

SPECIAL CONDITIONS

- A MINIMUM COVER OF THREE AND ONE HALF (3.5) FEET OVER THE PROPOSED LINES IS REQUIRED.
- 1A. A PRECONSTRUCTION CONFERENCE SHALL BE SCHEDULED WITH CITY OF ROANOKE PRIOR TO COMMENCING WITH CONSTRUCTION.
2. NO WORK SHALL BEGIN WITHOUT NOTIFYING CITY OF ROANOKE 24 HOURS IN ADVANCE. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ANY AND ALL NECESSARY PERMITS.
3. NO WORK SHALL BEGIN WITHOUT WRITTEN APPROVAL OF CONSTRUCTION PLANS.
4. WORK SHALL BE SUBJECT TO INSPECTION BY THE CITY INSPECTORS AND DESIGN ENGINEER. SANITARY SEWER CUT SHEETS SHALL BE SUBMITTED TO THE ROANOKE CITY ENGINEER.
5. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING AND UNCOVERING ALL VALVE BOXES AFTER SURFACE TREATMENT OF ROADS AND ADJUSTING BOXES TO FINAL ROAD GRADES, IF NECESSARY.
6. ALL EXISTING UTILITIES MAY BE SHOWN OR MAY NOT BE SHOWN IN THE EXACT LOCATION. THE CONTRACTOR SHALL COMPLY WITH THE STATE WATER WORKS REGULATIONS, SECTION 12.05.03 WHERE LINES CROSS.
7. THE CONTRACTOR SHALL NOTIFY THE CITY AND OBTAIN CITY APPROVAL OF ANY FIELD CORRECTION TO THE APPROVED PLANS PRIOR TO SUCH CONSTRUCTION.
8. ALL TRENCHES WITHIN THE EXISTING OR FUTURE CITY OF ROANOKE RIGHT-OF-WAY MUST BE COMPACTED IN SIX INCH LAYERS.
9. ALL LINES TO BE STAKED PRIOR TO CONSTRUCTION.
10. CONTRACTOR TO COORDINATE WITH THE ENGINEER TO PROVIDE AS-BUILT PLANS CONTRACTOR SHALL MAINTAIN A SET OF RED-LINE PLANS SHOWING AS-BUILT LOCATION OF ALL STRUCTURES. AS-BUILT INFORMATION TO BE SUBMITTED TO DESIGN ENGINEER FOR PREPARATION OF RECORD AS-BUILT PLANS. SUCH AS-BUILT PLANS SHALL BE SUBMITTED TO ROANOKE CITY PRIOR TO CITY ACCEPTANCE.
11. ALL CONSTRUCTION SHALL BE IN ACCORDANCE TO APPROVED CONSTRUCTION PRACTICES OF THE APPLICABLE TRADES.
12. UNLESS NOTED OTHERWISE HEREIN ALL CONSTRUCTION SHALL BE IN ACCORDANCE TO THE LATEST EDITION OF AWWA STANDARDS.

EXCAVATION, STABILIZATION AND BEDDING

- TRENCHING
 1. EXCAVATION FOR TRENCHES SHALL INCLUDE THE REMOVAL OF ALL MATERIAL ENCOUNTERED REGARDLESS OF LOCATION OF ALL STRUCTURES AND STATIONS INDICATED ON THE PLANS OR SPECIFIED HEREIN.
 2. EXCAVATION, UNLESS OTHERWISE SPECIFIED, SHALL BE OPEN CUT. THE CONTRACTOR SHALL OPEN NO MORE THAN TWO HUNDRED (200) FEET OF TRENCH AT ONE TIME DURING THE LAYING OF PIPE, UNLESS APPROVED BY THE ENGINEER.
 3. TRENCHES SHALL BE EXCAVATED IN STRAIGHT LINES AND SHALL BE ACCURATELY GRADED IN ORDER TO ESTABLISH A TRUE ELEVATION FOR THE INVERT OF THE PIPE.
 4. THE WIDTH OF TRENCHES, FROM EXISTING GRADE TO ONE (1) FOOT ABOVE THE TOP OF THE PIPE SHALL BE OF SUFFICIENT WIDTH TO PERMIT THE PROPER INSTALLATION OF BRACING, SHORING OR SHEETING.
 5. THE SIDES OF THE TRENCHES SHALL BE AS VERTICAL AS PRACTICAL.
 6. EXCAVATION FOR STRUCTURES SHALL ALLOW A MINIMUM OF TWELVE (12) INCHES CLEAR BETWEEN THE STRUCTURE AND THE SIDES OF THE TRENCH OR ANY REQUIRED BRACING, SHORING OR SHEETING.
 7. EXCAVATED MATERIALS SUITABLE FOR BACKFILL SHALL BE STOCKPILED IN AN ORDERLY MANNER AT A SUFFICIENT DISTANCE FROM THE SIDES OF THE TRENCH IN ORDER TO AVOID OVERLOADING THE BANKS OF THE TRENCH AND TO PREVENT SLIDES OR CAVE-INS.
 8. EXCAVATED MATERIALS WHICH ARE NOT REQUIRED OR APPROVED FOR BACKFILL, SHALL BE REMOVED FROM THE SITE AND DISPOSED OF BY THE CONTRACTOR, AT HIS EXPENSE.
 9. CONTRACTOR TO ADHERE TO ALL LOCAL, STATE AND FEDERAL CONSTRUCTION LAWS, INCLUDING OSHA TRENCH SAFETY REGULATIONS.
- TRENCH STABILIZATION
 1. TRENCH STABILIZATION MATERIAL SHALL BE COARSE AGGREGATE SIZE NUMBER 2 AND SHALL CONFORM WITH VOOT SECTION 203 AND/OR ASTM C 33.
 2. WHENEVER EXCESSIVELY WET OR UNSTABLE MATERIAL IS ENCOUNTERED IN THE BOTTOM OF THE TRENCH, WHICH IN THE OPINION OF THE ENGINEER IS INCAPABLE OF PROPERLY SUPPORTING THE PIPE OR STRUCTURES, SUCH MATERIAL SHALL BE REMOVED AND BACKFILLED WITH TRENCH STABILIZATION MATERIAL AND SHALL BE GRADED TO ALLOW FOR THE COMPACTED BEDDING MATERIAL.
 3. ALL UNAUTHORIZED OVERDEPTHS OF EXCAVATION SHALL BE BACKFILLED, AT THE CONTRACTOR'S EXPENSE, WITH TRENCH STABILIZATION MATERIAL AND SHALL BE GRADED TO ALLOW FOR THE COMPACTED BEDDING MATERIAL.
- COMPACTED BEDDING MATERIAL
 1. BEDDING MATERIAL SHALL BE COARSE AGGREGATE SIZE NUMBER 57 AND SHALL CONFORM WITH VOOT SECTION 203 AND/OR ASTM C 33.
 2. THE BOTTOM OF THE PIPE TRENCH SHALL BE EXCAVATED TO A MINIMUM OVERDEPTH OF SIX (6) INCHES BELOW THE BOTTOM OF THE PIPE, TO PROVIDE FOR THE COMPACTED BEDDING MATERIAL. BEDDING MATERIAL SHALL BE PLACED, SHAPED AND COMPACTED.
 3. BELL HOLES AND DEPRESSIONS REQUIRED FOR THE JOINING OF THE PIPE SHALL BE DUG AFTER THE COMPACTED BEDDING MATERIAL HAS BEEN GRADED AND SHAPED AND SHALL BE ONLY OF THE LENGTH, DEPTH AND WIDTH REQUIRED TO MAKE THE JOINT PROPERLY.

PIPE, JOINTS AND FITTINGS

- SCOPE OF WORK
 1. ALL MATERIALS AND APPURTENANCES REQUIRED FOR THE WORK SHALL BE NEW, OR FIRST CLASS QUALITY AND SHALL BE FURNISHED, DELIVERED, ERECTED CONNECTED AND FINISHED IN EVERY DETAIL AS SPECIFIED OR INDICATED. ALL MATERIALS FOUND DEFECTIVE, REGARDLESS OF THE CIRCUMSTANCES, SHALL BE REPLACED WITH NEW MATERIAL AT THE EXPENSE OF THE CONTRACTOR.
 2. THE MATERIALS SPECIFIED FOR THE CONSTRUCTION SHALL COMPLY WITH THE LATEST REVISIONS OF THE APPLICABLE AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM), AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) AND/OR THE VIRGINIA DEPARTMENT OF TRANSPORTATION (VDOT) STANDARDS.

B. OPTIONAL PIPE SELECTIONS

1. THE CONTRACTOR SHALL INSTALL ONLY ONE (1) TYPE OF PIPE BETWEEN STRUCTURES EXCEPT WHERE DUCTILE IRON PIPE IS SPECIFIED OR INDICATED. WHERE EXISTING PIPE IS TO BE REPLACED OR EXTENDED THE SAME TYPE OF PIPE SHALL BE INSTALLED, UNLESS SPECIFIED OR INDICATED OTHERWISE.
2. WATER LINE SHALL BE EITHER PVC OR DUCTILE IRON.
3. SANITARY SEWERS WITH AN INSIDE DIAMETER LESS THAN OR EQUAL TO TWELVE (12) INCHES SHALL BE EITHER POLYVINYL CHLORIDE (PVC) DUCTILE IRON PIPE, AT THE CONTRACTOR'S OPTION, UNLESS SPECIFIED OR INDICATED OTHERWISE. CONTRACTOR SHALL OBTAIN APPROVAL OF PIPE MATERIAL BY ROANOKE CITY ENGINEER PRIOR TO BEGINNING CONSTRUCTION.
4. SERVICE LATERALS SHALL BE SCHEDULE 40 POLYVINYL CHLORIDE.

C. TYPES OF PIPE

1. POLYVINYL CHLORIDE (PVC) WATER PIPE SHALL BE AWWA C900 DR 18 MINIMUM, UNLESS SPECIFIED OR INDICATED OTHERWISE.
2. DUCTILE IRON PIPE SHALL CONFORM WITH AWWA C 151/ANSI 21.51 AND FITTINGS SHALL CONFORM WITH AWWA C 110/ANSI 21.10. THE PIPE AND FITTINGS SHALL BE BITUMINOUS COATED AND GASKET LINED IN ACCORDANCE WITH AWWA C 104/ANSI 21.40. THE PIPE THICKNESS SHALL CONFORM WITH AWWA C 150/ANSI 21.50 AND SHALL BE CLASS 50, AS A MINIMUM, UNLESS SPECIFIED OR INDICATED OTHERWISE.
3. PVC SEWER PIPE AND FITTINGS SHALL BE SDR 35 (ASTM D 3034).
4. JOINTS COUPLINGS AND APPURTENANCES
 1. PVC PIPE AND FITTINGS SHALL BE BELL AND SPIGOT TYPE JOINTS. THE BELL AND SPIGOT JOINT SHALL BE SEALED WITH ELASTOMERIC GASKETS CONFORMING TO ASTM 3212. THE JOINTS SHALL BE MADE IN STRICT ACCORDANCE WITH THE RECOMMENDATION OF THE PIPE MANUFACTURER.
 2. DUCTILE IRON PIPE AND FITTINGS SHALL BE EITHER MECHANICAL OR BELL AND SPIGOT TYPE JOINTS AS SPECIFIED OR INDICATED. JOINTS SHALL BE MADE WITH SINGLE WATER-TIGHT RUBBER GASKET MANUFACTURED IN ACCORDANCE WITH AWWA C 111/ANSI 21.11. THE JOINTS SHALL BE MADE IN STRICT ACCORDANCE WITH THE RECOMMENDATIONS OF THE PIPE MANUFACTURER.
 3. GATE VALVES SHALL BE IRON-BODY, BRONZE-MOUNTED, DOUBLE-DESC, PARALLEL-STEM, NON-RISING SEAM, NON-RISING STEM, FITTING WITH 2 INCH SQUARE OPERATING NUT FOR VALVE PAULT SERVICE. ALL IN ACCORDANCE WITH AWWA STANDARD C500 (LATEST REVISION). CONNECTIONS SHALL BE SUITABLE FOR THE PIPE WITH WHICH IT IS USED. THE VALVES SHALL BE SUITABLE FOR 200 P.S.I. WATER WORKING PRESSURE AND SHALL BE TESTED AT TWICE THE RATED WORKING PRESSURE. ALL GATE VALVES SHALL BE INSTALLED IN WATER VAULTS AND EQUIPPED WITH A 2-INCH SQUARE OPERATING NUT. THE NUT SHALL BE SECURED WITH AN ARROW AND THE WORD "OPEN" AND SHALL OPEN BY TURNING TO THE RIGHT (CLOCKWISE).
 4. ALL OTHER MATERIALS AND APPURTENANCES TO BE IN ACCORDANCE WITH DETAILS SHOWN ON PLANS.

PIPE INSTALLATION

A. GENERAL

1. THE CONTRACTOR SHALL NOT LAY PIPE OR PLACE MANHOLES UNTIL ALL WATER HAS BEEN REMOVED FROM THE TRENCH, OR WHEN IN THE OPINION OF THE ENGINEER, THE TRENCH OR THE WEATHER CONDITIONS ARE UNSUITABLE FOR WORK.
2. PIPE THAT MAY REQUIRE FIELD CUTTING SHALL BE DONE SO IN A NEAT AND WORKMANLIKE MANNER, SO AS TO LEAVE A SMOOTH END AT RIGHT ANGLES TO THE AXIS OF THE PIPE. CUTS SHALL BE TAKEN TO AVOID DAMAGING THE PIPE AND ANY COATINGS OR LININGS. DUCTILE IRON PIPE SHALL NOT BE CUT WITH AN OXYACETYLENE TORCH.
3. THE MATERIALS SHALL BE VISUALLY INSPECTED FOR DEFECTS BEFORE LOWERING THE PIPE OR PLACING THE MANHOLES INTO THE TRENCH. DURING THE LAYING OF THE PIPE, THE CONTRACTOR OR OTHER MATERIAL SHALL BE PLACED IN THE PIPE OR MANHOLE. THE INTERIOR OF THE PIPE SHALL BE CLEAR OF ALL SOIL, DEBRIS AND SUPERFLUOUS MATERIALS PRIOR TO AND DURING THE INSTALLATION.
4. THE CONTRACTOR SHALL EXERCISE EVERY PRECAUTION TO PREVENT FOREIGN MATERIAL FROM ENTERING THE PIPE WHILE IT IS BEING PLACED IN THE TRENCH. FAILURE BY THE CONTRACTOR TO TAKE SUCH PRECAUTIONS MAY RESULT IN THE ENGINEER REQUIRING A HEAVY, TIGHTLY WOVEN CANVAS BAG OF SUITABLE SIZE BE PLACED OVER EACH END OF THE PIPE AND REMOVED ONLY WHEN THE JOINT CAN BE MADE PROPERLY.

5. THE PIPE AND MANHOLES SHALL BE LOWERED CAREFULLY INTO THE TRENCH BY SUITABLE MEANS AND HANDLED WITH CARE AT ALL TIMES TO AVOID DAMAGE. UNDER NO CIRCUMSTANCES SHALL THE MATERIALS BE DROPPED OR DUMPED INTO THE TRENCHES.

6. WHEN WORK IS NOT IN PROGRESS, THE CONTRACTOR SHALL PLUG THE OPEN ENDS OF THE PIPE TO PREVENT TRENCH WATER OR OTHER SUBSTANCES FROM ENTERING THE PIPE. THE PLUG SHALL BE WATER-TIGHT AND SHALL REMAIN IN PLACE UNTIL ANY REQUIRED Dewatering HAS BEEN COMPLETED.

7. PARALLEL INSTALLATION - WATER LINES SHALL BE LAID AT LEAST TEN FEET HORIZONTALLY FROM A SEWER OR SEWER MANHOLE WHENEVER POSSIBLE. WHEN LOCAL CONDITIONS PREVENT A HORIZONTAL SEPARATION OF TEN FEET, THE WATER LINE MAY BE LAID CLOSER TO A SEWER OR SEWER MANHOLE PROVIDED THAT:
 - I. THE INVERT OF THE WATER MAIN SHALL BE AT LEAST 18 INCHES ABOVE THE CROWN OF THE SEWER.
 - II. WHERE THIS VERTICAL SEPARATION CANNOT BE OBTAINED, THE SEWER SHALL BE CONSTRUCTED OF AWWA APPROVED WATER PIPE, PRESSURE TESTED IN PLACE WITHOUT LEAKAGE PRIOR TO BACKFILLING.
 - III. THE SEWER MANHOLE SHALL BE OF WATER-TIGHT CONSTRUCTION AND TESTED IN PLACE.

- CROSSING - WATER LINES CROSSING SEWERS SHALL BE LAID TO PROVIDE A SEPARATION OF AT LEAST 18 INCHES BETWEEN THE BOTTOM OF THE WATER LINE AND THE TOP OF THE SEWER. WHENEVER POSSIBLE, THE CONTRACTOR SHALL PREVENT THIS VERTICAL SEPARATION. THE FOLLOWING CONSTRUCTION SHALL BE USED:
 - I. SEWERS PASSING OVER OR UNDER WATER LINES SHALL BE CONSTRUCTED OF AWWA APPROVED WATER PIPE, PRESSURE TESTED IN PLACE WITHOUT LEAKAGE PRIOR TO BACKFILLING.
 - II. WATER LINES PASSING UNDER SEWERS SHALL, IN ADDITION, BE PROTECTED BY PROVIDING:
 - (A) A VERTICAL SEPARATION OF AT LEAST 18 INCHES BETWEEN THE BOTTOM OF THE SEWER AND THE TOP OF THE WATER LINE.
 - (B) ADEQUATE STRUCTURAL SUPPORT FOR THE SEWERS TO PREVENT EXCESSIVE DEFLECTION OF THE JOINTS AND THE SETTLING ON AND BREAKING OF THE WATERLINE, AND
 - (C) THAT THE LENGTH OF THE WATER LINE BE CENTERED AT THE POINT OF THE CROSSING SO THAT JOINTS SHALL BE EQUAL DISTANCE AND AS FAR AS POSSIBLE FROM THE SEWER.

NO WATER PIPES SHALL PASS THROUGH OR COME IN CONTACT WITH ANY PART OF A SANITARY SEWER MANHOLE. ALL SANITARY SEWER MANHOLES SHALL BE PLACED A MINIMUM OF 10 FEET HORIZONTALLY FROM ALL WATER MAINS WHENEVER POSSIBLE. WHEN THIS HORIZONTAL SEPARATION CAN NOT BE MAINTAINED, THE MANHOLE SHALL BE OF WATER-TIGHT CONSTRUCTION AND TESTED IN PLACE.

8. BEFORE JOINTS ARE MADE THE PIPE SHALL BE WELL BEDDED ON A FIRM FOUNDATION AND NO PIPE SHALL BE BROUGHT INTO POSITION UNTIL THE PRECEDING LENGTH HAS BEEN THOROUGHLY EMBEDDED AND SECURED IN PLACE. ANY DEFECTS DUE TO SETTLEMENT SHALL BE MADE GOOD BY THE CONTRACTOR AT HIS EXPENSE. BELL HOLES SHALL BE DUG SUFFICIENTLY LARGE TO INSURE THE MAKING OF PROPER JOINTS.
9. PIPE SHALL BE JOINED IN FULL ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. PUSH-ON JOINTS SHALL BE THOROUGHLY CLEANED, THE RUBBER GASKET INSERTED IN THE BELL SOCKET, A THIN FILM OF APPROVED GASKET LUBRICANT APPLIED, THE SPIGOT END OF THE PIPE CENTERED INTO THE SOCKET AND THE JOINT COMPLETED BY FORGING THE SPIGOT END TO THE BOTTOM OF THE SOCKET BY A JACK-TYPE TOOL, OR OTHER DEVICE APPROVED BY THE ENGINEER. MECHANICAL JOINTS SHALL BE THOROUGHLY CLEANED, THE GASKET PLACED OVER THE SPIGOT END OF THE PIPE, THE RUBBER GASKET PAINTED WITH SOAP SOLUTION AND PLACED ON THE SPIGOT END, THE SPIGOT END OF THE PIPE SEATED IN THE BELL, THE GASKET PRESSED INTO PLACE WITHIN THE BELL, THE GASKET PRESSED INTO PLACE WITHIN THE BELL, THE GASKET PRESSED INTO POSITION, AND BOLTS AND NUTS ASSEMBLED BY HAND AND TIGHTENED WITH AN APPROVED TORQUE-LIMITING WRENCH.

B. INSTALLING WATER MAINS

1. THE WATER MAIN SHALL BE LAID AND MAINTAINED AT THE REQUIRED LINES AND GRADES WITH FITTINGS AND VALVES AT THE REQUIRED LOCATIONS.
2. DEFLECTION OF THE LINE OF PIPE, IN EITHER, THE VERTICAL OR HORIZONTAL PLANE, TO AVOID OBSTRUCTIONS, OR IN LOCATIONS WHERE LONG-RADIUS CURVES ARE REQUIRED, THE AMOUNT OF DEFLECTION SHALL NOT EXCEED APPROVED AWWA STANDARDS. ALIGNMENT THAT MAY REQUIRE DEFLECTIONS IN EXCESS OF THE RECOMMENDED LIMITATIONS, SPECIAL BENDS, OR A SUFFICIENT NUMBER OF SHORTER LENGTHS OF PIPE TO PROVIDE THE ANGULAR DEFLECTIONS WITHIN THE LIMITS AS SET FORTH, SHALL BE APPROVED BY THE ENGINEER.
3. ALL PLUGS, EXCEPT MECHANICAL JOINT PLUGS AT CONNECTIONS FOR FUTURE LINES, ALL TEES, AND ALL BENDS IN WATER MAINS UNDER PRESSURE SHALL BE PROVIDED WITH REACTION BACKING CONSISTING OF CONCRETE OR BRICK. BRICK VALVES FOR CONNECTIONS TO FUTURE LINES AND FIRE HYDRANTS SHALL BE ANCHORED TO THE WATER MAIN WITH THE ROOS.
4. DETECTION TAPE TO BE INSTALLED 12"-18" ABOVE ALL NEW PVC WATER LINES.

C. DISINFECTION OF WATER MAINS

1. ALL PIPE SHALL BE DISINFECTED, TESTED AND FLUSHED IN ACCORDANCE WITH AWWA STANDARD C601 (LATEST REVISION).
2. CONTRACTOR SHALL PROVIDE ALL MATERIALS, EQUIPMENT, NECESSARY TAPS AND PERFORM ALL WORK REQUIRED FOR THE STERILIZATION, TESTING AND FLUSHING OF THE WATER MAIN.
3. NO TESTED SECTION OF WATER LINE SHALL BE APPROVED TO DELIVER WATER SERVICE UNTIL A FAVORABLE LABORATORY REPORT HAS BEEN OBTAINED. ANY TESTED SECTION OF WATER LINE FAILING TO MEET THE REQUIREMENTS SPECIFIED SHALL BE REQUIRED BY THE CONTRACTOR AND RETESTED UNTIL THE RESULTS ARE WITHIN THE LIMITS SPECIFIED.
4. THE WATER MAIN OR VALVED OFF SECTION THAT HAS BEEN COMPLETED SHALL BE FILLED, TESTED AND FLUSHED. TEST LOCATIONS SHALL BE SUBJECT TO THE DISCRETION OF THE ENGINEER AND AS VALVES AND BLOW-OFFS PERMIT.
5. AFTER TESTING AND BEFORE FINAL INSPECTION OF THE COMPLETED SYSTEM, WATER MAINS AND SERVICE LATERALS SHALL BE FLUSHED AND DISINFECTED IN ACCORDANCE WITH AWWA SPECIFICATIONS C601(LATEST REVISION). FLUSHING SHALL BE ACCOMPLISHED AT A FLOW VELOCITY OF NOT LESS THAN 2.5 FEET PER SECOND.

DISINFECTION AS DESCRIBED IN AWWA C601 - "PLACING OF CALCIUM HYPOCHLORITE TABLETS" SHALL BE USED, 5 GRAM CALCIUM HYPOCHLORITE TABLETS WITH 3.25 GRAM AVAILABLE CHLORINE PER TABLET SHALL BE ATTACHED AT THE INSIDE TOP OF THE PIPE BY AN ADHESIVE SUCH AS PERMATEX NO. 2 OR EQUIVALENT. THE FOLLOWING NUMBER OF TABLETS FOR THE GIVEN PIPE SIZE SHALL BE USED FOR AN INITIAL DOSE OF 25 MG/L (PPM) CHLORINE:

PIPE DIAMETER	NUMBER TABLETS PER 15-20 FT. PIPE SECTION
8"	2
10"	3
12"	4
14"	5
16"	7

OR THE NUMBER OF TABLETS EQUAL TO 0.001202L ROUNDED TO THE NEXT HIGHER INTEGER, WHERE L IS THE INSIDE DIAMETER, IN INCHES AND L IS THE LENGTH OF THE PIPE SECTION, IN FEET. USE OF THE CONTINUOUS FEED OR SLUG METHOD OF DISINFECTING MAY ONLY BE USED TO RE-CHLORINATE A WATER PIPE AFTER THE INITIAL DISINFECTION OR IN OTHER SPECIFIC CASES APPROVED BY THE DESIGN ENGINEER. WHEN FILLING THE PIPELINE FOR DISINFECTION, THE RATE OF FILLING MUST RESULT IN A VELOCITY OF LESS THAN 1 FT./SEC.

THE DISINFECTION SOLUTION SHALL REMAIN IN THE PIPE LINE FOR NOT LESS THAN TWENTY-FOUR (24) HOURS, AFTER WHICH TIME A CHLORINE RESIDUAL OF 10 PPM AT ALL PARTS OF THE LINE SHALL BE REQUIRED.

FOLLOWING CHLORINATION, THE PIPING SHALL BE THOROUGHLY FLUSHED. THE VIRGINIA WATERWORKS REGULATIONS REQUIRE AT LEAST TWO CONSECUTIVE BACTERIOLOGICAL SAMPLES AT 24 HOUR INTERVALS FROM THE DISTRIBUTION SYSTEM AT MAXIMUM SPACING OF 2000 FEET BEFORE THE SYSTEM CAN BE PLACED IN SERVICE. IF THE INITIAL TESTING IS NOT SATISFACTORY THE NEW LINES WILL BE RETESTED UNTIL SATISFACTORY RESULTS ARE ACHIEVED. THE CONTRACTOR SHALL PAY ALL COSTS ASSOCIATED WITH DISINFECTION AND TESTING OF INSTALLED FACILITIES INCLUDING ANY BACTERIOLOGICAL SAMPLES AND RETESTING IF REQUIRED. SAMPLES WILL BE COLLECTED IN ACCORDANCE WITH THE VIRGINIA WATERWORKS REGULATIONS.

D. INSTALLING SEWER PIPE & MANHOLES

1. THE INSTALLATION OF THE SANITARY SEWER SYSTEM SHALL BEGIN AT THE DOWNSTREAM MANHOLE AND PROCEED UPSTREAM. THE DOWNSTREAM SECTIONS SHALL BE COMPLETED, TESTED, AND APPROVED PRIOR TO ALLOWING SANITARY SEWAGE TO ENTER THE SYSTEM.
2. THE PIPE SHALL BE INSTALLED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS AND AS DIRECTED BY THE ENGINEER. THE PIPE SHALL BE LAID IN TRUE STRAIGHT LINES WITH THE BELL ENDS UPSTREAM AND WITH THE INVERT OF THE PIPE BEING THE TRUE ELEVATION AND GRADE OF THE SYSTEM.

3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ESTABLISHING AND MAINTAINING THE HORIZONTAL ALIGNMENT AND VERTICAL ELEVATION AND GRADE OF THE SYSTEM IN ACCORDANCE WITH THE SURVEY INFORMATION INDICATED ON THE PLANS.
4. THE HORIZONTAL ALIGNMENT OF THE PIPE SHALL BE MAINTAINED BY A TRANSIT OR THEODOLITE PLUMMED OVER THE CENTER OF THE DOWNSTREAM MANHOLE. THE VERTICAL ELEVATION AND GRADE SHALL BE MAINTAINED BY NOT LESS THAN THREE (3) BATTER BOARDS PLACED BETWEEN MANHOLES OR BY AN ADJUSTABLE LASER LEVEL MOUNTED AT THE INVERT OF THE DOWNSTREAM MANHOLE WITH TARGET(S) PLACED IN THE BELL END OF THE PIPE BEING LAID.
5. SEWER PIPE SHALL BE INSTALLED IN 4 INCH GRAVEL BEDDING EXTENDING TO THE SPRINGLINE OF PIPE AND IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
6. THE SANITARY SEWER SYSTEM SHALL BE LAID AND JOINED COMPLETE-IN-PLACE SO THAT EACH LENGTH AND SECTION OF PIPE BETWEEN THE MANHOLES SHALL HAVE A SMOOTH AND UNIFORM INVERT.
7. THE PIPE SHALL BE CONNECTED TO MANHOLES THROUGH PRECAST OPENINGS AND JOINED WITH EITHER A FLEXIBLE BOOT ADAPTER OR A PIPE SEAL GASKET.
8. DETECTION TAPE TO BE INSTALLED 12" TO 18" ABOVE ALL NEW SEWER PIPE MAINS AND SEWER SERVICE LATERALS.

E. CONNECTION TO EXISTING SYSTEMS

1. THE NEW PIPE CONNECTION TO BE MADE TO AN EXISTING MANHOLE WHERE NO STUD OR OPENING EXISTS, SHALL BE MADE THROUGH AN OPENING OF MAXIMUM DIAMETER CUT INTO THE MANHOLE WALL AT THE REQUIRED LOCATION AND ELEVATION.
2. THE EXISTING INVERT CHANNELS AND BENCHES SHALL BE REWORKED AS REQUIRED TO FORM A NEW FLOW CHANNEL FROM THE NEW CONNECTION TO THE EXISTING FLOW CHANNEL.
3. THE NEW PIPE CONNECTED TO AN EXISTING MANHOLE SHALL BE REQUIRED IN POSITION AND THE REMAINING OPENING SHALL BE FILLED AND SEALED WITH BRICK AND MORTAR. THE OUTER SURFACE OF THE CONNECTION SHALL BE GIVEN A COAT OF HEAVY BITUMASTIC WATERPROOFING COMPOUND.

F. SERVICE CONNECTIONS

1. THE CONTRACTOR SHALL MAKE ALL SERVICE CONNECTIONS TO THE SEWER PIPE AND FROM MANHOLES WHERE SHOWN ON THE PLANS AND/OR WHERE REVEALED. CONNECTIONS SHALL BE SUITABLE CONNECTIONS TO THE SEWER PIPE SHALL BE MADE WITH A WYE OR TEE WYE BRANCH FITTING.
2. THE WYE AND TEE WYE BRANCH FITTINGS FOR SERVICE CONNECTIONS SHALL BE COMMERCIALLY MANUFACTURED AND INSTALLED IN STRICT ACCORDANCE WITH THE RECOMMENDATIONS OF THE PIPE MANUFACTURER.
3. THE SEWER PIPE SHALL NOT BE CUT OR TAPPED FOR SERVICE CONNECTIONS EXCEPT WHEN AND WHERE PERMITTED BY THE ENGINEER.
4. ALL SERVICE CONNECTIONS SHALL BE MADE WITH FOUR (4) INCH PIPE AS A MINIMUM, UNLESS THE SIZE OF AN EXISTING SERVICE CONNECTION DICTATES OTHERWISE, AND SHALL BE INSTALLED ON A MINIMUM GRADE OF ONE-QUARTER (1/4) INCH PER ONE (1) FOOT FROM THE SEWER PIPE OR MANHOLE TO THE PROPERTY OR EASEMENT LINE.
5. FUTURE SERVICE CONNECTIONS SHALL EXTEND TO THE PROPERTY OR EASEMENT LINE WITH CLEANOUT AND BE PROPERLY CAPPED WITH A WATER-TIGHT FITTING TO PREVENT INFILTRATION INTO THE SEWERAGE SYSTEM. THE FITTING SHALL BE INSTALLED IN STRICT ACCORDANCE WITH THE RECOMMENDATIONS OF THE PIPE MANUFACTURER.
6. FUTURE SERVICE CONNECTIONS SHALL BE FIELD MARKED BY A TREATED, SOLID WOODEN (2 X 4) MARKER THREE (3) FEET LONG SET VERTICALLY PLUMB WITH THE END OF THE CAPPED EXTENSION. THE TOPS OF THE MARKERS SHALL BE PAINTED YELLOW AND SET 24" ABOVE THE FINISHED GRADE. THE LOCATION AND INVERT DEPTH OF THE SERVICE CONNECTION SHALL BE SHOWN ON THE AS-BUILT PLANS.

BACKFILLING

A. JOB CONDITIONS

1. PRIOR TO PLACING BACKFILL, ALL ORGANIC, RUBBISH, DEBRIS, OR OTHER UNSUITABLE OR OBJECTIONABLE MATERIAL WITHIN THE TRENCH SHALL BE REMOVED. ALL CONCRETE FORMS SHALL BE REMOVED. ALL SHORING OR SHEETING SHALL BE REMOVED OR CUT OFF AT THE DEPTH STIPULATED BY THE ENGINEER.
2. PRIOR TO PLACING BACKFILL, THE TRENCH BOX SHALL BE REMOVED. ALL CONCRETE FORMS SHALL BE REMOVED. ALL SHORING OR SHEETING SHALL BE REMOVED OR CUT OFF AT THE DEPTH STIPULATED BY THE ENGINEER.
3. BACKFILL MATERIAL SHALL BE PLACED IN UNIFORM HORIZONTAL LAYERS AND THOROUGHLY COMPACTED WITH PROPER MECHANICAL OR HAND OPERATED TAMPERS OR OTHER EQUIPMENT AS APPROVED BY THE ENGINEER TO PERFORM SUCH WORK.
4. BACKFILL MATERIAL SHALL BE PLACED AND COMPACTED SO AS TO NOT UNEVENLY SUPPORT DAMAGE OR DISPLACE THE ALIGNMENT OF THE PIPE OR STRUCTURES.
5. BACKFILL SHALL NOT BE PLACED OR COMPACTED AGAINST CAST IN PLACE CONCRETE UNTIL IT HAS OBTAINED SUFFICIENT STRENGTH TO WITHSTAND THE BACKFILLED PRESSURE PLACED UPON IT.
6. UPON THE COMPLETION OF BACKFILLING, ALL EXCESS SOIL, STONES AND DEBRIS SHALL BE REMOVED FROM THE SITE AND DISPOSED OF BY THE CONTRACTOR.

B. BACKFILL MATERIAL

1. MATERIALS FOR BACKFILL SHALL BE APPROVED EXCAVATED MATERIAL OR APPROVED SUITABLE MATERIAL OBTAINED FROM OTHER SOURCES. ALL MATERIAL SHALL BE APPROVED BY A SOILS ENGINEER.
2. MATERIAL SHALL CONSIST OF DURABLE NATURAL GRANULAR MATERIAL OR GRANULAR AGGREGATE FREE OF ORGANIC MATERIAL, LOAM, DEBRIS, OR OTHER OBJECTIONABLE MATERIAL WHICH CANNOT BE THOROUGHLY COMPACTED.
3. MATERIAL SHALL NOT CONTAIN STONES LARGER IN DIAMETER THAN THOSE SPECIFIED HEREIN, GRANITE, BROKEN CONCRETE, MASONRY RUBBLE OR OTHER MATERIAL OR MATERIALS IN THE OPINION OF THE ENGINEER IS UNSUITABLE FOR BACKFILL.
4. EXCESSIVELY WET EXCAVATED MATERIAL SHALL NOT BE USED AS BACKFILL. FROZEN MATERIAL SHALL NOT BE PLACED IN THE TRENCH, NOR SHALL APPROVED BACKFILL BE PLACED UPON FROZEN MATERIAL. HOWEVER, BACKFILLING MAY BE ALLOWED IN FREEZING WEATHER WITH PRIOR APPROVAL OF THE ENGINEER.

C. BACKFILL BELOW UNPAVED AREAS

1. BACKFILL FROM THE TOP OF THE PIPE BEDDING OR BOTTOM OF THE PIPE TRENCH TO ONE (1) FOOT ABOVE THE TOP OF THE PIPE SHALL BE FREE OF STONES LARGER THAN ONE (1) INCH IN DIAMETER AND SHALL BE PLACED IN LAYERS NOT TO EXCEED SIX (6) INCHES AND COMPACTED WITH HAND OPERATED TAMPERS.
2. BACKFILL FROM ONE (1) FOOT ABOVE THE TOP OF THE PIPE TO THE TOPSOIL SUBGRADE SHALL BE FREE OF STONES LARGER THAN FIVE (5) INCHES IN DIAMETER AND SHALL BE PLACED IN LAYERS NOT TO EXCEED TWELVE (12) INCHES AND COMPACTED WITH MECHANICAL TAMPERS.
3. DRAINAGE CHANNELS TO BE CONSTRUCTED OF FILL MATERIAL SHALL BE GRADED AND SHAPED TO THE TOPSOIL SUBGRADE WITH MATERIAL FREE OF STONES LARGER THAN FOUR (4) INCHES IN DIAMETER AND SHALL BE PLACED IN LAYERS NOT TO EXCEED EIGHT (8) INCHES AND COMPACTED WITH MECHANICAL TAMPERS.
4. BACKFILL BELOW EXISTING OR NEW PAVED AREAS AND SIDEWALKS

1. BACKFILL FROM THE TOP OF THE PIPE BEDDING OR BOTTOM OF THE PIPE TRENCH TO ONE (1) FOOT ABOVE THE TOP OF THE PIPE SHALL BE FREE OF STONES LARGER THAN ONE (1) INCH IN DIAMETER AND SHALL BE PLACED IN LAYERS NOT TO EXCEED SIX (6) INCHES AND COMPACTED WITH HAND TAMPERS.
2. BACKFILL FROM ONE (1) FOOT ABOVE THE TOP OF THE PIPE TO THE PAVEMENT SUBGRADE SHALL BE FREE OF STONES LARGER THAN FOUR (4) INCHES IN DIAMETER AND SHALL BE PLACED IN LAYERS NOT TO EXCEED EIGHT (8) INCHES AND COMPACTED WITH MECHANICAL TAMPERS.

INSPECTION AND TESTS

A. TESTING OF SANITARY SEWER

1. THE CONTRACTOR SHALL PROVE THE WATER-TIGHTNESS OF THE SEWER SYSTEM OR PORTIONS THEREOF BY ONE OF THE FOLLOWING TESTS, AT SUCH TIMES AS THE ENGINEER MAY DIRECT. TESTS SHALL BE MADE IN THE PRESENCE OF THE ENGINEER. THE CONTRACTOR SHALL FURNISH ALL LABOR AND EQUIPMENT REQUIRED FOR THE TEST AND SHALL MAKE REPAIRS NECESSARY UNTIL TEST RESULTS ARE SATISFACTORY. ROANOKE COUNTY ENGINEER SHALL BE NOTIFIED OF ALL TESTS 48 HOURS PRIOR TO CONDUCTING SUCH TESTS. ALL TESTS SHALL BE COORDINATED WITH THE DESIGN ENGINEER FOR HIS ATTENDANCE AND OBSERVATION.
2. AIR TEST
THE TESTING EQUIPMENT, PROCEDURE, AND RESULTS WILL ALL BE SUBJECT TO THE STRICT APPROVAL OF THE ENGINEER. RESULTS OF THE AIR TEST WILL BE REVIEWED FOR COMPLIANCE WITH ASTM DESIGNATION C-828, CURRENT REVISION. THE AIR TEST IS TO BE CONDUCTED BETWEEN TWO (2) CONSECUTIVE MANHOLES. THE TEST EQUIPMENT SHALL CONSIST OF TWO (2) PLUGS (ONE TAPPED AND ONE FOR AIR INLET CONNECTION), A SHUT-OFF VALVE, A PRESSURE REGULATING VALVE, A PRESSURE REDUCTION VALVE, AND A MONITORING PRESSURE GAUGE HAVING A PRESSURE RANGE FROM 0 TO 5 PSI, GRADUATED IN 0.10 PSI WITH AN ACCURACY OF PLUS/MINUS 0.05 PSI. THE TEST EQUIPMENT SHALL BE SET UP OUTSIDE THE MANHOLE FOR EASY ACCESS AND READING. AIR SHALL BE SUPPLIED TO THE TEST SLOWLY AND SHALL BE REGULATED TO PREVENT THE PRESSURE INSIDE THE PIPE FROM EXCEEDING 5.0 PSIG. THE PIPELINE SHALL BE FILLED UNTIL A CONSTANT INTERNAL PRESSURE OF 3.5 PSIG IS MAINTAINED. THE INTERNAL PRESSURE SHALL BE MAINTAINED AT 3.5 PSIG OR SLIGHTLY ABOVE FOR A FIVE (5) MINUTE STABILIZATION PERIOD, AFTER WHICH TIME THE INTERNAL PRESSURE WILL BE ADJUSTED TO 3.5 PSIG. THE AIR SUPPLY SHUT OFF AND THE TEST BEGUN. NO PERSON SHALL REMAIN IN THE MANHOLE WHILE PIPE IS BEING PRESSURIZED OR THROUGHOUT THE TEST FOR SAFETY PURPOSES. A PRESSURE DROP OF 1.0 PSI FROM 3.5 TO 2.5 PSIG SHALL BE ALLOWED FOR THE TEST TIME SPECIFIED IN THE FOLLOWING TABLE, BASED UPON THE DESIGNATED PIPE SIZE AND TEST SEGMENT LENGTH.

BASED ON EQUATIONS FROM ASTM C-828-80 SPECIFICATIONS TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP FROM 3.5 TO 2.5 PSI WHEN TESTING ONE PIPE DIAMETER ONLY.	
LENGTH OF TEST SEGMENT	PIPE DIAMETER, INCHES
	4 6 8 10 12 15 18
25 0:04 0:10	0:18 0:28 0:40 1:02 1:29
50 0:09 0:20	0:35 0:55 1:19 2:04 2:58
75 0:13 0:30	0:53 1:25 2:08 3:08 4:27
100 0:18 0:40	1:10 1:50 2:28 3:08 5:56
125 0:22 0:50	1:28 2:18 3:18 5:09 7:26
150 0:26 0:59	1:46 2:46 3:56 5:11 8:30
175 0:31 1:09	2:03 3:13 4:37 7:05
200 0:35 1:19	2:21 3:40 5:17
225 0:40 1:29	2:39 3:58 5:40
250 0:44 1:39	2:56 4:35
275 0:48 1:49	3:14 4:43
300 0:53 1:59	3:31 4:43
350 1:02 2:19	3:47
400 1:10 2:38	8:16 10:12
450 1:19 2:50	6:03 9:27 13:36
500 1:28	6:48 10:38 15:19
	5:14 7:34 11:49 17:01

SHOULD THE 1.0 PSI DROP OCCUR IN LESS TIME THAN THAT SPECIFIED IN THE TABLE, THE SEWER SEGMENT SHALL HAVE FAILED. IF THE TIME REQUIRED FOR THE PRESSURE TO DROP 1.0 PSI IS GREATER THAN THAT SHOWN IN THE TABLE, THE SEWER SEGMENT SHALL HAVE PASSED.

FOR A MORE DETAILED DESCRIPTION OF THE AIR TEST METHOD REFER TO ASTM DESIGNATION C-828, CURRENT REVISION. AN AIR PRESSURE CORRECTION SHALL BE REQUIRED WHEN THE PREVALENT GROUND WATER IS ABOVE THE SEWER LINE BEING TESTED. IT SHALL BE CALCULATED AS FOLLOWS:

GROUND WATER DEPTH (FT) + 3.5 = STARTING TEST PRESSURE
2.31
ENDING TEST PRESSURE = STARTING PRESSURE - 1.0 PSI

THERE IS NO CHANGE FROM TIME REQUIREMENTS ESTABLISHED FOR THE BASIC AIR TEST.

C. MANHOLE VACUUM TESTS

1. MANHOLES SHALL BE TESTED BY VACUUM TEST, AFTER ASSEMBLY BUT PRIOR TO BACKFILLING. TEST SHALL COMPLY WITH ASTM STANDARDS. A SEGMENT OF WATER PROGRAMS WORKING MEMO #550, DATED NOVEMBER 1987, MANHOLES SHALL BE TESTED BY VACUUM ONLY IF CONSTRUCTED OF PRECAST CONCRETE. TESTING SHALL INCLUDE ALL CONCRETE RISER, INCLUDING SPACER RINGS, AND THE JOINT BETWEEN THE CONCRETE AND THE MANHOLE.

2. STUBOUTS, MANHOLE BOOTS AND PIPE PLUGS SHALL BE SECURED TO PREVENT MOVEMENT WHILE THE VACUUM IS DRAWN.
3. INSTALLATION AND OPERATION OF VACUUM EQUIPMENT AND INDICATING DEVICES SHALL BE IN ACCORDANCE WITH EQUIPMENT SPECIFICATIONS FOR WHICH PERFORMANCE INFORMATION HAS BEEN PROVIDED BY THE MANUFACTURER AND APPROVED BY THE VIRGINIA STATE DEPARTMENT OF HEALTH.
4. A MEASURABLE VACUUM OF 10 INCHES OF MERCURY SHALL BE ESTABLISHED IN THE MANHOLE. THE TIME FOR THE VACUUM TO DROP TO NINE INCHES OF MERCURY SHALL BE RECORDED.
5. ACCEPTANCE STANDARDS FOR LEAKAGE SHALL BE ESTABLISHED FROM THE ELAPSED TIME FOR A NEGATIVE PRESSURE CHANGE FROM 10 INCHES TO NINE INCHES OF MERCURY. THE MAXIMUM ALLOWABLE LEAKAGE RATE FOR FOUR-FOOT DIAMETER MANHOLE SHALL BE IN ACCORDANCE WITH THE FOLLOWING:

MANHOLE DEPTH	MINIMUM ELAPSED TIME FOR A PRESSURE CHANGE OF 1 INCH HG
10 FT. OR LESS	60 SECONDS
> 10 FT. BUT < 15 FT.	75 SECONDS
> 15 FT. BUT < 25 FT.	90 SECONDS

- FOR MANHOLES FIVE FEET IN DIAMETER, AND AN ADDITIONAL 30 SECONDS TO THE TIME REQUIREMENTS FOR FOUR-FOOT DIAMETER MANHOLES.
- IF THE MANHOLE FAILS THE TEST, NECESSARY REPAIRS SHALL BE MADE, AND THE VACUUM TEST AND REPAIRS SHALL BE REPEATED UNTIL THE MANHOLE PASSES THE TEST.

7. IF A MANHOLE JOINT MASTIC IS COMPLETELY PULLED OUT DURING THE TEST, THE MANHOLE SHALL BE DISASSEMBLED AND THE MASTIC REPLACED.

- D. MANHOLE TEST
ALL SEWER LINES SHALL BE TESTED BY PULLING A STANDARD TEST MANHOLE BETWEEN TEST SECTIONS.

E. TESTING OF WATER LINES

1. AFTER PLACING AND HARNESSEING AND ALL VALVE SUPPORT CONCRETE, SUFFICIENT BACKFILL SHALL BE PLACED PRIOR TO FILLING THE PIPE WITH WATER AND FIELD TESTING TO PREVENT LIFTING OF THE PIPE. WHEN LOCAL CONDITIONS REQUIRE THAT THE TRENCH BE BACKFILLED IMMEDIATELY AFTER THE PIPE HAS BEEN LAID, THE TESTING SHALL BE CARRIED OUT AFTER BACKFILLING HAS BEEN COMPLETED BUT PRIOR TO PLACEMENT OF THE PERMANENT SURFACE. AT LEAST FOURTEEN (14) DAYS SHALL ELAPSE AFTER THE LAST VALVE SUPPORT OR HYDRANT BLOCK HAS BEEN CAST (TYPE 1 PORTLAND CEMENT) PRIOR TO TESTING, UNLESS HIGH EARLY STRENGTH CONCRETE (TYPE II) IS USED, IN WHICH CASE THREE (3) DAYS SHALL ELAPSE.
2. ALL TESTING WILL BE PERFORMED IN ACCORDANCE WITH THE AWWA C800-82 OR CURRENT REVISION.
3. PRESSURE TEST: AFTER THE PIPE HAS BEEN LAID, ALL NEWLY LAID PIPE OR ANY VALVED SECTION THEREOF SHALL BE SUBJECTED TO A HYDROSTATIC PRESSURE OF AT LEAST 1.5 TIMES THE WORKING PRESSURE AT THE POINT OF TESTING.

- TEST PRESSURE RESTRICTIONS. TEST PRESSURES SHALL:
 - A. NOT BE LESS THAN 1.50 TIMES THE WORKING PRESSURE AT THE HIGHEST POINT ALONG THE TEST SECTION;
 - B. NOT EXCEED PIPE OR THURST RESTRAINT DESIGN PRESSURES;
 - C. BE OF AT LEAST 2-HOUR DURATION;
 - D. NOT VARY BY MORE THAN 4% FROM THE TEST PRESSURE;
 - E. NOT EXCEED TWICE THE RATED PRESSURE OF THE VALVES OR HYDRANTS WHEN THE PRESSURE BOUNDARY OF THE TEST SECTION INCLUDES CLOSED GATE VALVES OR HYDRANTS;
 - F. NOT EXCEED THE RATED PRESSURE OF THE VALVE.

EACH VALVED SECTION OF PIPE SHALL BE FILLED WITH PROPERLY DISINFECTED WATER SLOWLY, AND THE SPECIFIED TEST PRESSURE SHALL BE APPLIED BY MEANS OF A PUMP CONNECTED TO THE PIPE IN A MANNER SATISFACTORY TO THE ENGINEER.