Section 5: Sewer Design

Version 4.1

A. Hydraulic Study

1. {106} The Planning Unit will provide information which shall be used for hydraulic sizing. Actual final design location, configuration, and limits shall be based on the Engineer's judgment encompassing all aspects of the design process.
2. For projects including water, water relay requirements will be provided concurrently with sewer requirements on a completed sewer base plan.
3. Consultants should see Section 6 A [119] for the base plan submittal and review procedure.

B. Proposed Sewer and Stormwater Conduit Design (General)

1. {105} Definition
    a. Sewers carry sanitary flow. They could carry some stormwater also but they must carry some sanitary flow. Stormwater Conduits are not designed to carry sanitary flow. They only carry stormwater. That being said, Stormwater Conduits are often referred to as Stormwater Sewers or just Sewers for ease of discussion. This Manual is no exception. For example: Size of Sewer in B.2. below also refers to Size of Stormwater Conduits.
2. Size of Sewer
    a. Size of proposed sewers is typically calculated by the Planning Unit, however, it may be changed if grades are adjusted.
    b. Size of proposed sewers is based on quantity of flow, grade and velocity.
    c. For comparative pipe data see Appendix VIII [78] “Velocities & Flow Capacities of Pipe Sewers”.
3. Velocity Restrictions
    a. Minimum velocity to ensure a self-cleaning sewer is 3 ft/sec.
    b. Maximum velocity to ensure no abrasion of the invert is 15 ft/sec.
    c. In certain areas of the City, where rock excavation or naturally steep grades make maintaining a velocity of 15 ft/sec costly and prohibitive, higher velocities may be used. Prior to designing a sewer with a velocity higher than 15 ft/sec, the situation shall be discussed with the PWD’s Water/Sewer Engineering Supervisor. If the flow velocity is greater than 15ft/sec, Class V, Wall C RCP pipe shall be used/considered instead of Class III, Wall B RCP. The Class V, Wall C pipe is made with higher strength concrete and is approximately ¾ inch thicker and will lengthen the life of the pipe in these conditions. The Water/Sewer Engineering Supervisor should be consulted in these situations.
4. Sewer Materials
    a. In separate systems the sanitary sewer is made of vitrified clay and the stormwater sewer is made of reinforced concrete pipe.
    b. In combined systems the sewer is made of reinforced concrete pipe.
    c. For large sewers (above 84” in diameter), cast in place reinforced concrete box sewers may be required.
    d. For sewers with velocities above 20 ft/sec a special liner or other special precaution may be required. Class V, Wall C RCP may be an option, please contact the Water/Sewer Engineering Supervisor for guidance.
    e. For further information on sewer materials consult the Standard Details and Specifications for Sewers.
5. Minimum Grades
    a. In spite of minimum velocity requirements, a minimum grade of 0.5ft/100ft. (0.5%) is recommended.

6. Location
    a. On sewer reconstruction projects the sewer is typically reconstructed in the same location as the existing sewer.
    b. Sewer elevations may vary from existing conditions depending on the existing and future conditions of the upper and lower end and on minimum and maximum velocities. Consideration should also be given to the depth of laterals,
    c. Connection to intersecting sewer shall be as follows:
        i. Where practicable sewers shall match spring lines. (Spring line is the centerline of a circular sewer or the line that bisects an egg shaped sewer at a point 2/3 the height above the invert.)
        ii. If not practicable sewers may match inverts.
    d. At all times proposed sewers shall be placed so as to receive all existing laterals.
    e. Proposed sewers and water mains shall be located such that the water main is completely outside a line drawn on a 2 vertical to 1 horizontal slope from the outside trench line of the sewer, or there exists a minimum of 3′-0”’ clearance between the sewer and water main trench, whichever is greater. In rare cases due to excessive utilities, a water main may be approved to be placed in close proximity to the sewer, but this must be approved by the Water/Sewer Engineering Supervisor.
    f. Where a sewer, for whatever reason, is to be abandoned and is 16” in diameter or greater it shall be filled with flowable fill in accordance with the Standard Details and Standard Specifications for Sewers.
    g. On new sewer construction, the sewer shall be located so as to minimize lateral length, however at all times it shall be located in the cartway, or Philadelphia Water Department Right of Way where no cartway is present. 8’- 0” from the curb with the most properties is the preferred location. This is because at 8’- 0” cars will not park over the manhole.
    h. For new sewer construction, proposed sewers shall be placed at a depth to insure proper drainage of the lowest portion of each property and/or structure in the development.
7. Utility Interference
    a. Philadelphia Gas Works
        i. The City has an agreement with PGW, which basically states that if the proposed sewer and/or water main places the gas main within a 2 vertical to 1 horizontal influence line, PGW will replace the gas main, and the City will reimburse PGW for up to 50% of the replacement cost for the gas main. It is therefore in the Water Department’s best interests to evaluate our locations for proposed water mains/sewers in context of the potential costs associated with reimbursement to PGW. See Appendix IVg for the Water Department/PGW Agreement [90].

b. Other Utilities

i. If other utilities have constructed their facilities over our sewer then they shall be responsible for either relocating their facility or reaching an agreement with the Water Department where we will relocate our facility and the other utility will pay for any additional costs to the Water Department.

ii. Utility presence in the street is by permit of the Streets Department. A highway opening permit must be obtained through the Streets Department's Guaranteed Paving Information System (GPIS) for each location where they install a new facility. This permit, along with the highway opening permit guidelines establishes the terms and conditions under which all utilities are governed in City streets. This permit gives the City and all its Departments certain rights concerning the relocation of non-city utility's facilities, for the benefit of the City. Due to the costs involved in relocating infrastructure, much prudence and engineering judgment must be used in invoking our rights with respect to other utilities. See Appendix IVb [91] for a further explanation and reference samples of the GPIS application.

8. Foundation and Substructure Conditions

a. For new construction, a complete soil investigation shall be performed with borings taken at least once for every 150 feet of sewer.

i. In cases where the standard penetration resistance value (or N-value) is consistently 17 blows per foot or greater pile supports are not required by the Water Department.

ii. Where soil conditions are poor, the sewer along with the laterals, inlet pipes, inlets and manholes will be required to be placed on piles.

iii. In areas of moderately poor soils, other means of support may be required. Each case shall be evaluated on an individual basis.

b. Where sewers are to be reconstructed and where poor soil is suspected, similar precautions shall be taken.

c. Where borings are required, a plan showing the location of the proposed borings along with a memo requesting the borings shall be sent to the PWD Design Branch. On the proposed boring plans, the minimum depth must be five (5) feet below the invert of the proposed sewer at that specific boring location. The boring must advance beyond the minimum depth until one of two conditions are met: (a) Three (3) consecutive blow counts of 25 or greater, (b) Refusal is achieved.

d. Where a ground water level is determined to exist within the proposed sewer excavation, special precautions shall be specified, such as:

i. Well points to draw down the water level in the area of the sewer construction.

ii. Underdrainage system to drain water away from the construction area.

9. Sheathing & Shoring
    a. Sheathing and shoring using steel soldier beams shall be included in the contract, where the sewer trench is 18′ deep or greater, or where, based on good engineering judgment and practice such is warranted. Items to evaluate are:
        i. Depth of proposed sewer
        ii. Type of soil
        iii. Proximity to other major/minor utilities
        iv. Proximity to structures
        v. Condition & Foundation type of adjacent structures
    b. The Sheathing & Shoring is typically designed by the contractor and submitted for approval to the Water Department.

C. Vent Design (Sanitary and Combined Sewer Systems)

1. Size and Materials
    a. Vents shall be 12″ vitrified clay pipe for combined sewers and 8” vitrified clay for separate system sanitary sewers. Stormwater conduits have no vents because they have vented manhole covers.
2. Configuration
    a. Vents shall be installed such that they are self draining in case water were to enter them, via infiltration or overflow.
    b. Vents shall be installed such that they will not act as an overflow until the water level is at least as high as the inside top of crown of the higher sewer.
3. Location
    a. Existing vents may be reconnected where engineering judgment deems it acceptable. Engineering judgment shall include but not be limited to:
        i. Age and probable condition of vent
        ii. Proximity of existing vent to street disruption of proposed sewer construction
        iii. Length, Cost, and difficulty of replacing existing vent pipe.
    b. Where a new vent is to be installed at the upper end of a combined sewer, it shall vent to an adjacent sewer. Whenever possible, vents shall be installed from the upper end manhole to a manhole on the adjacent sewer. If there is no convenient manhole on the adjacent sewer then the vent shall be connected directly to the adjacent sewer.
    c. If there is no sewer to vent to, or if the sewer is too far away, ask the Water/Sewer Engineering Supervisor for direction to possibly not install a vent. On a separate system, if there is no sewer to vent to, vent the sanitary sewer to the Summit Manhole.
4. Vent Installation
    a. New vent installation locations may deviate from the existing. In this case it will be necessary to excavate at the connection of the existing vent to the existing adjacent sewer and seal the vent opening in the existing adjacent sewer.
5. Cover
    a. The ideal minimum cover for a vent is 6’- 0” so that other utilities can cross easily. However, this is left to the engineer’s judgment.

D. House Lateral Design

1. Size and Materials
    a. In separate systems the stormwater lateral is typically 6″ vitrified clay pipe (VCP) and the sanitary lateral is typically 5″ VCP.
    b. In combined systems the lateral is typically 6″ VCP.
    c. In certain areas where poor soils are present, ductile iron laterals may be required. (If used, a corrosion control engineering study may be required).
2. Grade and Depths
    a. House lateral traps shall be 7′ deep to the invert, wherever possible.
    b. House laterals shall maintain a minimum slope of 2%.
    c. If lateral grades exceed a 1 to 1 slope, a riser shall be used as detailed in the Standard Details and Standard Specifications for Sewers.
    d. Typically house laterals are placed in an open cut trench without concrete cradle. They should have a Class D bedding and be installed in accordance with ASTM C 12.
    e. When soil conditions warrant, special foundation should be used, such as cradles or piles.
3. Plumbing Convention
    a. Laterals shall be installed and shown such that the sanitary lateral is located downstream of the stormwater lateral in relation to the flow of the main sewer.
4. Connection to Sewer
    a. House laterals shall be connected to the sewer by wye branches or saddle connections as per the Standard Details and Standard Specifications for Sewers
    b. Typically in a sewer reconstruction project, the house laterals are not replaced, but are reconnected to the new sewer, within the sewer trench.
    c. Where lateral reconstruction occurs outside the sewer trench the proposed lateral work should be shown on the cross section or otherwise detailed.
    d. When the sewer is within 5 feet of curb, all house laterals on the short side of the street shall be replaced up to and including the house trap and vent. The new house laterals shall be vitrified clay pipe, and the house trap and vent shall be cast iron pipe.
5. Streets 16 feet wide or less
    a. When streets are 16 feet or less in width, all house laterals on both sides of the street shall be replaced up to and including the house trap and vent. The new house laterals shall be vitrified clay pipe, and the house trap and vent shall be cast iron pipe.

E. Inlets

1. Size and Materials
    a. Typically, inlets shall be 4 feet, except where large and fast flows are expected, where a 6’ inlet or 4′ vane grate may be required.
2. Inlet Replacement Policy
    a. Replace all No. 1, No. 2, No. 3, or No. 4 inlets. Inlet pipe diameter for existing No. 3 and No. 4 inlets is 12″ and 8″ respectively, and therefore, shall be reconstructed with 15″ diameter VCP.
    b. Replace all inlets in poor condition. Check with the Superintendent of Sewer Maintenance at 215-685-2034.
    c. Replace all grate inlets with open mouth grate inlets if possible.
    d. All inlets which are not required to be replaced by the above criteria and do not appear to be in obvious poor condition from field observations, shall be examined by Sewer Maintenance. An electronic set of plans showing the inlets to be examined along with a cover letter/memo requesting the examination shall be sent to the following. This should be completed as soon as possible in the design process.
        i. Erin Williams, Chief, Collector Systems 215-313-4595
        Erin.Williams@phila.gov
        Copy: **Joseph.McAninley@phila.gov**
    e. If the inlet pipe is 15″ in diameter and in good condition, reconstruction of the inlet pipe will not be necessary.
    f. Preference of Inlet Types:
        i. Open mouth grate inlet (preferred)
        ii. Open Mouth Inlet (where open mouth grate is not possible).
        iii. Highway Grate inlet (where curb is depressed).
    g. Size of open mouth grate, open mouth, city, and modified grate inlets:
        i. 4 foot for street grades of 3.5% or less.
        ii. 6 foot or 4′ vane grate for street grades over 3.5%.
    h. See Appendix Va [83] for sketch of preferred inlet locations. Although the PWD has preferences for inlet type and placement, there may be other factors that could dictate the actual inlet selection and placement. Some of these factors may include the following: ADA ramps, curb bumpouts, street furniture, utility lines, castings, hydrants, street drainage, etc. Should there be questions about what would be acceptable in these situations you may contact the Water/Sewer Engineering Supervisor for guidance.
    i. Gutter flow should not flow past ADA curb ramps. This may mean eliminating a radius inlet and installing 2 inlets at the Points of Curvature. Appendix IVc [84] provides some general guidance on ADA curb ramp design. Should there be questions about what would be acceptable, you may contact the Water/Sewer Engineering Supervisor for guidance.

3. Inlet Materials
    a. Inlets shall be precast reinforced concrete conforming to the Standard Details and Standard Specifications for Sewers and the Quality Assurance Program, except as may be required at special locations.
    b. Where utility conflicts warrant, custom sized catch basins constructed of pre-cast concrete or cast-in-place concrete shall be detailed and specified.
    c. All pertinent castings shall also conform to the above standards.
4. Inlet Installation
    a. Inlets shall be installed in accordance with the Standard Details and Standard Specifications for Sewers.
    b. For poor soil areas, special foundation requirements shall be provided, similar to that used on the sewer.
5. Inlet Pipes
    a. Inlet pipes shall be 15″ VCP
    b. If inlet pipe grades exceed a 1 to 1 slope, a riser shall be used as detailed in the Standard Details and Specifications for Sewers.
    c. Inlet pipes shall be connected to the sewer by wye branches as per Standard Details and Standard Specifications for Sewers
    d. Any deviations from this policy will require prior approval by the Water/Sewer Engineering Supervisor

F. Manholes

1. Size
    a. Manhole risers typically are 4 foot in diameter.
    b. 6 foot diameter manhole risers may be used where special conditions warrant.
2. Materials
    a. Manholes and all their components shall conform to the Standard Details and Standard Specifications for Sewers and the Quality Assurance Program.
3. Location
    a. Manholes shall be located at all locations of change of direction, grade or size of sewer.
    b. Manholes shall also be placed so as to maintain a maximum distance between manholes of 300 feet for sewers 48″ in diameter and under and 400 feet for sewers 54″ and over in diameter.
4. Type
    a. Whenever the upstream sewer invert elevation coming in to a manhole is less than 2 feet higher than the downstream sewer invert elevation of the sewer leaving the manhole, a) standard manhole may be used.
    b. If the difference between the sewer invert elevation coming in to a manhole and the outlet sewer invert elevation leaving the manhole is greater than 2 feet, a drop manhole shall be used for sanitary sewers, a wellhole shall be used for stormwater and combined sewers.
5. Manholes on Separate Systems
    a. Where sanitary manholes are required on a separate system, the stormwater sewer will require a turn out to avoid the sanitary manhole.
    b. The stormwater sewer shall require a manhole upstream of the turnout.
6. Drop Manholes
    a. Wherever drop manholes are required they shall be designed in accordance with the Water Department's Standard Details and Standard Specifications for Sewers and the Quality Assurance Program.
    b. The vertical pipe sewer shall be located on the exterior of the manhole and encased in concrete. In certain instances the vertical pipe sewer may be located inside the drop manhole. In such cases a 6′ diameter manhole shall be used. This situation shall be detailed on the drawings. The 6′ interior drop manhole shall be considered in depths exceeding 18′.
    c. The manhole shall also have a cleanout for accessing the sanitary sewer.
    d. All sewers upstream of a drop manhole shall have a manhole within 25′ of the drop for maintenance purposes.

7. Wellholes
    a. Wellholes shall be in accordance with the Water Department's Standard Details and Specifications and the Quality Assurance Program.
    b. Wellholes shall contain drip slabs to dissipate the energy of the storm flow between each wellhole riser section between the two pipes.
    c. Where the flow is large, the velocity great, or the vertical drop large, granite block invert and drip slabs or special abrasive resistant concrete may be required.
    d. All sewers both upstream and downstream of a wellhole shall have manholes for maintenance purposes, as wellholes are not man accessible. The upstream and downstream manholes shall be located within 25′ of the wellhole where practicable.
8. Summit Manholes
    a. Summit manholes shall be in accordance with the Water Department's Standard Details and Specifications.
    b. Summit manholes shall be placed at the upper end of separate system sewers.
    c. Sanitary pipes within summit manholes are to remain capped using a vitrified clay stopper.
    d. Sanitary pipes connecting to the summit manhole shall have 8" vent attached to an adjacent combined or sanitary sewer system.
9. Transition Manhole
    a. Transition manholes shall be in accordance with the Water Department's Standard Details and Specifications.
    b. Transition manholes shall be used for all connections between an existing egg shape brick sewer and proposed RCP or VCP sewer.
10. Junction Manhole
    a. Junction manholes shall be in accordance with the Water Departments Standard Details and specifications and the Quality Assurance Program.
    b. Junction manholes shall be used for all connections of 3 or more sewer mains.
    c. Sizing of the junction manhole shall be determined based on the number, size and orientation of all connecting sewers as outlined in NPCA's Junction Manhole Sizing Recommendations located in **Appendix III** ☛ water.phila.gov/design/manual/appendices.
11. Doghouse Manhole
12. Manhole or Wellhole structures below water table
    a. Manholes placed below the water table or sanitary manholes with inverts below 0.00 city datum, shall use an approved water tight gasket material around all openings into them to prevent infiltration. The Water/Sewer Engineering Supervisor shall be consulted for the specifications.

G. Box Sewer and Box Stormwater Conduit Design (see Section 5 B.1 for definition [105])

1. Design Criteria
    a. Designed and constructed in accordance with the recommendations of ACI 350 Concrete Sanitary Engineering Structures.
    b. Design loading shall consist of a minimum H-20 loading at the street surface in addition to all other dead loads. If actual loading is greater, then use the larger loading condition. However, a minimum of 1200 psf shall be used.
    c. Minimum wall thickness shall be 12 inches.
    d. Minimum roof slab thickness shall be 12 inches.
    e. Minimum base slab thickness shall 15 inches.
    f. Minimum reinforcing bar size shall be #4.
    g. Since box sewers are typically formed on the interior only and the exterior face of the walls are poured against the trench sheathing, an additional 3″ of cover should be added to the exterior face of the box sewer. This will allow for any variations in the sheathing. This additional 3″ cover should not be included in the design, and is in addition to the minimum wall thickness in the previous paragraph.
2. Materials
    a. Concrete shall be ready-mixed and shall be batched, mixed, and transported in accordance with ASTM C94 – Standard Specification for Ready Mixed Concrete. Concrete shall have a 28 day compressive strength of 4000 psi and be air-entrained.
    b. Reinforcing steel shall consist of deformed steel bars that are rolled from new billet-steel and shall conform to ASTM A 615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement. The bars shall be tested in accordance with ASTM A 370 – Standard Methods and Definitions for Mechanical Testing of Steel Products. All reinforcing steel shall be Grade 60.
    c. Rubber dumbbell type waterstops and vitrified clay liner plates shall be in accordance with specifications outlined in the Standard Details and Standard Specifications for Sewers.
3. Inverts
    a. The invert of rectangular reinforced concrete combined or sanitary sewers shall be constructed with a 156° vee shape at 12° off the horizontal. Rectangular reinforced concrete stormwater conduits shall be constructed with flat inverts.
    b. For velocities over 12 feet per second, vitrified clay liner plates, stone block, redressed blocks or other means of abrasion control shall be used for the invert.
4. Construction Joints
    a. Transverse and longitudinal construction joints shall have a keyway 2 inches deep and 4 inches wide and a rubber dumbbell type waterstop.
    b. Transverse construction joints shall be constructed at the end of each section at a distance not to exceed 50 feet.

5. Connections and Transitions
    a. Transitions from existing sewers to box sewers of different sizes, or between two sections of different size box sewers, shall be done with flare sections.
    b. Flare sections shall not be counted in the quantity of linear feet of box sewer. They shall be separated for lump sum payment per each flare section.
    c. Connections between the existing sewers and the proposed box sewer shall be detailed.

H. Trunk Sewers

1. Trunk sewers are large combined sewers servicing large areas of the city which drain both sanitary and storm flow from smaller combined flow sewers servicing smaller areas of the city.
    a. Typically Trunk Sewers flow toward the rivers and creeks, thereby toward the Intercepting Sewers.
    b. Dry weather flow of the Trunk Sewers is diverted to the Intercepting Sewers via Intercepting Chambers and Dry Weather Outlet (DWO) pipes.
    c. During periods of wet weather, the intercepting chamber captures the first flush. When the volume of flow in the Trunk Sewer exceeds the capacity of the Intercepting Chamber's diversion structure the diluted excess flow goes to the river. This is known as a Combined Sewer Overflow (CSO).

I. Intercepting Sewers

1. Intercepting Sewers (Interceptors) are the main sanitary sewers which service large areas of the city and carry the sanitary flow to the wastewater treatment facilities. These sewers have limited number of connections.
    a. Connections usually consist of other sanitary sewers or combined sewers (via Dry Weather Outlet pipes) which service smaller portions of the city.
    b. Lateral connections are typically not permitted into the Intercepting Sewers.
    c. All connections into intercepting sewers must be specifically approved and connection details must be approved to insure integrity of the Intercepting Sewer System.
    d. Intercepting Sewers are typically located along creeks and rivers as these are the naturally occurring low areas of the city.
    e. Special precautions should be taken to limit any infiltration and/or exfiltration from the intercepting Sewer System.

J. Quantities for Sewer Work

1. Excavation
    a. Excavation shall be calculated in cubic yards based on a payment width equal to the width of the standard concrete cradle width for pipe sewers and the outside faces of box sewers. See Standard Details and Specifications for Sewers.
    b. The interior volume of the existing sewers is not included in the quantity for excavation.
    c. The excavation quantity for inlet pipes, vent pipes, house laterals beyond sewer trench, etc., shall be calculated and included in the quantity for excavation.
    d. For excavations less than 18′ deep and where other reasons do not warrant the use of steel soldier beams or where good engineering judgment does not require steel soldier beams, timber sheathing and shoring without steel soldier beams is to be used. The sheathing and shoring shall not be included in the quantity for excavation, but rather paid for in a separate quantity of Sheathing and Shoring left in place at the fixed unit price specified. The estimated amount of sheathing and shoring shall be calculated and specified in the proposal. The formulas for calculating the quantity of sheathing and shoring left in place are as follows:

$$MBM = \frac{2TLC\,(D-2)}{1000}$$

Where:
MBM = Thousand square feet of board 1″ thick
T = Thickness of the board required in inches on either side of the trench.
For trenches *less* than 7 feet deep, use 2.
For trenches *greater* than 7 feet deep, use 3.
L = Length of the trench in feet
D = Depth of excavation in feet

    e. Sheathing and shoring including steel beams should be used for excavations greater than 18′ or where other reasons warrant it or where good engineering judgment requires it. There may be instances where sheathing and shoring with steel soldier beams may not be required such as areas where v-cut or step sheathing may be used. These special situations shall be evaluated on an individual basis and shall be approved by the Water/Sewer Engineering Supervisor. Payment for sheathing and shoring including steel beams is included with the price bid for excavation. The Contractor shall submit shop drawings to the Manager of Design for approval prior to excavation.
2. Length of Pipe
    a. The length of each size of pipe sewer or each combination of separate system sewers shall be calculated. Pipe length shall be calculated through manholes. Pipe length shall not be calculated through wellholes or drop manholes. Where there is a pipe size change at a manhole the larger pipe size shall extend through the manhole and be measured accordingly.
    b. Use 6 feet of lateral piping for the quantity of lateral piping needed for each existing lateral connection, unless additional lateral piping is specified.
    c. The length of inlet pipe shall be calculated separately.
3. Inlets
    a. The number of inlets of each type shall be calculated separately.
4. Manholes
    a. The number of each type of manhole (e.g. manholes for pipes 30″ and under).

5. Paving

a. Repaving quantities in asphalt surfaced streets shall be calculated using similar limits as shown in the current Water Main Standard Details and Corrosion Control Specifications.

b. Repaving quantities in concrete surfaced streets, concrete driveways and footways shall be based on replacement to the existing joints or a saw cut depending on the wording of the specifications.

c. Footway paving is replaced in kind, with quantities extended to the next joint.

d. Binder quantities, when not specified by Streets Department, shall be based on a 1.5 inch thickness weighing 100 pounds per square yard per inch thick, and specified in tons.

e. Backfill in State Highways shall be (2A) from 6 inches above the sewer to the bottom of the concrete base. (2A) is specified in tons (use 100 pound/cubic foot).

f. Concrete base in State Highways shall be 10 inches thick high-early strength concrete.

g. Concrete base in City Streets shall be 8 inches thick.

h. Repaving quantities in City and State Highways are specified separately.

i. Whenever a curb requires removal, the footway will require replacement to at least the first joint and the cartway shall be reconstructed for 2 feet from curb.

j. When the proposed sewer is located in a City Street or State Highway and the outside of the trench is within 3 feet or less from curb, the repaving (including the base concrete) shall extend from cutback line on one side, to the curb on the other. In addition, the curb and one block of footway shall be replaced.

k. When the proposed main is located in the cartway of a State Highway the road surface will be required to be milled and repaved. The extent of milling will be for any travel, bike, or parking lanes directly affected by the standard trench restoration.

l. When the proposed sewer is located in an intersection of a State Highway and a City Street, the State Highway paving requirements shall extend up to the projected curb lines of the State Highway where the City Street paving requirements shall begin. Such shall be noted in the specifications. The paving quantities shall reflect this.

m. When 50% or more of the cartway base is disturbed, full width/depth roadway reconstruction will be required. This requires replacement of all cartway and sidewalks and will need roadway grading plans approved by the District Surveyor.

n. Slivers of base concrete left between trenches should not be less than 4'. If less than 4' of base concrete is left between trenches, the sliver should be removed. The removal of the sliver will count towards the 50% disturbance rule above.

o. If the Streets Department paving requirements request additional paving to be added to the contract and will be paid for by the Streets Department, those quantities should be separated and placed in the proposal of the specifications as a separate section of P-items and an X should be added to the suffix of the work number. In addition, the front office staff of the Design Branch shall be notified.

p. Where full width street restoration is required, a full width 6" stone sub-base shall be required. This will be a separate payment item in TONS (use 100 pounds per cubic foot).

q. For full width paving there are different paving items than for trench restoration. The Water/Sewer Engineering Supervisor should be contacted for which items to use prior to preparing the quantities and specifications.

r. For general guidance on roadway restoration requirements, please see the City Streets Roadway Restoration Flow Chart in **Appendix IV** ☛ water.phila.gov/design/manual/appendices.

6. Curb
    a. When the proposed sewer is located so that the outside of the trench is within 3 feet of the curb on City Streets or 4 feet on State Highways, valuation of the curb and footway to the first joint shall be performed.
    b. Full width street reconstruction usually requires curb replacement which in turn requires the replacement of at least one paving block of footway.
7. Quantity Tabulation
    a. See Appendix III for the Sewer Quantity Sheet [82]. Direct link to Sewer Quantity Sheet working file.

K. Green Stormwater Infrastructure

1. For Green Stormwater Infrastructure, see the **GSI Planning and Design Manual** ☛ water.phila.gov/gsi/planning-design/manual.
2. ~~Trenching installed parallel to footings and walls shall not extend into the bearing plane of a footing or wall. The upper boundary of the bearing plane is a line that extends downward, at an angle of 45 degrees (0.79 rad) from horizontal, from the outside bottom edge of the footing or wall.~~

L. Cured in Place Lining (CIPP)

1. Sewer reconstruction may not be the preferred method to rehabilitate an existing sewer. Using a CIPP liner may be a consideration in many cases including the following:
    a. heavy/severe utility conflict
    b. under/alongside active rails
    c. under/along streams/rivers/creeks
    d. sanitary only replacement in separate sewer system areas
    e. sensitive business areas
    f. high traffic areas
    g. downtown locations
2. If you are considering a CIPP liner replacement method, you must first get the approval of the Water/Sewer Engineering Supervisor before pursuing the change in scope of work. If a significant utility conflict is found during the drafting of the base plans, the engineer or consultant shall contact the Water/Sewer Engineering Supervisor to discuss the potential for a trenchless solution (CIPP or other method). This may save unnecessary drafting hours/expense for a full base plan when one is not necessary for CIPP (See base plan requirements below).
3. The existing pipe size and capacity also must be a consideration. The sewer must not be in a surcharged condition, or need to be upsized. Planning will determine if the existing sewer is surcharged. Consultants should ask the Water/Sewer Engineering Supervisor who in turn will ask Planning.
4. Conditions for Lining
    a. Circular sewers must not be out of round by more than 10% to 15%. A point repair may be completed prior to lining to fix the defect prior to lining. If there are many repairs required, reconstruction should again be considered.
    b. Access to sewer manholes on both ends of the segment is required. A manhole may be added, if practical, to the end of a sewer segment to facilitate the lining. This would be built concurrent to the lining work if at all possible
    c. A sewer inspection video is REQUIRED on all potential lining projects.
    d. A sewer video should be requested through the Water/Sewer Engineering Supervisor only. The PWD Flow Control Unit will complete the video at their earliest convenience.
    e. Once the video is completed, the condition of the sewer should be assessed.
    f. If there are significant repairs required or the sewer cannot be lined, reconstruction or another method of replacement shall be discussed with the Water/Sewer Engineering Supervisor.

5. Base Plan Requirements
    a. The base plan requirements are less than a standard base plan. They should show:
        i. The city plan drawn to scale.
        ii. The sewer and sewer vent as-built location including manholes with the rim and invert elevations.
        iii. All properties.
        iv. All inlets and inlet pipes.
        v. An example of a completed lining base plan can be provided to the consultant upon request.
        vi. The sewer limits to be lined shall be called out in bold, including the manholes within the limits of the lining.
6. Design Requirements
    a. Planning shall provide the Estimated Theoretical Dry Weather Flows for each location to be lined. A formal email request must be submitted from a consultant to Planning with the Water/Sewer Engineering Supervisor copied.
    b. A liner thickness calculation shall be provided by the Engineer or Consultant using the ASTM F-1216.
    c. A chart showing the minimum liner thicknesses required including the sewer sizes, lengths and thicknesses to be lined shall be shown on the Contract Plans.
    d. Contact the Water/Sewer Engineering Supervisor for an example of a completed lining contract plan.
7. Manhole Lining
    a. All manholes within the limits of CIPP rehabilitation shall be lined.
8. Specifications
    a. SECTION 2705 MANHOLE LINING and SECTION 2768 SEWER LINING shall be added to all lining projects.

Change Log

Version	Type	Change
4.1	Content	Referenced NPCA's Junction Manhole Sizing Recommendations in subsection F.10. Junction Manhole.
4.1	Content	Content added to subsection '5. Paving' of 'J. Quantities for Sewer Work': Updated sliver width requirement for combined trench restoration from less than 3′ to less than 4′ and referenced general guidelines for city street roadway restoration, as included in Appendix IV.
4.0	Format	Manual converted from PDF to web content.