



# DENVER

## THE MILE HIGH CITY

CITY AND COUNTY OF DENVER  
DEPARTMENT OF PUBLIC WORKS | ENGINEERING DIVISION

## Storm Drainage and Sanitary Sewer Construction Detail and Technical Specifications

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### 11.0 Structures and Appurtenances

#### 11.0.1 General

Except where otherwise indicated in these Detail and Technical Specifications, manholes, special structures, box culverts, vaults, storm inlets, and other miscellaneous structures and appurtenances shall conform to the details included in these Specifications or as shown on the drawings. All concrete and reinforcing for structures shall conform to the requirements set forth in the 1999 Standard Specifications for Road and Bridge Construction, by the Colorado Department of Transportation, as described below, or otherwise modified herein.

#### 1. CDOT Section 601 Structural Concrete

*CDOT Section 601 Structural Concrete shall be utilized and revised as follows:*

Class D Concrete will be utilized for all structural concrete work; using ¾" nominal sized aggregate (100% passing the 1" sieve and 90% to 100% passing the ¾" sieve).

Type II Portland Cement will be used.

*Subsection 601.05 shall be revised to include:*

The concrete used in upper deck slabs shall have a maximum substitution of fly ash for portland cement of 10% by weight.

*CDOT Subsection 601.18 shall be revised as follows:*

Method of measurement shall be deleted. Method utilized will be as specified elsewhere in the contract documents.

*Subsection 601.19 shall be revised as follows:*

Basis of payment will be deleted. Basis of payment utilized will be as specified elsewhere in the contract documents.

**2. CDOT Section 602 Reinforcing Steel**

*CDOT Section 602 Reinforcing Steel shall be utilized and revised as follows:*

Subsection 602.02 shall be revised as follows:

Epoxy coated reinforcing steel will not be utilized unless otherwise specified in the Contract Documents.

*Subsection 602.07 shall be revised as follows:*

Method of measurement will be deleted. Method utilized will be as included otherwise in the contract documents.

*Subsection 602.08 shall be revised as follows:*

Basis of payment will be deleted. Basis of payment will be as included otherwise in the contract documents.

**11.0.2 Manholes**

Except where otherwise specified or indicated on the drawings, storm and sanitary sewer manholes shall conform to the requirements as set forth below. Manholes shall be constructed of precast concrete or cast-in-place concrete as outlined in the drawing details. All manholes and related component items shall be designed for AASHTO HS20 loading.

**11.0.2.1 Size**

The minimum internal diameter of the manhole barrel shall be as follows for both storm and sanitary sewer installations (please refer to the Standard Detail Drawings).

Pipe Size	MH Barrel I.D.	Standard Top Section	Standard Detail
30" dia. and smaller	4'-0"	Concentric Cone	S501.1
30" to 36"	5'-0"	Concentric Cone	S501.1
42" and larger	Type B or P or Special Detail	As detailed	S503 S504

**Note:** Standard ring and cover is 24 inch diameter.

**11.0.2.2 Materials**

The materials to be used in the construction of sewer manholes shall conform to the following requirements:

**1. Precast Reinforced Concrete Manhole Sections**

Precast manhole sections including barrels, cones, flat tops, etc. shall be manufactured in accordance with ASTM C-478, Precast Reinforced Concrete Manhole Sections. All cones furnished shall be concentric except for manholes with less than 4 feet of cover, which shall be flat top. Concrete used in precast manhole bases shall have a minimum 28 day compressive strength of 4000 psi, and shall be constructed of Type II, Portland

Cement. Welded wire fabric used in precast manhole sections shall be as specified in ASTM C-478. These precast manhole elements are intended to be utilized as components of non-pressurized sewer and manhole systems only. Pressure systems were warranted and authorized by the Division will require special design pressure manholes, joints, and other appurtenant items.

## **2. Cast-in-Place Concrete Manholes**

All concrete used in construction of cast-in-place manhole bases shall be CDOT Class D. Construction shall be in conformance with the Standard Detail Drawings.

## **3. Structural Reinforcement**

All structural reinforcement shall be placed in accordance with the Standard Detail drawings and in conformance with this specification.

## **4. Frame and Cover**

Unless otherwise noted on the drawings, frame and covers for manholes and special structures shall be the current Denver Standard pattern, manufactured by an approved foundry. Castings shall, at the minimum, meet the requirements of ASTM A48, Class 35B, and other Agency requirements as a condition of approval. Horizontal bearing surfaces of all rings and covers shall be machined to eliminate any rocking action or non-uniform bearing. Castings shall not be dipped or painted prior to field inspection and acceptance. Refer to the Standard Detail Drawings for additional requirements.

## **5. Manhole Steps**

All manhole steps shall be similar and equal to those specified below and shall be installed in a straight vertical alignment as shown in the Standard Detail Drawings. Manhole steps shall normally be cast into the wall at the time the concrete sections are cast. Agency-approved press-fit systems can be utilized at the Contractors' option; otherwise no step will be allowed to be grouted into the wall after it is cast. Approved fixed ladders will be required for retro-fits on existing structures. Nominal spacing of manhole steps or ladder rungs will be 12 inches. Steps will be Agency-approved polypropylene-coated steel reinforced steps as shown in the Standard Detail Drawings. As an alternate, approved aluminum manhole steps extruded from an aluminum-magnesium-silicon alloy conforming to Federal Specification QC-A-200/8 or a cast aluminum-magnesium alloy conforming to the commercial standard designation ALMAG 35 may be utilized.

## **6. Flexible Plastic Joint Sealing Compound**

All joints in the manhole barrel, cone and/or flat top sections including the joint between the cast-in-place base and the bottom barrel section, shall be sealed with an approved preformed, flexible plastic gasket conforming to the following requirements:

- a. The flexible plastic gasket shall be in conformance with ASTM C-990-91, AASHTO M198-B, and ASTM C-990, latest versions.
- b. The plastic sealing compound shall be packaged in extruded pre-formed rope-like shapes of proper size to completely fill the joint when completely compressed, as per

the pipe manufacturer's recommendations. The material shall be protected by a suitable, removable two-piece wrapper that may be removed as the compound is applied to the joint surface without disturbing the other wrapper, which remains attached to the compound for protection. The sealing compound shall be impermeable to water, have high immediate bonding strength to the concrete surface and shall maintain permanent plasticity, as well as resistance to water, acids, and alkalis inherent in sewer systems.

- c. All lifting holes shall be permanently and properly sealed with the plastic sealing compound or an approved concrete grout.

## 7. Adjustment

Grade rings shall be used to adjust and set final rim elevations, brick is not allowed. A 3-inch cast iron riser shall be used in conjunction with grade rings on all construction within streets. Cast iron shall conform to ASTM C62, Grade SW [AASHTO M114].

## 8. Mortar and Grout

Mortar and grout used in the shaping of inverts, grade ring gaps, setting and anchoring cast iron street fabrications, etc., shall consist of one part Type II Portland Cement and two parts of fine, clean sand. Only sufficient water shall be added to provide a stiff, workable cement mixture for proper troweling. Hydrate lime or masonry cement shall not be used. Where relatively thin portions of grout are to be applied to the flow channel, top of bench, etc., and approved epoxy bonding coat shall be applied to the exposed concrete surfaces prior to grouting.

### 11.0.2.3 Bases and Inverts

Except as otherwise shown on the drawings, manhole bases shall be constructed of cast-in-place or precast concrete, as shown in the Standard Detail Drawings, and as otherwise described in these Detail and Technical Specifications. Inverts may be cast separately, but shall be constructed of cast-in-place concrete. All concrete used for these applications shall meet the requirements set forth in section 11.0.2.2 of these Detail and Technical Specifications.

#### 1. Sanitary Sewer Manholes

Sanitary Sewer manholes are normally designed and constructed such that inverts of the influent and effluent sewers are at the same relative elevation with sufficient drop to compensate for pressure head losses occurring in the manhole. Therefore except for special cases, the bench around the flow channel shall be constructed to the outside top of the largest pipe in the manhole. The top of the bench shall be poured with a slope towards the flow channel with an overall cross slope not exceeding  $\frac{1}{2}$  inch. Flow channels shall have smooth, rounded inverts shaped to match the lower half of the pipe. Proper shaping shall be accomplished by forming or shaping with a proper cement grout mixture. Changes in direction of flow through the manhole shall be made with a smooth continuously-curved channel utilizing the maximum radius possible. Changes in the size of channels, multiple flow channels, or changes in invert slopes, shall be made gradually and evenly, and shall be formed directly in the concrete.

Outside Drops. Whenever specified on the Drawings, directed by the Project Construction Engineer, or where the elevation difference between the incoming sewer inverts and the outgoing invert is 18 inches or greater, an outside drop shall be constructed. The diameter of the drop shall not be less than the diameter of the incoming sewer pipe to be dropped. Concrete encasement will be required around the drop pipe as shown and detailed in DWMD Standard Detail S-530.

Quantities and costs for the outside drop configuration shall be measured and paid for separately from the manhole unless otherwise specified.

## **2. Storm Sewer Manholes**

Flow channels in storm sewer manholes shall be as shown in the Standard Detail Drawings for the particular type of manhole base utilized. Except for special situations, and where specifically noted, outside manhole drops will not be required. All exposed channel edges and cut pipe edges shall be grouted smooth. The minimum thickness of the cast-in-place concrete at any point shall not be less than 6-inches. The construction of the manhole base and shaping of inverts, including all pipes within the dimensions of the manhole, will be considered to be incidental to the construction of the manhole and all costs shall be included in the unit price bid for the manhole structure.

### **11.0.2.4 Stub-Outs**

Where indicated on the drawings, stub-outs of the specified size for future connections shall be constructed. The pipe used for stubbing shall extend a nominal 2 feet beyond the outside of the manhole barrel, unless otherwise noted, and shall terminate with a bell end [or spigot end if applicable]. The pipe end shall be sealed with an approved, pre-fabricated plug or cap conforming to the joint detail of the pipe supplied. For large sewers, a full section of pipe shall be installed as the manhole stub. Shop drawings shall be submitted for approval. The use of brick or concrete fill as a means of plugging will only be permitted on sewers that are to be abandoned. Unless otherwise stated in the contract documents, stub-outs will be considered to be incidental to the construction of the associated manholes, and all costs incurred shall be included in the unit price bid for the manhole structure.

### **11.0.2.5 Flexible Booted Connections**

Flexible watertight rubber boots for the jointing of any sewer pipe to any precast manhole base, barrel section, inlet box, or vault shall conform to the Specifications contained herein and to the Standard Detail Drawings. Flexible connectors shall meet the requirements of ASTM C923.

## **11.0.3 Structures**

### **11.0.3.1 Concrete**

All structural concrete shall be CDOT Class D, with the revisions noted within this section.

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### **11.0.3.2 Reinforcement**

All structures shall be reinforced as shown on the Drawings or within the Standard Details. All reinforcing steel shall be ASTM A-615, Grade 60 with deformed bars.

### **11.0.4 Concrete Flatwork**

#### **11.0.4.1 Concrete**

All flatwork shall be CDOT Class D, unless otherwise approved by the Project Engineer.

#### **11.0.4.2 Reinforcement**

All required reinforcement shall be in accordance with the Contract Documents.

### **11.0.5 Storm Inlets**

The work under this subsection shall consist of furnishing all materials and constructing concrete catch basins, including excavation, concrete removal and backfill. Work shall be done at the locations designated on the project plans and in accordance with the Standard Detail Drawings and other requirements of the Contract Documents. All inlet structures and related components shall be designed for AASHTO HS20 loading conditions.

#### **11.0.5.1 Materials**

##### **1. Concrete**

Concrete shall be Class D, with a minimum 28-day strength of 4500 psi. Cement used in concrete shall conform to ASTM Designation C-150 Type II cement. All concrete used for these applications shall meet the requirements set forth in section 11.0.2.2 of these Detail and Technical Specifications.

##### **2. Masonry Mortar**

Masonry mortar (grout) shall be composed by volume of one part portland cement, two parts fine aggregate, one fifth part hydrated lime and sufficient water to provide a plastic mixture. Mortar in concrete fill shall obtain a 28 day strength of 2000 psi.

##### **3. Reinforcement**

All inlets shall be reinforced as shown on the Drawings or Standard Details. All reinforcing steel shall be ASTM A-615, Grade 60 with deformed bars. The diameter of bend measured on the inside of the bar shall be 6 bar diameters. All reinforcing steel shall be 2" clear minimum from formed surfaces and 3" clear against earth unless otherwise noted. Splicing of reinforcing steel shall be permitted only where detailed on the Drawings.

##### **4. Connectors**

Connectors for single inlets shall be 15" diameter (Min.) with desired slope of 1 percent, for double inlets connectors shall be 18" diameter with desired slope of 1.8 percent and for triple inlets connectors shall be 21" with a desired slope of 1.8 percent. All connections to main line storm sewers shall be cored and collared in accordance with the Standard Detail Drawings. Saw cutting and/or jack hammering will not be permitted.

## 5. Castings (No. 16 Inlets)

Frame shall be Denver Standard Pattern and grate where required shall be No. 16 Grate (Standard Detail-S-716). All castings shall conform to ASTM A-48 (Class 35b) with a minimum tensile strength of 35 ksi. Castings shall not be dipped or painted prior to field inspection; once castings are approved by the Division for project usage, they shall be coated with an approved material. All castings shall be heavy duty and capable of withstanding AASHTO H-20 loadings. Horizontal bearing surfaces of all frames and grates shall be machined to eliminate any rocking action or non-uniform bearing.

## 6. Steps

Manhole steps shall be used in conformance to the Standard Detail Drawings and shall be used in inlets that are 3' 6" or deeper. Steps shall be installed at 12" maximum spacing in straight vertical alignment with the bottom step 12" above the floor elevation of the bottom slab.

### 11.0.5.2 Construction Requirements

All storm inlets shall be constructed of cast-in-place concrete, unless specifically approved for precast construction by the City.

#### 1. Bedding and Backfill

All catch basins/inlets shall be cast in place. Subgrade shall be Class B Bedding compacted to 90% maximum dry density (AASHTO designation T-180). Backfill shall be hand tamped in 6" lifts, Backfill Method B.

#### 2. Inlet Depths

Desired depths for single inlets shall be 3.5 feet (flow line to floor), for double inlets depth shall be 4 feet and for triple inlets depth shall be 4.5 feet. Inlets are designed to allow for 6 foot depth maximum; for depths greater than 6 feet, shop drawings and design analysis shall be submitted for approval by the Project Construction Engineer.

#### 3. Forming

Inlets shall be formed both inside and out; casting of sidewalls against earth walls or other structures is not permitted. No formwork shall remain inside structure when complete.

### 11.0.6 Backfill Requirements

The following outlines backfill requirements around manholes, structures, inlets, utilities and appurtenances. Structures shall include but not be limited to: type B manholes, type P manholes, box culvert and special structures noted within the Contract Documents. All structures shall be constructed in accordance with the most recent addition of the Standard Detail drawings, and/or in conjunction with special details provided within the Contract Documents.

Method B backfilling, as described in section 5.0.2.5 of these Detail and Technical Specifications, is required around manholes, structures, inlets, utilities and appurtenances,

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unless otherwise specified or directed by the Project Construction Engineer. The following backfilling constraints and requirements shall apply for all such facilities:

**1. Cast-in-place: Inlets ( $\leq 6'$  deep), Manhole Bases and Structure Bases**

May be backfilled and compacted around, once the concrete has achieved 80% of the required 28-day compressive strength indicated in the Contract Documents.

For inlet depths larger than six (6) feet, from top of base slab to the top of wall at flow line of the lip, shop drawings and a design analysis must be submitted to the Project Construction Engineer for approval. These submittals shall address the backfilling constraints during and after inlet placement.

**2. Cast-in-place: Structure Walls**

Shall not be backfilled or compacted against until the deck (top) slab has been placed, the walls have attained 80% of the required 28-day compressive strength, and the deck (top) slab has attained 80% of its required 28-day compressive strength as indicated in the Contract Documents.

**3. Cast-in-place: Structure Decks or Top Slabs**

May only be backfilled and compacted over once the concrete has attained the required 28-day compressive strength indicated in the Contract Documents.

**4. Precast: Structures, Manhole Bases, Barrels, Cone Sections and Inlets**

May be backfilled and compacted against, if manufactured a minimum of 28-days prior to placement, or if concrete test results demonstrate that the required 28-day compressive strength indicated in the Contract Documents has been achieved.

Alterations and special allowances to these criteria may be granted at the discretion of the Project Construction Engineer on a case by case basis.