

Section 400

Sanitary Sewer Piping

400.1. General

400.1.1 Description

- A. This section covers the handling, installation and testing of gravity pipes and sanitary sewers, fittings, specials, and other appurtenances as indicated or specified.
- B. Definition of manhole depth: The distance measured at centerline from the invert of the lowest pipe to the top of the ring and cover.

400.1.2 Related Sections

- A. **Section XXX - Manholes.**
- B. **Section XXX - Trenching, Backfilling, and Compacting**

400.1.3 Quality Assurance:

- A. Lay pipe and set manhole inverts true to the line and grade shown on the Drawings. Under no circumstances shall inverts result in a level invert, reverse slope invert, or grade flatter than will accommodate design flows.

400.1.4 Delivery, Storage, and Handling

- A. Handle in a manner to ensure installation in sound and undamaged condition.
 - 1. Do not drop or bump.
 - 2. Use slings, lifting lugs, hooks, or other devices designed to protect the pipe, joint elements, linings, and coatings.
 - 3. Prevent foreign material from entering pipe.
- B. Ship, move, and store with provisions to prevent movement or shock contact with adjacent units.
- C. Handle with equipment capable of work with adequate factor of safety against overturning or other unsafe procedures.

400.1.5 Job Conditions.

- A. Precaution shall be taken to minimize damage to newly installed pipeline.

1. Prevent foreign material from entering the pipe.
2. Do not place debris, tools, clothing, or other materials in the pipe.
3. Whenever pipe laying is interrupted close the open end of the pipe with a tight-fitting plug or cap to prevent the entry of foreign material into the pipe. No pipe shall be left open overnight or during lunch breaks.
4. Use effective measures to prevent the uplift or floating of the line prior to completion of the backfilling operation.
5. Under no circumstances shall the sewer line be used to remove excess water which has infiltrated into the trenches.

400.2. Products

400.2.1 Polyvinyl Chloride (PVC) Gravity Sewer Pipe

- A. Conform to the following standards:
 1. Pipe fifteen inches (15") and smaller: ASTM D3034, Type PSM, SDR 35.
 2. Pipe eighteen inches (18") and larger: ASTM F794.
 3. Joints: ASTM D3212, Push On.
 4. Fittings: Fifteen inches (15") and smaller: SDR35 Gasketed Sewer Fittings: ASTM D3035

400.2.2 Manhole Materials.

- A. Refer to [Section XXX - Manholes](#).

400.2.3 Flexible Couplings.

- A. When jointing two pipes of dissimilar material or two pipes with different outside diameters use the following:
 1. Pipe sized fifteen inches (15") or smaller.
 - a. Fernco, Inc.
 - b. Mission Rubber Company
 - c. Or equal.
 2. In pipe sizes larger than fifteen inches (15") inside diameter wrap the joint with two laps of rubber or vinyl and band each pipe with a stainless-steel band.
 - a. Lap joint downward at springline of pipe.

- b. Rubber or vinyl shall extend at least six inches (6") on each pipe past the joint, minimum thickness 1/16-inch rubber or 32-ounce vinyl.
- B. Encase flexible couplings in a concrete collar with a minimum of six inches (6") thick and extending a minimum of six inches (6") on either side of the joint.

400.3. Execution

400.2.4 Preparation.

- A. Perform excavation in accordance with **Section XXX – Trenching, Backfilling, and Compaction**.
- B. Where connections are to be made to existing pipes or appurtenances, the exact location of which cannot be determined without exposing the existing appurtenance, excavate and expose the existing improvement before installing any pipe. TOWN will examine pipe or appurtenance and specify any necessary adjustments in line or grade of the proposed pipe to accomplish the connection.
- C. Examine pipe and fittings and do not use individual sections containing:
 - 1. Cracks, dents, abrasions, or other defects.
 - 2. Mark rejected pipe and remove from the site.

400.2.5 Pipe Installation.

- A. General:
 - 1. Utilize equipment, methods, and materials ensuring installation to lines and grades indicated.
 - a. Maintain within tolerances specified or acceptable laying schedule.
 - i. Alignment: Plus or minus one inch ($\pm 1''$) per one hundred feet (100') in open cut or tunnel.
 - ii. Grade: Plus or minus one inch ($\pm 1''$) inch per one hundred feet (100').
 - b. Do not lay on blocks unless pipe is to receive total concrete encasement.
- B. Pipe Laying.
 - 1. Cutting the pipe – prior to cutting, score the pipe. Cut pipe square with saw or pipe cutter designed specifically for the material. Bevel

the end in accordance with manufacturer's recommendations.
Remove burrs and wipe off all dust and dirt from jointing surfaces.

2. Begin pipe laying at the lowest point, unless otherwise directed by the TOWN, and install the pipe with the spigot ends pointing in the direction of flow.
 3. Lay pipe true to line and grade and join in such a manner that the offset of the inside of the pipe at any joint is held to a minimum at the invert. The maximum offset at the invert shall be one percent (1%) of the inside diameter, or three-eighths inch (3/8"), whichever is smaller.
 4. As each length of pipe is placed in trench, complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade. Make adjustments by scraping away or filling pipe bedding under the body of the pipe, and not by wedging or blocking up the bells. Remove all dirt and foreign material from pipe ends, gasket, and gasket groove. Apply lubricant furnished by pipe manufacturer to spigot end of the pipe.
 5. Secure the pipe in place with the specified bedding tamped under and around the pipe. Do not walk on small diameter pipe or otherwise disturb any pipe after the jointing has been completed.
 6. Clean interior of all pipes, fittings, and joints prior to installation. Exclude entrance of foreign matter during discontinuance of installation.
 - a. Close open ends of pipe with snug-fitting closures.
 - b. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate.
 - c. Remove water, sand, mud, and other undesirable materials from trench before removal of end cap.
 7. Brace or anchor as required to prevent displacement after establishing final position.
 8. Perform only when weather and trench conditions are suitable. Do not lay in water.
 9. Observe extra precaution when hazardous atmospheres might be encountered.
- C. Waterline Crossing.
1. Where sewer lines cross watermains, and the sewer is above the watermain or less than eighteen inches (18") clear distance vertically below the watermain, construct the crossing by one of the following methods:

- a. Using one length of pipe, PVC, or DIP, at least eighteen feet (18') long centered over or under the watermain. Use Flexible Couplings when jointing two pipes of dissimilar materials or two pipes with different outside diameters. Encase couplings in concrete as specified herein.
 - b. Encase the sewer pipe with reinforced concrete at least six inches (6") thick at all locations within ten feet (10') on either side of the waterline and in conformance with standard details.
2. In all cases, provide suitable backfill or other structural protection to preclude settling or failure of the higher pipe.

D. Service Lines and Connections.

1. General: Sanitary sewer service lines shall be four inches (4") or larger in diameter and connected, by means of a wye, watertight saddle, or fused adaptor to a lateral or a main. The wye or adaptor shall be mounted such that the service line effluent enters at an angle equal to or in excess of forty-five degrees (45°) to the springline of the lateral or main. Vertical risers shall be installed when the top elevation of the wye, installed through the service saddle or adaptor, is more than twelve feet (12') below finished grade. Riser connections shall reach a grade of nine feet (9') below finished grade within a horizontal distance of two feet (2') from the vertical centerline of the lateral or main. All services greater than six inches (6") must be connected by a manhole.
2. On all new main, install forty-five degree (45°) "Y" branches in the direction of flow as per standard details or existing or future service connections at locations designated on the Drawings. Verify that service connection locations have been marked prior to commencing construction of any segment of sewer line.
3. Where an existing sewer is being replaced at the same alignment, locate, and connect all existing services to the new sewer. Contractor to record location (distance from upstream or downstream manhole) and note on record drawings.
4. Install service connection on existing sewers using saddles securely fastened on the main. Cut a neat hole in the main by means of a tapping machine designed for such use. The finished connection shall be watertight and there shall be no projections inside the sewer main.
5. Incline the centerline of the branch upward at an angle of forty-five degrees (45°) per standard details.
6. As appropriate lay services for future service connections to five feet (5') outside of roadway surface (edge of asphalt, back of curb, or back

of sidewalk) at a minimum grade of two percent (2%) unless otherwise instructed by Engineer.

7. Install removable watertight plugs in each unused service branch and each unconnected lateral stub-out.
8. Mark the end locations of each unconnected branch with a steel fence post marker extended from the branch vertically to within one foot (1') of the ground surface. Anchor markers and maintain in a vertical position during backfilling. The letter "S" shall be etched into the curb face directly above the service for future reference. Record location (exact distance) of each marker on the Drawings.

400.2.6 Manhole Construction.

- A. Construct manholes in accordance with [Section XXX - Manholes](#).
- B. Connections to existing manholes.
 1. Construct in such a manner that the finished work conforms to the requirements specified for new manholes (where practical).
 2. Where no provision has been made for additional tie-ins, break out as small of an opening as necessary to insert the new pipe.
 3. Chip out existing invert to accommodate the cross section of the newly inserted pipe, finish with mortar to form a smooth, continuous invert, and seal space between the new pipe and the manhole wall with non-shrink grout.
 4. One service line will be allowed to connect to a manhole located on the end of a sewer main in a cul-de-sac. This service line must be installed prior to the placing of the manhole base and shall have a maximum drop of six inches (6") into the manhole. No service line shall connect to the main line closer than five feet (5') from the outside diameter of the manhole.

400.2.7 Field Quality Control.

- A. Each section of sewer shall meet the requirements of the following tests. Furnish all equipment, labor, and incidentals necessary and conduct tests in the presence of TOWN.
- B. Stop all work, locate leaks, make repairs, and correct construction methods as needed as indicated as a result of any of the following tests.
- C. Alignment Tests.
 1. TOWN may lamp each section of sewer between manholes to determine whether any displacement of the pipe has occurred. CONTRACTOR shall provide suitable assistants to help TOWN. A full

diameter ("full moon") of the pipe should be visible when viewed between manholes.

D. Air Tests.

1. Air testing shall be used for testing PVC sewer pipe, but not for manholes or reinforced concrete pipe. At the direction of the TOWN, manholes shall be tested using infiltration or exfiltration tests. Comply with the requirements of the latest edition of Uni-Bell PVC Pipe Association, Uni-B-6 – Low Pressure Air Testing of Installed Sewer Pipe.
2. Preparation for test: Flush and clean the sewer line prior to testing in order to wet the pipe surfaces and produce more consistent results. Plug and brace all openings in the main sewer line and the upper connections. Provide pressurizing equipment with a relief valve set at five (5.0) psi to avoid over-pressurizing and damaging an otherwise acceptable line. Check all pipe plugs with a soap solution to detect any air leakage. If leaks are found release the air pressure, eliminate the leaks, and start the test procedure over again.
3. Pressure Stabilization: Add air until the internal pressure of the sewer line is raised to approximately four (4.0) psi gauge at which time the flow of air shall be throttled to maintain the four (4.0) psi air pressure for two (2) minutes to allow the air temperature to come to equilibrium with the temperature of the pipe.
4. Timed Pressure Loss: After pressure stabilization, shut off air supply. The continuously monitoring pressure gauge shall be observed while the pressure is decreased to three and one half (3.5) psi. Upon reaching the three and one half (3.5) psi pressure, timing shall commence (using a stopwatch or sweep hand watch) to measure the time interval for the pressure to drop to one half (0.5) psi, or to three (3.0) psi. If the timed pressure loss is greater than the minimum time outlined in the table below, the section being tested is considered to pass the test.
5. Air Pressure Adjustment: When the groundwater table is above the pipe, a correction factor must be added to the three and one half (3.5) psig normal test starting pressure according to the following criteria: Divide the average vertical height of groundwater above the invert of the sewer pipe to be tested by 2.31 and add this factor to three and one half (3.5) psi.

SPECIFIED TIME REQUIRED FOR 0.5 PSIG PRESSURE DROP

FOR SIZE AND LENGTH OF PIPE

Diameter (Inches)	Minimum	Length For Minimum	Time For Additional								
	Time (min:sec)	Time (feet)	Length (sec)	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	46:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

6. If section being tested fails, the Contractor may be required to video tape the sewer line to determine the location of the defective area. The defective pipe shall be repaired, and the pressure air test performed until the test requirements are satisfied.

E. Exfiltration Tests.

1. Conduct exfiltration tests on section of sewer where the groundwater table is less than five feet (5') above top of the sewer pipe at any point.
2. Test between manholes by plugging all pipe entrances at manholes except between those connecting the reach being tested.
3. Fill the upper manhole and pipe with water to a depth of five feet (5') above the invert of the sewer at the center of the upper manhole, or if groundwater is present, fill to a depth of five feet (5') above the groundwater level at the upper manhole for a period of seventy-two (72) hours prior to testing.

4. Duration of Test: Two (2) hours minimum, maximum allowable exfiltration shall be two hundred fifty (250) gallons per day per inch of pipe diameter per mile of the pipe length.
5. For the purpose of determining the maximum allowable leakage, manholes shall be considered sections of equivalent size pipe.
6. Remove all water from sewer used for testing, at completion of test.

F. Infiltration Tests.

1. Conduct infiltration tests where infiltration appears to exceed specified limits.
2. Conduct tests by placing a calibrated V-notch weir or flume in the line as it enters the manhole and plugging the line as it enters the higher manhole.
3. Allow sufficient time for the water level behind the weir to stabilize before reading. Take successive readings until consistent results are obtained. Groundwater dewatering shall not occur adjacent to the lines being tested for a period of seventy-two (72) hours prior to testing.
4. Maximum allowable infiltration shall be:
5. Fifty (50) gallons per inch of pipe diameter per one (1) mile per day
6. Zero point zero four (0.04) gallons per inch of pipe diameter per one hundred feet (100') of pipe length per hour.
7. If the infiltration rate exceeds the maximum allowable, suspend construction and provide electronic or photographic visual inspection of the interior of the pipeline.
8. Manholes and pipelines shall not have any visible leaks or damp spots.
9. Retest lines that fail tests until satisfactory results are obtained.

400.2.8 3Cleaning.

- A. Prior to substantial completion, remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system. Use mechanical rodding or bucketing equipment as required. After all paving activities have been completed, all mains must be flushed and cleaned.
- B. At the time of final acceptance, all mains must be flushed and cleaned again.

400.2.9 Acceptance.

- A. Final Completion. After the Final completion of sanitary sewer improvements including associated paving or other site restoration, all sewer mains constructed will be considered initially accepted by the TOWN for a one (1) year correction period upon:
1. Successful inspection of all "initial punch list" item remedies.
 2. Successful lamp test and visual inspection of the manhole rings and covers.
 3. Successful Air Testing conducted by the CONTRACTOR and observed by the TOWN. Successful exfiltration/infiltration testing if deemed necessary by the TOWN.
 4. Successful flushing of all mains as observed by the TOWN.
 5. Receipt of paper and electronic as-builts. Format for the electronic version shall be confirmed with the TOWN.
 6. Receipt of full system video record, taken at the time of request of initial acceptance. Format for the video shall be in accordance with the following TOWN Standards.
 - a. Latest version of NASCO – Camera Operator's NASCO certificate shall also be provided.
 - b. Manhole and pipe naming must match the TOWN's designations on the plans in accordance with GIS designations.
 - c. Cameras must be wheeled or tracked, push cameras are not acceptable.
 - d. Quality of the video shall be sufficient enough to allow for clear measure and inspection as judged by the Town of Johnstown.

END OF SECTION

Section 401

Manholes

401.1. General

401.1.1 Description

- A. This section covers manholes, including ring and covers, steps, grade rings, fittings, and other appurtenances.
- B. This section also covers the rehabilitation of existing manholes.

401.1.2 Related Sections

- A. **Sections 100-110** for general specifications.

401.1.3 Quality Assurance

- A. Manhole inverts shall not deviate from elevations shown on the Drawings by more than ± 0.03 ft.

401.1.4 Product Delivery, Storage and Handling

- A. Do not deliver precast concrete sections to job until concrete has attained at least eighty percent (80%) of specified strength.

401.1.5 Alternatives

- A. Manhole bases may be either monolithically precast or cast-in-place. **Reference Section xxx** for concrete specifications.

401.2. Products

401.2.1 Concrete

- A. Cast-In-Place.
 - 1. Meet the Requirements of **Section xxx** - Cast-in-Place Concrete.
 - 2. CDOT Class D
 - 3. Strength: Four thousand five hundred (4500) psi at twenty-eight (28) days
 - 4. Cement: Type II or Type I/II
 - 5. Slump: Two inches (2").
 - 6. Air Entrapment: Five to Eight percent (5%-8%).
- B. Mortar.

1. One (1) part Portland Cement, ASTM C150, Type II.
 2. Three (3) parts sand, ASTM C144.
 3. One-half (1/2) part hydrated lime, ASTM C207, Type S.
- C. Grout (non-shrink).
1. Pre-mixed: Quickrete "Non-Shrink Precision Grout", or equal.
 2. Job Mixed:
 - a. One (1) part Portland Cement, ASTM C150, Type II.
 - b. One (1) part sand, ASTM C144.
 - c. One (1) part Quickrete Non-Shrink Precision grout, or equal.

401.2.2 Precast Concrete

- A. Bases, barrels, cones and flat tops.
1. Cast base at first barrel section monolithic.
 2. Meet Requirements of: ASTM C478.
 3. Cement: Type II or Type I/II
 4. Invert: Cast-in-place concrete as specified in [paragraph 401.2.1](#) above.
 5. Provide horseshoe shaped openings for manholes to be installed in existing lines.

401.2.3 Manhole Gaskets.

- A. Meet Requirements of: SS-S-210 A, AASHTO M-198 75 1, and ASTM C990-91
- B. Diameter:
1. 48-inch manholes: One and one-half inch (1½").
 2. 60-inch manholes: One and three-quarters inch (1¾").
 3. 72-inch manholes: Two inch (2").
- C. Approved Manufacturers.
1. K.T. Snyder Co., "Ram-Nek" or "Rubr'-Nek."
 2. Hamilton-Kent Mfg. Co., "Kent Seal."
 3. ConSeal, "CS-231 Controlled Expansion Waterstop Sealant."
 4. Or equal.

401.2.4 Pipe Penetration Gaskets.

- A. Approved Manufacturers.
 - 1. Dukor Co., "Ko-N-Seal".
 - 2. A-lok Corp., "A-lok".
 - 3. Or equal.

401.2.5 Ring and Cover.

- A. Material: Gray Iron meeting requirements of ASTM A48.
- B. Construction.
 - 1. Size: Min. Clear opening twenty-four-inch (24") diameter.
 - 2. Weight: Heavy duty four hundred (400) pounds minimum.
 - 3. Bearing surfaces: machined.
 - 4. Lid pattern: checkered top or indented top.
 - 5. Pick hole: concealed.
 - 6. Utility type (SANITARY SEWER) and Town Logo shall be cast into the cover, see Standard Details.

401.2.6 Steps.

- A. Materials: Polypropylene plastic-coated steel. See Standard Detail.
- B. Construction.
 - 1. Reinforcing rod: One-half inch (1/2") diameter, Grade 60 steel.
 - 2. Length: Nine and three-quarter inches (9³/₄"), designed for six and three-eighths inch (6 ³/₈") protrusion from manhole wall.
 - 3. Width: Fourteen inches (14") clear.
 - 4. Tread: notched ridge with retainer lugs on each end.
- C. Spacing.
 - 1. Eight inches (8") above bench.
 - 2. Twenty inches (20") maximum below rim.
 - 3. Twelve inches (12") vertical spacing between steps.

401.2.7 Pre-cast Manufacturing.

- A. Forms must be rigid, adequately braced, free from dents, gouges or other irregularities which would impair quality, appearance, or performance of members.
- B. Holes and Openings. Incorporate into design and fabrication, openings indicated on the approved plans.
- C. Surface Finish and Formed Surfaces. Provide a smooth, transverse broom finish at top surface of flat-top slabs. Provide smooth, uniform texture and color for formed surfaces. Remove fins and other projections.
- D. Shop Marking. Label or paint, on each section, a shop marking to indicate location and position of each member.
- E. Curing. Cure precast sections in accordance with ACI 308 to attain specific design strength.

401.2.8 Renovating Manholes

- A. The materials to be utilized in the lining of manholes shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment.
- B. Equipment for installation of lining materials shall be high quality grade and be as recommended by the manufacturer.
- C. The lining system to be utilized for manhole structures shall be multi-component stress skin panel liner system as described below:

1. Liner

<u>Installation</u>	<u>Liner</u>
Moisture Barrier	Modified Polymer
Surfacer	Polyurethan/Polymeric blend foam
Final Corrosion Barrier	Modified Polymer

- 2. Modified polymer shall be sprayable, solvent free, two-component polymeric, moisture/chemical barrier specifically developed for the corrosive wastewater environment.

401.2.9 Approved Manufacturers.

- A. SpectraShield
- B. Poly-Triplex Technologies
- C. Or equal.

401.3. Execution

401.3.1 Inspection

- A. Examine each precast section, ring and cover and appurtenance for cracks and other defects. Remove all defective materials from the site.
- B. Reference: ASHTO R-73

401.3.2 Manhole Size.

- A. Unless directed otherwise on the Drawings use forty-eight (48) inch diameter manholes on sewers eight (8) inch through eighteen (18) inch in diameter, sixty (60) inch manholes on sewers twenty-one (21) inches through thirty (30) inches in diameter, and seventy-two (72) inch manholes on sewers thirty-three (33) inches through forty-two (42) inches in diameter.
- B. Use eccentric cones where manhole depth is sixty (60) inches or greater on forty-eight-inch (48") manholes and seventy-two inches (72") or greater on sixty-inch (60") manholes. Use flat top manholes when manhole depth is less than the above and on all seventy-two-inch (72") manholes.
- C. Manholes installed at depths greater than twenty feet (20') measured from finished grade to invert shall have an intermediate platform as shown on the Towns Standard Detail.

401.3.3 Installation of Precast Manhole Sections.

- A. Connect all pipes to precast manhole sections using pipe penetration gaskets.
- B. If inverts are not constructed by precaster and wherever grade and alignment permit, lay the main sewer continuously through the manhole and split the pipe after construction of the invert. Where this is not possible, terminate pipe flush with interior manhole wall and construct transition smooth and of proper radius for uninterrupted flow. In no case shall the invert flow section through the manhole be greater than that of the outgoing pipe. Finish invert with a steel trowel prior to adding riser section to the base.
- C. Set each manhole riser section plumb. Use sections of various heights to bring ring and cover to grade. Join manhole sections or pre-formed flexible plastic gaskets. The last barrel section prior to placement of the eccentric cone or the flat top slab shall be the manufacturer's shortest, but in no case greater than twenty-four (24) inches in height. All joint surfaces shall be clean, dry and warm during installation.

- D. Install ring and covers on one or a maximum of two (2) pre-cast adjusting rings of varying heights, not to exceed six (6) inches in height each. On buried manholes the total allowable height of adjusting rings and the ring and cover shall be one inch less than the manufacturer's shortest precast barrel section. Set rings in a full bed of mortar and encase in mortar around the entire perimeter. Unless otherwise indicated, set the top of the rings twenty-four (24) inches below finished grade in farmed fields, six (6) inches below finish grade in gravel roadways and such that no part of the ring or cover will project above a point one-quarter (1/4) inch below the finish surface of pavement in paved areas subject to cleaning by snowplows.
- E. Fill all lifting holes and other imperfections with mortar. Neatly point inside of joints no matter what joint material is used.

401.3.4 Construction of Cast-in-Place Bases.

- A. Set stubs and mains before concrete is placed and recheck for alignment and grade before concrete has set. Where grade and alignment permit, lay the main sewer continuously through manholes and split the pipe after construction of the base. Where this is not possible, terminate the pipe flush with the interior manhole wall and construct transitions smooth and of proper radius for uninterrupted flow. In no case shall the invert flow section be larger than that of the outgoing pipe. Shape the base with a wood float and finish with a steel trowel. Allow the base to set a minimum of forty-eight (48) hours before continuing construction. Twenty-four (24) hour set time allowable with high early as approved by the Town.
- B. When thermoplastic pipe is used, connections to the manhole base shall be made using approved manhole couplings cast into the base or a minimum of three (3) pipe gaskets spaced two inches (2") apart on the end of each pipe and cast into the base.
- C. If the pipe connection is to a precast section, use pipe penetration gaskets as specified above.
- D. Install precast manholes risers, cones, and tops and the ring and covers as specified in paragraphs 401.3.3.C through 401.3.3.E above.

401.3.5 Drop Manholes.

- A. Requirements: Drop manhole bases shall be constructed large enough to form a base for the concrete encasing the sewer drop entering the bottom of the manhole. The drop entering the manhole shall be completely encased in concrete up to the spring line of the main sewer line as shown on the Standard Details(s) for sewer line up to fifteen

inches (15") and twelve inches (12") above the pipe as shown on the Standard Detail(s) for sewer line eighteen inches (18") and larger.

- B. Drop Distance. All drop manholes must be constructed with an outside drop. The maximum vertical drop shall be ten feet (10').
- C. Cleanout. Install a cleanout in the manhole at the level of the main sewer line, as shown in the Standard Details.
- D. Lining. All drop manholes must be completely lined as shown in the Standard Details.

401.3.6 Underdrain.

- A. The use of all sanitary sewer trench for either a pipe or gravel underdrain is prohibited.
- B. Foundation perimeter pipe or gravel are prohibited from connecting to a service or main line trench, and a positive method shall be used to prevent water collected in the foundation perimeter drain from flowing through the service line trench to the main line trench.
- C. Sump pumps and foundation perimeter drains are prohibited from connecting directly, or indirectly as through a floor drain, to the sanitary sewer line.

401.3.7 Field Quality Control.

- A. Inspect each manhole for and repair all visible leaks and damp spots.

401.3.8 Vacuum Testing.

- A. All manholes must pass vacuum testing per ASTM C1244-11. Vacuum testing shall be performed after backfilling. Vacuum testing must be observed by the Town.
- B. Typical Field Test Procedure:
 1. Plug and brace all penetrations.
 2. Install 5 psig rated plugs beyond boot seals on influent and effluent pipes.
 3. Secure vacuum apparatus.
 4. Start vacuum.
 5. Attain a vacuum of 10-inches Hg.
 6. Time pressure drop to 9-inches Hg.
 7. Release vacuum.
 8. Compare time of pressure drop to the table below.

9. If leaks are evident excavate, seal, re-backfill, and re-test.

MINIMUM TEST TIMES FOR VARIOUS MANHOLE DIAMETERS (ASTM C1244-93)									
Depth (feet)	Diameter (inches)								
	30	33	36	42	48	54	60	66	72
	Time (seconds)								
5	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	25	27	32	38	45	52	59	65	73
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	115
28	39	42	49	59	69	81	91	101	113
30	42	45	53	65	74	87	98	108	121

END OF SECTION

Section 402

Cast-In-Place Concrete

402.1. General

402.1.1 Description

- A. This section covers all cast-in-place concrete, including forms, reinforcing steel, finishing, curing and other appurtenant Work.

402.1.2 Related Sections

- A. **Sections 100-110** for general specifications.

402.1.3 Quality Assurance

A. Reference Standards:

1. Except as modified or supplemented in these Specifications, all structural concrete shall meet the requirements of the following standards. Refer to the latest version of the following standards for detailed requirements.

- a. American Concrete Institute Standards (ACI).

- i. ACI 301 Specification for Structural Concrete for Buildings.
- ii. ACI 347 Recommended Practice for Concrete Formwork (Chapters 1 through 5).
- iii. ACI 306 Recommended Practice for Cold Weather Concreting.
- iv. ACI 305 Recommended Practice for Hot Weather Concreting.
- v. ACI 304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

- b. American Society for Testing and Materials (ASTM).

- i. As referred to in this section.

B. Mix Design:

1. Compressive Strength: Four thousand five hundred (4500) psi at twenty-eight (28) days.
 - a. Minimum number of cylinders passing above requirement shall be ninety percent (90%).

- b. Minimum strength of cylinder acceptable, four thousand two hundred (4200) psi.
2. Cement Content: 600-615 lbs. per cubic yard, minimum.
3. Maximum permissible Water - absolute cement ratio by weight:
 - a. Non air-entrained: 0.58.
 - b. Air-entrained: 0.46.
4. Slump: Four-inch (4") maximum.
5. Air Content: Six percent (6%) \pm one percent (1%) for concrete with exposed surfaces or subject to freezing and thawing; not required for other concrete.

402.1.4 Product Delivery, Storage and Handling

- A. Cement: Store in weather-tight enclosures and protect against dampness, contamination and warehouse set. Do not use cement that has become caked or lumpy.
- B. Aggregates:
 1. Stockpile to prevent excessive segregation or contamination with other materials or other sizes of aggregates.
 2. Use only one supply source for each aggregate stockpile.
 3. Do not use the bottom six inches (6") of aggregate piles in contact with the ground.
- C. Admixtures:
 1. Store to prevent contamination, evaporation, or damage.
 2. Protect liquid admixtures from freezing or harmful temperature ranges.
 3. Agitate emulsions prior to use.
- D. Mixing and Transporting Ready-mixed Concrete:
 1. The maximum elapsed time from the time water is added to the mix until the concrete is in place shall not exceed thirty (30) minutes when concrete is transported in revolving-drum truck bodies.
- E. Reinforcing Steel:
 1. Deliver to site in bundles marked with metal tags indicating bar size and length.

2. Carefully handle and store on supports which will keep the steel from coming in contact with the ground.
3. Remove all mud, oil, loose rust or mill scale and other foreign materials prior to placing concrete.
4. Rust or mill scale which is "tight" will be permissible without cleaning or brushing, provided weights, dimensions, cross sectional area, and tensile properties meet the requirements of ASTM A615.

402.1.5 Job Conditions.

A. Environmental Requirements:

1. Do not place concrete during rain, sleet or snow unless adequate protection is provided.
2. Do not allow rainwater to increase the mixing water or damage the surface finish.

B. Cold Weather Concreting:

1. Conformance: ACI 306, "Recommended Practice for Cold Weather Concreting."
2. Temperature of concrete when placed shall not be less than the following:

Minimum Air Temperature (°F)	Minimum Concrete Temperature Sections <12"	Minimum Concrete Temperature Sections ≥12"
30 to 45	60	50
0 to 30	65	55
Below 0	70	60

3. When placed, heated concrete shall not be warmer than 80°F.
4. Prior to placing concrete, all ice, snow, surface a subsurface frost shall be removed, and the temperature of the surfaces to be in contact with the new concrete shall be raised above 35 °F.
5. Heated enclosures shall be strong and windproof to insure adequate protection of corners, edges and thin sections.
6. Do not permit heating units to locally heat or dry the concrete.
7. Do not use combustion heaters during the first twenty-four (24) hours unless the concrete is protected from exposure to exhaust gases which contain carbon dioxide.

C. Hot Weather Concreting:

1. Conformance: ACI 305 "Recommended Practice for Hot Weather Concreting."
2. Take precautions when the ambient air temperature is 90°F or above.
3. Temperature of concrete when placed shall not exceed 85°F.
4. Cool forms and reinforcing to a maximum of 90°F by spraying with water prior to placing concrete.
5. Do not use cement that has reached a temperature of 170°F or more.
6. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.
7. Do not place concrete when the evaporation rate (actual or anticipated) equals or exceeds 0.20 pounds per square foot per hour, as determined by ACI 305.
8. Approved set-retarding and water reducing admixtures may be used when ambient air temperature is 90°F or above to offset the accelerating effects of high temperature.

402.2. Products

402.2.1 Concrete Materials.

- A. Cement: ASTM C150, Type II or I/II.
- B. Aggregates:
 1. Fine aggregate - ASTM C33, except that manufactured sands shall not be considered acceptable.
 2. Coarse aggregate - ASTM C33 except air-cooled blast furnace slag is acceptable. Nominal maximum size - as permitted by ACI 318.
- C. Water: Clean and fresh.
- D. Air-entraining Agent: ASTM C260.
- E. Ready-mixed Concrete: Mixed and delivered, ASTM C94.
- F. Batching and Mixing Equipment: ACI 304, "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete."

402.2.2 Form Materials.

- A. Forms:
 1. Plywood - Waterproof, resin-bonded, exterior type, Douglas fir.

2. Lumber - straight, uniform width and thickness, free from knots, off-sets, holes, dents and other surface defects.
3. Designed to produce hardened concrete having the shape, lines and dimensions shown on the Drawings.

B. Form Oil:

1. Light colored paraffin oil, or other non-staining material. For exposed surfaces not in contact with earth backfill, acceptable chemical release agents are Protex Industries, "Pro-Cote," Symons Corp., "Magic Kote," L&M, "Debond," or equal.

C. Form Ties:

1. Commercially manufactured permanently embedded type with removable ends for all exposed surfaces.
2. Permanently embedded portion shall terminate not less than one inch from the face of the concrete.

402.2.3 Reinforcing Materials.

- A. Bars: ASTM A615, Grade 60 unless specified otherwise.
- B. Welded Wire Fabric: ASTM A185 or A497.
- C. Fabrication ACI 315 and 318 unless shown otherwise on Drawings.

402.2.4 Non-Shrink Grout.

- A. Quickrete "Non-Shrink Precision Grout", or equal.

402.2.5 Curing and Sealing Compounds.

- A. Sheet materials: ASTM C171.
 1. Six (6) mil polyethylene film.
- B. Spray applied membrane forming curing compounds.
 1. For use on paving, curb and gutter, sidewalks, and other open areas exposed to direct sunlight: ASTM C309, Type 2, Class B.
 2. For use on other surfaces not exposed to direct sunlight: ASTM C309, Type 1-D, Class B.

402.2.6 Expansion Joint Filler.

- A. Bituminous type: ASTM D994.
- B. Cork type: ASTM D1752, Type 2 or 3.
- C. Fiber type: ASTM D1751.

402.3. Execution

402.3.1 Erection of Forms.

- A. Brace or tie to maintain desired position, shape and alignment before, during and after concrete placement.
- B. Construct forms for beams and slabs supported by concrete columns so the column forms can be removed without disturbing the beam or slab supports.
- C. Provide temporary openings at the bottom of columns and wall forms and at other locations where necessary to facilitate cleaning and inspection.
- D. Where concrete is placed against rock, remove loose pieces of rock and clean the exposed surface with a high-pressure air hose.
- E. Place Chamfer strips in forms to bevel salient edges and concrete corners of exposed surfaces except the top edges of walls and slabs which are to be tooled. Unless otherwise noted on the Drawings, bevels shall be $\frac{3}{4}$ inch wide.
- F. Remove mortar or grout from previous concrete and other foreign material from the surfaces. Coat form surfaces with approved coating material before either the reinforcing steel or concrete is placed.
- G. Do not allow form coating to:
 - 1. Stand in puddles in the forms.
 - 2. Come in contact with the reinforcing steel.
 - 3. Come in contact with adjacent hardened concrete against which fresh concrete is to be placed.

402.3.2 Removal of Forms.

- A. Do not remove or disturb forms until the concrete has attained sufficient strength to safely support all dead and live loads.
- B. Remove forms with care to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

402.3.3 Reinforcing.

- A. Installation:
 - 1. Accurately place reinforcing bars and maintain in proper position while concrete is being placed and compacted.
- B. Bar Supports:

1. Provide minimum number of supports as required by ACI 315.
2. Do not use pebbles, pieces of broken stone, common or face brick, metal pipe or wood blocks to support reinforcement.
3. On ground, where necessary, supporting solid concrete bricks may be used. Use one half concrete bricks whenever possible.
4. Use metal, plastic or other approved bar chairs, bolsters and spacers over flat form surfaces.
5. Where the concrete surface will be exposed to the weather in the finished structure the portions of all accessories within 2-inches of the concrete surface shall be non-corrosive or protected against corrosion.

C. Splices.

1. Do not splice bars, except at locations shown on the Drawings, without Engineer's approval.
2. Minimum lap distance shall be as shown on the Drawings. If not shown, splices shall be as specified in ACI 318.
3. Tie splices securely to prevent displacement during placement of concrete.

D. Welded Wire Fabric.

1. Install in longest practicable length.
2. Lap adjoining pieces one full mesh plus two inches (2") minimum.

402.3.4 Embedded Items.

- A. Anchor bolts, castings, steel shapes, conduits, sleeves, masonry anchorage, and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.
- B. Install conduits in walls or slabs with reinforcement in both faces between the two faces of reinforcing steel.
- C. In slabs which have only a single face of reinforcing steel, place conduits near the center of the slab.

402.3.5 Inspection.

A. General.

1. Assure that excavations and form work are completed.
2. Assure that dirt, mud, encrusted concrete, debris, and excess water has been removed.

3. Check that reinforcement is properly positioned and secured in place.
4. Verify that expansion joint material, anchors, water stops, and other embedded items are secured in proper position.
5. Verify that all required tests for pipes under slabs have been completed.

402.3.6 Concrete Placement.

A. Conveying:

1. Convey to the point of final deposit by methods which will prevent the separation or loss of ingredients.
2. During and immediately after placement, concrete shall be thoroughly compacted, worked around reinforcements and embedment's, and worked into all corners of the forms.
3. Carefully deposit concrete for drilled piers excavated piers caissons to avoid contact with forms, reinforcing, and earth sides until completion of drop.
 - a. Prevent earth or other material from falling into excavations.
 - b. Prevent dislocation of reinforcing during concrete placement.
 - c. Place concrete continuously to top of each pier caisson at a rate of vertical rise of not less than two (2) feet per hour.
 - d. Use cylindrical steel or fiber forms acceptable to Engineer above grade line.

402.3.7 Expansion and Contraction Joints.

A. Installation:

1. Formed where shown on the Drawings, but in no case more than fifty (50) feet in any direction.
2. Install expansion joints, fillers and water stops as detailed on the Drawings or in accordance with manufacturer's instructions.
3. Do not extend reinforcement through expansion joints, except where specifically noted or detailed on the Drawings.

402.3.8 Construction Joints.

A. Location:

1. Formed where shown on the Drawings.
2. Construct in one continuous concrete placing operation all concrete included between construction joints.

3. Obtain Engineer's approval for location of additional construction joints desired.

402.3.9 Finishing Formed Surfaces.

A. Rough Form Finish:

1. Rough form finish is acceptable for surfaces not exposed to view such as surfaces in contact with earth backfill.
2. Patch tie holes with mortar.
3. Repair defects.
4. Smooth form finish is acceptable alternative.

B. Smooth Form Finish:

1. Provide smooth form finish for surfaces not specified to have grout leaned finish.
2. Use form facing to produce a smooth, hard, uniform surface.
3. Keep number of seams to a minimum.
4. Patch all tie holes with mortar.
5. Remove all fins.
6. Repair all defects.

C. Grout Cleaned Finish.

1. Provide grout cleaned finish for surfaces so designated on the Drawings and the following surfaces:
2. Complete operations for smooth form finish.
3. Wet surface and apply grout mix of one (1) part Portland Cement and one and one half (1 ½) parts of fine sand.
4. Substitute white Portland cement for gray as required to match surrounding concrete.
5. Rub surface with cork float or stone to fill air bubbles and holes.
6. Remove excess grout by rubbing with a rubber float, sack or other means.
7. Do not begin cleaning until all contiguous surfaces are completed and accessible.

402.3.10 Finishing Unformed Surfaces.

- A. Slabs, Pavements, Sidewalks, Driveways, Curb and Gutters and Similar Structures:
 - 1. Screed and give an initial float finish as soon as concrete has stiffened sufficiently for proper working.
 - 2. Remove coarse aggregates disturbed by the initial floating or which cause a surface irregularity and replace with mortar.
 - 3. Initial floating shall produce a surface of uniform texture and appearance.
 - 4. Follow with a second floating at the time of initial set. This floating shall produce a finish of uniform texture and color.
 - 5. In areas where concrete is to remain exposed, follow the second floating with a broomed treatment to the surface to provide a uniform abrasive texture of constant color, except where steel trowel surface is indicated.

402.3.11 Defective Concrete.

- A. Repair in accordance with ACI 301, Chapter 9.

402.3.12 Curing.

- A. Keep concrete continuously moist for at least seven (7) days (or two (2) days for high early strength concrete) after placement by use of:
 - 1. Ponding or continuous sprinkling.
 - 2. Wet burlap, wet absorptive mats, or wet sand.
 - 3. Waterproof sheets.
 - 4. Polyethylene film.
 - 5. Membrane curing compound.
 - a. Do not use membrane curing compounds when the surface is to be painted or other material is to be bonded to the surface.
- B. Maintain concrete within 50° to 70°F range during curing.
- C. Apply curing and sealing compounds in accordance with manufacturer's instructions.

402.3.13 Field Quality Control.

A. Test Cylinders:

1. Make a set of three (3) test cylinders for each fifty (50) cubic yards placed or portion thereof.
2. Cylinders shall have a diameter of six inches (6") and be twelve inches (12") tall.
3. Deliver test cylinders to testing laboratory.
4. Comply with ASTM C912.

B. Failure of test cylinder results.

1. Upon failure of any set of test cylinder, the Engineer or Town may, at Contractor's expense, require a test of at least three (3) two-inch (2") diameter cored samples from area in question.
2. Concrete will be considered adequate if average of three cores is at least eighty-five percent (85%) of, and if no single core is less than seventy-five percent (75%) of, specified twenty-eight (28) day strength.
3. Upon failure of core test results, the Engineer or Town may require Contractor, at Contractor's expense, to perform all work necessary to remove and replace all concrete which, in Engineer's opinion, is represented by the failed tests. All work necessary to expose the concrete to be removed, and to restore all other effected work to satisfactory status shall be at Contractor's expense.
4. Fill all core holes as specified for repairing defective concrete.
5. Contractor shall have no right to claim additional costs as a result of any work required to comply with [paragraph 401.3.13.B](#) and its sub-paragraphs.

END OF SECTION

Section 403

Grease and Sand & Oil Interceptors

403.1. General

403.1.1 Description

- A. This section concerns the selection and installation of grease interceptors and combination sand & oil interceptors.

403.1.2 Related Sections

- A. **Sections 100-110** for general specifications.

403.1.3 Product Delivery, Storage and Handling

- A. All products shall be handled, stored, and protected in a manner which will prevent damage to materials.

403.2. Products

403.2.1 Precast Concrete Products

- A. All precast concrete products shall conform to ASTM C478 and shall be made with Type I/II cement.
- B. Reference **Section XXX – Structural Concrete**.

403.2.2 Cast-in-Place Concrete

- A. All cast-in-place concrete shall be made with Type I/II Portland Cement conforming to ASTM C150.
- B. Reference **Section XXX – Structural Concrete**.

403.2.3 Mortar

- A. Mortar shall be sand-cement grout, using the following ratio of ingredients:
 1. One part Portland Cement; conforming to ASTM C150, Type I/II.
 2. Two parts sand; conforming to ASTM C144.
 3. ½ part hydrated lime; conforming to ASTM C207, Type S.

403.2.4 Grout

- A. Grout shall be one of the following:

1. Pre-mixed non-shrinking grout; the acceptable types and manufacturers of which are listed below:
 - a. Reference the Design Standards Volume II, Appendix A - Approved Materials List.
 - b. Or an approved equal.
2. Job mixed grout, using the following ratio of ingredients:
 - a. One part Portland Cement; conforming to ASTM C207, Type I/II.
 - b. One part sand; conforming to ASTM C144.
 - c. One part shrinkage correcting aggregate; the acceptable types and manufacturers of which are listed below:
 - i. Master Builders; "Embeco Aggregate".
 - ii. Sonneborn; "Ferreloith G-D-S".
 - iii. Or an approved equal.

403.2.5 Ring And Cover

- A. Acceptable ring and covers are:
 1. Neenah, R-1706. Reference section 01000 – Approved Product Listing.
 2. Or an approved equal.

403.2.6 Steps

- A. All steps shall be made of one of the following materials:
 1. Copolymer polypropylene plastic, conforming to ASTM C478 and ASTM C497.
- B. Acceptable steps and their manufacturers are:
 1. Reference the Design Standards Volume II, Appendix A - Approved Materials List.
 2. Or an approved equal.

403.3. Execution

403.3.1 General

- A. Unless written approval is given by the Utility, all food serving, food preparing, food catering, meat cutting establishments; fish, fowl, animal slaughter houses, soap factory, tallow rendering, fat rendering, hide curing establishments; and others capable of discharging large amounts

of grease into the sanitary sewer system, shall be required to install a grease interceptor.

- B. Grease interceptors shall not be required for private residences or dwellings.
- C. Owners of businesses that may require grease interceptors shall submit plans to the Utility for review and approval.

403.3.2 Location of Grease Interceptors

- A. Unless prior permission is given by the Utility, all grease interceptors shall be located outside, on private property, within thirty (30) feet of the facility served, and shall be easily accessible at all times for maintenance and examination.
- B. All grease interceptors shall be Type A.
 - 1. Reference Standard Detail.
- C. All grease interceptors shall have two compartments, the smallest of which shall have at least one-third the capacity of the entire interceptor.

403.3.3 Size of Grease Interceptors

- A. The size of grease interceptors shall be determined by the Utility.
 - 1. If the seating capacity of the restaurant can be determined, the following method of sizing shall be used.
 - a. Number of seats times a full capacity factor of 0.9 times a turnover rate of 2.2 per meal period equals the number of meals served per meal period.
 - b. Number of meals per meal period times 2.5 gallons per meal equals the required volume of the grease interceptor.
 - i.e., $214 \text{ seats} \times 0.9 = 192.6$ estimated full capacity
 - $192.6 \times 2.2 = 423.7$ estimated meals per period.
 - $423.7 \times 2.5 = 1059.3$ gallons.
 - 2. If food is prepared but not consumed on the premises, or if the seating capacity cannot be determined, the following method of sizing shall be used.
 - a. A fixture unit count for the various pieces of kitchen equipment shall be determined following the methods outlined in the Uniform Plumbing Code.
 - b. The total number of fixture units times 7.5 gallons per minute equals the maximum flow rate.

c. The maximum flow rate times 8.0 equals the required volume of the grease interceptor.

d. For example:

1 dishwasher = 3 fixture units (f.u.)

2 3-compartment sink = 6 f.u.

1 mop sink = 3 f.u.

1 floor drain = 2 f.u.

14 f.u.

11 f/u x 7.5 gpm x 8-minute retention = 840 gallons.

e. If the required volume is within 10% of a smaller approved precast grease interceptor, the smaller unit will be acceptable.

403.4. Combination Sand & Oil Interceptors

403.3.4 General

- A. Unless written permission is obtained from the Utility or the City's Building Inspection Department, all service stations, truck or car wash facilities, vehicle maintenance facilities, machine shops and others where significant amounts of sand, oil and/or flammable wastes could enter the sanitary sewer system, shall be required to install a combination sand & oil interceptor.
- B. Owners of businesses that may require sand & oil interceptors shall submit plans to the Utility for review and approval.

403.3.5 Location of Combination Sand & Oil Interceptors

- A. All combination sand & oil interceptors shall be located outside, on private property, within thirty (30) feet, and not less than five (5) feet, of the facility served, and shall be accessible at all times for maintenance and examination.
- B. All sand & oil interceptors shall be either Type A, or B.
 - 1. Reference Standard Detail.
- C. All combination sand & oil interceptors shall have two compartments, the smallest of which shall have at least one-third the capacity of the entire interceptor.

403.3.6 Size of Combination Sand & Oil Interceptors

- A. The size of combination sand & oil interceptors shall be determined by the Utility.

1. A fixture unit count for the various drains shall be determined following the values listed below:
 - a. Three (3) inch diameter floor drains shall be rated at six (6) fixture units.
 - b. Four (4) inch diameter floor drains shall be rated at eight (8) fixture units.
 - c. If trough drains are used, each bay, or compartment, or area equaling the square foot surface of a standard service station bay which is served by the trough drain shall be rated at six (6) fixture units per bay.
 - d. Vehicle wash drains shall be rated at eight (8) fixture units, regardless of the size.
2. The total number of fixture units times 7.5 gallons per minute equals the maximum flow rate.
3. The maximum flow rate times a 5-minute retention time equals the required volume of the sand & oil interceptor.
4. For example:
 - 4 4-inch floor drains = 32 fixture units
 - 32 f.u. x 7.5 gpm x 5.0-minute retention = 1,200 gallons.
- B. Commination sand & oil interceptors small than 750 gallons will not be allowed.

END OF SECTION

Section 404

Sanitary Sewer System

404.1. General

404.1.1 Description

- A. This section covers the installation and testing of sanitary sewer lines plus the furnishing and installation of manhole materials, and other appurtenances.

404.1.2 Related Sections

- A. **Sections 100-110** for general specifications.

404.1.3 Quality Assurance

- A. Lay pipe and set manhole inverts true to line and grade shown on Construction Drawings. Under no circumstances shall pipe be laid which results in a level invert, reverse sloping invert, or a grade flatter than shown on the Construction.

404.1.4 Job Conditions

- A. Use effective measures to prevent foreign material from entering the pipe.
- B. Do not place debris, tools, clothing, or other materials in the pipe.
- C. Close the open end of any pipe with a plug, or cap, to prevent the entry of foreign material or water into the pipe.
- D. Use effective measures to prevent the uplift or floating of the line prior to completion of the backfilling operation.

404.2. Products

404.2.1 Pipe Materials

- A. Type.
 - 1. Plastic Non-Pressure Pipe: Reference **Section xxxx**.
- B. Stubouts.
 - 1. All stubouts shall meet the requirements of **Section xxxx, Plastic Non-Pressure Pipe**.

404.2.2 Manhole Materials

A. Reference Section xxxx, Manholes.

B. Plugs and Caps

1. Plugs or stoppers consisting of a PVC plugs or stoppers shall be furnished for all temporary or permanent stub-outs and all unused branch pipes. The size of the stopper shall be determined by the size of the pipe in which it is installed.

404.3. Execution

404.3.1 Preparation

- A. Perform excavation in accordance with Section xxxx, Trenching, Bedding and Backfill.

404.3.2 Pipe Installation

A. Pipe Laying

1. Begin pipe laying at the lowest point, unless otherwise approved by Engineer/Utility, and install the pipe with the spigot ends pointing in the direction of flow.
2. Lay pipe true to line and grade.
3. As each length of pipe is placed in the trench, complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade. Make adjustments by scraping away or filling pipe bedding under the body of the pipe, and not by wedging or blocking up the bells.
4. Secure the pipe in place with the specified bedding tamped under and around the pipe except at the joints. Do not use mechanical compacting equipment in the zone above the horizontal centerline of the pipe and below a plane 1 foot above the top of the pipe. Do not walk on small diameter pipe or otherwise disturb pipe after the jointing has been completed.

- B. Contractor shall arrange delivery of pipe and bedding material so as to only save enough on the roads to complete the work. Large stockpiles of equipment and material will not be permitted on the road right-of-ways.

- C. Where shown on the Construction Drawings a piece of pipe of the proper size shall be built into the manhole where future laterals may be connected. This pipe shall be sealed with a plug at its outer end and an invert shall be built into each manhole for such lateral connections.

- D. The physical connection to the existing sewer system shall be plugged until the sewer has been completed to the satisfaction of the Engineer/Utility.

404.3.3 Water Line Crossings

- A. Where sewer lines cross water mains, and the sewer is above the water main or less than 18 inches clear distance vertically below the water main, construct the crossing using one length of pipe at least 14 feet long centered over or under the water main. Encase all sewer line joints with concrete that exist within 10 feet either side of the waterline.
- B. In lieu of the above, Contractor may, upon approval of the Engineer/Utility, wrap the joints of the joints of the sewer pipe with Butyl adhesive tape.
 - 1. Tape shall be 12" wide at all locations within 10 feet either side of the water line.
 - 2. Comply with ASTM C 877 (Type III) and manufacturer's instructions for installation of the material.
 - 3. Provide suitable backfill or other structural protection to preclude settling or failure of the higher pipe.
- C. The center of the sewer line pipe shall be centered under or over the waterline.

404.3.4 Field Quality Control

- A. Sewer shall meet the requirements of the following tests. Furnish all equipment, labor and incidentals necessary and conduct tests in the presence of Engineer.
 - 1. Air tests of individual pipe joints and alignment tests shall be used to test the sanitary sewer pipeline.
 - 2. Vacuum tests and leakage tests shall be used to test the sanitary sewer manholes.
- B. Alignment Tests
 - 1. The contractor may choose to lamp each section of sewer between manholes to determine whether any displacement of the pipe has occurred. The Engineer/Utility will verify proper alignment by performing TV Camera Inspection after completion of construction.
 - 2. Repair poor alignment, displaced pipe, or other defects discovered.

C. Air Tests

1. Where no service line connections exist between manholes, use the following procedure.
 - a. The Contractor shall perform these tests with suitable equipment specifically designed for air testing sewers. A suitable gauge shall be used for readings not to exceed 15-pounds/square inch (PSI) maximum reading. The gauge shall be located at the surface. Flush and clean the sewer line prior to testing in order to wet the pipe surfaces and produce more consistent results. Plug and brace all openings in the main sewer line and the upper connections. Check all pipe plugs with a soap solution to detect any air leakage. If leaks are found release the air pressure, eliminate the leaks and start the test procedure over again.
 - b. Contractor shall furnish to the Engineer/Utility written documentation of the testing results which are signed by both the contractor's representative and the utility inspector.
 - c. The line shall be plugged at each manhole with pneumatic plugs. Low pressure air shall be introduced into the plugged line until the internal pressure reaches four (4.0) PSIG greater than the average back pressure of any ground water pressure that may submerge the pipe. At least two (2) minutes shall be allowed for the air temperature to stabilize before readings are taken and the time is started.
 - d. If the time shown in Table 1 for the designed pipe size and length elapses before the air pressure drops 0.5 PSIG; section undergoing test shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even through the 0.6 PSIG drop has not occurred.
 - e. Brace all plugs sufficiently to prevent blowouts and vent the pipeline completely before attempting to remove the plugs.
 - f. Provide pressurizing equipment with a relief valve set at 5 psi to avoid over pressurizing and damaging an otherwise acceptable line.
 - g. All pipelines shall be tested for compliance with the specifications. If leaks are discovered, they shall be repaired by the Contractor as part of the work of laying this pipe and appurtenances and approved by the Engineer/Utility.
 - h. All equipment and appurtenances shall be repaired or replaced, and the tests repeated at the Contractor's expense until the pipe,

appurtenances and equipment are in satisfactory compliance with these specifications in the judgment of the Engineer/Utility.

Pipe Dia. (in)	100'	150'	200'	250'	300'	350'	400'	450'	500'	>500'
8	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42	6:20	0.760 L
12	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50	14:15	1.709 L
15	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	22:16	2.671 L
18	8:30	9:97	12:49	16:01	19:14	22"26	25:38	28:51	32:03	3.846 L
21	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	43:38	5.235 L
24	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	56:59	6.837 L
27	14:25	21:36	28:51	36:04	43:16	50:30	57:42	64:54	72:07	8.653 L

2. Where service line connections exist between manholes, only testing of individual pipe joints is required.
 - a. Low pressure air shall be slowly introduced at each joint. Introduce air until the internal pressure reaches 4.0 PSIG greater than the average back pressure of any groundwater above the pipe, as shown in the soils report covering the area; but not greater than 9.0 PSIG.
 - b. Duration of test per joint shall be 5 minutes. Duration of test shall be the same for all pipe sizes.
 - c. If air pressure drop is less than 0.5 PSIG, joint undergoing test shall be presumed to be free of defects.

D. Vacuum Testing

1. Manholes shall be vacuum tested after assembly and prior to backfilling.
 - a. Care shall be taken to affect a seal between the vacuum base and the manhole rim. Pipe plugs shall be secured to prevent movement while the vacuum is drawn.
 - b. Contractor shall furnish to the Engineer/Utility written documentation of the testing results which are signed by both the contractor's representative and the Utility inspector.
 - c. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

- d. Acceptance shall be defined as when the time to drop to 9 inches meets or exceeds the following:

<u>Diameter</u>	<u>Time to Drop 1" Hg</u>
4 ft.	60 seconds
5 ft.	75 seconds
6 ft.	90 seconds
8 ft.	120 seconds

- e. If the manhole fails the test, make necessary repairs. Repairs and repair procedures must be acceptable to Engineer/Utility.
 - f. If preformed plastic gaskets are pulled out during the vacuum test, the manhole shall be disassembled and the gaskets shall be replaced.
- E. Manholes and pipelines shall not have any visible leaks or damp spots.
 - F. Repair and retest lines and manholes that fail tests until satisfactory results are obtained.
 - G. Camera inspection will be done by the Town on all sewers. Sewers must pass camera inspection prior to acceptance.

404.3.5 TV Camera Inspection

- A. Town may, at its own expense, inspect the new sewer lines using a TV camera.
- B. Displaced joints of pipe or other defects resulting in poor workmanship shall be corrected by the Contractor. TV inspection will be scheduled again after such repairs have been made.
- C. TV inspection will occur twice: once upon completion and again prior to the end of the warranty period.

404.3.6 Cleaning

- A. Prior to completion of the Work, remove all accumulated construction debris, rocks, gravel, sand, silt and other foreign material from the sewer system. This shall be accomplished with a sewer jet rodding rig. No mechanical rodding or bucketing equipment will be permitted.
- B. Upon final inspection if any foreign matter is present in the system, flush and clean the sections of the line as required.

END OF SECTION

Section 405

Cured in Place Pipe (CIPP)

405.1. General

405.1.1 Description

- A. This section covers the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube that is tightly formed to the original conduit. The resin is cured using either hot water under hydrostatic pressure, steam pressure within the tube, or ultraviolet light. The Cured-In-Place Pipe (CIPP) will be continuous and tight fitting.

405.1.2 Quality Assurance

- A. ASTM F1216 (Rehabilitation of pipelines by the inversion and curing of a resin-impregnated tube)
- B. ASTM F1743 (Rehabilitation of pipelines by pulled-in-place installation of a cured-in-place thermosetting resin pipe)
- C. ASTM F2019 (Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP Cured-In-Place Thermosetting Resin Pipe (CIPP))
- D. ASTM D790 (Test methods for flexural properties of non-reinforced plastics)

405.1.3 Submittals

- A. Certification: Submit Manufacturer's certification that products meet referenced standards.
- B. Shop Drawings: Submit Manufacturer's specifications, cut sheets and any other applicable information for insituform materials.

405.2. Products

405.2.1 CIPP (ASTM F1216 or ASTM F1743)

- A. Tube
 1. The sewn Tube shall consist of one or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F1216 or ASTM F1743, Section 5. The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe, and stretch to fit irregular pipe sections.

2. The wet out Tube shall have a uniform thickness that when compressed at installation pressures will meet or exceed the calculated Design thickness.
3. The Tube shall be sewn to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion. Overlapped layers of felt in longitudinal seams that cause lumps in the final product shall not be utilized.
4. The outside layer of the Tube (before wet out) shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate monitoring of resin saturation during the resin impregnation (wet out) procedure.
5. The Tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the Tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.
6. The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.
7. Seams in the Tube shall be stronger than the non-seamed felt.
8. The outside of the Tube shall be marked for distance at regular intervals along its entire length, not to exceed five feet (5').

B. Resin.

1. The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system that when properly cured within the tube composite meets the requirements of ASTM F1216 and ASTM F1743, the physical properties herein, and those which are to be utilized in the Design of the CIPP for this project. The resin shall produce CIPP which will comply with the structural and chemical resistance requirements of applicable ASTM Standards.

405.2.2 CIPP (ASTM F2019)

A. Tube

1. Fabric tube shall consist of at least two separate tubes made of corrosion resistant (E-CR) glass fibers in accordance with ASTM D 578.
2. Internal surface shall consist of a veil preferably made of polyester. Constructed with unidirectional glass.

3. External foils – shall consist of one or more layers of styrene resistant or light proof, or both, tube-shaped plastic foils.

B. Resin:

1. The resin system shall consist of a chemically resistant isophthalic polyester or vinylester thermoset resin and catalyst system or an epoxy resin and hardener that is compatible to the installation process. The resin shall produce CIPP which will comply with the structural and chemical resistance requirements of applicable ASTM Standards.

405.2.3 Design Considerations.

- A. The CIPP shall be designed as per ASTM F1216 Appendix X.1. The CIPP design shall assume no bonding to the original pipe wall.

B. Design

1. The Enhancement Factor 'K' to be used in 'Partially Deteriorated' Design conditions shall be assigned a value of seven (7). Application of Enhancement (K) Factors in excess of seven (7) shall be substantiated through independent test data.
2. The layers of the cured CIPP shall be uniformly bonded.
3. The cured pipe material (CIPP) shall conform to the structural properties, as listed in applicable ASTM Standards.
4. The required structural CIPP wall thickness shall be based as a minimum, on the physical properties in Section b.3 and in accordance with the Design Equations in the appendix of ASTM F 1216 and the following design parameters:

Design Safety Factor (typically used value)	=	2.0
Retention Factor for Long-Term Flexural Modulus to be used in Design (As determined by long-term tests described in section 5.2 and approved by the Owner)	=	1% - 60%
Ovality* (calculated from (X1.1 of ASTM F1216)	=	%
Enhancement Factor, K	=	See Section b.1
Groundwater Depth (above invert of existing pipe)*	=	ft.
Soil Depth (above crown of existing pipe)*	=	ft.
Soil Modulus**	=	psi
Soil Density**	=	pcf
Live Load**	=	H20 Highway
Design Condition (partially or fully deteriorated)***	=	***

* Denotes information, which can be provided here or in inspection videotapes or project construction plans. Multiple lines segments may require a table of values.

** Denotes information required only for fully deteriorated design conditions.

*** Based on review of video logs, conditions of pipeline can be fully or partially deteriorated. (See ASTM F1216 Appendix) The Owner will be sole judge as to pipe conditions and parameters utilized in design.

5. Refer to the Dimensional Ratio table for specific pipe section requirements, based on the pipe condition, depth, ovality, etc. as computed for the conditions shown, using ASTM F 1216 Design Equations.

CIPP WALL THICKNESS

FULLY DETERIORATED DESIGN (FD)

		Required DR (D / t)			
		Ei = 250,000 psi		Ei = 400,000 psi	
		Ground Water Depth			
Ovality	Range of Depth to invert (feet)	50% Depth	Full Depth	50% Depth	Full Depth
2 % *	4 - 8	49	43	58	51
	8 - 12	49	43	58	51
	12 - 16	44	39	52	46
	16 - 20	40	36	47	41
	20 - 24	37	33	44	38
5 %	4 - 8	41	37	48	43
	8 - 12	41	36	48	43
	12 - 16	37	33	44	38
	16 - 20	34	30	40	35
	20 - 24	31	27	37	32
8 %	4 - 8	35	31	40	36
	8 - 12	35	30	41	36
	12 - 16	31	27	37	32
	16 - 20	28	25	33	29
	20 - 24	26	23	31	27

FD wall thickness considers groundwater, soil and live loads upon the CIPP pipe. The table assumes two heights of groundwater, 120-lbs/cu. ft. of soil density and an AASHTO H20 highway load. The table represents CIPP pipe wall thickness for a host pipe range of 8 to 48 inches. This is a guideline only. Specific calculations should refer to ASTM F-1216, Appendix X.1.

Design Parameters:

Factor of Safety = 2.0

DR = Dimension Ratio = Diameter / thickness => $t = D / DR$

Effective reduction of Ei-modulus to approximate effects of creep = 50 %

Soil Modulus = 1,000 psi, assumed for highway loads or depths ≥ 10 feet (all others 700 psi).

Ovality % = $100 \times (\text{Mean Dia.} - \text{Minimum Dia.}) / \text{Mean Dia.}$

* 2% ovality is typically assumed when the host pipe measurements have not been field verified.

6. Any layers of the tube that are not saturated with resin prior to insertion into the existing pipe shall not be included in the structural CIPP wall thickness computation.

405.2.4 Testing Requirements

- A. Chemical Resistance - The CIPP shall meet the chemical resistance requirements of ASTM F1216, Appendix X2, or of ASTM D5813 as applicable. CIPP samples for testing shall be of tube and resin system similar to that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet these chemical testing requirements.
- B. Hydraulic Capacity - Overall, the hydraulic profile shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation.

405.3. Execution

405.3.1 Initial Work

- A. If a street must be closed to traffic because of the orientation of the sewer, the CONTRACTOR shall institute the actions necessary to do this for the mutually agreed time period.
- B. The TOWN shall provide free access to water hydrants for cleaning, inversion and other work items requiring water.
- C. Cleaning of Sewer Lines - The CONTRACTOR shall remove all internal debris out of the sewer line that will interfere with the installation of CIPP, and coordinate with the TOWN a dump site for all debris removed from the sewers during the cleaning operation.
- D. Bypassing Sewage – The CONTRACTOR, when required, shall provide for the flow of sewage around the section or sections of pipe designated for repair. Plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system shall make the bypass. The pump(s) and bypass line(s) shall be of adequate capacity to accommodate the sewage flow.

- E. Inspection of Pipelines - Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by close circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of CIPP into the pipelines, and it shall be noted so that these conditions can be corrected. A video tape and suitable log shall be kept for later reference by the TOWN.
- F. Line Obstructions - It shall be the responsibility of the CONTRACTOR to clear the line of obstructions such as solids and roots that will prevent the insertion of CIPP. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or a collapse that will prevent the inversion process, and it cannot be removed by conventional sewer cleaning equipment, then the CONTRACTOR shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved by the TOWN prior to the commencement of the work and shall be considered as a separate pay item.
- G. Public Notification - The CONTRACTOR shall make every effort to maintain service usage throughout the duration of the project. In the event that a service will be out of service, the maximum amount of time of no service shall be 8 hours for any property served by the sewer. A public notification program shall be implemented, and shall as a minimum, require the CONTRACTOR to be responsible for contacting each home or business connected to the sanitary sewer and informing them of the work to be conducted, and when the sewer will be off-line. The CONTRACTOR shall also provide the following:
 - 1. Written notice to be delivered to each home or business the day prior to the beginning of work being conducted on the section, and a local telephone number of the CONTRACTOR they can call to discuss the project or any problems which could arise.
 - 2. Personal contact with any home or business, which cannot be reconnected within the time stated in the written notice.
- H. The CONTRACTOR shall be responsible for confirming the locations of all branch service connections prior to installing and curing the CIPP.

405.3.2 Installation.

- A. CIPP installation shall be in accordance with ASTM F1216, Section 7, or ASTM F1743, Section 6, or ASTM F2019, Section 6 with the following modifications:
 - 1. Resin Impregnation - The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with

additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. Certification, documentation concerning date, type of resin, resin calculation and volume shall be provided to OWNER.

2. Tube Insertion – The wet out tube shall be positioned in the pipeline using either inversion or a pull-in method. If pulled into place, a power winch should be utilized and care should be exercised not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extend to the next designated manhole or termination point.
3. Once the inversion/tube installation has started, the pressure shall be maintained between the manufacturer's minimum and maximum pressures until the installation of the tube has been completed and the finished pipe is fully cured. Should the pressure deviate from the minimum and maximum allowable range the tube shall be removed from the existing conduit and discarded.

4. CIPP (ASTM F2019)

CIPP installation shall be in accordance with ASTM F2019, Section 6. Ultraviolet Light Curing shall follow a full protocol for time, rate of travel etc.

405.3.3 Reinstatement of branch connections.

- A. It is the intent of these specifications that branch connections to buildings be reopened without excavation, utilizing a remote controlled cutting device, monitored by a video TV camera. Unless otherwise directed by the owner or his authorized representative, all laterals will be reinstated to a minimum of 95% and a maximum of 100%. No additional payment will be made for excavations for the purpose of reopening connections and the CONTRACTOR will be responsible for all costs and liability associated with such excavation and restoration work.

405.3.4 Inspection.

- A. CIPP samples shall be prepared and physical properties tested in accordance with ASTM F1216 or ASTM F1743, Section 8, or ASTM F2019 Section 7 using methods described. Samples The flexural properties must meet or exceed the values listed in Table 1 of the applicable ASTM.
- B. Wall thickness of samples shall be determined as described, the minimum wall thickness at any point shall not be less than eighty seven and one-half percent (87½%) of the design thickness as calculated in paragraph 5.6 of this document.

405.3.5 Clean-up.

- A. Upon acceptance of the installation work and testing, the CONTRACTOR shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

END OF SECTION