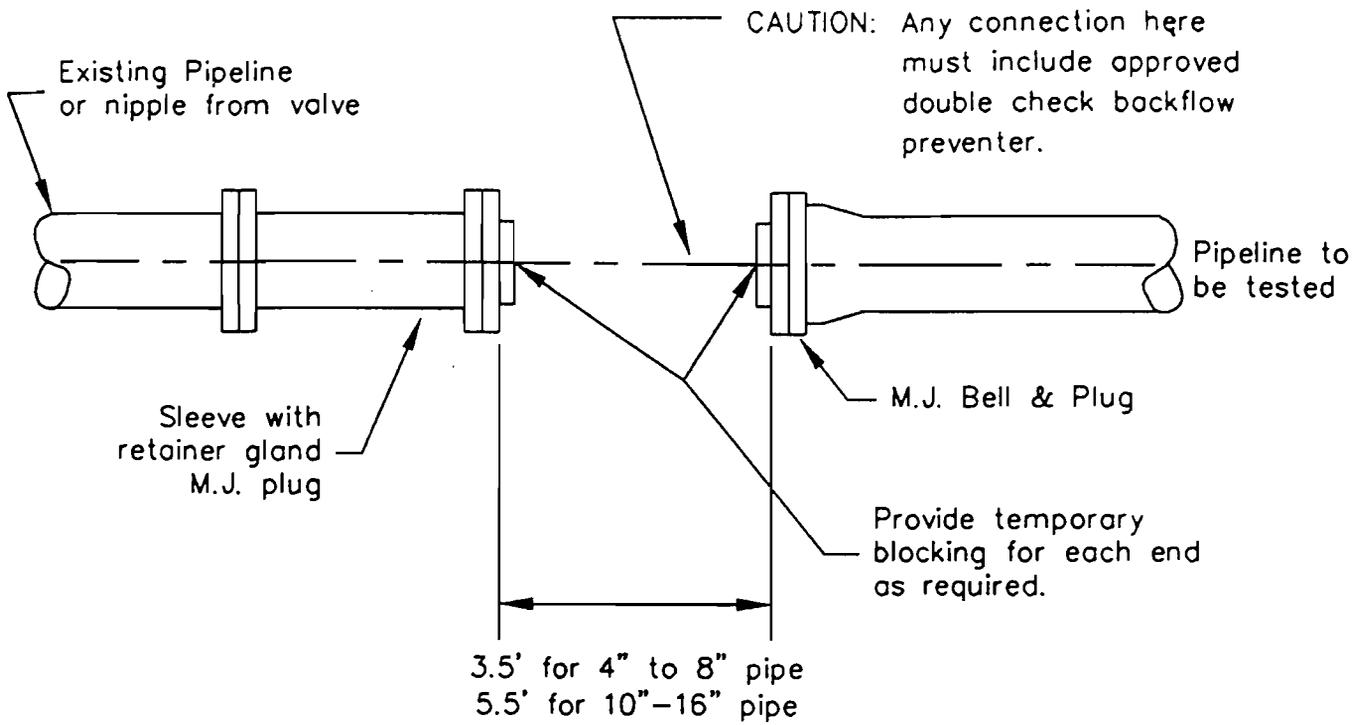
City of Chesapeake, Dept of Utilities P.O. Box 15225, Chesapeake, Virginia 23328

| | | | | | |
|-----------------------------------|--------------------------------|---|-----------------------------------|--------------------------------|---|
| Return Results: | | Acct. No. | Return Results: | | Acct. No. |
| Project Name: | | Sample No. | Project Name: | | Sample No. |
| Collection Pt.: | | | Collection Pt.: | | |
| Date & Time Coll.: | Chlorine Res. mg/L: (F) (T) | Collected By: | Date & Time Coll.: | Chlorine Res. mg/L: (F) (T) | Collected By: |
| FOR LABORATORY USE ONLY: | | | FOR LABORATORY USE ONLY: | | |
| Date & Time Analyzed: | | Analyzed By: | Date & Time Analyzed: | | Analyzed By: |
| DIRECT MEMBRANE FILTRATION METHOD | | | DIRECT MEMBRANE FILTRATION METHOD | | |
| Volume Filtered, mL | | Collection Site: Bathroom Kitchen OutsideTap | Volume Filtered, mL | | Collection Site: Bathroom Kitchen OutsideTap |
| Coliform per Filter | | | Coliform per Filter | | |
| Coliform Colonies/100ml | | | Coliform Colonies/100ml | | |
| Remarks: | | | Remarks: | | |
| Read By: | Date & Time: | | Read By: | Date & Time: | |

CG-16,077B

ATTACHMENT 2

Appendix A

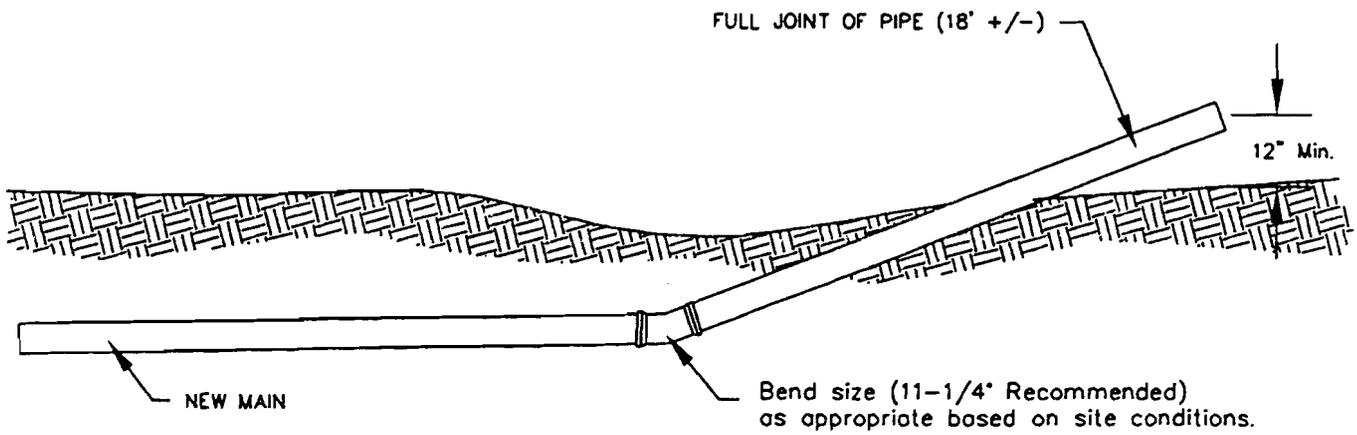


Appendix A - Figure 1

CITY OF CHESAPEAKE
DEPARTMENT OF PUBLIC UTILITIES
CHESAPEAKE, VIRGINIA

Pipeline Preparation
Prior to Testing & Tie-in

| | | | | |
|---------------|--|--|--|--|
| REVISED BY: | | | | |
| REVISED DATE: | | | | |



NOTE:

1. DIRECT DISCHARGE TO MINIMIZE DAMAGE FROM EROSION.
2. ELEVATION AT DISCHARGE TO BE HIGH ENOUGH TO PREVENT WATER FROM RE-ENTERING THE PIPE.

Appendix A - Figure 2

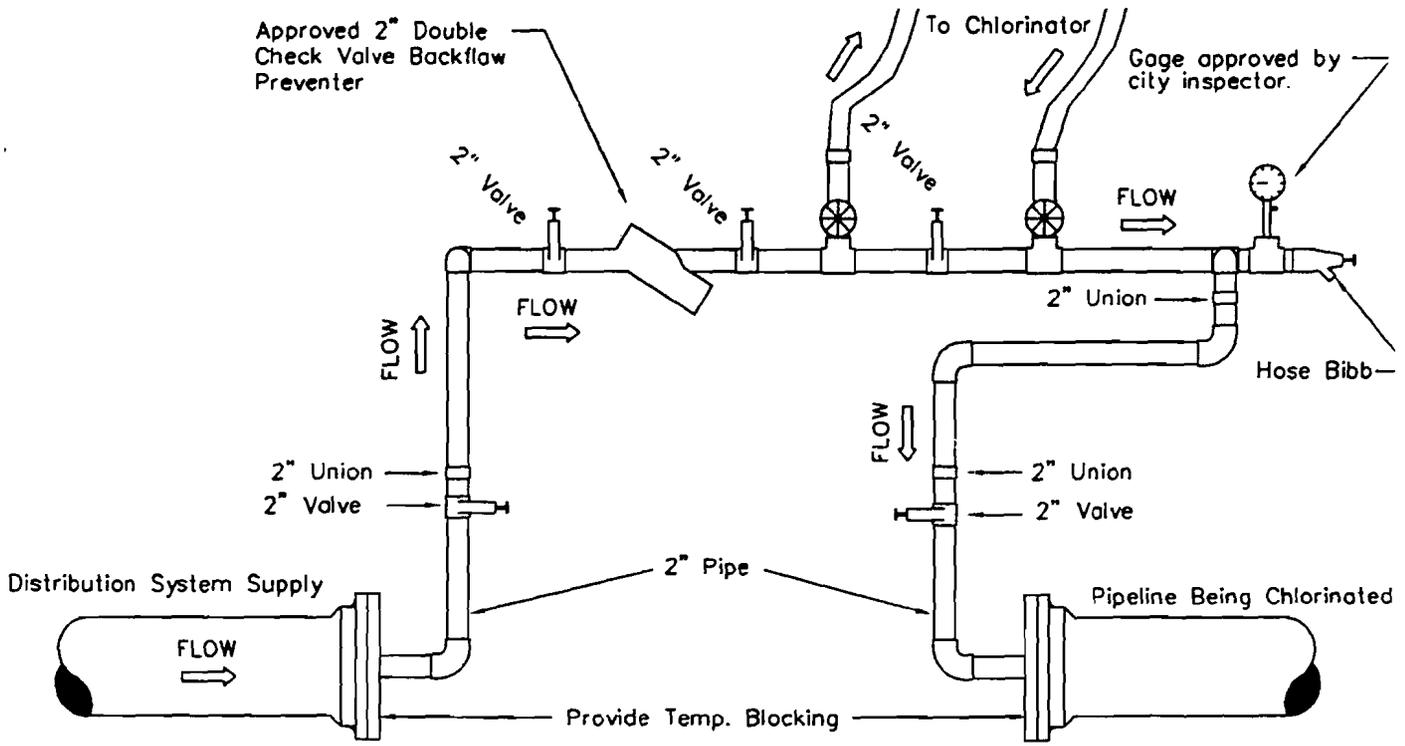
CITY OF CHESAPEAKE
 DEPARTMENT OF PUBLIC UTILITIES
 CHESAPEAKE, VIRGINIA

FULL SIZE TEMPORARY
 BLOW-OFF

| | | | | |
|---------------|--|--|--|--|
| REVISED BY: | | | | |
| REVISED DATE: | | | | |

d:\outocod\miscell\us\w-app-a-2.dwg

d:\autoc\scellaneous\W-app-a3.dwg



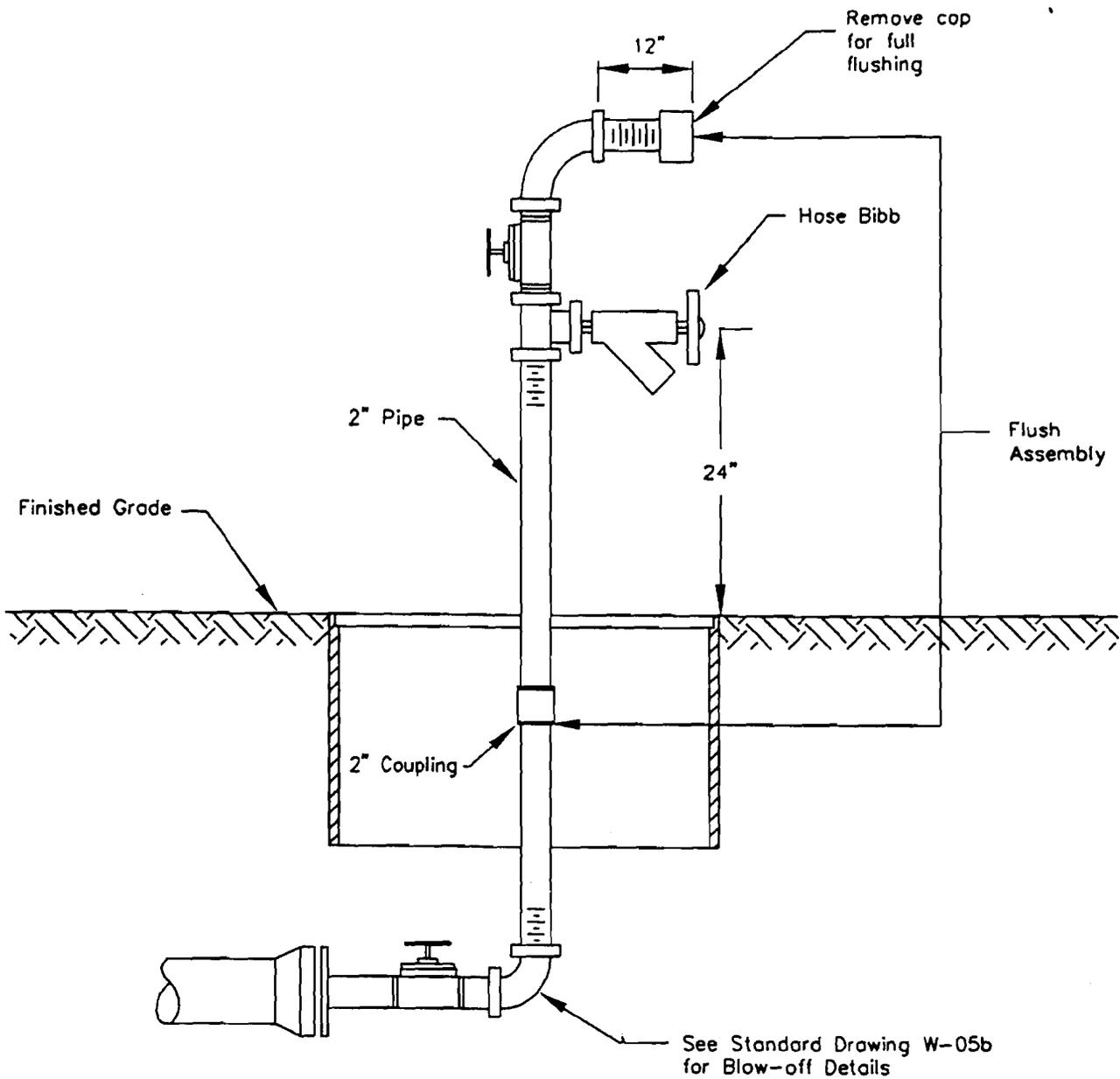
- NOTE:
1. COPY OF TEST REPORT ON BACKFLOW PREVENTER SHALL BE PROVIDED TO THE INSPECTOR IF REQUESTED.
 2. ANY DEVICE W/SIMILAR CAPABILITIES MAY BE USED IF APPROVED BY PUBLIC UTILITIES

Appendix A - Fig. 3

CITY OF CHESAPEAKE
 DEPARTMENT OF PUBLIC UTILITIES
 CHESAPEAKE, VIRGINIA

MANIFOLD FOR TEST
 AND CHLORINATION

| | | | | |
|---------------|--------|--|--|--|
| REVISED BY: | B.W.S. | | | |
| REVISED DATE: | 1/98 | | | |



NOTES:

1. ALL PIPE FITTINGS TO BE BRASS OR COPPER.
2. UPON COMPLETION OF EACH SAMPLING, THE FLUSHING ASSEMBLY SHALL BE REMOVED.
3. PRIOR TO EACH PLACEMENT, THE ASSEMBLY SHALL BE DISINFECTED.
4. CAP SHALL BE PLACED ON THE BLOW OFF RISER WHEN FLUSHING ASSEMBLY NOT INSTALLED.

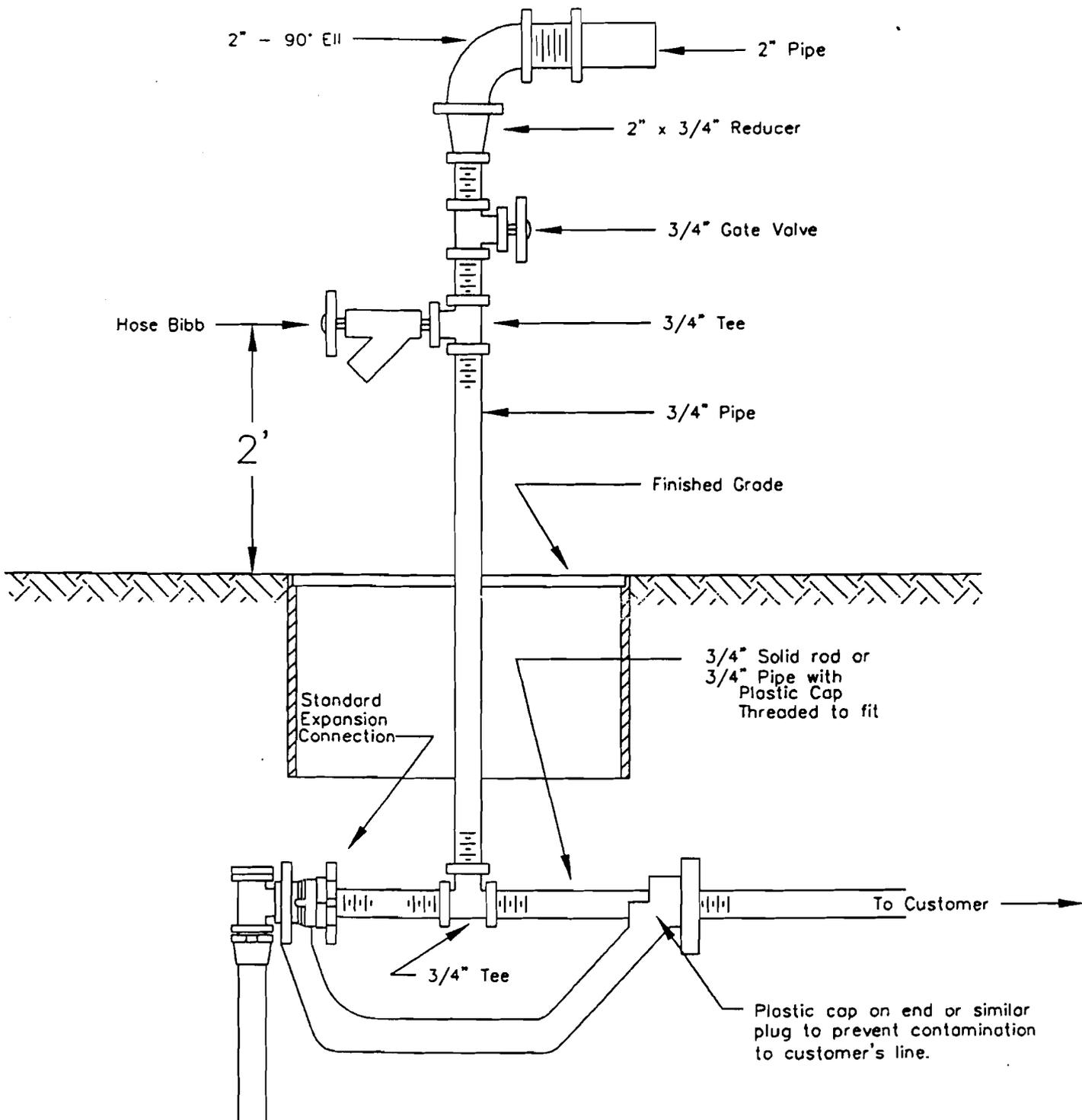
Appendix 'A' - Figure 4

CITY OF CHESAPEAKE
 DEPARTMENT OF PUBLIC UTILITIES
 CHESAPEAKE, VIRGINIA

Sampling Riser
 on Standard 2" Blow-off

| | | | | | |
|---------------|--|--|--|--|--|
| REVISED BY: | | | | | |
| REVISED DATE: | | | | | |

Appendix B



NOTE:

1. ANY SIMILAR TYPE OF FLUSH PIPE OF SERVICE BLOW-OFF IS ACCEPTED.
2. ALL FITTINGS AND PIPE TO BE BRASS OR COPPER.

Appendix B - Figure 1

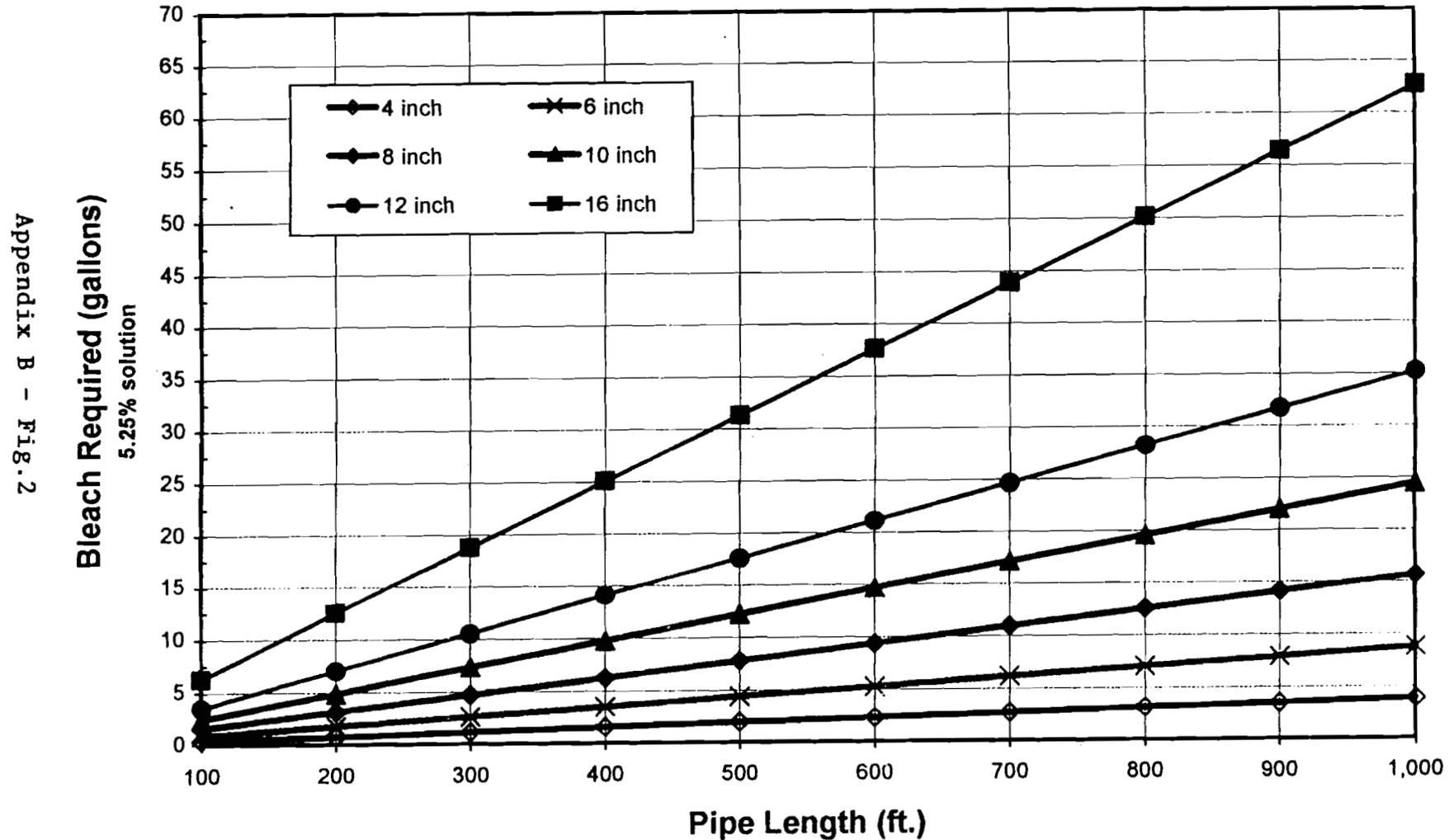
CITY OF CHESAPEAKE
 DEPARTMENT OF PUBLIC UTILITIES
 CHESAPEAKE, VIRGINIA

Service Blow-off
 (Meter Removed)

| | | | | |
|---------------|--|--|--|--|
| REVISED BY: | | | | |
| REVISED DATE: | | | | |

Chlorine Required to Disinfect Mains

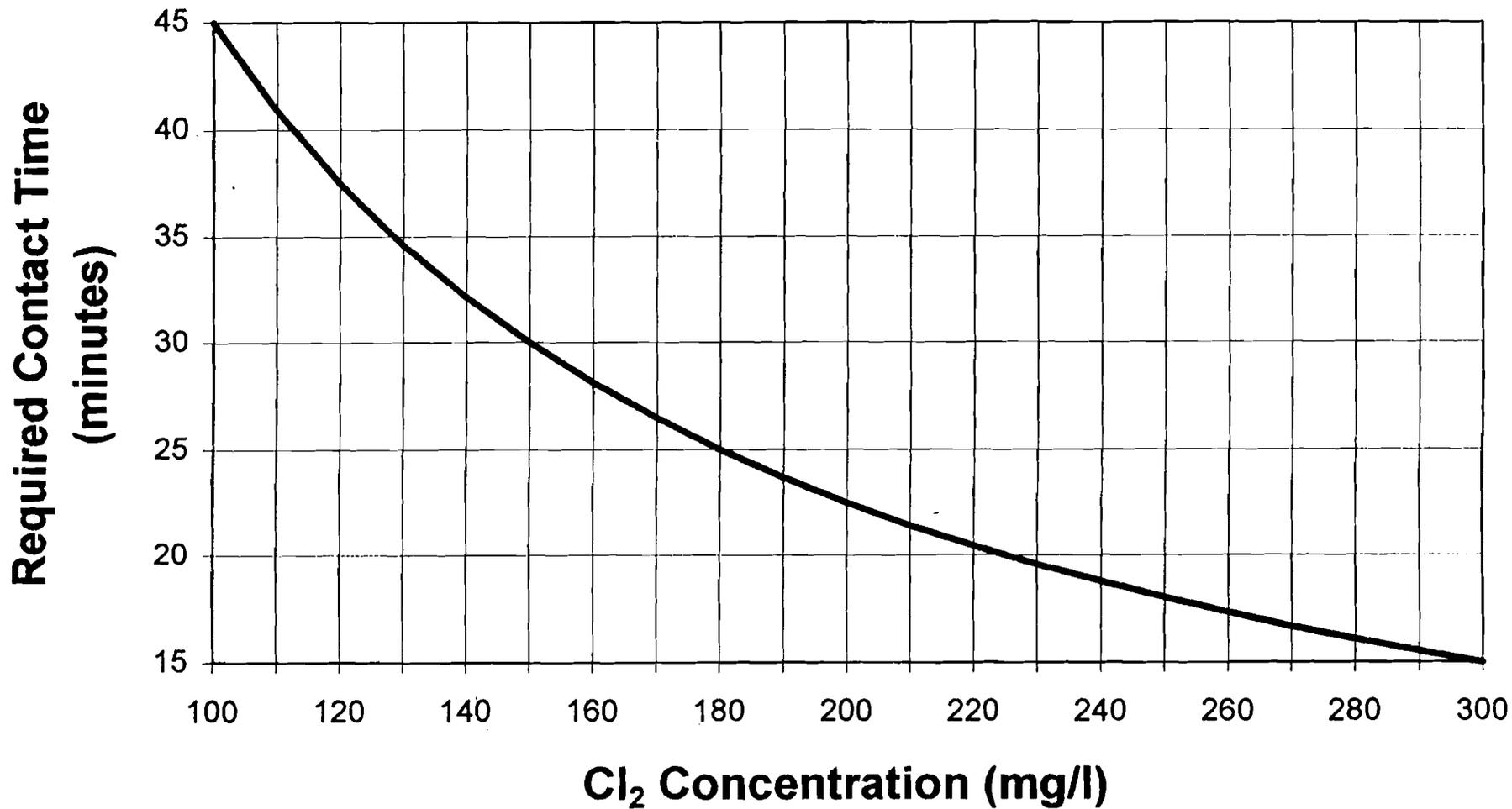
300 mg/l concentration



For other solution strengths divide 5.25% by the concentration and multiply times gallons noted

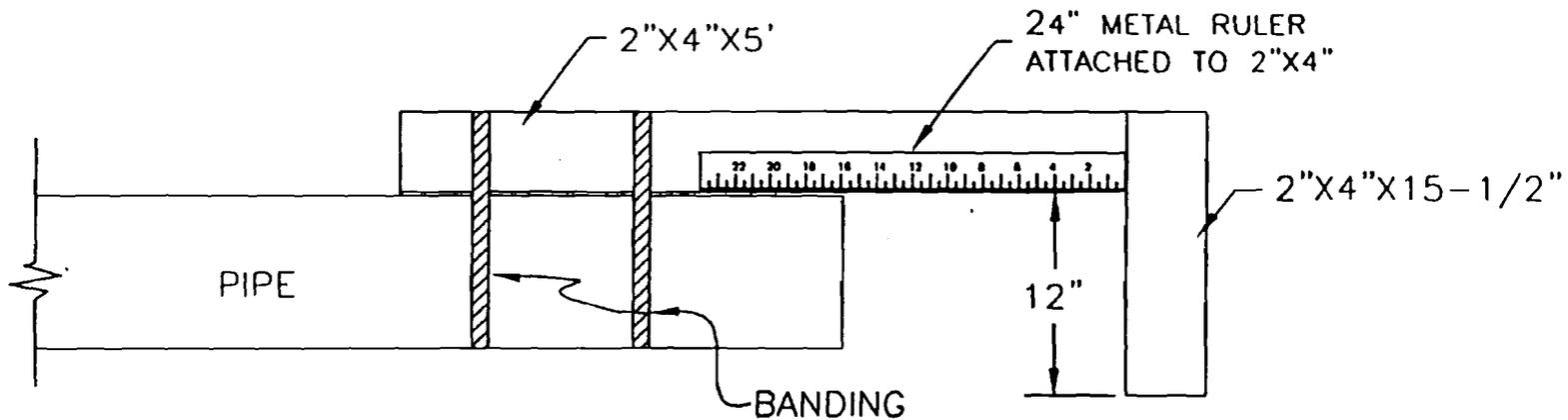
Prepared 10/5/99

Required Contact Time



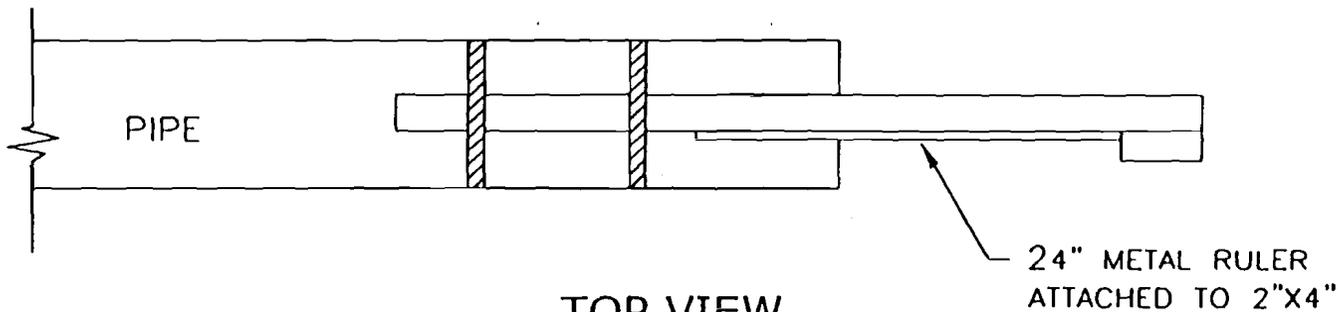
Appendix C

Appendix C Figure 1



SIDE VIEW

NOT DRAWN TO SCALE

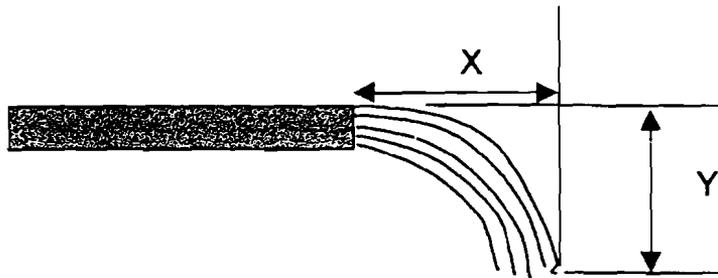


TOP VIEW

NOT DRAWN TO SCALE

Horizontal Distance in inches for open ended discharge (X)

| (V) velocity (fps) | Vertical Drop (in.) (Y) | | | | | |
|-----------------------|-------------------------|------------|------------|-------------|-------------|-------------|
| | 6 | 12 | 18 | 24 | 30 | 36 |
| 0.5 | 1.1 | 1.5 | 1.8 | 2.1 | 2.4 | 2.6 |
| 1.0 | 2.1 | 3.0 | 3.7 | 4.2 | 4.7 | 5.2 |
| 1.5 | 3.2 | 4.5 | 5.5 | 6.3 | 7.1 | 7.8 |
| 2.0 | 4.2 | 6.0 | 7.3 | 8.5 | 9.5 | 10.4 |
| 2.5 | 5.3 | 7.5 | 9.2 | 10.6 | 11.8 | 12.9 |
| 3.0 | 6.3 | 9.0 | 11.0 | 12.7 | 14.2 | 15.5 |
| 3.5 | 7.4 | 10.5 | 12.8 | 14.8 | 16.6 | 18.1 |
| 4.0 | 8.5 | 12.0 | 14.7 | 16.9 | 18.9 | 20.7 |
| 4.5 | 9.5 | 13.5 | 16.5 | 19.0 | 21.3 | 23.3 |
| 5.0 | 10.6 | 15.0 | 18.3 | 21.1 | 23.6 | 25.9 |
| 5.5 | 11.6 | 16.4 | 20.1 | 23.3 | 26.0 | 28.5 |
| 6.0 | 12.7 | 17.9 | 22.0 | 25.4 | 28.4 | 31.1 |
| 6.5 | 13.7 | 19.4 | 23.8 | 27.5 | 30.7 | 33.7 |
| 7.0 | 14.8 | 20.9 | 25.6 | 29.6 | 33.1 | 36.3 |
| 7.5 | 15.9 | 22.4 | 27.5 | 31.7 | 35.5 | 38.8 |
| 8.0 | 16.9 | 23.9 | 29.3 | 33.8 | 37.8 | 41.4 |
| 8.5 | 18.0 | 25.4 | 31.1 | 36.0 | 40.2 | 44.0 |
| 9.0 | 19.0 | 26.9 | 33.0 | 38.1 | 42.6 | 46.6 |
| 9.5 | 20.1 | 28.4 | 34.8 | 40.2 | 44.9 | 49.2 |
| 10.0 | 21.1 | 29.9 | 36.6 | 42.3 | 47.3 | 51.8 |



- Notes:
1. It makes no difference if the pipe is sloping up (30 degrees or less) or straight the same dimensions apply to indicate the approximate velocity.
 2. The diameter of the pipe does not affect the dimensions
 3. Equation $V(2Y/32.2)^{.5} = X$
 where V = velocity of the water in FPS
 and X and Y are in ft.