# TECHNICAL SPECIFICATIONS, STANDARD DRAWINGS AND STORM WATER MANAGEMENT PLAN

**JULY, 2022**

**ADOPTED:**

**SEPTEMBER 20, 2016**

**REVISED:**

**_____FEBRUARY 21__, 2023**

**CITY OF CLEVER, MISSOURI**
**304 S. Clarke, P.O. Box 52**
**Clever, MO 65631**
**(417) 743-2544**

**THE CITY OF CLEVER RESERVES THE RIGHT TO MAKE REVISIONS TO THESE TECHNICAL SPECIFICATIONS AND STORM WATER MANAGEMENT PLAN AS NECESSARY.**

**THE CITY OF CLEVER RESERVES THE RIGHT TO WITHDRAW THE APPROVAL OF PLANS AND SPECIFICATIONS AT ANY TIME IT IS FOUND THAT ADDITIONAL ALTERATIONS ARE NECESSARY TO ASSURE REASONABLE OPERATION AND TO AFFORD ADEQUATE PROTECTION TO THE PUBLIC.**

**ALL SAMPLES COLLECTED FOR TESTING PURPOSES SHALL BE OBTAINED IN THE PRESENCE OF APPROVED CITY OF CLEVER PERSONNEL. ANY SAMPLES TESTED WHICH HAVE NOT BEEN OBTAINED IN THE PRESENCE OF CITY OF CLEVER PERSONNEL SHALL BE CONSIDERED INVALID. ALL COSTS ASSOCIATED WITH TESTING SHALL BE PAID BY THE CONTRACTOR. THE CITY OF CLEVER RESERVES THE RIGHT TO REQUEST TESTING AT THEIR DISCRETION.**

**THE CITY OF CLEVER RESERVES THE RIGHT TO CORE TEST ANY NEW STREET. SHOULD THE TEST SHOW ANY DISCREPANCIES TO THESE SPECIFICATIONS THE CONTRACTOR SHALL BE RESPONSIBLE FOR RECONSTRUCTION OF ALL OR A PORTION OF THE STREET TO SATISFY THE CITY OF CLEVER. ALL CORE TESTING SHALL BE PAID FOR BY THE CONTRACTOR.**

# NOTICE

Water and sanitary sewer specifications and standard drawings were provided by Shaffer & Hines, Inc. Consulting Engineers and Professional Land Surveyors and were submitted to and approved by the Missouri Department of Natural Resources (MDNR) as required. The water and sanitary sewer specifications and standard drawings approved by the Missouri Department of Natural Resources include the following:

Water:

Specification Sections: 2A, 2B, 2B1, 2G1, 2I, 2J, 2M, 3A, 15A and 15B.

Standard Drawings: B1 – B9

Sanitary Sewer:

Specification Sections: 2A, 2C, 2D, 2E, 2F, 2G, 2H, 2K, 2L, 2M, 3A, 3B, 11A, 11B, 11C, 14 A and 15A.

Standard Drawings: C1 – C17

**Revisions to the above referenced specification sections and standard drawings requires the notification and approval of the Missouri Department of Natural Resources. The approval of the above sections does not result in a waiver of any other applicable rules and regulations.**

Those specifications and standard drawings related to other utilities are listed below:

Streets:

Specification Sections: 2A, 2N, 3A, 4A, 4B, 4C, 4D, 4E, 4F, 4G and 4H.

Standard Drawings: D1 – D8

Lift Stations:

Specification Sections: 11A, 11B, 11C and 14A

Standard Drawings: E1 – E3

Stormwater:

Specification Sections:

Standard Drawings: F1 – F8

Electric:

Specification Sections: 16A.

Standard Drawings: n/a

# TABLE OF CONTENTS


| SECTION | | PAGES |
|---|---|---|
| **I. GENERAL CONDITIONS** | | 1A-1 – 1A-10 |
| **II. SPECIFICATIONS** | | |
| **DIVISION 2 - WATER AND SEWER** | | |
| 2A | Excavation and Trenching | 2A-1 - 2A-10 |
| 2B | PVC Water Pipe | 2B-1 - 2B-15 |
| 2B1 | Protection of Potable Water Supply | 2B1-1- 2B1-2 |
| 2C | PVC Sewer Pipe | 2C-1 - 2C-6 |
| 2D | PVC Force Main | 2D-1 - 2D-3 |
| 2E | Vitrified Clay Pipe | 2E-1 - 2E-2 |
| 2F | Ductile Iron Pipe | 2F-1 - 2F-3 |
| 2G | Manholes | 2G-1 - 2G-4 |
| 2H | Sewer Acceptance Testing | 2H-1 - 2H-4 |
| 2I | Water Acceptance Testing | 2I-1 - 2I-3 |
| 2J | Waterline Disinfection | 2J-1 |
| 2K | Chain-link Fence | 2K-1 - 2K-3 |
| 2L | Crushed Rock Surfacing | 2L-1 |
| 2M | Seeding | 2M-1 - 2M-2 |
| 2N | Demolition | 2N-1 - 2N-2 |
| **DIVISION 3 - CONCRETE** | | |
| 3A | Concrete | 3A-1 - 3A-3 |
| 3B | Grouting | 3B-1 |
| **DIVISION 4 - STREETS** | | |
| 4A | Portland Cement Concrete Curb and Guttering | 4A-1 - 4A-3 |
| 4B | Portland Cement Concrete Pavement and Integral Concrete Curb | 4B-1 - 4B-8 |
| 4C | Plant Mix Bituminous Surface Course | 4C-1 - 4C-8 |
| 4D | Plant Mix Bituminous Base Course | 4D-1 - 4D-9 |
| 4E | Aggregate For Base | 4E-1 |
| 4F | General Notes | 4F-1 - 4F-3 |
| 4G | Design Standards for Streets and Roadways | 4G-1 - 4G-2 |
| 4H | Street Cuts | 4H-1 |
| **DIVISIONS 5 - 10 - RESERVED** | | |

## TABLE OF CONTENTS (Continued)


| SECTION | PAGES |
|---|---|
| **DIVISION 11 - EQUIPMENT** | |
| 11A Submersible Pump Station | 11A-1 - 11A-10 |
| 11B Wet Well Mounted Vacuum Primed Pump Station | 11B-1 |
| 11C Standby Generator | 11C-1 - 11C-3 |
| **DIVISION 14 - CRANES** | |
| 14A Portable Cranes | 14A-1 |
| **DIVISION 15 - MECHANICAL AND PLUMBING** | |
| 15A Valves | 15A-1 - 15A-2 |
| 15B Meter Services | 15B-1 - 15B-2 |
| **DIVISION 16 - ELECTRICAL** | Omitted |
| **II. STORM WATER MANAGEMENT PLAN** | |
| **PART I - GUIDELINES AND DESIGN** | |
| A. General Provisions | IA-1 - IA-7 |
| B. Stormwater Planning and Design | IB-1 - IB-5 |
| C. Reserved | N/A |
| D. Stormwater Runoff Calculations | ID-1 - ID-4 |
| **PART II - EFFECTS OF DRAINAGE OR NATURAL FEATURES** | |
| A. Sinkholes and Karst Features | IIA-1 - IIA-14 |
| **PART III - DRAINAGE STRUCTURES** | |
| A. Inlets | IIIA-1 - IIIA-2 |
| B. Storm Sewers | IIIB-1 - IIIB-10 |
| C. Bridges and Culverts | IIIC-1 - IIIC-2 |
| D. Open Channels | IIID-1 - IIID-4 |
| E. Drainage of Streets and Roadways | IIIE-1 - IIIE-2 |

## TABLE OF CONTINENTS (Continued)


| SECTION | PAGES |
|---|---|
| **PART IV - SEDIMENT AND EROSION CONTROL** | |
| A. Purpose, Goals and Objectives | IVA-1 |
| B. General Design Guidelines | IVB-1 |
| C. Grading Permits | IVC-1 - IVC-2 |
| D. Other Permits | IVD-1 |
| E. Design Standards and Criteria | IVE-1 - IVE-9 |
| **PART V - DETENTION** | |
| A. Detention Facilities | VA-1 - VA-4 |
| B. Design Criteria | VB-1 - VB-5 |
| **PART VI - ENGINEERING AND RELATIVE TERMS** | VI-1 - VI-13 |
| **PART VII - REFERENCES** | VII-1 - VII-2 |

# TABLE OF CONTENTS FOR STANDARD DRAWINGS


| SECTION | PAGES |
|---|---|
| **DRAWING** | **DRAWING NUMBER** |
| **A. GENERAL** | |
| Typical Utility Locations | A1 |
| **B. WATER** | |
| Typical Waterline Embedment Details | B1 |
| Typical Valve Detail (Unpaved Areas) | B2 |
| Typical Valve Detail (Paved Areas) | B3 |
| Fire Hydrant Details | B4 |
| Typical Common Trench Detail | B5 |
| 6" Live-Tap Detail | B6 |
| Typical Flush Valve Detail | B7 |
| Typical Water Service Connection | B8 |
| Typical Water Service Location | B9 |
| Anchor for Gate Valves | B10 |
| **C. SEWER** | |
| Typical Embedment Detail | C1 |
| Standard Manhole Detail | C2 |
| Standard Manhole Over Existing Sewer Detail | C3 |
| Standard Inside Drop-Manhole Detail | C4 |
| Standard Manhole Frame & Cover | C5 |
| Air Release Valve Detail | C6 |
| Typical Service Connection | C7 |
| Typical Common Trench Detail | C8 |
| Sanitary Sewer Stream Crossing Detail | C9 |
| Sanitary Sewer Ditch Crossing Detail | C10 |
| Sanitary Sewer Aerial Crossing Detail | C11 |
| Sanitary Sewer Aerial Crossing w/Pier Detail | C12 |
| Typical Thrust Block Detail | C13 |
| Typical Shallow Manhole Detail | C14 |
| Typical Bore/Encasement Detail | C15 |
| Typical Crossing Detail (Water over Sewer) | C16 |
| Typical Crossing Detail (Sewer over Water) | C17 |

## TABLE OF CONTENTS FOR STANDARD DRAWINGS
**(Continued)**


| DRAWING | DRAWING NUMBER |
|---|---|
| **D. STREET** | |
| Typical Street Detail | D1 |
| Typical Curb & Gutter Detail | D2 |
| Typical 5’ Concrete Sidewalk Detail | D3 |
| Typical Curb Ramp Detail | D4 |
| Asphalt Street Repair Detail | D5 |
| Concrete Street Repair Detail | D6 |
| Concrete Street Joint Locations | D7 |
| Concrete Street Joint Details | D8 |
| Typical Pavement Details | D9 |
| Residential Driveway and Sidewalk Details | D10 |
| Parking Stall Layout Details | D11 |
| **E. LIFT STATION** | |
| Typical Lift Station Plan Detail | E1 |
| Typical Lift Station Profile Detail | E2 |
| Chain-link Fence Details | E3 |
| **F. ELECTRIC** | Omitted |
| **G. DRAINAGE** | |
| Seed and Mulch Specifications | F1 |
| Rainfall Intensities for Duration Less than 60 Minutes | F2 |
| Rainfall Depths for Duration of 1to 24 Hours | F3 |
| Curb Inlet Detail | F4 |
| Precast Inlet Lids | F5 |
| Junction Box Detail | F6 |
| Pipe Headwall & Wingwall @ 30 and 45 Degrees | F7 |
| Straight Headwall & Rip Rap Protection | F8 |

# II. SPECIFICATIONS

# I. GENERAL CONDITIONS

**DIVISION 1**
**SECTION 1A – GENERAL CONDITIONS**

## 1A-1: CITY OF CLEVER EXTENSION POLICIES:

A. Request for City Utilities Inside the City Limits of Clever.

1. All properties within the designated planning area must be annexed into the City Limits of Clever to access any City utility.

2. All properties within the designated planning area will be considered for annexation upon request if state statute requirements are fulfilled.

3. All existing structures annexed into the city limits of Clever will be required to pay the fees for wastewater as per voter approved guidelines.

4. It will be the responsibility of the annexation petitioner to determine zoning requirements and fee structures.

5. The petitioner must be the legal representative for the property owner and the petitioner may withdraw the annexation by a written and notarized request up to the time of the passage of the annexation ordinance.

6. All building and development plans under consideration at the time of annexation must be submitted for City staff review. Staff will review the request within a 30-day time frame.

7. Any building and development that is underway at the time of annexation shall conform to all current City Codes.

8. The City may reimburse the developer for any City requested increase in lift station or line capacity that is over the size required by the State Department of Natural Resources. Lift station capacity and line sizing shall be approved by the City and its consulting engineer. Provided reimbursement is considered, the amount will be determined by computing the difference between the bids for the required versus requested improvements. The City reserves the right to reject any or all bids.

9. All street, stormwater, electric, water and wastewater extensions, whether internal or external to development shall be the sole expense of the party requesting the street and/or utility unless otherwise approved by the Board of Aldermen.

10. Off-street improvements may be required by the City. City staff will review traffic and road conditions, change in classification and potential traffic hazards. Off-street road improvements and upgrades will meet City Street Specifications and will be the responsibility of the developer. When necessary, City may require the developer to supply a professional traffic study to determine offsite needs.

11. The City encourages the formation of neighborhood improvement districts to pay for infrastructure improvements within the planning area.

B. Request for City Utilities Outside the City Limits of Clever.

1. All developments must be built to City of Clever Development Standards.

2. All developments must contractually agree to pay the fees for wastewater capacity as per voter approved guidelines.

3. All developments must be approved by the Department of Natural Resources before construction begins.

4. Request for utilities from outside of the Clever Planning Area will be considered for residential purposes only. Outside utilities will only be given in instances when annexation is not possible. Prior to connection, the applicant must sign a "Consent to Annex" form, to be executed when State Statute requirements can be met.

5. All street, stormwater, electric, water and wastewater extensions shall be the sole expense of the party requesting the street and/or utility unless otherwise approved by the Board of Aldermen.

6. Off-street improvements may be required by the City. City staff will review traffic and road conditions, change in classification and potential traffic hazards. Off-street road improvements and upgrades will meet City Street Specifications and will be the responsibility of the developer. When necessary, City may require the developer to supply a professional traffic study to determine offsite needs.

7. All developments must have approval from the Christian County Planning and Zoning Authority before construction begins.

8. All requests require thirty (30) day staff review before permits are granted or hearing scheduled.

## 1A-2: CITY OF CLEVER CONSTRUCTION DISCUSSION ITEMS:

This list is presented as a typical construction check list, but may not include specific items pertaining to a particular project.

If in doubt concerning any of the City requirements or Ordinances, contact the appropriate City Department. Failure to comply with any discussion item may be cause

for a stop work order, exposure of completed work or lack of willingness of the City's part to accept part or all of the work.

A. General:

1. Prior to approval of the Preliminary Plat, it will be the individual developer's responsibility to acquire all required off-site water, sewer, drainage, street and electric easements required by the City to serve the proposed development.

2. The City of Clever requires that prior to beginning construction; the Owner will be responsible for convening a pre-construction conference to be held at City Hall between the Consulting Engineer(s), the Owner, the Contractor, City of Clever personnel and all private utility providers.

3. All construction and materials shall conform to the City of Clever General Development Regulations and Technical Specifications as adopted and revised from time to time by the City of Clever.

4. It shall be the sole responsibility of the contractor to contact the utility suppliers and arrange for any necessary modifications required to facilitate construction activities.

5. It shall be contractor's responsibility to keep rock, mud and other debris from adjacent streets by construction equipment throughout the day and at the end of each work day. Contractors shall provide a construction traffic plan for approval at the pre-construction conference and be responsible to notify all related contractor agencies.

6. All buried pipe shall comply to the City of Clever's bedding requirements. (See Detail Drawing B-1 and B-5 in the attached Appendix)

7. No pipe shall be backfilled until it has been approved by the City's Superintendent or City Inspector. It shall be the responsibility of the contractor to contact City Public Works at (417) 743-2544 and arrange for this inspection.

8. All City inspections shall be made during regular City business hours unless prior arrangements for inspections have been made. All costs (including overtime) associated with inspections outside normal hours will be charged to the contractor.

9. Testing of water and wastewater lines shall meet the City of Clever specifications. It shall be the Contractor or Developer's responsibility to notify both the **Engineer and the City of Clever**, a minimum of 24 hours prior to the scheduled testing. It shall also be the Contractor's responsibility to have all necessary equipment needed to perform the testing on site and ready to proceed with testing at the scheduled time. Failure to make these arrangements may necessitate rescheduling the test.

10. All utility road crossings shall be properly bedded and the trench backfilled with ¾" base rock. Base Rock shall be installed in lifts no more than 6" thick and each lift shall be compacted individually to grade.

11. The City of Clever will issue building permits only after all utilities, with the exception of street asphalting, are in place and all grading work has been completed.

12. Upon completion of the project, the Developer/Contractor will be responsible for furnishing a copy of redlined as-built drawings to the City. The as-built drawings shall indicate any deviations from the original City-approved drawings shall indicate dimensions from lot lines to sewer tees and shall locate water, sewer and buried electric by dimensions from the street right-of-way line. As-built drawings shall be submitted to the City prior to the issuance of building permits.

13. Prior to any changes to City approved specifications or approved construction plans, contractors shall be responsible for completing a Request for Plan Revision from the City of Clever. All appropriate signatures will be required and copies distributed to all parties.

B. Water:

1. Testing of waterlines shall meet the City of Clever specifications. It shall be the Contractor or Developer's responsibility to notify both the **Engineer** and **the City of Clever** at least **24 hours** prior to the scheduled testing. It shall also be the Contractor's responsibility to have all necessary equipment to perform the testing on site and to be ready to proceed with testing at the scheduled time. A failure to do so could lead to rescheduling the testing.

2. All buried pipe shall comply to the City of Clever bedding requirements. (See Detail Drawing B-1 and B-5 in the attached Appendix)

3. No cutting of concrete or asphalt surfaces shall be allowed unless prior City approval is obtained in writing. Crossing permits may be obtained from the

City at (417) 743-2544.

4. All utility road crossings shall be properly bedded and the trench backfilled with ¾" base rock. Base Rock shall be installed in lifts no more than 6" thick and each lift shall be compacted individually to grade.

5. Upon completion of waterline construction, no existing water valves shall be operated unless City Personnel are notified and are present. Contractor shall notify City personnel prior to making connection to the City's water distribution system.

6. A metal fence post shall be placed by all meter pits to prevent damage to the meter after installed;. (See Detail Drawing A-1 in the attached Appendix)

7. Water Meter Box Lids shall be equivalent to a Crouch 104 lid, which is a 2-piece lid.

8. Damage to all individual lot utilities shall be the responsibility of the person named on the building permit.

9. Subdivisions that opt to construct underground electric shall install the water line at 4-foot and the gas line at 7-foot behind the curb on the same side of the street, underground electric shall be installed at 4-foot and the sewer line at 7-foot distance behind the curb on the opposite side of the street. The water meters shall be on every other lot line and the electric meters are to be placed on alternate lots. (See Detail Drawing A-1 in the attached Appendix)

10. An insulated copper tracer wire shall be placed on top of all water mains and at all meter boxes and valves. Tracer wires within meter boxes and valves shall be extended to the top of the box plus 12-inches and back to the main in a continuous run. Any necessary stripping or splicing of the tracer wire shall be repaired by placing electrical tape over the un-installed area. (See Detail Drawing B-3 in the attached Appendix)

11. All water mains shall be Class 200 SDR 21 pipe.

12. The water meter lids and valve boxes shall be set at final grade elevation by the contractor. Should final grade elevation change due to yard work, the builder responsible for the yard work shall reset meter lids and valve boxes to the revised grade. The cost incurred for raising meter setters shall be the responsibility of the builder.

13. These requirements are not intended to include all waterline construction information. The Developer/Contractor shall refer to the Water Specifications in the City of Clever Technical Specifications Book for additional information.

14. All water main construction shall comply with the "Missouri Department of Natural Resources Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013, and the City of Clever Technical Specifications.

15. The Developer shall be solely responsible for making connection to the City's existing water main and shall meet all construction specifications and guidelines set forth in this document.

16. Typical Water Service: (See Detail Drawing B-8 in the attached Appendix.)

C. Water Crossings:

All water services shall be High Density Polyethylene (HDPE) tubing.

D. Sewer:

1. All new sewer construction shall be completed and accepted by the City before final tie in to the City system. This may be completed by keeping the two systems physically separated or by plugging the new system at the City connection point until approval has been completed.

2. All testing of sewer lines shall meet the City of Clever specifications. It shall be the Contractor's/Developer's responsibility to notify both the Engineer and the City of Clever, a minimum of 24 hours prior to the scheduled testing. It shall also be the Contractor's responsibility to have all necessary equipment needed to perform the testing on site and ready to proceed with testing at the scheduled time. Failure to make these arrangements may necessitate rescheduling the test.

3. All buried pipe shall comply with the City of Clever bedding requirements. (See Detail Drawing B-1 and B-5 in the attached Appendix)

4. No cutting of concrete or asphalt surfaces shall be allowed unless City approval is obtained in writing. Crossing or street cut permits may be obtained from the City, (417) 743-2544.

5. All utility road crossings shall be properly bedded and the trench backfilled with ¾" base rock. Base Rock shall be installed in lifts no more than 6" thick and each lift shall be compacted individually to grade.

6. It shall be the responsibility of the Developer/Contractor to insure that all manholes on the street shoulders are at curb level at final grade.

7. All manholes placed within the street shall be flush with the final pavement and meet specification details in Drawing.

8. The City Inspector shall be contacted for inspection of any lateral crossings prior to backfilling.

9. Subdivisions that opt to construct underground electric shall install the water line at 4-foot and the gas line at 7- foot distance from the curb on the same side of street; underground electric shall be installed 4-foot and the sewer line at 7-foot behind the curb on the opposite side of the street. The water meters shall be on every other lot line and the electric meters are to be placed on alternate lots. (See Detail Drawing A-1 in the attached Appendix)

10. All sewer main lines shall be 8" or larger SDR 35 when the depth of sewer is less than 10 feet. Sewer mains greater than 10 feet in depth shall be SDR 21.

11. An insulated copper tracer wire shall be placed on top of all sewer mains and at all manholes. Tracer wires within manholes shall be extended to the top of the manhole top plus 12-inches and back to the sewer main in a continuous run. Any necessary stripping or splicing of the tracer wire shall be repaired by placing electrical tape over the un-installed area. (See Detail Drawing C-1 in the attached Appendix)

12. At the location of the sewer tees there shall be an "S" painted on the curb. A PVC pipe stake shall be set vertically to indicate the sewer tee location.

13. These requirements are not intended to include all sewer line construction information. The Developer/Contractor shall refer to the Sewer Specification in the City of Clever Technical Specifications Book for additional information.

E. Streets:

1. All proposed street construction shall be placed on a suitable subgrade. Where

over excavation is required, suitable, consistent material shall be placed to bring the excavation to subgrade elevations. (See Detail Drawing D-1 in the attached Appendix).

2. The City Inspector shall inspect the street sub-grade prior to base rock placement and after base rock placement. It shall be the responsibility of the Developer/Contractor to contact the City to arrange for these inspections.

3. At all locations where street construction terminates at a phase line, with construction to be continued in the future, a pavement construction joint shall be constructed by means of placing a 2"x4" board laterally across the roadway and paving flush with the board. The board shall remain in place.

4. Concrete lined ditches or suitable storm sewers shall be required at all locations where stormwater is conveyed from the streets or along back lot lines.

5. These requirements are not intended to include all street construction information. The Developer/Contractor shall refer to the Street Specifications in the City of Clever Technical Specifications Book for additional information.

F. Underground Electric and Lighting:

1. Street lights are to be placed every 200 feet on straight runs. At cul-de-sacs, lights shall be placed at the end of the cul-de-sac and spaced as indicated on straight runs.

2. Easements shall be provided to the electrical cooperative for constructing buried and overhead electric lines to poles.

3. Subdivisions that opt to construct underground electric shall install the water line at 4-foot and the gas at 7-foot distance behind curb on the same side of street. Underground electric shall be installed 4-foot and the sewer line at 7-foot distance behind the curb on the opposite side. The water meters shall be on every other lot line and the electric meters are to be placed on alternate lots. (See Detail Drawing A-1 in the attached Appendix)

4. The City does not stock maintenance or repair parts for street lighting other than standard lights included in this document. The developer shall contact the electrical cooperative to obtain pricing information for optional types of street lights if desired. Optional street lighting may require special agreement assuring future parts and materials necessary for maintenance as well as cost

for same.

G. Drainage/Detention:

1. All stormwater drainage shall be conveyed through concrete lined ditches or installed in pipe unless a grass lined ditch is allowed by the City of Clever Development Department and a written approval is obtained.

2. The Contractor shall place sod on the entire floor of the ditch and shall be responsible for maintaining all sod through the first growing season after placement.

3. Contractor shall spray hydro mulch on interior and exterior sides and floors of all detention basins in areas where a 4 foot concrete trickle channel is constructed within the basin. Seeding and strawing shall be allowed within those basins where an 8 foot concrete low flow channel is constructed. (See Detail Drawing F-1 in the attached Appendix) The contractor/Developer shall be responsible for proper cover through the first full growing season.

4. Contractor shall provide erosion control by placing silt curtains at strategic locations within the project. Silt curtains shall consist of silt socks or straw bales tied together and secured to any applicable drainage ways. (See Detail Drawings F9 – F11 in the attached Appendix)

5. The Developer shall be responsible for maintenance of all required detention basins for a period of one year after City's acceptance of the work.

6. Building permits will normally be issued upon completion of all drainage and detention improvements. Permits may be issued on a case by case basis for those subdivisions with approved drainage plans and a letter of credit from the Developer's financial institution.

## 1A-3: SERVICE OWNERSHIP/RESPONSIBILITY:

Generally, after acceptance, all production, main distribution, service lines and other facilities are the responsibility of the City of Clever with the exception of transformers and meters which are the responsibility of the local electrical cooperative. Service lines include all piping and facilities from the outlet side of all meters and are the responsibility of the customer. All customer lines shall be installed, maintained and repaired to meet currently adopted codes and ordinances of the City of Clever. Transfer of commodity such as electricity and water also transfers ownership on the outlet side of the meter.

Customer’s lines on the wastewater collection system include all building piping

and yard piping from the structure to the City's main including the main tap or "Y" regardless of location. All customer lines shall be installed, maintained and repaired to meet currently adopted codes and ordinances of the City of Clever.

**DIVISION 2**
**SECTION 2A - EXCAVATION AND TRENCHING**

**2A-1 SCOPE:** This section covers excavation and trenching work and shall include the necessary clearing, grubbing, and preparation of the site: removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other appurtenant work.

**2A-2 GENERAL REQUIREMENTS:** Excavation work shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

Excavations for manholes and similar structures constructed of masonry units shall have horizontal dimensions so not less than 6-inch clearance is provided for outside plastering.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the City or City's Engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill or embankment.

**2A-3 BLASTING:** The Contractor shall comply with all laws, ordinances, applicable safety codes, requirements, and regulations relative to the handling, storage, and use of explosives and the protection of life and property. The Contractor shall be responsible for all damage caused by his blasting operations. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench.

Contractor shall avoid excessive overbreak or damage to adjacent structures, equipment, utilities or buried pipeline. Blasting near utilities shall be subject to approval of the utility owner or City.

Before delivery of any explosives at jobsite, Contractor must have obtained blasting endorsement on his public liability and property damage insurance policy.

All rock which cannot be handled and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed.

**2A-4 UNAUTHORIZED EXCAVATION:** Except where otherwise authorized, shown, or specified, all material excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced, by and at the expense of the Contractor, with concrete placed at the same time and monolithic with the concrete above.

**2A-5 DEWATERING:** The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed, therein is completed to the extent that no damage from hydrostatic pressure, floatation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below ground water shall be dewatered by lowering and keeping the ground water level beneath such excavations 12 inches or more below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

**2A-6 SHEETING AND SHORING:** Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, and shored, as necessary, to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities.
Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining shape and position under all circumstances.

Trench sheeting shall not be pulled before backfilling unless pipe strength is sufficient, in the opinion of the City or City's Engineer, to carry trench loads based on trench width to the back of sheeting, nor shall sheeting be pulled after backfilling.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

**2A-7 STABILIZATION:** Subgrades for concrete structures and trench bottoms shall be firm dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Subgrades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with one or more layers of crushed rock or gravel. Not more than ½ inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding materials are placed thereon. The finished elevation of stabilized subgrades for concrete structures shall not be above subgrade elevations shown on the drawings.

All stabilization work shall be performed by and at the expense of the Contractor.

**2A-8 TRENCH EXCAVATION:** The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One block or 400 feet (whichever is the shorter) shall be the maximum length of open trench on any line under construction.

Except where tunneling is shown on the drawings, is specified, or is permitted by the Engineer, all trench excavation shall be open cut from the surface.

**2A-8.01** Alignment, Grade, And Minimum Cover: The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the sections covering installation of water and sewer pipe.

Where pipe grades or elevations are not definitely fixed by the contract drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 42 inches. Greater pipe cover depths may be necessary on vertical curves or to provide necessary clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation.

**2A-8.02** Limiting Trench Widths: Trenches shall be excavated to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, and embedment. Unless otherwise shown on the drawings, the maximum trench widths, below an elevation 6 inches above the top of the installed pipe, shall be not more than 24 inches greater than the outside diameter of the pipe. The minimum permissible clearances between the installed pipe and either trench wall shall be 6 inches.

Stipulated minimum clearances are not minimum average clearances, but are minimum clear distances which will be required.

Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes which shall not extend lower than one foot above the top of the pipe.

**2A-8.03** Unauthorized Trench Widths: Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted, either pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the expense of the Contractor.

**2A-8.04** Mechanical Excavation: The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used. Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated that the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalls are obtained at least from an elevation one foot (1') above the top of the installed pipe to the bottom of the trench, and that trench alignment is such that pipe when accurately laid to specified alignment will be centered in the trench with adequate clearance between the pipe and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will not be permitted.

**2A-8.05** Cutting Concrete and Asphalt Surface Construction: No cutting of concrete/asphalt surfaces shall be allowed unless prior City approval is obtained in writing. Cuts in concrete or asphalt pavement and base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1 ½ inch deep along each side of the trench and along the perimeter of cuts for structures.

Concrete and asphalt pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6" in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than at the top and no undercutting will be permitted.

Pavement cuts shall be made to and between straight or accurately marked curved lines, which unless required, shall be parallel to the centerline of the trench.

Pavement removed for connection to existing lines or structures shall not be of greater extent than necessary for the installation as determined by the City or City's Engineer.

Where the trench parallels the length of concrete walks and trench location is all or partially under the walk, the entire walk shall be removed and replaced. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and replaced between existing joints or between saw cuts.

**2A-8.06** Excavation Below Pipe Subgrades: Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, to provide for the installation of ¾ inch clean, crushed limestone embedment pipe foundation material.

**2A-8.07** Artificial Foundations in Trenches: Whenever so ordered by the Engineer, the Contractor shall excavate to such depth below grade as the Engineer may direct and the trench bottom shall be brought to grade with such material as the Engineer may order installed. All timber, concrete, or other foundations made necessary by unstable soil.

**2A-8.08** Bell Holes: Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

**2A-9 INSTALLATION OF MAINS:** Specifications shall incorporate the provisions of the AWWA standards and/or manufacturer's recommendations and Missouri Department of Natural Resources "Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013.

**2A-9.01** Bedding, Embedment and Backfill: Bedding is the portion of the trench beneath the pipe and supporting the pipe to its spring line. Embedment is the material placed around the pipe to at least six inches above the top of the pipe. Backfill is the material placed into the trench above the embedment. Water main installation design shall meet the following requirements.

a. Trench construction, bedding, and embedment shall be appropriate for the type and size of the pipe installed.
b. Continuous, firm, stable, and uniform bedding shall be provided in the trench for all buried pipe. The bedding design shall insure that there is full support in the haunches of the pipe and be smooth and free of ridges, hollows, and lumps.
c. Bell holes should be excavated so that only the barrel of the pipe receives bearing from the trench bottom.
d. The weight of metallic fittings shall not be supported by the pipe. Metallic fittings shall be provided with proper support, such as crushed stone, concrete pads or a well compacted trench bottom.
e. Rocks and hard objects larger than one inch diameter found in the trench shall be removed at least four inches below and on each side of the pipe and the trench bottom should be filled with 4 to 6 inches of tamped bedding material.
f. When an unstable sub-grade condition which will provide inadequate pipe support is encountered, an alternative foundation shall be provided such as over digging and backfilling with tamped granular material.
g. The trench shall be kept free from water during pipe installation until the pipe has been installed, embedded and backfilled.
h. If the trench passes over another pipe or previous excavation, the trench bottom shall be filled with granular material and compacted.
i. Blocks shall not be used to change pipe grade or to intermittently support pipe across excavated sections.
j. All bedding and embedment material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stones.
k. Embedment material should be tamped in layers around the pipe, and to a sufficient height above the pipe that the pipe is adequately supported, stabilized, and protected. Shaped beddings perform essentially as well as full-contact embedment with select granular soil and are considered equal to full contact bedding.
l. Bedding normally consists of free flowing material such as gravel, sand, silty sand, or clayey sand. If this material is not used, a chipper should be used on the trencher to prepare the soil removed from the trench as embedment and backfill.
m. Embedment material diameter for plastic pipe shall be no greater than ½ inch for 4-inch diameter pipe, ¾ inch for 6 and 8-inch diameter pipes, and 1-inch for pipe diameters from 10 inches and greater.

n. Sand or other non-acidic granular material shall be used for pipe bedding, embedment and backfill in high traffic areas and under paved roads.
o. Backfill may consist of the excavated material, provided it is free from unsuitable matter such as large lumps of clay, frozen soil, organic material, boulders, or stones larger than 8 inches, or construction debris.
p. Width of trenches shall be at least four inches larger than the pipe's diameter. The minimum clear width of a trench should be the pipe outside diameter plus twelve inches to be wide enough to accommodate the compaction equipment.

**2A-10 BEDDING:** A continuous and uniform bedding shall be provided in the trench for all buried pipe; Backfill material shall be tamped in layers around the pipe, and to a sufficient height above the pipe that the pipe is adequately supported, stabilized and protected. Rocks and hard objects larger than one inch diameter found in the trench shall be removed for a depth of at least six inches below the bottom of the pipe.

**2A-11 MATERIAL:** Material for bedding shall be 3/4 inch clean crushed limestone.

**2A-12 TRENCH BACKFILL:** All trench backfill above pipe bedding shall conform to the following requirements.

1. Compacted Crushed Stone Backfill: Compacted backfill above the bedding shall consist of 3/4 inches clean crushed limestone and will be required for the full depth in the following locations:

    a. Beneath pavements, surfacing, driveways, curbs, gutters, walks, or other surface construction or structures.

    b. In the street, road, or on highway shoulders or any paved roadways.

2. Other Backfill: A continuous and uniform material shall be provided in the trench for all buried pipe above the bedding and shall be free of brush, roots more than 2 inches in diameter, debris, and refuse, but may contain rubble and detritus from rock excavations and stones smaller than 2"; Compaction of trench backfill above pipe bedding in locations other than those specified will not be required except to the extent necessary to prevent future settlement.

    Uncompacted backfill material above bedding may be placed by any method, acceptable to the City or City's Engineer, which will not impose excessive concentrated or unbalanced loads, shock, or impact on, and which will not result in displacement of installed pipe.

**2A-13 LABORATORY TESTS:** All laboratory tests to determine compliance of embedment and backfill materials with specified treatments and to determine compliance with specified compaction requirements will be paid for directly by the Contractor.

**2A-14 DRAINAGE MAINTENANCE:** Trenches across roadways, driveways, walks, or other traffic ways adjacent to drainage ditches or watercourses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the traffic way to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the Contractor.

Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other water courses crossed by the line of trench shall be removed immediately after backfilling is completed and the original section, grades, and contours of ditches or water courses shall be restored. Surface drainage shall not be obstructed longer than necessary.

**2A-15 PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSE:** Where trenches are constructed in ditches or other water courses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds 1 percent, ditch checks shall be installed. Unless otherwise shown on the drawings or directed by the Engineer, ditch checks shall be concrete. Ditch checks shall extend no less than 2 feet below the original ditch or water course bottom for the full bottom width and at least 18 inches into the side slopes and shall be at least 12 inches thick.

**2A-16 DISPOSAL OF EXCESS EXCAVATED MATERIALS:** Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site of the work.

Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be and actually installed in trench backfill, junk, and debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site of the work.

Excess earth from excavations located in unimproved property shall be distributed over the pipe trench and within the pipeline right-of-way to a maximum depth of 6" above the original ground surface elevation at and across the trench and sloping uniformly each way. Material thus wasted shall be carefully finished with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point. Wasting of excess excavated material in the above manner will not be permitted where the line of trench crosses or is within a railroad, public road, or highway right-of-way. The disposal of waste and excess excavated materials, including hauling, handling, grading, and surfacing shall be a subsidiary obligation of the Contractor.

**2A-17 SETTLEMENT:** The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within one year after final completion of the contract under which the work was performed.

The Contractor shall make or cause to be made all repairs or replacements made necessary by settlement within 30 days after notice from the City or City’s Engineer

**2A-18 SEEDING AND SODDING:** The work shall consist of furnishing all labor, equipment, and materials necessary for the preparation, fertilization, seeding, and mulching of the areas specified. All disturbed areas shall be seeded and mulched except for sodded areas, surfaced areas, and solid rock. Disturbed areas outside of authorized construction limits shall be seeded and mulched, or sodded at the contractor's expense.

1. Topsoil: Topsoil shall consist of a fertile, friable soil of loamy character, free of sub-soil, stumps, stones, refuse, and other foreign material. It shall contain a normal amount of natural humus and be reasonably free of roots, hard dirt, heavy or stiff clay, coarse sand, noxious weeds, noxious weed seeds, sticks, brush, and other litter. The topsoil shall be obtained from well-drained, arable land and be of even texture so that all the soil will pass a one-half (1/2) inch screen. The topsoil shall not be infested with nematodes or with any other noxious animal life or toxic substances. Sandy loam of low fertility, even though mixed with leaf mold, manure, or other fertilizers, will not be accepted.

2. Seed: Provide grass seed for established areas in a blend as specified below, unless directed otherwise by the landowner or City.

    a. 75% by weight of a three-way blend (equal parts) of turf fescues, consisting of any three of the following varieties: Olympic, Falcon, Bonanza, Rebel, Hound Dog, Astro 2000, Eldorado, Wrangle, FineLawn One, Anthem, or Apache.

    b. 15% by weight of Perennial Rye, consisting of one or more of the following varieties: Affinity, Derby, Regal, Manhattan, or Chateau.

    c. 10% by weight of Bluegrass, consisting of either Kentucky Bluegrass, Park Bluegrass, or both.

    d. Purity of seed shall be 98%.

    e. Germination shall be 85%.

3. Fertilizer: Provide a mixture containing 13 pounds each of soluble nitrogen, phosphate, and potash per 100 pounds.

4. Mulch for Hydraulically Seeded Areas: Provide a mixture of 50% recycled slick paper mulch and 50% ground corrugated paper mulch by weight. The recycled slick paper mulch shall be produced from printer's slick paper containing wood cellulose and kaolin clay. Newsprint is not allowed. The \slick paper mulch shall have a maximum moisture content of 8% by weight, and shall have a pH of 4.5 to 6.5. The corrugated paper mulch shall have a moisture capacity of 700 grams water per 100 grams dry mulch minimum, a dry moisture content of 12% maximum, and a pH of 5.0 to 8.0. All mulch materials must be free of any germination or growth-inhibiting substances, green in color, and have the property of being evenly dispersed and suspended when agitated in water.

Clean wheat straw shall be material applied over the hydraulic mulch.

5. Seed for Pasture and Cropland Areas: Match as nearly as possible the species in existence prior to disturbance. Alfalfa or other exotic grasses will not be replaced but will be compensated if the land is privately owned.

6. Replacement of Plants, Trees, Shrubs, Sod: Plants, trees, shrubs and sod shall be replaced with the same strain as removed and approximately the same size and dimensions as those removed including trees up to 4 inches in diameter.

7. Sod: Machine cut, strongly rooted, certified turf-grass sod, at least 2 years old, and be relatively free of weeds or other undesirable native grasses. Provide sod capable of vigorous growth and development when planted (viable, not dormant). Composed primarily of Kentucky bluegrass. Moisten sod to depth at which it is to be cut when stripped during dry periods. Provide sod in uniform thickness of 5/8-inch, plus or minus ¼-inch, measured at time of cutting and excluding top growth and thatch. Strips shall be of supplier's standard size of uniform length and width with maximum 5% allowable deviation in either length or width. Broken or torn pads, or pads with uneven ends are not acceptable. Sod pads shall be capable of supporting their own weight and retaining size and shape when pad is suspended vertically from a firm grasp on upper 10% of pad. Handle sod with care to prevent loss of native soil from roots.

8. Liming Material: Shall consist of agricultural liming materials conforming to the Missouri Agricultural Liming Materials Act of 1976.

**2A-19 STRUCTURE BACKFILL:** Backfill around structures shall be compacted, to the extent necessary to prevent future settlement, by tamping or other means acceptable to the City or City's Engineer. Water settlement will be permitted only where no damage to the work would be caused thereby.

Material for backfill shall be composed of earth only and shall contain no wood, grass, roots, broken concrete, stones, trash, or debris of any kind. No tamped or otherwise mechanically compacted backfill shall be deposited or compacted in water.

**2A-20 CLASSIFICATION OF EXCAVATED MATERIALS:** No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.

**DIVISION 2**
**SECTION 2B - PVC WATER PIPING**

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**2B-1 SCOPE:** This section covers Polyvinyl Chloride Piping (PVC). PVC pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking encasement, and other necessary appurtenances. Waterline construction shall be in accordance with the "Missouri Department of Natural Resources Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013.

**2B-2 STANDARDS OF MATERIALS SELECTION:** Unless otherwise required by the drawings or specified in the Section, all fittings shall be D.I.P. mechanical joint.

Pipes shall conform to the latest edition of the AWWA, ASTM, Plastic Pipe Institute (PPI), or UniBell Plastic Pipe Association standards or recommendations. Fittings, valves and fire hydrants shall conform to the latest standards issues by the AWWA and, where applicable, shall be certified by NSF or Underwriters Laboratories for use in drinking water. Special attention shall be given to selecting pipe materials that will protect against both internal and external pipe corrosion. PVC pipes must be at least Class 200 and conform to SDR-21. Pipes, fittings and appurtenances containing more than 0.25 percent lead calculated by weighted average shall not be used. Fittings shall have at least the same pressure rating as the pipe.

**2B-3 PERMEATION OF PIPE WALLS:** In areas that are contaminated with organic chemicals, permeation of organic chemicals into the water system shall be prevented by using non-permeable materials for all portions of the water system including pipe, fittings, service connections and hydrant leads.

**2B-4 USED MATERIALS:** Only water mains that have been used previously for conveying potable water may be reused and must meet the above standards and have been practically restored to their original condition.

**2B-5 JOINTS:** Packing and joining materials used in the joints of pipe shall conform to the latest edition of the AWWA standards. Pipe having mechanical joints or slip-on joints with nylon or synthetic rubber gaskets is preferred. Natural rubber shall not be used.

**2B-6 HANDLING:** Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling, and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces.

**2B-7 CUTTING PIPE:** Cutting shall be done in a neat manner, without damage to the pipe. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

**2B-8 CLEANING:** The interior of all pipe and fittings shall be thoroughly cleaned for foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all joint contact surfaces shall be wire brushed, if necessary, wiped clean, and kept clean

until jointing is completed.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

The end of the pipe must be protected from contamination when construction is terminated at the close of each day or for any extended period of discontinuation of construction activities. The pipe end must be sufficiently sealed with a cap or plug so is no foreign material may enter the line/pipe and maintained clean in accordance with all applicable specifications.

**2B-9 INSPECTION:** Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

**2B-10 ALIGNMENT:** Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not be permitted. Either shorter pipe sections or fittings shall be installed where the alignment or grade requires them.

**2B-11 LAYING PIPE:** Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions. Pipe shall be laid with the bell ends facing the direction of laying except when reverse laying is specifically authorized by the City of City's Engineer.

**2B-12 PUSH-ON JOINTS:** All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

**2B-13 MECHANICAL JOINTS:** Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Over-tightening bolts to compensate for poor installation practice will not be permitted.

**2B-14 FLANGED JOINTS:** Whenever screwed-on flanges are used; the pipe shall extend completely through the flange. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe center line.

When bolting flanged joints, care shall be taken to insure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell and spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform.

**2B-15 WALL CASTINGS:** Unless otherwise shown on the drawings, wall castings shall be provided where cast iron pipes pass through concrete or masonry walls.

**2B-16 CONNECTIONS WITH EXISTING PIPELINES:** Where connections are made between new work and existing piping, such connections shall be made using suitable fittings for the conditions encountered. All connections shall be live taps unless consent of the City or City's Engineer is given due to special site conditions. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by the City of City's Engineer. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing pipe. No trench water, mud, or other contaminating substances shall be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with, or dipped in, chlorine solution having a chlorine content of 200 milligrams per liter.

**2B-17 REACTION ANCHORAGE AND BLOCKING:** All unlugged bell and spigot or all-bell tees, Y-branches, bends deflecting 11 degrees or more, and plugs which are installed in piping subjected to internal hydrostatic heads in excess of 30 feet shall be provided with suitable reaction blocking, anchors, joint harness or other acceptable means for preventing movements of the pipe caused by internal pressure.

**2B-17.01** Concrete Blocking: Concrete blocking shall extend from the fitting to solid undisturbed earth and shall be installed so that all joints are accessible for repair. The bearing area of concrete reaction blocking shall be as shown on the drawings or as determined by the Engineer. If adequate support against undisturbed ground cannot be obtained, metal harness anchorages consisting of steel rods across the joint and securely anchored to pipe and fitting or other adequate anchorage facilities shall be installed to provide the necessary support. Should the lack of a solid vertical excavation face be due to improper trench excavation, the entire cost of furnishing and installing metal harness anchorages in excess of the contract value of the concrete blocking replaced by such anchorages shall be borne by the Contractor.

**2B-17.02** For Other Locations: Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, above grade, or exposed within structures, shall be provided as required by the drawings or as necessary to prevent movement.

**2B-17.03** Protection of Metal Surfaces: All steel clamps, rods, bolts, and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be protected from corrosion by two coats of coal tar paint applied to clean, dry metal surface. The first coat shall be dry and hard before the second coat is applied. Metal surface exposed above grade or within structures shall be painted with two coats (in addition to a prime coat) of paint acceptable to the City or the City's Engineer.

**2B-18 LEAKAGE:** All joints shall be watertight and free from leaks. Each leak which is discovered within 1 year after final acceptance of the work by the Owner shall be repaired by and at the expense of the Contractor.

**2B-19 TRACER WIRE:** All PVC waterline shall be buried with a 12-gauge (solid) copper wire for future location efforts. Wire shall be placed on top of all water mains and at all meter boxes and valves. Tracer wires within meter boxes and valves shall be extended to the top of the box plus 12-inches and back to the main in a continuous run. Any necessary stripping or splicing of the tracer wire shall be repaired by placing electrical tape over the un-insulated area. (See Standard Detailed Drawing and the General Discussion Notes)

At all water services a tracer wire from the water main to within 2 feet of the residence or building shall be provided for. During development the tracer wire shall be coiled at the water meter pit located at the right-of-way line and during building construction shall be extended to the surface at the cleanout adjacent to the residence or building.

**2B-20 WATER MAIN DESIGN:**

2B-20.1 Pressure: All water mains shall be sized in accordance with a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 35 psi at ground level at all points on the distribution system under all conditions of design flow not including fire flow, except that the department may approve a minimum design pressure of 20 psi in areas served by rural water districts that are isolated from the City's distribution system or on a case-by-case basis in accordance with the "Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013. The normal working pressure in the distribution system should be approximately 60 psi.

2B-20.2 Diameter:

1. The minimum size of a water main for providing fire protection and serving fire hydrants shall be six inches in diameter. Larger mains shall be required to allow withdrawal of the required fire flow while maintaining the minimum residual pressure of 20 psi throughout the distribution system.

2. For public water systems not providing fire protection, no water main shall be smaller than 2 inches in diameter. Water lines serving more than one service connection shall be considered a water main.

2B-20.3 Fire Protection: Fire protection shall be provided for all waterline extensions. The system design should be such that fire flows and facilities meet the classification criteria of the state Insurance Service Offices (ISO). Systems that cannot provide a minimum fire flow of 250 gpm for a two-hour duration are not designed to provide fire protection. All water mains shall be designed to carry fire flows and shall have fire hydrants connected to them.

2B-20.3 Flushing:

1. Flushing devices and valving shall be provided to allow every main in the distribution system to be flushed. Flushing devices should be sized to provide flows that will give velocity of at least 2.5 feet per second on the water main being flushed.

2. In order to provide increased reliability of service and reduce head loss, dead ends shall be minimized by making appropriate tie-in wherever practical.

3. Where dead-end mains occur, they shall be provided with an approved flushing device.

4. No flushing device shall be directly connected to any sewer.

2B-20.4 Isolation Valves: Sufficient valves shall be provided on water mains so that inconvenience and sanitary hazards to customers will be minimized during repairs. Valves should be located at not more than 500-foot intervals in commercial districts and at not more than one block (or 800 foot) intervals in residential or other districts. Where systems serve widely scattered customers and where future development is not expected, the valve spacing should be at every water main branch on both the feeder main and the branch line.

## 2B-21 FIRE HYDRANTS:

2B-21.1 Location and Spacing: Fire Hydrants shall be provided at each street intersection and at intermediate points between intersections to meet the current classification criteria of the Insurance Services Office (ISO). Generally, the fire hydrant spacing shall be 500 feet in residential areas or 300 feet to 350 feet in commercial areas. The number of hydrants required shall be based on use/occupancy type, required fire flow, along with distance and access considerations. The maximum distance from any structure's access point to a hydrant in a commercial area shall not exceed 200 feet, as measured along the required access. Final approval of fire hydrant spacing shall be by the City or the City's Engineer. Acceptable hydrant manufacturers are Mueller, Co., Clow Valve, Co. or American Valve, Co. Other manufacturers may be acceptable upon review by the City of Clever.

2B-21.1 Valves and Nozzles: Fire hydrants shall be as manufactured by Clow, Mueller or approved equal and shall have a minimum bottom valve opening of at least 5 1/4 inches and one 4 ½ inch pumper nozzle and two 2 ½ inch nozzles.

2B-21.2 Hydrant Leads: The hydrant lead shall be a minimum of six inches in diameter and contain a shutoff valve.

2B-21.3 Drainage: A gravel pocket or dry well shall be provided unless the natural soils will provide adequate drainage for the hydrant barrel. Hydrant drains shall not be connected to or located within ten feet of sanitary sewers or storm drains.

2B-21.4 Installation: Installation of fire hydrants shall meet the following requirements.

a. The weight of the hydrant shall not be carried by the pipe. Hydrants, lead valves, fittings, and branch connections shall be provided with proper support, such as crushed stone, concrete pads or a well compacted trench bottom.
b. Drainage shall be provided for dry barrel hydrants. This is generally washed stone extending at least one foot on all sides of the hydrant.
c. Hydrants shall be plumb.
d. The center of a hose outlet shall be not less than 18 inches above final grade and so that the final hydrant installation is compatible with the final grade elevation.
e. As a rule, hydrants are either oriented with the pumper outlet perpendicular to the curb which faces the street, or with the pumper outlet set at a 45-degree angle to the street.
f. Hydrants shall be protected if subject to mechanical damage. The means of protection shall be arranged in a manner that will not interfere with the connection to, or operation of, hydrants.
g. A clearance space of at least three feet (3 ft.) surrounding the hydrant body should be provided around every hydrant.
h. Utility poles, vaults, walls, plants and other landscape materials should be kept outside the hydrant's clearance space.
i. In poor load-bearing soil, special construction such as support collars may be required.

## 2B-22 AIR RELIEF VALVES, VALVES, METER AND BLOW-OFF CHAMBERS:

2B-22.1 Location: At high points in water mains where air can accumulate, provisions shall be made to remove air by means of manually operated hydrants or automatic air relief valves. Automatic air relief valves shall not be used in situations where flooding of the manhole or chamber may occur.

2B-22.2 Piping: The open end of an air relief pipe from automatic valves shall be extended to at least one foot above grade and terminate in a downturned position with the opening covered with an 18-mesh, corrosion resistant screen. The pipe from a manually operated valve shall be capped with a threaded removable cap or plug and should be extended to the top of the pit. Vaults or wells housing automatic air relief valves shall be drained to daylight with drains sized to carry the maximum output of the air relief valve.

2B-22.3 Chamber Drainage: Chambers, pits or manholes containing valves, blow-offs, meters, or other such appurtenances to a distribution system shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected to any sanitary sewer. Such chambers or pits shall be drained to the surface of the ground or provided with a sump.

**2B-23 INSTALLATON STANDARDS:** Specifications shall incorporate the provisions of the AWWA C-605 standards and/or manufacturer's recommended installation procedures.

## 2B-24 CROSSINGS:

2B-24.1 General: The following factors shall be considered in providing adequate separation.

a. Materials and type of joints for water and sewer pipes.
b. Soil conditions.
c. Service and branch connections into the water main and sewer line.
d. Compensating variations in the horizontal and vertical separations.
e. Space for repair and alterations of water and sewer pipes.
f. Off-setting of water mains around manholes.

**2B-25 PARALLEL INSTALLATION:** Water main shall be located at least ten feet horizontally from any existing or proposed line carrying non-potable fluids such as, but not limited to drains, storm sewers, sanitary sewers, combined sewers, sewer service connections, and process waste or product lines. The distance shall be measured edge to edge.

In cases where it is not practical to maintain a ten-foot separation, the city may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a non-potable fluid line, provided that the water main is laid in a separate trench located as far away from the non-potable line as feasible and meets other specific construction requirements. Locating a water main on an undisturbed earth shelf located on one side of the non-potable line as feasible and meets other specific construction requirements. Locating a water main on an undisturbed earth shelf located on one side of the non-potable line is not recommended and requires justification by the engineer and specific case-by-case approval of the department. In either case, an elevation shall be maintained such that the bottom of the water main is at least 18 inches above the top of the non-potable line while meeting minimum cover requirements.

In areas where the recommended separations cannot be obtained, either the waterline or the non-potable line shall be constructed of mechanical or manufactured restrained joint pipe, fusion welded pipe, or cased in a continuous casing. Casing pipe must be a material that is approved for use as water main. Conventional poured concrete is not an acceptable encasement.

**2B-26 LINE CROSSINGS:** Water mains crossing sewers, or any other lines carrying non-potable fluids shall be laid to provide a minimum vertical clear distance of 18 inches between the outside of the water main and the outside of the non-potable pipeline. This shall be the case where the water main is either above or below the non-potable pipeline. An 18-inch separation is a structural protection measure to prevent the sewer or water main from settling and breaking the other pipe. At crossings, the full length of water pipe shall be located so both joints will be as far from the non-potable pipeline as possible but in no case less than ten feet or centered on a 20-foot pipe. In areas where the recommended separations cannot be obtained either the waterline or the non-potable pipeline shall be constructed of mechanical or manufactured restrained joint pipe, fusion welded pipe, or cased in a continuous casing that extends no less than ten feet on both sides of the crossing. Special structural support for the water and sewer pipes may be required.

Casing pipe must be a material that is approved for use as water main. Conventional poured concrete is not an acceptable encasement.

**2B-27 EXCEPTIONS:** Any exceptions from the specified separation distances in Sections 2B-25 or 2B-26 must be submitted to the City for approval.

**2B-28 IN RELATION TO FORCE MAINS:** There shall be at least a ten-foot horizontal separation between water mains and sanitary sewer force mains or other force mains carrying non-potable fluids and they shall be in separate trenches. In areas where the recommended separations cannot be obtained, either the waterline or the non-potable line shall be constructed of mechanical joint pipe or cased in a continuous casing, be constructed of mechanical joint pipe, or be jointless or fusion welded pipe. Where possible, the waterline shall also be at such an elevation that the bottom of the water main is at least 18 inches above the top of the non-potable line. Casing pipe must be a material that is approved for use as water main. Conventional poured concrete is not an acceptable encasement.

**2B-29 IN RELATION TO SEWER MANHOLES:** No waterline shall be located closer than ten feet to any part of a sanitary or combined sewer manhole. Where the separation cannot be obtained, the waterline shall be constructed of mechanical or manufactured restrained joint pipe, fusion welded pipe, or cased in a continuous casing. Casing pipe must be a material that is approved for use as water main. The full length of water pipe shall be located so both joints will be as far from the manhole as possible, but in case less than ten feet or centered on a 20-foot pipe. No water pipe shall pass through or come into contact with any part of a sanitary or combined sewer manhole.

**2B-30 IN RELATION TO DISPOSAL FACILITIES:** No water main shall be located closer than 25 feet to any wastewater disposal facility, agricultural waste disposal facility, or landfill. Water mains shall be separated by a minimum of 25 feet from septic tanks and wastewater disposal areas such as cesspools, subsurface disposal fields, pit privies, land application fields, and seepage beds.

**2B-31 ABOVE WATER CROSSINGS:** The pipe shall be adequately supported and anchored, protected from damage and freezing and accessible for repair or replacement.

**2B-32 UNDERWATER CROSSINGS:**

a. Flowing streams and water body crossings five hundred feet or less in length shall have a minimum cover of four feet over the pipe. When crossing water courses greater than 15 feet in width, the following shall be provided:

   i. The pipe shall be of special construction, having flexible watertight joints. Steel or ductile iron ball-joint river pipe shall be used for open cut crossings. Mechanical or restrained joint or fusion welded pipe may be used for open cut crossings, provided it is encased in a welded steel casing. Mechanical or restrained joint or fusion weld pipe shall be used for bored crossings.

ii. Adequate support and anchorage shall be provided on both sides of the stream.

iii. Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves shall be easily accessible and should not be subject to flooding.

iv. The valve closest to the supply source shall be in an accessible location and installed in a vault, manhole, or meter pit sized to allow the installation of leak detection equipment.

v. Permanent taps shall be provided on each side of the valve within the manhole, vault, or meter pit to allow insertion of a small meter to determine leakage and for sampling purposes.

vi. Bank erosion is a major cause of stream crossing failures, and erosion protection measures such as rip rap have limited success. Stream movement and the history of bank erosion must be considered when choosing the length that the crossing pipe or casing shall extend beyond the upper edge of the stream channel. The stream crossing pipe or casing shall extend at least 15 feet beyond the upper edge of the stream channel on each side of the stream.

vii. Large river crossings such as those crossing the Missouri or Mississippi River require specialized design and shall be considered on a case-by-case basis.

b. For lake, waterbody, and flood plain crossings greater than 500 feet in length, the design shall consider the ability to access and repair or replace the pipe in these crossings. Consideration shall also be given to the ability to continue service to areas served by the crossing in the event of a submerged leak or pipe break.

i. Submerged portions of pipe crossing proposed lakes shall not be buried when the submerged pipe is greater than 500 feet in length except for the transition from water to land.

ii. Steel or ductile iron ball-joint river pipe or fusion welded pipe shall be used under water during normal flow conditions. Mechanical, restrained joint, or fusion welded pipe shall be used in flood plains.

iii. Underwater installations shall be tested for leaks prior to installation.

iv. Valves above the high-water level shall be provided at both ends of water crossings so that the section can be isolated for testing or repair.

v. The valve closest to the supply source shall be in an accessible location and installed in a vault, manhole, or meter pit sized to allow the installation of leak detection equipment.

vi. Permanent taps shall be provided on each side of the valve within the manhole, vault, or meter pit to allow insertion of a small meter to determine leakage and for sampling purposes.

c. Intermittent flowing streams

i. Restrained joint or thermal welded pipe shall be used for all stream crossings.

ii. The pipe shall extend at least 15 feet beyond the upper edge of the stream channel on each side of the stream.

iii. Adequate support and anchorage shall be provided on both sides of the waterway.

**2B-33 STREET CROSSINGS:** No cutting of concrete/asphalt surface shall be allowed unless prior City approval is obtained in writing. At all locations where water lines are placed within the city street, water trench shall be backfilled with 3/4-inch clean crushed limestone to the subgrade of the proposed pavement. Contractor shall be responsible for obtaining necessary permits and approvals for crossings on county or state highways.

**2B-34 WATER SERVICES:** All water services shall be made with 200 psi High Density Polyethylene (HDPE) pipe equal to copper tubing size (CTS) SDR 9 potable water pipe. Service pipe shall meet the requirements of ASTM 2737, AWWA C901 and NSF Standards 14 and 61.

1. Typical Water Service: (See Standard Detail Drawing in the City of Clever's Technical Specifications Book)

    a. Crossings Serving Single Lot: Water service crossing shall be made using 1 inch diameter High Density Polyethylene (HDPE) pipe.

    Water services on same side as water main shall be High Density Polyethylene (HDPE) pipe.

    b. Crossings serving Twin lots: Water service crossing shall be made using a single 2-inch diameter or 2 - 1" diameter High Density Polyethylene (HDPE) pipes. Dual Services on same side as water main shall be High Density Polyethylene (HDPE) pipe.

2. Typical Water Meter Box: (See Standard Detail Drawing in the City of Clever's Technical Specifications Book)

**2B-35 PROTECTION OF WATER METER BOXES:** It shall be the responsibility of the contractor to place a metal fence post at each meter box to prevent damage to the meter after installation.

**2B-36 WATERLINE ACCEPTANCE TESTING:**

2B-36.1 General: This section covers simultaneous hydrostatic pressure testing and leakage testing of the waterline. The pipelines shall be tested as specified herein.

It shall be the responsibility of the contractor to notify the City of Clever personnel at least 24 hours in advance of the time and place at which testing work will be done. All defects shall be repaired to the satisfaction of the City of Clever.
Temporary discharge piping shall be provided for wasting test water at a suitable remote location where such water will drain away from the work.

2B-36.2 Pressure/Leakage Test: The pipelines shall be subjected to a simultaneous hydrostatic pressure and leakage testing. The test shall be conducted prior to connection of the pipeline to the existing water lines. All shutoff valves shall be open during testing. Anchored or blocked test plugs shall be provided as necessary.

2B-36.3 Filling and Venting the Line: The pipelines shall be slowly filled with water and all air expelled from the pipe. Vents shall be provided where necessary. A suitable plug shall be provided for the tapped vents.

2B-36.4 Testing Equipment Facilities: The Contractor shall furnish the gauges and measuring device for the hydrostatic and leakage tests, pump, pipe, connections, and all other necessary apparatuses, unless otherwise specified, and shall furnish the necessary assistance to conduct the test.

2B-36.5 Test Pressure: During the test the pipeline shall be subjected to 150 percent of the working pressure at the point of the test, but not less than 125 percent of normal working pressure at the highest elevation in the pipeline. Working pressure is defined as the maximum anticipated sustained operating pressure.

2B-36.6 Test Duration: The test pressure shall be maintained for at least 2 hours or for whatever longer period is necessary for City personnel to inspect the pipeline.

2B-36.7 Leakage Measurement: Leakage shall be defined as the quantity of water that must be supplied into the pipe section being tested to maintain a pressure within 5 psi of the specified leakage-test pressure after the pipe has been filled with water and the air in the pipeline has been expelled.

2B-36.8 Allowable Leakage: No installation will be accepted if the leakage is greater than that determined by the formula:

$$L = \frac{ND(P)^{1/2}}{7{,}400}$$

WHERE:

L = Allowable leakage (gal/hr)
N = Number of joints in the length of pipeline tested
D = Nominal diameter of pipe (inches)
P = Average test pressure during the leakage test (psi-gauge)

2B-36.9 Defects: It is the intent of these specifications and the contract based thereon that all joints in piping shall be watertight and free from visible leaks during the prescribed leakage test

and each and every leak which may be discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the City shall be located and repaired by and at the expense of the Contractor, regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

If the specified leakage test is made after the pipeline has been backfilled and the joints covered, and such test shows a leakage rate in excess of the permissible maximum, the Contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount. Where evidence of leaking joints does not appear on the ground surface above or near the leaks, the Contractor shall prospect the line by sinking a hole, with an auger or otherwise, at the location of each joint and determine any undue saturation of the soil which would indicate a leak at such joint; such prospecting shall be done after pressure has been maintained in the line a sufficient time to provide adequate soil saturation for locating leaks by this method.

Leaks in mechanical joints shall be repaired by dismantling, cleaning, realigning gland and gasket, and rebolting. Under no circumstances shall gland bolts be tightened beyond the specified and allowable torque limits in an attempt to reduce or stop leakage from a defective joint or for any other purpose.

2B-36.10 Repetition: Materials shall be replaced as necessary and the pressure test shall then be repeated until the line and all parts thereof withstand the test in a satisfactory manner.

## 2B-37- WATERLINE DISINFECTION:

2B-37.1 General: The waterline shall be disinfected with a strong chlorine solution. Disinfecting may be done concurrently with pressure and leakage testing or after pressure and leakage testing at the option of the Contractor. All necessary disinfection equipment and materials shall be provided by the Contractor. Disinfection work shall conform to the requirements of AWWA C651-99, "Standard for Disinfecting Water Mains" as modified or supplemented herein.

2B-37.2 Disinfectants: The forms of chlorine that may be used in the disinfection operations are liquid chlorine, sodium hypochlorite solution, and calcium hypochlorite granules or tablets.

1. Liquid Chlorine: Liquid chlorine conforming to ANSI/AWWA B301 contains 100% available chlorine and is packaged in steel containers usually of 100-lb, 150-lb, or 1-ton net chlorine weight. Liquid chlorine shall be used only: (1) in combination with appropriate gas-flow chlorinators and ejectors to provide a controlled high-concentration solution feed to the water to be chlorinated; (2) under the direct supervision of someone familiar with the physiological, chemical, and physical properties of liquid chlorine who is trained and equipped to handle any emergency that may arise; and (3) when appropriate safety practices are observed to protect working personnel and the public.

2. Sodium Hypochlorite: Sodium hypochlorite conforming to ANSI/AWWAB300 is available in liquid form in glass, rubber-lined, or plastic containers typically ranging in

size from 1 qt. to 5 gal. Containers of 30 gal. or larger may be available in some areas. Sodium hypochlorite contains approximately 5% to 15% available chlorine, and the storage conditions and time must be controlled to minimize its deterioration.

3. Calcium Hypochlorite: Calcium hypochlorite conforming to ANSI/AWWA B300 is available in granular form or in 5-g tablets, and must contain approximately 65% available chlorine by weight. The material should be stored in a cool, dry, and dark environment to minimize its deterioration. Minimum contact time to allow tablets to dissolve shall be 7 hours.

2B-37.3 Feeding: Pipelines shall be disinfected by the tablet method, the continuous feed method or the slug method in accordance with ANSI/AWWA C651-99.

1. Tablet Method: The tablet method consists of placing calcium hypochlorite granules or tablets in the water main as it is being installed and then filling the main with potable water when installation is completed. This method shall be used only if the pipes and appurtenances are kept clean and dry during construction.

2. Continuous Feed Method: The continuous feed method consists of placing calcium hypochlorite granules in the main during construction (optional), completely filling the main to remove all air pockets, flushing the completed main to remove particulates, and filling the main with potable water. The potable water shall be chlorinated so that after a 24-hour period in the main there will be a free chlorine residual of not less than 10 mg/l.

3. Slug Method: The slug method consists of placing calcium hypochlorite granules in the main during construction; completely filling the main to eliminate all air pockets; flushing the main to remove particulates; and slowly flowing through the main a slug of water dosed with chlorine to a concentration of 100 mg/l. The slow rate of flow ensures that all parts of the main and its appurtenances will be exposed to the highly chlorinated water for a period of not less than 3 hours.

   During disinfection all valves shall be operated to insure that all appurtenances are disinfected.

2B-37.4 Bacteriological Tests: After the chlorine solution is flushed out of the line and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the new main. At least one set of samples shall be collected from every 1,200 ft of the new water main, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater; and shall show the absence of coliform organisms; and, if required, the presence of a chlorine residual. Turbidity, pH, and a standard heterotrophic plate count or test may be required at the option of the purchaser, because new material does not typically contain coliform but does typically contain HPC bacteria.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by Standard Methods for the Examination of Water and Wastewater. No hose or fire hydrant shall be used in the collection of samples. The record of compliance shall be the bacteriological test results certifying that the water sampled from the new water main is free of coliform bacteria contamination and is equal to or better than the bacteriologic water quality in the distribution system.

2B-37.5 Redisinfection: If initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results is obtained.

## 2B-38 CONNECTIONS:

1. Automatic Fire Sprinkler Systems and Standpipe Systems: The potable water supply to automatic fire sprinkler and standpipe systems shall be protected against backflow by a double check-valve assembly or a reduced pressure principle backflow preventer.

   The exception is where systems are installed as a portion of the water distribution system in accordance with the requirements of this code and are not provided with a fire department connection, isolation of the water system shall not be required

2. Additive or Non-potable Source: Where systems contain chemical additives or antifreeze, or where systems are connected to a non-potable secondary water supply, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer. Where chemical additive or antifreeze is added to only a portion of an automatic fire sprinkler or standpipe system, the reduced pressure principle backflow preventer shall be permitted to be located so as to isolate that portion of the system.

3. Subject to Back Pressure: Where a potable water connection is made to a non-potable line, fixture, tank, vat, pump or other equipment subject to backflow pressure, the potable water connection shall be protected by a reduced pressure principle backflow preventer.

4. Lawn Irrigation Systems**:** The potable water supply to lawn irrigation systems shall be protected against backflow by a double check valve back flow preventer or a reduced pressure principle backflow preventer. Where chemicals are introduced into the system, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer.

**DIVISION 2**
**SECTION 2B1 – PROTECTION OF POTABLE WATER SUPPLY**

**2B1-1 GENERAL:** The Contractor shall be solely responsible for assuring protection of the City's potable water supply by means of providing backflow prevention as indicated in these specifications.

**2B1-2 PROTECTION OF POTABLE WATER OUTLETS:** All potable water openings and outlets shall be protected against backflow, in accordance with one of the following.

1. Air Gap: Openings and outlets shall be protected by an air gap between the opening and the fixture flood level rim. Openings and outlets equipped for hose connection shall be protected by means other than an air gap.

2. Hose Connections: Sillcocks, hose bibs, wall hydrants and other openings with a hose connection shall be protected by an atmospheric-type or pressure type vacuum breaker or a permanently attached hose connection vacuum breaker.

3. Reduced Pressure Principle Backflow Preventer: Openings and outlets shall be protected by a reduced pressure principle backflow preventer.

**2B1-3 CONNECTIONS:**

1. Automatic Fire Sprinkler Systems and Standpipe Systems: The potable water supply to automatic fire sprinkler and standpipe systems shall be protected against backflow by a double check-valve assembly or a reduced pressure principle backflow preventer.

   The exception is where systems are installed as a portion of the water distribution system in accordance with the requirements of this code and are not provided with a fire department connection, isolation of the water system shall not be required

2. Additive or Non-potable Source: Where systems contain chemical additives or antifreeze, or where systems are connected to a non-potable secondary water supply, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer. Where chemical additive or antifreeze is added to only a portion of an automatic fire sprinkler or standpipe system, the reduced pressure principle backflow preventer shall be permitted to be located so as to isolate that portion of the system.

3. Subject to Back Pressure: Where a potable water connection is made to a non-potable line, fixture, tank, vat, pump or other equipment subject to backflow pressure, the potable water connection shall be protected by a reduced pressure principle backflow preventer.

4. Lawn Irrigation Systems**:** The potable water supply to lawn irrigation systems shall be protected against backflow by a double check valve back flow preventer or a reduced pressure principle backflow preventer. Where chemicals are introduced into

the system, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer.

**DIVISION 2**
**SECTION 2C - PVC SEWER PIPE**

**2C-1 SCOPE:** This section covers Polyvinyl Chloride Piping (PVC). PVC pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking, encasement, and other necessary appurtenances. All sewer line construction shall be in accordance with 10CSR 20-8.120, effective January 30, 2012. The minimum diameter of gravity sewer mains shall be 8 inches as indicated in the General Conditions.

**2C-2 MATERIALS:** In depth less than 10 feet SDR-35 gasket-bell type pipe shall be used. All sewer pipe with a depth of 10 feet or greater shall be SDR-21 gasket-bell type pipe. Any adaptation from SDR-35 to SDR-21 shall be completed with a solvent weld coupling. PVC pipe and fittings 4 inches through 15 inches shall meet or exceed the requirements of the latest revision of ASTM D-3034 and shall be cell classification of 12454-B, 12454-C or 13364-B as defined in ASTM D 1784.

Pipe and fittings 18 inches through 27 inches shall meet ASTM F-679 and shall be cell classification of 12364-C or 12454-C.

Minimum pipe stiffness (F/Y) at 5° deflection shall be 46 for all sizes when tested in accordance with ASTM D2412.

All Joints of pipe and fittings shall have elastomeric gaskets and shall show no signs of leakage when tested in accordance with D 3212. Solvent weld joints will not be permitted below grade.

| SIZES | O.D. DIMENSIONS | WALL THICKNESS |
|---|---|---|
| 4" | 4.215 | .125 inches |
| 6" | 6.275 | .180 inches |
| 8 " | 8.400 | .240 inches |
| 10" | 10.500 | .300 inches |
| 12" | 12.500 | .360 inches |
| 15" | 15.300 | .414 inches |
| 18" (T-1) | 18.700 | .536 inches |
| 21" (T-1) | 22.047 | .632 inches |
| 24" (T-1) | 24.803 | .711 inches |
| 27" (T-1) | 27.953 | .801 inches |

**2C-2.1** Location of Services: All SCH40 and SDR-21 PVC wyes or tee fittings will be located in the center of each lot for ease of location on future hookups.

**2C-2.2** Lateral Lines: All service lateral lines shall be schedule 40 meeting the requirements of ASTM D2665 or D2441.

**2C-3 HANDLING:** Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces.

**2C-4 CUTTING PIPE:** Cutting shall be done in a neat manner, without damage to the pipe. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

**2C-5 CLEANING:** The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all contact surfaces shall be wire brushed, if necessary, wiped clean, and kept clean until jointing is completed.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

**2C-6 INSPECTION:** Pipe fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

**2C-7 ALIGNMENT:** Sewers twenty-four inches (24") or less shall be laid with straight alignment between manholes. Straight alignment shall be checked by either using a laser beam or lamping.

Curvilinear alignment of sewers larger than twenty-four inches (24") may be considered on a case-by-case basis provided compression joints are specified and ASTM or specified pipe manufacturers' maximum allowable pipe joint deflection limits are not exceeded. Curvilinear sewers shall be limited to simple curves which start and end at manholes. When curvilinear sewers are proposed, the recommended minimum slopes must be increased accordingly to provide a minimum velocity of two feet (2') per second when flowing full.

**2C-8 LAYING PIPE:** Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.

Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of four inches (4") below and on each side of all pipe(s).

**2C-9 TRACER WIRE:** A copper tracer wire (insulated #12 wire) shall be laid in the bedding within 1 foot above the top of the pipe. Tracer connections shall be placed in areas not to exceed 500 feet. Tracer connections shall be supplied at all manholes.

At all sewer laterals a tracer wire from the sewer main to the cleanout at the residence or building shall be provided for. During development the tracer wire shall be coiled at the end of the sewer lateral located at the right-of-way line and during building construction shall be extended to the surface at the cleanout adjacent to the residence or building.

## 2C-10 EMBEDMENT MATERIALS:

2C-10.1 Plastic Pipe: Embedment materials for bedding, haunching, and initial backfill, Classes I, II, or III, as described in ASTM D2321, shall be used and carefully compacted for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load based on the type of soil encountered and potential groundwater conditions.

2C-10.2 Composite pipe: Except as described in ASTM D2680, the bedding, haunching, and initial backfill requirements for composite pipe shall be the same as for plastic pipe.

2C-10.3 Final Backfill: Shall be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods, stones, organic matter, or other unstable materials shall not be used for final backfill within two (2') of the top of the pipe.

**2C-11 STEEP SLOPE PROTECTION:** Sewers on twenty percent (20%) slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

a. Not over thirty-six feet (36') center-to-center on grades twenty percent (20%) and up to thirty-five percent (35%);

b. Not over twenty-four feet (24') center-to-center on grades thirty-five percent (35%) and up to fifty percent (50%); and

c. Not over sixteen feet (16') center-to-center on grades fifty percent (50%) and over.

**2C-12 HIGH VELOCITY PROTECTION:** Where velocities greater than fifteen feet (15') per second are attained, special provision shall be made to protect against displacement by erosion and impact.

**2C-13 PUSH-ON-JOINTS:** All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed.

**2C-14 CROSS CONNECTIONS:** There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

**2C-15 SERVICE CONNECTIONS:** Service connections to the sewer main shall be watertight and not protrude into the sewer. If a saddle-type connection is used, it shall be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.

## 2C-16 RELATION TO WATER MAINS

**2C-16.01** Horizontal Separation: Sewer mains shall be laid at least 10 feet (3.0 m) horizontally from any existing or proposed water main. The distances shall be measured edge to edge. In cases where it is not practical to maintain a 10-foot separation, the City may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviations may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches (46 cm) above the top of the sewer.

**2C-16.2** Crossings: Sewers crossing water mains shall be laid to provide a minimum of vertical distance of 18 inches (46 cm) between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equal distance and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

**2C-16.3** Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer must be constructed of slip-on or mechanical joint pipe or continuously encased and be pressure tested to one hundred fifty pounds per square inch (150 psi) to assure watertightness.

**2C-17 STREET CROSSING:** No cutting of concrete/asphalt surfaces shall be allowed unless prior City approval is obtained in writing. At all locations where sewer lines are placed within the street, sewer trench shall be backfilled with ¾ inch crushed limestone to the subgrade of the proposed pavement. Creek gravel or similar material will not be allowed. Contractor shall be responsible for obtaining necessary permits and approvals for crossings on county or state highways.

**2C-18 STREAM CROSSING:** Sewers entering or crossing streams shall be constructed of ductile iron pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods shall provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting trees and vegetation, dumping of soil or debris, or pumping silt laden water into the stream. Specifications shall require that clean-up, grading, seeding, planting, or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven (7) days.

**2C-19 AERIAL STREAM CROSSING:** Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning, and settlement. Precautions against freezing, such as insulation and increased slope, shall be

provided. Expansion jointing shall be provided between above-ground and below-ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize frost heaving.

For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the fifty (50) year flood.

Aerial crossings shall be constructed of ductile-iron pipe with mechanical joints; otherwise, they shall be constructed so that they will remain watertight and free from changes in alignment or grade.

**2C-20 MARKING:** Each pipe and fitting shall have plainly and permanently marked thereon:

a. Manufacturer's name or trademark.
b. Nominal pipe size.
c. ASTM Designation D3034 and Class Number
d. SDR number.
e. Material designation.

**2C-21 ACCEPTANCE TESTS:** Each reach of sewer shall meet the requirements of Section 2H - SEWERLINE ACCEPTANCE TESTING.

**2C-22 BUILDING SEWER:**

1. General: It shall be the responsibility of the property owner to construct and maintain the sewer lines from the building to the sewer main. The property owner assumes all ownership of the line from the building to the main tap or "Y" on the City main.

2. Materials: All sewer service connection lines shall be a minimum of 4 inches diameter, Sch 40 PVC.

3. Laying of Pipe: All sewer lines shall have a minimum of 3 feet of cover over the top of the pipe with a fall of 1/4 inch per foot. At no time shall 90-degree turns be acceptable. It shall be acceptable to use 45-degree bends providing there is a minimum of 1 foot of pipe between each bend.

4. Service Hookup: The City shall be notified to provide assistance in locating building sewer extensions at the sewer main. No unauthorized connection to the sewer main at locations other than building sewer extensions shall be allowed. No split services will be allowed; all buildings will have a separate sewer service. Service connections to the sewer main shall be watertight and not protrude into the sewer. If a saddle-type connection is used, it shall be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.

5. Tracer Wire: A copper tracer wire (insulated #12 wire) shall be laid at all sewer laterals within 1 foot above the top of the pipe. During development the tracer wire shall be coiled at the sewer lateral marker for the end of the sewer stub-out and during building construction the tracer wire shall be extended to the surface at the cleanout next to the residence or building.

**2C-23 APPROVAL OF OTHER REGULATORY AGENCIES:** It shall be the responsibility of the Developer to acquire all required permits, approvals, and authorization from applicable agencies in addition to the City of Clever including, but not limited to all applicable Missouri Department of Natural Resources permits prior to the start of construction of any regulated sewer improvements. Copies of all applicable permits shall be provided to the City of Clever prior to the acceptance of any or all improvements.

**DIVISION 2**
**SECTION 2D -PVC FORCE MAIN**

**2D-1 SCOPE:** This section covers bell and spigot rubber gasketed PVC pressure pipe. Pipe shall be furnished complete with all fittings, jointing material, anchors, blocking, encasement, and other necessary appurtenances.

**2D-2 MATERIALS:** All materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM D 1784, Type 1, Grade 1, Class 200. All pipe and fittings shall have integral bells and conform to the following:

| | |
|---|---|
| Pipe Dimensions: | ASTM D2241, SDR 21 |
| Fittings: | Rated to exceed pipe |
| Rubber Joint Rings: | ASTM D1869 |

**2D-3 HANDLING:** Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Extra care shall be used in handling during cold weather.

Pipe and fittings which have been scratched during handling or installation shall be replaced by and at the expense of the Contractor. Pipe repairs will not be permitted.

**2D-4 STORAGE:** All pipe shall be stored on a flat surface so as to support the barrel evenly with the bell ends overhanging and not stacked in piles higher than 5 feet. Bells shall be inverted in alternate rows.

Pipe to be stored for an extended period (several months) shall be covered with an opaque material to protect the pipe from the sun's rays.

Rubber gaskets shall be stored away from grease, oil, ozone-producing electric motors, excessive heat and in a cool dark place.

**2D-5 CLEANING:** The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed. All joint contact surfaces shall be kept clean until the jointing is completed.

Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug, which will prevent trench water, sand and earth from entering the pipe.

**2D-6 CUTTING PIPE:** Cutting shall be done with a fine-toothed saw and miter box or tubing cutter approved for PVC pipe. Remove all burrs from inside the cut end with a file or knife. The cut end shall be beveled with a milled curve-tooth flat file or beveling tool designed for PVC pipe.

**2D-7 JOINTS:** All instructions and recommendations of the pipe manufacturer relative to gasket installation and other jointing operations shall be followed by the Contractor.

**2D-8 ALIGNMENT:** Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall be as shown on the drawings.

Either shorter pipe or fittings shall be installed if the alignment or grade requires them. Pipe shall not be bent.

**2D-9 LAYING PIPE:** Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.

Pipe shall be laid with the bell ends facing direction of laying except where reverse laying is authorized by the City of City's Engineer.

A copper tracer wire (insulated #12 wire) shall be laid in the bedding within 1 foot above the top of the pipe. Tracer connections shall be placed in areas not to exceed 500 feet. Tracer connections shall be supplied at all air relief valves.

**2D-10 STREET CROSSING:** No cutting of concrete/asphalt surfaces shall be allowed unless prior City approval is obtained in writing. At all locations where sewer lines are placed within the street, sewer trench shall be backfilled with ¾ inch crushed limestone to the subgrade of the proposed pavement. Creek gravel or similar material will not be allowed. Contractor shall be responsible for obtaining necessary permits and approvals for crossings on county or state highways.

Where pressure lines cross State maintained roadways the PVC pipe shall conform to ASTM D-2241-76, or latest revision thereof, within the State right-of-way. Contractor shall be responsible for obtaining required state or county permits.

**2D-11 PRESSURE TEST:** Pressure testing is required and is covered in the Section 2H - SEWERLINE ACCEPTANCE TESTING.

**2D-12 MARKING:** Each pipe and fitting shall have plainly and permanently marked thereon:

a. Manufacturer's name or trademark.
b. Nominal pipe size.
c. ASTM Designation D2241.
d. SDR Number.
e. Material designation.

Each pipe length shall be clearly marked as sanitary sewer pipe force main or shall bear sufficient other markings or characteristics, in the opinion of the City, to allow for easy identification of the line as a sanitary sewer force main whenever the sanitary sewer force main is constructed of materials which might be confused with potable water mains. Markings shall be oriented to appear within the upper half of the placed pipe so as to be visible when excavated.

**2D-13 RELATION TO WATER MAINS**

**2D-13.01** Horizontal Separation: Sanitary sewer force mains shall be laid at least 10 feet (3.0 m) horizontally from any existing or proposed water main. The distances shall be measured outer edge to outer edge. In cases where it is not practical to maintain a 10-foot separation, the City may allow deviation on a case-by-case basis, if in the City's opinion it is appropriately supported by data from the design engineer and does not conflict with any other applicable regulations. Such deviations may allow installation of the sanitary sewer force main closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sanitary sewer force main at such an elevation that the bottom of the water main is at least 18 inches (46 cm) above the top of the sanitary sewer force main.

**2D-13.02** Crossings: Sanitary sewer force mains crossing water mains shall be laid to provide a minimum of vertical distance of 18 inches (46 cm) between the outside of the water main and the outside of the sanitary sewer force main. This shall be the case where the water main is either above or below the sanitary sewer force main however, whenever possible the water main is to be placed above the sanitary sewer force main. The crossing shall be arranged so that the sanitary sewer force main joints will be equal distance and as far as possible from the water main joints. Where a water main crosses under a sanitary sewer force main, adequate structural support shall be provided for the sanitary sewer force main to prevent damage to the water main.

**2D-13.03** Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sanitary sewer force main must be constructed of slip-on or mechanical joint pipe or continuously encased and be pressure tested to one hundred fifty pounds per square inch (150 psi) to assure watertightness.

**DIVISION 2**
**SECTION 2E - VITRIFIED CLAY SEWER PIPE**

**2E-1 SCOPE:** Vitrified clay sewer pipe shall not be allowed.

**DIVISION 2**
**SECTION 2F - DUCTILE IRON PIPING**

**2F-1 SCOPE:** This section covers ductile iron piping. Ductile iron pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking, encasement, and other necessary appurtenances.

Piping furnished complete with all joint gaskets, bolts, and nuts required for installation.

**2F-2 MATERIALS:** Unless otherwise required by the drawings or specified herein, joints in ductile iron piping shall be mechanical or push-on type.

| | |
|---|---|
| Ductile | ANSI A21.51; AWWA C151, ASMT A536, Grade60-42-10; thickness Class 50. |
| Fittings | ANSI A21.10, AWWA C110, except shorter laying lengths will be acceptable. |
| 12" and Under | 250 psi pressure rating. |
| Over 12" | 150 psi pressure rating. |
| Mechanical Joints | ANSI A21.11, AWWA C111 |
| Locked Joints | American "Loc-Fastite", U.S. Pipe "Lok-Tyton", or Clow "Super-Lock". |
| Push-On Joints | ANSI A21.11, except gaskets shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable. |
| Flexible Couplings | Elastomeric polyvinyl-chloride or resin impregnated fabric provided with stainless steel tightening bands. Assemblies shall be capable of connecting pipe of different size and material with a flexible leak-proof joint. |

Shop Coating and Lining

| | |
|---|---|
| Cement Lining | ANSI A21.4 |
| Bituminous Coating | Manufacturer's Standard. |
| Field Coating | Heavy coal tar paint, MIL-C-18480; Koppers "50 Bitumastic", Tnemec "476 Super Tnemecol", or USS Tarmastic 101." |

**2F-3 HANDLING:** Pipe fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition.

Equipment, tools, and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipes shall

have broad, well-padded contact surfaces.

Pipe fittings in which the cement lining has been broken or loosened shall be replaced by and at the expense of the Contractor.

**2F-4 CUTTING PIPE:** Cutting shall be done in a neat manner, without damage to the pipe or to the cement lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

Ends of ductile iron pipe shall be cut with a saw, abrasive wheel, or oxyacetylene torch. Field cutting of holes for saddles shall be done by mechanical cutters; oxyacetylene cutting will not be permitted.

**2F-5 CLEANING:** The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all joint contact surfaces shall be wire brushed if necessary, wiped clean, and kept clean until jointing is completed.

Every precaution shall be taken to prevent foreign matter from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

Whenever a pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug which will prevent trench water from entering the pipe.

**2F-6 INSPECTION:** Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

**2F-7 LAYING PIPE:** Pipe shall be protected from lateral displacement by placing the specified embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.

Pipe shall be laid with the bell ends facing the direction of the laying except when reverse laying is specifically authorized by the City or City's Engineer.

**2F-8 MECHANICAL JOINTS:** Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Over tightening bolts to compensate for poor installation practice will not be permitted.

**2F-9 PUSH-ON JOINTS:** All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations, shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed.

Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot shall be suitably beveled to facilitate assembly.

**2F-10 COUPLINGS:** Dresser couplings shall be carefully installed in accordance with the manufacturer's recommendations.

Flexible couplings shall be installed at joints between ductile iron pipe and pipe of unlike material. Flexible couplings shall be concrete encased.

**2F-11 SHOP COATING AND LINING:** The interior surfaces of all pipe for gravity sewers, drain lines and dewatering lines shall be provided with the standard cement lining. The exterior surfaces of all pipe and fittings shall be shop coated with a bituminous coating.

**2F-12 CONCRETE ENCASEMENT:** Concrete encasement shall be installed where and as shown on the drawings. Concrete and reinforcing steel shall be in accordance with the cast-in-place concrete section. All pipe to be encased shall be suitably supported and blocked in proper position and shall be anchored against floatation.

**2F-13 LEAKAGE:** All joints shall be watertight and free from leaks. Each leak which is discovered within one year after final acceptance of work by the Owner shall be repaired by and at the expense of the Contractor.

**2F-14 MARKING:** Each pipe or fitting shall be plainly and permanently marked thereon:

a. Pipe Class.
b. Manufacturer's Name or Trademark.
c. Nominal Pipe Size.
d. Weight.
e. Date of Manufacture.
f. Sampling Period.

**DIVISION 2**
**SECTION 2G - MANHOLES**

**2G-1 GENERAL:** This section covers standard, drop, and wetwell manholes. Manholes shall be constructed complete with covers, steps, fittings, and other appurtenances, in accordance with the details shown on the drawings.

At the option of the Contractor, manholes shall be constructed of precast concrete sections or cast-in-place concrete.

Only manholes which are required to have inside pipe and fittings for dropping sewage into the lower line will be designated as drop manholes. Outside drop manholes shall not be allowed. All drop manholes shall have a minimum inside diameter of 5 feet.

**2G-2 MATERIALS:**

| | |
|---|---|
| Portland Cement: | ASTM C150, Type II. |
| Concrete: | ASTM C94 with compressive strength of 3000 psi at 28 days. Curing and protection shall be in accordance with Section "Cast-In-Place Concrete ". |
| Brick: | ASTM C32, Grade MS or ASTM C62, Grade SW. |
| Granular Backfill: | See bedding requirements Section 2A and this Section. |
| Precast Sections: | |
| Standard and Drop Manhole: | Circular precast concrete; ASTM C478 except as modified |
| Wet well Manhole: | Reinforced concrete pipe; ASTM C76, Class II, Wall B. |
| Minimum Thickness: | As indicated on drawings. |
| Openings: | Circular shaped boxout for each connecting pipe, with A-Lock locking-type gaskets installed by manhole manufacturer. |
| Hydrated Lime: | ASTM C207, Type S. |
| Sand: | Concrete sand, fine aggregate, sieved through 8 mesh screen. |
| Shrinkage-Correcting Aggregate: | Master Builders "Embeco" Sida"Kemox", or Sonneborn “Ferrolith G-DS”. |
| Mortar: | One part portland cement, 1/2 part hydrated lime, 3 parts sand. |

| | |
|---|---|
| Nonshrinking Mortar: | Premixed or job mixed; job mixed shall be one part shrinkage-correcting aggregate, one part portland cement, and one part sand. |
| Gaskets: | |
| Mastic: | Fed Spec SS-S-210; K.T. Snyder "Ram-Nek." |
| Rubber: | Neoprene or other synthetic, 40 plus or minus 5 hardness when measured by ASTM D2240, Type A durometer. |
| Rubber Joint Filler: | Natural or synthetic. |
| Hardness: | 40 plus or minus 5 when measured by ASTM D2240, Type A durometer. |
| Tensile Strength: | 1200 psi minimum. |
| Coal Tar Paint: | Koppers "Bitumastic Super-Service Black", Porter "Tarmastic 103" or Tnemec "46-449, Heavy Duty Black." |
| Manhole Steps: | |
| Cast Iron: | ASTM A48, with asphalt varnish coating applied at the foundry. |
| Composition: | Plastic ASTM 2146 Type II, Grade 16906. Steel reinforcing bar ASTM A615. |
| Manhole Frame and Cover: | ASTM A48, with asphalt varnish coating applied at the foundry. Frame and Cover shall be equal to a Neenah R-1642, Deeter 1247 or EJ 1045 Frame with 1040 AGS Cover imprinted with “City of Clever Sanitary Sewer”. Frames and covers located in locations where traffic, storm water, and or other significant loadings may exist shall be approved by the City of Clever on a case by case basis to assure proper application of selected frame and cover. |

**2G-3 DELIVERY:** Precast concrete sections shall not be delivered to the job until representative concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.

**2G-4 INSPECTION:** Precast concrete sections and brick shall be inspected when delivered and all cracked or otherwise visibly defective units rejected.

**2G-5 CONSTRUCTION:** All mortar shall be used within 40 minutes after mixing. Mortar

which has begun to take on initial set shall be discarded and not be mixed with additional cement or new mortar.

In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with as large radius of curve as practicable. All inverts shall be troweled to a smooth clean surface.

Circular precast sections shall be provided with a rubber or mastic gasket to seal joints between sections. The space between connecting pipes and the wall of precast sections shall be equipped with A-Lock Locking-type gaskets or equal to be installed at the factory.

**2G-6 WATERPROOFING:** Manholes shall be waterproofed by application of heavy duty coal tar coating applied over entire exterior surface to attain a dry film thickness of not less than 15 mils. Surface to receive coating shall be thoroughly dry.

**2G-7 FRAMES AND COVERS:** Frames shall be set so that the top of the cover is flush with finished pavement or two inches higher than finish grade in unpaved areas except where noted otherwise on the drawings.

**2G-8 PIPE CONNECTIONS:** Pipe connections shall be such that differential settlement between pipe and manholes is permitted and shall be made using waterstops, A-Lok gaskets, standard O-ring gaskets, special manhole couplings, or other methods as approved.

**2G-9 STUBS:** Future connections shall be provided in manholes at the locations shown on the drawings. Stubs shall be not less than 3 feet long and shall terminate in a bell plug. Final length shall be determined by City for future anticipated connection.

**2G-10 HOLES:** Core holes and handling holes shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to the Engineer.

**2G-11 PAINTING:** If castings arrive on the job without a foundry coating, one coat of coal tar paint shall be applied. Before painting all castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the paint is dry and hard.

**DIVISION 2**
**SECTION 2H - SEWER ACCEPTANCE TESTING**

**2H-1 SCOPE:** This section covers the performance testing of the installed sewer, manholes and force main.

**2H-2 GENERAL:** The Contractor shall provide at his expense all necessary pumping equipment, testing water, means of conveying test water to the testing site to include piping connections between the piping and the nearest available source of test water, pressure gauges, and other equipment, materials and facilities necessary for the tests.

All pipe, fittings, valves, pipe joints and other materials which are found to be defective shall be removed immediately and replaced with new and acceptable material by and at the expense of the Contractor.

**2H-3 SEWER PERFORMANCE TESTING:** Each reach of sewer shall be performance tested and shall meet the requirements of the following performance tests. It shall be the responsibility of the contractor to notify the City of Clever at least 24 hours in advance of the time and place at which testing work will be done. All defects shall be repaired to the satisfaction of the Engineer and the City of Clever.

**2H-3.01** Lamping: Each straight section of sewer between manholes shall be straight and uniformly graded. At the request of the City of Clever, each such section will be lamped by the Contractor under the supervision of an Engineer or other approved City of Clever personnel.

**2H-3.02** Air Testing: The Contractor shall conduct air testing of lines, air testing shall be in accordance with ASTM F1417-92 "Installation Acceptance of Plastic Gravity Sewer Pipe Using Low Pressure Air". A minimum pressure of 4 psi for 4 minutes or longer, as necessary in the opinion of the City or City's Engineer shall be maintained through each reach of sewer.

On a case by case basis as an alternative to air testing of lines the Contractor may conduct an exfiltration test on each reach of sewer between manholes. Exfiltration tests shall be conducted by blocking off all manhole openings except those connecting with the reach being tested, filling the line and measuring the water required to maintain a constant level in the manholes. Each manhole shall be subjected to at least one exfiltration test. During the exfiltration test, the water level shall be maintained at the top of the frame and cover on each manhole to locate all leaks.

The total exfiltration shall not exceed 200 gallons per inch of nominal diameter per mile of pipe per day for each reach tested. For purposes of determining maximum allowable leakage, manholes shall be considered sections of 48 inch pipe. The exfiltration tests shall be maintained on each reach for at least 2 hours and as much longer as necessary, in the opinion of the Engineer or City Inspector, to locate all leaks.

The Contractor shall provide, at his own expense, all necessary piping between the reach to be tested and the source of water supply, together with equipment and materials required for the tests.

If the leakage in any reach exceeds the allowable minimum, it shall be re-tested after the leaks are repaired.

**2H-3.03** Vertical Deflection: Initial installed vertical deflection for flexible pipe (PVC sewer pipe) shall not exceed 5 percent. The Contractor shall test the initial installed vertical deflection by pulling a mandrel or other device through all reaches of sewer to demonstrate that the 5 percent deflection limitation has not been exceeded. The deflection testing shall not be performed until a minimum of 30 days after backfilling of pipe. The method of test shall be acceptable to the City or City's Engineer. The Contractor shall submit all deflection test results to the City.

**2H-4 MANHOLE PERFORMANCE TESTING:** Each manhole shall be performance tested and shall meet the requirements of the following performance tests. It shall be the responsibility of the contractor to notify the City of Clever at least 24 hours in advance of the time and place at which testing work will be done. All defects shall be repaired to the satisfaction of the Engineer and the City of Clever.

**2H-4.01** Vacuum Testing: Each manhole shall undergo vacuum testing. A vacuum of 5 inches of mercury for a period of 5 minutes is required or as much longer as necessary, in the opinion of the City or the City's Engineer, to locate all leaks.

**2H-5 FORCE MAIN PERFORMANCE TESTING:** The force main shall be subjected to hydrostatic pressure testing and leakage testing as specified herein.

All testing work shall be done in the presence of the Engineer. The Contractor shall notify the City at least three days in advance of the times and places at which testing work is to be done.

**2H-5.01** Pressure Testing: The Contractor shall provide all necessary pumping equipment, piping connections, pressure gauges, anchored or blocked test plugs, and all other equipment, materials, and facilities necessary for the tests.

The test pressure at any point in the pipeline shall be equal to 100 psi. The test pressure shall be maintained for at least 30 minutes and for whatever longer period is necessary for the Engineer to inspect the pipeline.

All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed immediately and replaced with new and acceptable material, by and at the expense of the Contractor. Following such replacement, the pressure test shall be repeated. Such replacement of defective materials and re-testing shall continue until the line and all parts thereof withstand the test pressure in a satisfactory manner.

**2H-5.02** Leakage Test: After the specified pressure test is completed and all pipeline repairs have been made and retested to the satisfaction of the Engineer, the line being tested shall be subjected to a leakage test.

The hydrostatic pressure during leakage testing may be any predetermined pressure selected by the Contractor provided that it does not exceed and is at least 75 percent of the pressure specified for pressure testing.

The selected pressure shall be maintained constant (within a maximum variation of plus or minus 5 percent) during the entire time that line leakage measurements are being made.

Leakage measurements shall not be started until a constant test pressure is established; compression of air trapped in unvented pipes or fittings will give false leakage readings under changing pressure conditions. After the selected test pressure is stabilized, the line leakage shall be measured by means of a suitable water meter installed in the pressure supply piping on the line side of the force pump. The water meter shall be furnished and installed by the Contractor.

Line leakage shall be the total amount of water introduced into the line as measured by the meter during the leakage test.

Each leakage test shall have a duration of 2 hours plus whatever additional period is necessary to accurately determine leakage in the opinion of the Engineer.

The pipeline will not be accepted if the leakage indicated by the test is in excess of that determined by the following formula:

where: $Q = 0.015\ DxLxN$

Q = Allowable leakage in gallons per hour
D = Nominal diameter of pipe in inches
L = Length of section tested in thousand feet
N = Square root of average test pressure in psi

**2H-5.03** Defects: It is the intent of these specifications that all joints in piping shall be watertight and free from visible leaks during the prescribed leakage test and each and every leak which may be discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the Owner shall be located and repaired by and at the expense of the Contractor, regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

The specified leakage test is to be made after the pipeline has been backfilled and the joints covered. If such test shows a leakage rate in excess of the permissible maximum, the Contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount. Where evidence of leaking joints does not appear on the ground surface above or near the leaks, the Contractor shall prospect the line by sinking a hole, with an auger or otherwise, at the location of each joint and determine any undue saturation of the soil which would indicate a leak at such joint; such prospecting shall be done after pressure has been maintained in the line a sufficient time to provide adequate soil saturation for locating leaks by this method.

**DIVISION 2**
**SECTION 2I – WATERLINE ACCEPTANCE TESTING**

**2I-1 GENERAL:** This section covers simultaneous hydrostatic pressure testing and leakage testing of the waterline. The pipelines shall be tested as specified herein.

It shall be the responsibility of the contractor to notify the Engineer and City of Clever personnel at least 24 hours in advance of the time and place at which testing work will be done. All defects shall be repaired to the satisfaction of the Engineer and the City of Clever.

Temporary discharge piping shall be provided for wasting test water at a suitable remote location where such water will drain away from the work.

**2I-2 PRESSURE/LEAKAGE TEST:** The pipelines shall be subjected to a simultaneous hydrostatic pressure and leakage test. The test shall be conducted prior to connection of the pipeline to the existing water lines. All shutoff valves shall be open during pressure testing. Anchored or blocked test plugs shall be provided as necessary.

**2I-3 FILLING AND VENTING THE LINE:** The pipelines shall be slowly filled with water and all air expelled from the pipe. Vents shall be provided where necessary. A suitable plug shall be provided for the tapped vents.

**2I-4 TESTING EQUIPMENT FACILITIES:** The Contractor shall provide all necessary pumping equipment, piping connections, pressure gauges, anchored or blocked test plugs, and all other equipment, materials, and facilities for the tests.

**2I-5 TEST PRESSURE:** During the test the pipeline shall be subjected to 150 percent of the working pressure at the point of the test, but not less than 125 percent of normal working pressure at the highest elevation in the pipeline. Working pressure is defined as the maximum anticipated sustained operating pressure.

**2I-6 TEST DURATION:** The test pressure shall be maintained for at least 2 hours or for whatever longer period is necessary for the City to inspect the pipeline.

**2I-7 LEAKAGE MEASUREMENT:** Leakage shall be defined as the quantity of water that must be supplied into the pipe section being tested to maintain a pressure within 5 psi of the specified leakage-test pressure after the pipe has been filled with water and the air in the pipeline has been expelled.

**2I-8 ALLOWABLE LEAKAGE:** No installation will be accepted if the leakage is greater than that determined by the formula:

$$L = \frac{ND(P)^{1/2}}{7{,}400}$$

WHERE:

L = Allowable leakage (gal/hr)
N = Number of joints in the length of pipeline tested
D = Nominal diameter of pipe (inches)
P = Average test pressure during the leakage test (psi-gauge)

**2I-9 DEFECTS:** It is the intent of these specifications and the contract based thereon that all joints in piping shall be watertight and free from visible leaks during the prescribed leakage test and each and every leak which may be discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the City shall be located and repaired by and at the expense of the Contractor, regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

If the specified leakage test is made after the pipeline has been backfilled and the joints covered, and such test shows a leakage rate in excess of the permissible maximum, the Contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount. Where evidence of leaking joints does not appear on the ground surface above or near the leaks, the Contractor shall prospect the line by sinking a hole, with an auger or otherwise, at the location of each joint and determine any undue saturation of the soil which would indicate a leak at such joint; such prospecting shall be done after pressure has been maintained in the line a sufficient time to provide adequate soil saturation for locating leaks by this method.

Leaks in mechanical joints shall be repaired by dismantling, cleaning, realigning gland and gasket, and rebolting. Under no circumstances shall gland bolts be tightened beyond the specified and allowable torque limits in an attempt to reduce or stop leakage from a defective joint or for any other purpose.

**2I-10 REPETITION:** Materials shall be replaced as necessary and the pressure test shall then be repeated until the line and all parts thereof withstand the test in a satisfactory manner.

**DIVISION 2**
**SECTION 2J - WATERLINE DISINFECTION**

**2J-1 GENERAL:** The waterline shall be disinfected with a strong chlorine solution. Disinfecting may be done concurrently with pressure and leakage testing or after pressure and leakage testing at the option of the Contractor. All necessary disinfection equipment and materials shall be provided by the Contractor. Disinfection work shall conform to the requirements of AWWA C651-99, "Standard for Disinfecting Water Mains" as modified or supplemented herein.

**2J-2 DISINFECTANTS:** The forms of chlorine that may be used in the disinfection operations are liquid chlorine, sodium hypochlorite solution, and calcium hypochlorite granules or tablets.

1. Liquid Chlorine: Liquid chlorine conforming to ANSI/AWWA B301 contains 100% available chlorine and is packaged in steel containers usually of 100-lb, 150-lb, or 1-ton net chlorine weight. Liquid chlorine shall be used only: (1) in combination with appropriate gas-flow chlorinators and ejectors to provide a controlled high-concentration solution feed to the water to be chlorinated; (2) under the direct supervision of someone familiar with the physiological, chemical, and physical properties of liquid chlorine who is trained and equipped to handle any emergency that may arise; and (3) when appropriate safety practices are observed to protect working personnel and the public.

2. Sodium Hypochlorite: Sodium hypochlorite conforming to ANSI/AWWAB300 is available in liquid form in glass, rubber-lined, or plastic containers typically ranging in size from 1 qt. to 5 gal. Containers of 30 gal. or larger may be available in some areas. Sodium hypochlorite contains approximately 5% to 15% available chlorine, and the storage conditions and time must be controlled to minimize its deterioration.

3. Calcium Hypochlorite: Calcium hypochlorite conforming to ANSI/AWWA B300 is available in granular form or in 5-g tablets, and must contain approximately 65% available chlorine by weight. The material should be stored in a cool, dry, and dark environment to minimize its deterioration. Minimum contact time to allow tablets to dissolve shall be 7 hours.

**2J-3 FEEDING:** Pipelines shall be disinfected by the tablet method, the continuous feed method or the slug method in accordance with ANSI/AWWA C651-99.

1. Tablet Method: The tablet method consists of placing calcium hypochlorite granules or tablets in the water main as it is being installed and then filling the main with potable water when installation is completed. This method shall be used only if the pipes and appurtenances are kept clean and dry during construction.

2. Continuous Feed Method: The continuous feed method consists of placing calcium hypochlorite granules in the main during construction (optional), completely filling the main to remove all air pockets, flushing the completed main to remove particulates, and filling the main with potable water. The potable water shall be chlorinated so that after a 24 hour period in the main there will be a free chlorine residual of not less than 10 mg/l.

3. Slug Method: The slug method consists of placing calcium hypochlorite granules in the main during construction; completely filling the main to eliminate all air pockets; flushing the main to remove particulates; and slowly flowing through the main a slug of water dosed with chlorine to a concentration of 100 mg/l. The slow rate of flow ensures that all parts of the main and its appurtenances will be exposed to the highly chlorinated water for a period of not less than 3 hours.

   During disinfection all valves shall be operated to insure that all appurtenances are disinfected.

**2J-4 BACTERIOLOGICAL TESTS:** After the chlorine solution is flushed out of the line and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the new main. At least one set of samples shall be collected from every 1,200 ft of the new water main, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater; and shall show the absence of coliform organisms; and, if required, the presence of a chlorine residual. Turbidity, pH, and a standard heterotrophic plate count or test may be required at the option of the purchaser, because new material does not typically contain coliform but does typically contain HPC bacteria.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by Standard Methods for the Examination of Water and Wastewater. No hose or fire hydrant shall be used in the collection of samples. The record of compliance shall be the bacteriological test results certifying that the water sampled from the new water main is free of coliform bacteria contamination and is equal to or better than the bacteriologic water quality in the distribution system.

**2J-5 REDISINFECTION:** If initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained.

**DIVISION 2**
**SECTION 2K - CHAINLINK FENCE**

**2K-1 SCOPE:** This section covers chainlink fencing and gates. Fencing shall be provided in the alignment indicated on the drawings at the pump station sites.

**2K-2 FENCE TYPE:** Fencing shall consist of galvanized or aluminum coated steel fence with a fabric height of 6 feet and overall height of 7 feet from the bottom of the fabric to the top of the barbed wire. The fence shall have a top rail, bottom tension wire, and three strands of barbed wire mounted on 45 degree extension arms. The upper strand should be approximately 12 inches out from the fence and 12 inches above the top of the fabric. Posts shall be set in concrete.

**2K-2.01 Wooden Privacy Fence:** In lieu of chainlink fencing the Contractor may provide a wooden privacy fence assuming materials have been approved by the City or the City's Engineer.

**2K-3 MATERIALS:**

**2K-3.01** Steel Fencing: All steel or malleable iron parts and accessories shall be hot-dip galvanized or aluminum coated after fabrication.

| | |
|---|---|
| Fabric | 9 gage, 2 inch mesh; galvanized ASTM A392, Class II or aluminum coated ASTM A491, Class II: barbed salvage top and bottom. |
| Posts | Steel H-Section, 0.35 percent carbon; steelpipe, ASTM A120, standard weight (Schedule40) or steel hollow structural tubing, A500 or A501. |
| Line Posts | H-Section, 4.10 lb. per ft.; 2-3/8 in. ODpipe, 3.65 lb. per ft.; or 2 inch square, 3.85 lb. per ft. |
| Terminal Posts | End, corner, and pull posts, 2-7/8 inch OD pipe, 5.79 lb. per ft.; or 2-1/2 inch square 5.59 lb. per ft. |
| Gate Posts | 4 inch OD pipe, 9.10 lb. per ft. or 3 inch square, 9.10 lb. per ft. |
| Top Rail | 1-5/8 inch OD steel tubing, 140 lb. per ft. |
| Rail Couplings | Sleeve Type, 6 inches long. |
| Bracing | Pipe brace same as top rail, with 3/8 in. diameter steel rod truss and tightener. |
| Post Tops | Pressed steel, malleable iron with pressed steel extension arm, or one piece aluminum casting with hole for top rail, designed to prevent entry of moisture into tubular posts. |
| Barbed Wire | Galvanized ASTM A121, Class 2 or aluminum coated ASTM S585, Class II, tow 12-1/2 gage steel wires with a 4 |

| | |
|---|---|
| | point barbs. |
| Stretcher Bars | Steel, 3/5 inch by 3/4 inch or equivalent area. |
| Fabric Ties | Aluminum hands or wires. |
| Gate Frames | Steel tubing, 1-7/8 inch OD, 2.09 lb. per ft. or 2 inch square, 2.10 lb. per ft. |
| Tension Wires | Galvanized or aluminum coated coil spring wire, 7 gauge. |

**2K-3.02** Padlocks: Schlage, Yale, Russwen 2863; padlocks to have removable cylinders and be master keyed as directed by the owner.

**2K-4 GATES:** Gates shall be swing type, hinged to swing 90 degrees from closed to open, complete with frames, latches, stops, keepers, hinges, fabric, braces, padlocks, and three strands of barbed wire. Gate leaves shall have intermediate members and diagonal truss rods as required for rigid construction and shall be free from sag or twist. When adjacent fence has barbed wire, gates shall be fitted with vertical extension arms or shall have frame and members extended to carry barbed wire. Joints between frame members shall be made by welding or by means of heavy fittings, and shall be rigid and water tight. The fabric on the gates shall match the fence and shall be attached to frame ends by stretcher bars, bolt hooks, or other mechanical means.

Hinges shall be heavy pattern with large bearing surfaces and shall not twist or turn under the action of the gate. Latches shall be plunger bar type, full gate height, and arranged to engage the gate stop. Latches shall be arranged for padlocking with the padlock accessible from both sides of the gate. Stops shall consist of a roadway plate with anchor set in concrete and arranged to engage the plunger. Keepers shall consist of mechanical devices for securing and supporting the free end of the gates when in full open position.

Gates shall be installed so that they cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be peened so that removal will be difficult.

**2K-5 FENCE CONSTRUCTION:** The installed fence shall conform to the alignment and finish grade indicated. All posts shall be plumb and unless shown or required shall be spaced 10 feet apart. Where necessary, the fence grade shall be adjusted to fit the ground contour by slipping the fence fabric links. On steep grades, the posts may be set normal to the slope provided transition sections are constructed. Ground surface irregularities shall be graded as required to maintain not more than 2 inch clearance below the bottom of the fence fabric.

Where posts are set in earth, concrete foundations 36 inches deep shall be provided. Concrete foundations shall be circular in horizontal section, not less than 10 inches in diameter for line posts, and with a diameter not less than the post OD plus 9 inches for terminal and gate posts, except that foundations in bedrock shall be a minimum of 6 inches larger than the outside dimension of the post. Foundations shall extend above the ground surface and shall be crowned approximately one inch. Concrete for foundations shall conform to the cast-in-place concrete section. Each

foundation shall be cured for at least 72 hours before further work is done on the post.

Top rails and bottom tension wires shall be installed before the fabric. Top rails shall be furnished in at least 18 foot lengths and shall be securely connected to gate terminal and gate posts. A terminal post shall be provided at each change in slope.

Fabric shall be attached to the top rail, and bottom rail, or bottom tension wire at 24 inch centers and to the line posts at 15 inch centers. Barbed wire shall be fastened to each extension arm by internal clips or external fabric ties. Stretcher bars shall be provided at each gate, terminal, and pull post. Each stretcher bar shall be threaded through the fabric and anchored to the post at 15 inch centers by positive mechanical means.

Each gate, terminal, and pull post for the 6 foot fencing shall be braced by a horizontal pipe brace and an adjustable truss extending to an adjacent line post. Corner posts shall be braced in both directions.

Fabric shall be stretched taut and anchored so that a pull of 150 pounds at the middle of a panel will not lift the bottom of the fabric more than 6 inches.

All surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a heavy coat of coal tar paint.

**2K-6 DRAWINGS AND DATA:** Complete detail drawings and specifications for the fence, gates, and accessories shall be submitted for review by the City or the City's Engineer.

**DIVISION 2**
**SECTION 2L - CRUSHED ROCK SURFACING**

**2L-1 SCOPE:** This section covers crushed rock surfacing at the pump station sites, 15-foot wide access roads, and all other locations requiring crushed rock surfacing.

**2L-2 MATERIALS:** Aggregate shall be produced by crushing hard, durable limestone meeting the requirements of Section 1006 of the Missouri State Highway Commission Standard Specification, except as otherwise specified hereinafter. The deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 12 percent.

| Deleterious Material | Percent by Weight |
|---|---|
| Deleterious Rock & Shale | 12.0 |
| Mud Balls | 5.0 |
| Other Foreign Material | 2.0 |

The material shall be graded within the following limits:

| Sieve Designation | Percent by Weight Passing |
|---|---|
| 1" | 100 |
| ¾" | 80-100 |
| No. 4 | Not more than 60 |
| No. 10 | 10-35 |
| No. 200 | 0-10 |

**2L-3 APPLICATION:** Hauling of surfacing material will not be permitted when, in the opinion of the engineer, the weather or roadbed conditions are such that hauling operations would cause cutting or rutting of the roadbed. The material shall be placed only on approved subgrade.

**2L-4 PLACEMENT AND COMPACTION:** Sub grade shall consist of the compaction of earth below the rock base by rolling, tamping or any combination of these methods to meet minimum 98 percent compaction.

**2L-5 MAINTENANCE:** The Contractor shall maintain the surfacing at his own expense and to the satisfaction of the City until final acceptance of the work.

**DIVISION 2**
**SECTION 2M – SEEDING AND SODDING**

**2M-1 GENERAL:** The work covered by this section consists of furnishing all labor, equipment, and materials necessary for the preparation, fertilization, seeding, and mulching of the areas specified. All disturbed areas shall be seeded and mulched except for sodded areas, surfaced areas, and solid rock. Disturbed areas outside of authorized construction limits shall be seeded and mulched, or sodded at the contractor's expense.

**2M-2 TOPSOIL:** Topsoil shall consist of a fertile, friable soil of loamy character, free of sub-soil, stumps, stones, refuse, and other foreign material. It shall contain a normal amount of natural humus and be reasonably free of roots, hard dirt, heavy or stiff clay, coarse sand, noxious weeds, noxious weed seeds, sticks, brush, and other litter. The topsoil shall be obtained from well-drained, arable land and be of even texture so that all the soil will pass a one-half (1/2) inch screen. The topsoil shall not be infested with nematodes or with any other noxious animal life or toxic substances. Sandy loam of low fertility, even though mixed with leaf mold, manure, or other fertilizers, will not be accepted.

**2M-3 SEED:** Provide grass seed for established areas in a blend as specified below, unless directed otherwise by the landowner or City.

a. 75% by weight of a three-way blend (equal parts) of turf fescues, consisting of any three of the following varieties: Olympic, Falcon, Bonanza, Rebel, Hound Dog, Astro 2000, Eldorado, Wrangle, FineLawn One, Anthem, or Apache.

b. 15% by weight of Perennial Rye, consisting of one or more of the following varieties: Affinity, Derby, Regal, Manhattan, or Chateau.

c. 10% by weight of Bluegrass, consisting of either Kentucky Bluegrass, Park Bluegrass, or both.

d. Purity of seed shall be 98%.

e. Germination shall be 85%.

**2M-4 FERTILIZER:** Provide a mixture containing 13 pounds each of soluble nitrogen, phosphate, and potash per 100 pounds.

**2M-5 MULCH**: Materials for mulch shall consist of native hay, straw, or other approved locally available material. Mulch material which contains an excessive quantity of matured seed of noxious weeds or other species which would grow and be detrimental to overseeding or provide a menace to farm land will not be acceptable.

**2M-6 GRADING AND SEEDING:** Unless otherwise specified, all disturbed areas shall be graded with at least 4" of topsoil. Before final raking, areas to be seeded shall be fertilized with the specified mixture by spreading evenly using a mechanical spreader of the rotary type. The area shall then be raked to a smooth even surface, the soil loosened to a depth of at least 1" and seeded. The seed shall be evenly distributed over the area at a rate of 3 pounds per 1,000 square feet using a mechanical seeder. The seeded area shall be maintained as necessary until the project

is completed.

**2M-7 MULCH FOR HYDRAULICALLY SEEDED AREAS:** Provide a mixture of 50% recycled slick paper mulch and 50% ground corrugated paper mulch by weight. The recycled slick paper mulch shall be produced from printer's slick paper containing wood cellulose and kaolin clay. Newsprint is not allowed. The \slick paper mulch shall have a maximum moisture content of 8% by weight, and shall have a pH of 4.5 to 6.5. The corrugated paper mulch shall have a moisture capacity of 700 grams water per 100 grams dry mulch minimum, a dry moisture content of 12% maximum, and a pH of 5.0 to 8.0. All mulch materials must be free of any germination or growth-inhibiting substances, green in color, and have the property of being evenly dispersed and suspended when agitated in water.

Clean wheat straw shall be material applied over the hydraulic mulch.

**2M-8 SEED FOR PASTURE AND CROPLAND AREAS:** Match as nearly as possible the species in existence prior to disturbance. Alfalfa or other exotic grasses will not be replaced but will be compensated if the land is privately owned. All cost shall be borne by the contractor.

**2M-9 REPLACEMENT OF PLANTS, TREES, SHRUBS, SOD:** Plants, trees, shrubs and sod shall be replaced with the same strain as removed and approximately the same size and dimensions as those removed including trees up to 4 inches in diameter.

**2M-10 SOD:** Machine cut, strongly rooted, certified turf-grass sod, at least 2 years old, and be relatively free of weeds or other undesirable native grasses. Provide sod capable of vigorous growth and development when planted (viable, not dormant). Composed primarily of Kentucky bluegrass. Moisten sod to depth at which it is to be cut when stripped during dry periods. Provide sod in uniform thickness of 5/8-inch, plus or minus ¼-inch, measured at time of cutting and excluding top growth and thatch. Strips shall be of supplier's standard size of uniform length and width with maximum 5% allowable deviation in either length or width. Broken or torn pads, or pads with uneven ends are not acceptable. Sod pads shall be capable of supporting their own weight and retaining size and shape when pad is suspended vertically from a firm grasp on upper 10% of pad. Handle sod with care to prevent loss of native soil from roots.

**2M-11 LIMING MATERIAL:** Shall consist of agricultural liming materials conforming to the Missouri Agricultural Liming Materials Act of 1976.

**DIVISION 2**
**SECTION 2N - DEMOLITION**

**2N-1 SCOPE:** This work shall consist of the removal and satisfactory disposal of existing structures, except such structures, or portions thereof, as may be required or permitted to be left in place by the plans and specifications or at the direction of the City.

## 2N-2 CONSTRUCTION METHODS:

**2N-2.01** General: Unless otherwise specified, all portions of existing structures within the right-of-way above the ground surface as it existed before the work was started, that interfere in any way with the new construction shall be removed.

When explosives are used in demolition, the contractor shall use the utmost care to prevent injury to persons and property, and shall meet all requirements of the City for handling explosives.

Blasting or other operations which might endanger the new work shall be completed prior to the construction of any part of the new system.

**2N-2.02** Removal of Concrete and Other Structures: Existing structures shall be removed for their entire width and depth unless otherwise noted on the plans.

**2N-2.03** Disposal of Concrete and Other Materials: All concrete and masonry, reinforcement steel, or structural steel not salvageable, shall be disposed of by the contractor at his own expense, and to the satisfaction of the City at a location provided by the contractor outside the limits of the right-of-way. Any of the above materials deposited adjacent to the right-of-way shall be deposited with the written approval of the property owner. In addition, all disposal of waste construction material will be in accordance with Missouri Solid Waste Laws rules and regulations.

**2N-3 BASIS OF PAYMENT:** The cost of removal and disposal of all existing structures, concrete and other materials shall be considered as included in the unit prices included in the contract.

## 2N-4 REMOVAL OF EXISTING PAVEMENT, CURB, AND COMBINATION CURB AND GUTTER:

**2N-4.01** Scope: This work shall consist of the removal and satisfactory disposal of existing asphaltic concrete pavement, base course, curb, curb and gutter and similar objects.

**2N-4.02** General: Unless otherwise specified, all portions of existing pavement, curb, combination curb and gutter and similar objects within the right-of-way above the ground surface as it existed before the work was started, that interfere in any way with the new construction shall be removed.

Where portions of these objects are to be left in place, they shall be removed to an existing joint or to a new joint sawed to a minimum depth of 1" with a true line and vertical face. Sufficient portions of such objects shall be removed to provide for proper grade and connection to the new work.

**DIVISION 3**
**SECTION 3A - PORTLAND CEMENT CONCRETE**

**3A-1 DESCRIPTION:** The concrete described herein shall consist of a mixture of Portland cement, fine aggregate, coarse aggregate, an air-entraining agent and water combined in the proportions specified for the various classes of concrete used in construction work and as set forth in these specifications.

**3A-2 MATERIALS:** Cement shall be a standard brand Portland cement which shall form to ASTM Designation C-150. Type I/II cement shall be used unless otherwise provided in the special provisions.

Different brands or different types of cement from the same brand or type from different mills shall not be mixed or used alternately in the same item of construction unless authorized by the City or the City's Engineer.

The Contractor shall not store cement at the site of the work without prior approval from the City or the City's Engineer.

The right is reserved by the City to sample the cement either at the origin of the shipment or after delivery at the site of the work or the ready-mix concrete plant. Professional acceptance by the City prior to completion of tests shall in no way act as a waiver of the right to reject cement which has been shipped and not used if, on completion of the tests, it fails to meet the requirements of the specifications.

**3A-3 WATER:** Water used with cement in concrete or mortar shall be clean, clear, free from sugar and shall be free from injurious quantities of oil, acid, alkali, salt, organic matter, vegetable matter or other deleterious substances.

**3A-4 FINE AGGREGATE:** Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof. The gradation requirements of fine aggregate shall be as follows:

| | |
|---|---|
| Passing 3/8 inch Sieve | 100 percent |
| Passing No. 4 Sieve | 95-100 percent |
| Passing No. 16 Sieve | 40-80 percent |
| Passing No. 50 Sieve | 5-30 percent |
| Passing No. 100 Sieve | 0-10 percent |

Fine aggregate shall conform to the requirements of ASTM Designation C-33 with respect to deleterious substances, soundness and abrasion.

**3A-5 COURSE AGGREGATE:** The coarse aggregate shall consist of a crushed stone or crushed gravel of uniform quality. The gradation requirements of the coarse aggregate for Class "A" concrete shall be as follows:

| | |
|---|---|
| Passing 1 inch Sieve | 100 percent |
| Passing No. 3/4 Sieve | 90-100 percent |
| Passing No. 1/2 Sieve | 40-60 percent |

| | |
|---|---|
| Passing No. 3/8 Sieve | 10-30 percent |
| Passing No. 4 Sieve | 0-5 percent |

The gradation requirements of the Coarse aggregate for Class "X" concrete shall be as follows:

| | |
|---|---|
| Passing 1 inch Sieve | 100 percent |
| Passing No. 1/2 Sieve | 25-60 percent |
| Passing No. 4 Sieve | 0-10 percent |
| Passing No. 8 Sieve | 0-5 percent |

Coarse aggregates shall conform to the requirements of ASTM Designation C-33 with respect to deleterious substances, soundness and abrasion.

**3A-6 AIR-ENTRAINMENT:** The air-entrainment shall be obtained by the use of an approved air-entrainment admixture conforming to ASTM Designation C260, which shall be added during the process of mixing the concrete. Air-entrainment Portland cement hall not be used. The admixture shall be dispensed by means of a mechanically activated dispenser approved by the City or the City's Engineer, except that in the case of ready-mix concrete the flow may be started manually and the flow shall shut off automatically when the required amount is delivered. The air-entraining admixture shall be introduced into the stream of mixing water and the required amount shall be fully discharged before all the mixing water has entered the drum. The tank feeding the dispenser shall at all times contain an amount of air-entraining admixture sufficient for the next batch and shall be provided with a device approved by the City or the City's Engineer for indicating visually when the supply runs low. The amount of admixture to be used shall be not less than three (3) percent or more than six (6) percent of the volume of the concrete.

**3A-7 FLY ASH:** Fly Ash shall conform to ASTM Designation C-618.

**3A-8 PROPORTIONS OF MATERIALS:** Class "A" concrete and Class "X" concrete shall contain not less than 470 pounds of cement per cubic yard.

**3A-9 WATER CONTENT:** The mixing water, including free surface moisture on the aggregate, shall not exceed six (6) gallons per sack of cement. The slump, when tested in accordance with ASTM Designation C-143 shall be from one (1) inch to three (3) inches for curb and gutter sections and four (4) inches +/- one (1) inch in all other areas.

**3A-10 AIR CONTENT:** Portland cement concrete shall have air-testing of not less than three (3) percent nor more than six (6) percent of the volume of the concrete when tested in accordance with ASTM Designation C-173.

**3A-11 FLY ASH CONTENT:** The Portland cement concrete shall contain not more than 100 pounds of fly ash per cubic yard.

**3A-12 MIX PROPORTIONS:** In addition to the above requirements, the concrete materials shall be proportioned so as to provide a uniform workable mix. Prior to the beginning of construction, the Engineer may require the Contractor to furnish a written statement giving the

properties of the materials and the proportions by weight (dry) of cement and of the fine and coarse aggregates that are proposed to be used in each class of concrete.

**3A-13 GENERAL REQUIREMENTS:** Concrete pouring operations shall be discontinued when a descending ambient temperature away from artificial heat reaches 40 degrees Fahrenheit and not resumed until an ascending ambient temperature away from artificial heat reaches 35 degrees Fahrenheit. If it is necessary for the Contractor to take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates or applying heat directly to the contents of the mixer; aggregates shall not be heated higher than 150 degrees Fahrenheit, when cement is added. The temperature of the mixed concrete when heating is employed shall not be less than 30 degrees Fahrenheit and not more than 90 degrees Fahrenheit at the time of placement. Cement or fine aggregate containing lumps or crusts of hardened material or frost shall not be used. Concrete shall not be placed upon a frozen subgrade.

Ordinarily the concrete shall be delivered to the job site in trucks so designed and operated that the concrete will be thoroughly mixed during the time it is in transit and shall be discharged at the site within a period of one and one-half ( 1 1/2) hours after the introduction of the mixing water. When concrete is placed at the job site, it shall have the proper consistency and slump for satisfactory workability.

Testing shall be at the expense of the Contractor and shall consist of a slump test performed on each batch of concrete delivered. The slump test will be made after all on-site water has been added to the concrete prior to discharging. Three (3) test cylinders will be collected each day on random deliveries as directed by the City or the City's Engineer. Cylinders shall have a minimum 28-day compressive strength of 4,000 psi.

**DIVISION 3**
**SECTION 3B - GROUTING**

**3B-1 SCOPE:** This section covers grouting of pump, motor, and equipment baseplates or bedplates; other miscellaneous baseplates; and other uses of grout as shown on the drawings. All grouting shall be done with nonshrink grout.

**3B-2 MATERIALS:**

| | |
|---|---|
| Nonshrinking Grout | Master Builders "Special LL-713 Grout", Sauereisen Cements "F-100 Level Fill Grout", or U.S. Grout "Five Star Grout". |
| Water | Clean and free from deleterious substances. |

**3B-3 EXECUTION:** Grout shall be furnished factory premixed so that only water is added at the job site. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.

**3B-3.01** Preparation: The concrete foundation to receive grout shall be saturated with water for 24 hours prior to grouting.

**3B-2.02** Placement: Grout shall be placed in strict accordance with the directions of the manufacturer so that all space beneath baseplates and bedplates is completely filled without voids.

**3B-3.03** Edge Finishing: In all locations where the edge of the grout will be exposed to view, the grout after it has reached its initial set shall be finished smooth. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.

**3B-3.04** Curing: Grout shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 7 days.

**DIVISION 4**
**SECTION 4A - PORTLAND CEMENT CONCRETE CURB AND GUTTER**

**4A-1 SCOPE OF WORK:** Furnish all labor, materials, and equipment to perform all operations in connection with construction of concrete curb and gutter, in accordance with the specifications and drawings, subject to the terms and conditions of the contract.

**4A-2 MATERIALS:** Class "A" Concrete shall be Portland Cement Concrete in accordance with Section 3A of these specifications. Admixtures shall not be used unless specifically approved by the Engineer.

Expansion joints shall be made with performed expansion joint filler of a non-extruding type conforming to ASTM Designation D1751, configuration of the curb and gutter as indicated in Standard Drawing section included in this specifications book.

Joint sealing compound for contraction joints shall be CRS-2 Asphalt Emulsion meeting the requirements of ASTM Designation D3405. Curing compound shall be a white pigmented membrane-forming liquid conforming to the requirements of ASTM Designation C309, Type 2.

**4A-3 FORMS:** Forms shall be made of metal and shall have a depth equal to or greater than the prescribe edge the thickness of pavement slab. The minimum length of each section of form used shall be ten (10) feet. Each section or form shall be uniform and free from undesirable bends or warps.

The maximum deviation of the top surface of any section shall not exceed one-eighth (1/8) inch, or the inside face not more than (1/4) inch from planned alignment. The method of connection between sections shall be such that the joint thus formed shall be free from movement in any direction. Forms shall be of such cross-section and strength and so secured as to resist the pressure of the impact and vibration of any equipment which they support, without springing or settlement.

Every (10) foot length of form shall have at least three (3) form braces and pin sockets which shall be spaced at intervals of not more than five (5) feet, having the end brace and socket not more than six (6) inches from the end of the form. Approved flexible forms shall be used for construction where the radius is 150 feet or less.

The subgrade under the forms shall be compacted and cut to grade so that the form when set will be uniformly supported for its entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are free from play or movement in any direction. The supply of forms shall be sufficient to permit their remaining in place for at least twelve (12) hours after the concrete has been placed. All forms shall be cleaned and oiled prior to use.

The alignment and grade elevations of the forms shall be checked by the Contractor and the necessary corrections made immediately before placing the concrete. When any form has been disturbed or any subgrade thereunder has become unstable, the forms shall be reset and rechecked.

**4A-4 PLACING CONCRETE:** The subgrade shall be moist, but not muddy, at the time of placing of the concrete. If required by the City or the City's Engineer, the prepared subgrade shall be saturated with water the previous night, or not less than (6) nor more than (20) hours prior to placing the concrete. If the subgrade subsequently becomes too dry, it shall be sprinkled again

ahead of placing the concrete, in such a manner as not to form mud or puddles of water.

Contractor shall give the City at least eight (8) hours advance notice before placing concrete and the subgrade shall be checked and approved by the City or the City's Engineer before any concrete is placed.

The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade to the required depth and width of the curb and gutter in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. While being placed, the concrete shall be vibrated with suitable tools so that the formation of voids or honeycomb pockets is prevented.

The concrete shall be especially well vibrated and tamped against the forms along all joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab.

No concrete shall be placed around manholes or other structures until they have been adjusted to the required grade and alignment.

**4A-5 FINISHING:** The curb shall be tooled to the required radii as soon as possible after the concrete takes its initial set. The gutter shall be shaped with a wood float at least (4) feet long. After the face forms and templates are removed, the joints shall be tooled and the surface shall be final finished with a hard bristle broom to remove all imperfections without additional mortar or dryer. In all cases, the resulting surface shall be smooth and of uniform color, free from sags, twists or warps and true to the specified lines and grades shown on the plans.

**4A-6 JOINTS:** Expansion Joints shall be formed with bituminous preformed expansion joints three-quarters (3/4) inch thick or as specified on the plans and precut to exact cross section of curb shall be placed at all driveway radii and intersection radii and at intervals of not more than two hundred (200) feet, and at the location shown on the plans or standard drawings, so that they are not moved by depositing and compacting the concrete at these joints. Preformed expansion joint filler shall be of nonextruding type and shall conform to ASTM Designation D1751.
Contraction Joints shall be sawed or formed with templates at intervals between not greater than 25 feet and at the location shown on the plans or standard drawings and shall be sawed to a depth of one and one-half (1 1/2) inches. Asphaltic material used in filling these joints shall be CRS-2 asphalt emulsion or as approved by the City or the City's Engineer. Contraction joints in proposed medians shall match the location of joints in pavement. A template shall be one-quarter (1/4) inch thick, cut to the configuration of the curb section shown on the plans. Templates shall be secured so that they are not moved by depositing and compacting the concrete.

Unless otherwise shown on the plans, and as soon as the concrete has hardened sufficiently, the templates shall be rounded with an edging tool of one-eight (1/8) inch radius.

**4A-7 CURING:** Immediately after the finishing operation has been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be

sealed by spraying with a uniform application of white pigmented membrane curing compound, at the rate of one gallon for each 150 square feet of surface. If rains fall on the newly coated surface before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the contractor will be required to apply additional curing material to the affected portions.

**4A-8 COLD WEATHER PROTECTION:** Cold weather protection shall be as provided in Section 3A-13 of these specifications.

**4A-9 CURB AND GUTTER:** Curb and gutter laid by slip-form or extruding equipment will be accepted providing it complies with all of the above requirements other than forms.

**4A-10 BACKFILLING:** After curing, the curb shall be immediately backfilled to within four (4) inches of the top curb to eliminate any possibility of washing beneath the curb. The remaining four (4) inches shall be topsoil.

**4A-11 DRIVEWAY ENTRANCES:** At all entrances to residences or commercial buildings the concrete curb shall be removed by saw cutting of either side of the entrance. After cutting, the exposed ends will be rounded off by applying grout to provide a pleasing appearance. Removal of curb by sledge hammer without first saw cutting shall not be allowed. All replacement curbing and gutter pan shall be installed to provide positive drainage as originally designed.

**DIVISION 4**
**SECTION 4B - PORTLAND CEMENT CONCRETE PAVEMENT AND INTEGRAL CONCRETE CURB**

**4B-1 SCOPE OF WORK:** The work shall consist of furnishing all labor, materials, and equipment necessary to perform all operations in connection with construction of Portland Cement Concrete Pavement, in accordance with the specifications and drawings, subject to the terms and conditions of the contract.

**4B-2 MATERIALS:** Class "A" Concrete shall be Portland Cement Concrete in accordance with Section 3A of these specifications. Reinforcing steel, if specified by the plans, shall consist of deformed bars of grade 40 steel conforming to the requirements of ASTM Designation A615 or of wire fabric conforming to ASTM Designation A185.

Expansion Joints shall be preformed expansion joint fillers of a non-extruding type conforming to ASTM Designation D1751.

Joint sealing compound for sawed contraction joints and construction joints shall be grade CRS-2 asphalt emulsion, or as approved by the Engineer.

Metal supports for tiebars or reinforcing bars shall be channel shaped pressed out of 12-gauge sheet steel or heavier or as shown on the plans.

Dowel bars, where specified, for transverse joints shall be smooth, round bars of the size specified. Burrs, mill scale and rust shall be removed. The free end shall be painted with a suitable paint followed by a thin uniform coating of graphite grease.

Expansion tubes or dowel caps shall be manufactured from 32 gauge sheet metal, shall be indented to provide a limiting stop for the dowel bar and shall provide unobstructed expansion space of not less than one inch to permit movement of the dowel bar. They shall be of proper size to fit the specified bars tightly and the closed end shall be watertight.

Curing compound shall be a white pigmented membrane-forming liquid conforming to the requirements of ASTM Designation C309, Type 2.

**4B-3 FORMS:** Forms shall be made of metal and shall have a depth equal to or greater than the prescribed edge thickness of the pavement slab. The minimum length of each section of form used shall be ten (10) feet. Each section of form shall be uniform and free from undesireable bends or warps.

The maximum deviation from planned grade of the top surface of any section shall not exceed one-eighth (1/8) inch, or the inside face not more than one-fourth (1/4) inch from planned alignment. The method of connection between sections shall be such that the joint thus formed shall be free from movement in any direction. Forms shall be of such cross-section and strength and so secured as to resist the pressure of the concrete when planed, and the impact when planed, and the impact and vibration of any equipment which they support, without springing or settlement.

Each ten (10) foot length of form shall have at least three (3) form braces and pin sockets which

shall be spaced at intervals of not more than five (5) feet, having the end brace and socket not more than six (6) inches from the end of the form. Approved flexible forms shall be used for construction where radius is 150 feet or less.

The subgrade under the forms shall be compacted and cut to grade so that the form when set will be uniformly supported for its entire length at the specified elevation. Forms shall be joined neatly and in such a manner that the joints are free from play or movement in any direction. The supply of forms shall be sufficient to permit their remaining in place for at least twelve (12) hours after the concrete has been placed. All forms shall be cleaned and oiled prior to use.

The alignment and grade elevations of the forms shall be checked by the Contractor and the necessary corrections made immediately before placing the concrete. When any form has been disturbed or any subgrade thereunder has become unstable, the form shall be reset and rechecked.

**4B-4 PLACING CONCRETE:** Contractor shall refer to Division 4, Section 4A-4 for placement of concrete.

**4B-5 CONSOLIDATING AND FINISHING:** The pavement shall be struck off and consolidated with a mechanical finishing machine or by hand-finishing methods. When a mechanical finishing machine is used, the concrete shall be struck off at such a height that after consolidated and finishing it shall be at the elevations as shown on the plans. A depth of excess concrete shall be carried in front of the strike-off screed for the full width of the slab, whenever the screed is being used to strike off the pavement. The finishing machine shall be provided with a screed which will consolidate the concrete pressure. The concrete shall, through the use of this machine, be brought to a true and even surface, free from rock pockets, with the fewest possible number of passes of the machine. The edge of the screeds along the curb line may be notched out to allow for sufficient concrete to form the integral curb. Hand-finishing tools shall be kept available for use in the event the finishing machine becomes non- functional.

When hand-finishing is used, the pavement shall be struck off and consolidated by a vibrating screed or other approved equipment to the elevation shown on the plans. When the forward motion of the vibrating screed is stopped, the vibrator shall be shut off; and not be allowed to idle on the concrete. Internal mechanical vibration shall be used alongside all formed surfaces.

**4B-6 FLOATING, STRAIGHTENING AND EDGING:** After the concrete has been struck off and consolidated, it shall be further smoothed by means of a wood or aluminum float at least five (5) feet wide with a handle long enough to reach the entire width of the slab being placed. The float shall be operated so as to remove any excess water and laitance as well as surface irregularities. After the floating operation, the pavement surface should be within the specified tolerances.

While the concrete is still plastic, the slab surface shall be tested for smoothness with a ten (10) foot straightedge swung from handles three (3) feet longer than one-half the width of the slab. The straightedge shall be placed on the surface parallel to the center line of the pavement and at not more than five (5) foot intervals transversely. After each test the straightedge shall be moved forward one-half of its length and the operation repeated.

When irregularities are discovered, they shall be corrected by adding or removing concrete. All disturbed places shall again be floated with the wooded float and rechecked with a straight edge. The pavement surface shall have no depression in which water will stand.

Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be carefully finished with an edger of the radius shown on the plans.

**4B-7 FINAL SURFACE FINISH:** A broom finish shall be used as the final finishing method. A hard bristle broom shall be used which shall be kept clean and used in such a manner as to provide a uniform textured surface. The curb shall have the same final touch as the pavement.

The final surface of the concrete pavement and curb shall have a uniform gritty texture free from excessive roughness and true to the grades and cross section shown on the plans. The Engineer may require changes in the final finishing procedure as required to produce the desired final surface texture.

**4B-8 JOINTS:** Longitudinal and transverse joints shall be constructed as shown on the plans or standard drawings.

Longitudinal joints are those joints parallel to the lane of construction. They may be either center joints or the construction joints between construction lanes.

Traverse joints shall be contraction joints or contraction joints or construction joints. Construction joints are put in transversely whenever construction operations require them.

Expansion joints may be either longitudinal or transverse. They are used only where specifically shown on the plans or standard drawings.

The edges of the pavement and those joints where such edging is shown on the plans shall be rounded with an edger having a radius of not larger than 1/8 inch. Transverse joints, except keyed and tied construction joints, shall be continuous across the entire paved area including the curb.

**4B-9 TRANSVERSE JOINTS:** Transverse joints shall be contraction, expansion or construction joints. Contraction and expansion joints shall be placed as indicated on the plans and construction joints wherever construction may require them. They shall make a right angle with the center line of the pavement and with the surface of the subgrade.

Expansion joints shall be installed in accordance with the size and locations shown on the plans, and shall conform to the "Materials" requirements of these specifications. They shall conform to the exact configuration of the curb section. The filler shall be held accurately in place during the placing and finishing of the concrete by means of a bulkhead, a metal channel cap or other approved methods.
Under no circumstances shall any concrete be left above or below the expansion material or across the joint at any point. Any concrete spanning the ends of the joint next to the forms shall be carefully cut away after the forms are removed.

Transverse contraction joints shall be of the sawed type, unless otherwise shown on the plans. Care must be taken to saw the joints soon after concrete placement to prevent contraction cracks. All transverse joints shall be sawed at least 1/4 of the slab depth. Any procedure for sawing joints that results in premature and uncontrolled cracking shall be revised immediately by adjusting the time interval between the placing of the concrete and the cutting of the joint.

Transverse construction joints of the type shown on the plans or standard drawings shall be placed wherever the placing of concrete is suspended for more than 30 minutes. A butt type joint with dowels shall be used if the joint occurs at the location of a contraction joint. Keyed joints with tiebars are used if the joint occurs at any other location.

If joints are to be equipped with dowels, they shall be of the dimension and at the spacing and location indicated on the plans. They shall be firmly supported in place, and accurately aligned parallel to the pavement grade and the center line of the pavement by means of a dowel support which will remain in the pavement and will insure that the dowels are not displaced during construction. One-half of each dowel shall be painted and greased and in an expansion joint, one end shall be equipped with a tight fitting expansion tube of the dimensions shown on the plans and conforming to the requirements of Section 4B-2 - "Materials" of these Specifications.

**4B-10 LONGITUDINAL JOINTS:** Longitudinal joints shall be placed as shown on the plans or standard drawings. They shall be of the sawed or the keyed construction type, unless otherwise shown on the plans.

Sawed longitudinal center joints shall be sawed grooves made with a concrete saw after the concrete hardened. The saw cut shall be at least 1/4 of the slab depth. These joints are otherwise formed in the same manner as the transverse sawed joints entitled "Transverse Contraction Joints."

Longitudinal keyed construction joints (i.e. joints between construction lanes) shall be of the dimensions shown on the plans or standard drawings.

**4B-11 TIEBARS:** Tiebars or tiebolts when shown on the plans or standard drawings shall be of deformed steel and of the dimensions and at the spacing specified. Tiebars shall be firmly supported by subgrade chairs or so installed as not to be displaced during construction operation.

**4B-12 JOINT SEALER:** After the curing period, all sawed and dummy groove joints in the pavement shall be cleaned and sealed with material meeting the requirements of Section 4B-2 - "Materials" of these Specifications. All foreign materials, joint sawing residue, dirt and curing membrane shall be removed. Joints shall be lightly underfilled (about 1/2 inch) to prevent extrusion of sealer. Any excess material should be removed from the pavement surface as soon after sealing as possible.

**4B-13 STRUCTURES:** All manholes, catch basins, or structures of a permanent nature encountered in the area to be paved shall be raised or lowered as the case may be, to the surface of the new pavement, and the necessary expansion joint material placed around each structure for the full depth of the slab and of the thickness shown on the plans or standard drawings.

**4B-14 CURING:** Immediately after the finishing operation has been completed and as soon as marring of the concrete will not occur, then entire surface of the newly placed concrete shall be sealed by spraying with a uniform application of white pigmented membrane curing compound, at the rate of one gallon for each 150 square feet of surface. If rain falls on the newly coated surface before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply additional curing material to the affected portions.

**4B-15 COLD WEATHER PROTECTION:** Cold weather protection shall be provided as necessary.

**4B-16 TOLERANCE IN PAVEMENT THICKNESS:** It is the intent of these specifications that pavement shall be constructed strictly in accordance with the thickness shown on the plans. The thickness of the pavement will be measured, and where any pavement is found deficient in thickness, in excess of one inch, it shall be removed and replaced.

The thickness of the pavement will be determined by average caliper measurement of cores. For the purpose of determining the construction thickness of the pavement, 10 cores per mile will be taken at random intervals in each traffic lane. In addition, cores may be taken at other locations as may be determined by the Engineer. If the measurement of any core is deficient in excess of one (1) inch from the plan thickness, additional cores will be taken at 25-foot intervals parallel to center line ahead and back of the affected location until the extent of the deficiency has been determined.

It will be assumed that each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along center line, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section.

The drilling of cores in irregular areas, or on projects involving less than 2500 square yards of concrete pavement, may be waived by the City. In this case the designed thickness will be considered as the measured thickness.

**4B-17 PROTECTION AND OPENING TO TRAFFIC:** The Contractor shall protect the pavement against all damage prior to final acceptance of the work by the City or the City's Engineer. Traffic shall be excluded from the pavement by erecting and maintaining barricades and signs for at least seven days.

**4B-18 PAVING BY SLIP FORM:** Slip-forming equipment will be accepted providing it produces a paving operation in compliance with all the foregoing requirements other than forms.

**4B-19 INTEGRAL CURB:** The work shall consist of furnishing all labor, materials, and equipment necessary to construct integral curbs in accordance with the plans and specifications. Integral curbs shall be required along the edges of all street pavements as indicated on the plans, except at such locations as the City or the City's Engineer may direct. Depressed curbs shall be provided at all driveway entrances and sidewalks shown on the plans.

**4B-20 MATERIALS:** Class "A" concrete shall be Portland Cement Concrete in accordance with

these Specifications.

Expansion joints shall be preformed expansion joint fillers of a non-extruding type conforming to ASTM Designation D1751.

Joint sealing compound for sawed contraction joints and construction joints shall be grade CRS-2 emulsified asphalt, or as approved by the City or the City's Engineer.

Liquid curing compound shall be a white pigmented membrane-forming liquid conforming to the requirements of the ASTM Designation C309, Type 2.

**4B-21 CONSTRUCTION METHODS:** The integral curb shall be constructed immediately following the finishing operation unless otherwise shown on the plans. Special care shall be taken so that the curb construction does not lag the pavement construction and form a "Cold Joint".

Metal curb forms shall be required to form the backs of all curbs except where street returns of small radius or other special sections make the use of steel forms impractical.

The drilling of cores in irregular areas, or on projects involving less than 2500 square yards of concrete pavement, may be waived by the City or the City's Engineer. In this case the designed thickness will be considered as the measured thickness.

**4B-22 PAVING BY SLIP FORM:** Slip-forming equipment will be accepted providing it produces a paving operation in compliance with all the foregoing requirements other than forms.

In placing curb concrete, sufficient vibrating shall be done to secure adequate bond with the paving slab and eliminate all voids in the curb.

Curbs shall be formed to the cross section as shown on the drawings with a mule or templates supported on the side forms and with a wood float not less than four feet in length.

The finished surface of the curb and gutter shall be checked by the use of the 10 foot straightedge and corrected if necessary. Where grades are flat and while concrete is still plastic, the Engineer may require the Contractor to check the drainage at the gutter by pouring water at the gutter summit and observing its flow to the inlet. In order to prevent damage to the concrete surface, water should be poured onto a piece of impervious paper or plastic.

In the construction of transverse joints of concrete integral curb pavement, special care must be taken to see that all transverse joints extend continuously through the pavement and curb.

**DIVISION 4**
**SECTION 4C - PLANT MIX BITUMINOUS SURFACE COURSE**

**4C-1 SCOPE OF WORK:** The work shall include all labor, equipment, and materials necessary for the furnishing, mixing, hauling, placing and consolidation of plant mix bituminous surface course in accordance with the drawings and contract documents.

**4C-2 MATERIALS:** Asphalt cement for Surface Course shall meet, at a minimum, PG grade 64-22, homogeneous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to all standard industry requirements for the specified grade.

NOTE - The spot test shall be conducted in accordance with AASHTO T102, with the following modifications: Add to Section 5.2.1, "If, however, the drop forms a uniformly brown circular stain, the test shall be reported as negative. In case of dispute, the entire test shall be repeated. "Delete Section 5.3 through 7.3, inclusive."

**4C-3 COURSE AGGREGATE***:* All course aggregate shall consist of sound, durable rock, free from cemented lumps or objectionable coatings. When tested in accordance with AASHTO T96, the percentage of wear shall not exceed 50. The percentage of delirious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 8 percent.

| Rock Type | Percent by Weight |
|---|---|
| Deleterious Rock | 8.0 |
| Shale | 1.0 |
| Other foreign material | 0.5 |

The requirements of this section apply to each size or fraction of aggregate produced.

If a density requirement is specified for plant mix bituminous surface course the total quantity of chert in each size or fraction of produced crushed stone aggregate, including that permitted as deleterious, shall not vary more than 10 percentage points from the quantity present in the aggregates used in the approved laboratory job mixtures.

**4C-4 FINE AGGREGATE:** Fine aggregate for plant mix bituminous surface course shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature. With written approval of the City or the City's Engineer, chat sand produced from flint chat in the Joplin area, or fines manufactured from crushed limestone, igneous rock and chert gravel, or wet bottom boiler slag may be used as fine aggregate for plant mix bituminous surface course. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coatings or injurious material. The percentage of deleterious substances shall not exceed the following values:

| Item | Percent by Weight |
|---|---|
| Clay lumps and shale | 1.0 |
| Total lightweight particles, including coal and lignite | 0.5 |
| Other deleterious substances | 0.1 |

Lightweight sand particles are not considered deleterious lightweight particles. The total

lightweight particles requirement shall not apply to wet bottom boiler slag, angular chert sand, or manufactured sand.

**4C-5 MINERAL FILLER:** Mineral filler shall consist of limestone dust, portland cement, or other suitable mineral matter. It shall be thoroughly dry and free of lumps of aggregations or fine particles. When tested in accordance with AASHTO T37 the mineral filler shall conform to the following gradation requirements:

| Sieve SizePassing | Percent |
|---|---|
| Passing No. 30 sieve | 100 |
| Passing No. 50 sieve | 95-100 |
| Passing No. 100 sieve | 90-100 |
| Passing No. 200 sieve | 70-100 |

The gradation of coarse aggregate shall be such that the total aggregate meets the gradation requirements specified hereafter in Section 4C-6 Composition of Mixtures.

**4C-6 COMPOSITION OF MIXTURES:** The total aggregate prior to mixing with asphalt cement, shall meet the following requirements for Grade D mixture:

| Grade D Gradation | Percent by Weight |
|---|---|
| Passing 3/4 inch sieve | 100 |
| Passing 1/2 inch sieve | 95-100 |
| Passing No. 4 sieve | 60-90 |
| Passing No. 10 sieve | 35-65 |
| Passing No. 40 sieve | 10-30 |
| Passing No. 200 sieve | 4-12 |

The combinations of materials as required in this section shall meet the gradation requirements specified for the work.

Not less than 15 percent or more than 30 percent natural siliceous sand, porphyry sand, manufactured sand or flint sand of approved quality shall be added as a separate ingredient. Sand shall have 100 percent passing the 3/8-inch sieve and not more than six (6%) percent passing the No. 200 sieve.

The composition of the mixture shall conform to the following limits by weight:

| Item | Percent |
|---|---|
| Total Mineral Aggregate | 92.0 - 96.5 |
| Asphalt Cement | 3.5 - 8.0 |

**4C-7 JOB-MIX FORMULA:** Prior to preparing any of mixture on the project, the Contractor

shall submit for the City or the City's Engineer's approval, a job-mix formula for the mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the City. The job-mix formula shall be within the gradation range specified and shall include the type and sources of all materials, the gradation of the aggregates, and the relative quantity of each ingredient and shall state a definite percentage for each fraction of aggregate. No job-mix formula will be approved which does not permit within the limits specified in Section 4C-6, Composition of Mixture, the full tolerances specified in 4C-8, Changes in Proportion, for asphalt cement and not less than 1/2 the tolerances designated for material passing the No. 10 sieve and the material passing the No. 200 sieve. The job-mix formula approved for the mixture shall be in effect until modified in writing by the City or the City's Engineer. When unsatisfactory results or other conditions make it necessary or should a source of material be changed, a new job-mix formula may be required.

**4C-8 CHANGES IN PROPORTIONS:** The City or the City's Engineer will make such changes in the proportions of asphalt cement and aggregates as he considers necessary within the limits of the specifications. The proposed mixture will be compacted and tested in a laboratory in accordance with AASHTO T167 and the bulk specific gravity will be determined in accordance with the procedures described in AASHTO T165.

The mixture of mineral aggregate and asphalt cement shall result in a bituminous mixture which will be durable and retain satisfactory cohesion in the presence of moisture. Chemical additions approved by the City or the City's Engineer may be made to the asphalt cement or to the mixture.

**4C-9 GRADATION CONTROL:** In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls.

Total aggregated gradation shall be within the master range specified in Section 4C-6, Composition of Mixture, for Grade D mixture.

Maximum variation from the approved job-mix formula shall be within the following tolerances:

| | |
|---|---|
| Passing No. 10 sieve | + 5.0 percentage points |
| Passing No. 200 sieve | + 2.0 percentage points |

Quality of Asphalt Cement introduced into the mixture shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt cement specified in the job-mix formula without written approval of the Engineer. The quantity of asphalt cement determined by calculation or tests on the final mixture shall not vary more than + 0.5 percentage points from the job-mix formula.

**4C-10 COMMERCIAL MIXTURE:** The Contractor may, at his option, use an approved commercial mixture. The Contractor shall, at least 7 days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture he proposes to furnish. The statement shall include (1) the types and sources of aggregates, percentage range of each, and range of combined gradation; (2) the percent and grade of asphalt; and (3) the mixing time and range of

mixture temperature. The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. If the proposed mixture and plant are approved by the City or the City's Engineer, the component materials and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with each truck load, a certification in triplicate that the materials and mixture delivered are in conformance with his approved proposal. The mixture shall be transported, placed and compacted as specified herinafter.

**4C-11 WEATHER LIMITATIONS:** Bituminous mixtures shall not be placed (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 40 degrees Fahrenheit, (2) on any wet or frozen surface, or (3) when weather conditions prevent the proper handling or finishing of the mixture.

**4C-12 SUBGRADE PREPARATION:** The subgrade upon which bituminous surface course is to be placed shall be prepared in accordance with the requirements as shown on the plans. If the bituminous surface course is to be placed upon the top of a complete base course or existing hard surfaced pavement, then the base course or existing pavement will be considered the subgrade for the next operation.

**4C-13 TACK COAT:** The asphalt cement material used for tack coat shall be emulsified asphalt meeting the requirements of AASHTO M140 or M208, and shall be Grade SS-1 or SS-1H as designated by the City or the City's Engineer.

**4C-14 PREPARATION OF SURFACE:** The existing surface shall be free of all dust, loose material, grease, or other foreign material at the time the tack is applied. Any fat bituminous surface mixture or bituminous joint material will be removed by others without cost to the Contractor before the tack is applied. The surface shall be dry when the tack is applied, except in the case of emulsified asphalt.

**4C-15 APPLICATION:** Bituminous material shall be applied uniformly with a pressure distributor at the rate specified in the contract, or as revised by the Engineer to be within a minimum of 0.02 and a maximum of 0.10 gallon per square yard. In using emulsified asphalt water may be added to the material and mixed therewith in such proportion that the resulting mixture will contain not more than 50 percent of added water, the exact quantity of added water to be specified by the Engineer. The application of the resulting mixture shall be such that the original emulsion will be spread at the specified rate. The tack material shall be heated at the time of application to the temperature specified in the following table. The tack material shall be properly cured and the tacked surface shall be cleaned of all dirt and surplus sand before the next course is placed.

**APPLICATION TEMPERATURES FOR BITUMINOUS MATERIALS**
**Temperature in Degrees Fahrenheit**

| Bituminous Material | Spraying Min. | Spraying Max. | Mixing Asphalt Emulsions Min. | Mixing Asphalt Emulsions Max. |
|---|---|---|---|---|
| SS-1 | 75 | 130 | 75 | 130 |
| SS-1H | 75 | 130 | 75 | 130 |

The tack coat shall be applied in such manner as to cause the least inconvenience to traffic. The tack may be applied full width, provided the tacked surface is blotted with sand in such quantity as specified by the City or the City's Engineer before it is opened to traffic.

**4C-16 HAULING EQUIPMENT:** Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum quantity of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the bed. Each load shall be covered with canvas or other suitable material of sufficient size to protect the mixture from the weather. When necessary, truck beds shall be insulated so that the mixture will be delivered on the road to meet the requirements. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed during daylight.

**4C-17 SPREADING:** The base course, primed surface, or preceding course or layer shall be cleaned of all dirt, packed soil, or any other foreign material prior to spreading the bituminous mixture. When delivered to the roadbed, the mixture shall be at a temperature which will permit proper placement and compaction. It shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. The paver shall be operated at a speed that will give the best results. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed during daylight.

**4C-18 SURFACE CONDITION:** The mixture shall be spread without tearing the surface and struck off so that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with suitable mixture. The outside edges of the pavement shall be constructed to an angle of approximately 45 degrees with the surface of the roadbed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

**4C-19 SPOT WEDGING AND LEVELING COURSE:** Leveling course, consisting of a layer of variable thickness used to eliminate irregularities in the existing surface, shall be spread to the desired grade and cross section. Rigid control of the placement thickness of the leveling course will be required. Spot wedging operations over small areas, with featheredging at high points and ends of spot areas, may be required prior to placing the leveling course. The use of an approved finishing machine will be required on the spot wedging and leveling course, except that the spreading of the spot wedging with a blade grader will be permitted if results indicated the mixture is practically free from segregation.

**4C-20 JOINTS:** Longitudinal and transverse joints shall be carefully made and well bonded. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer. A single lane of any layer shall not be constructed to a length for which the adjacent

lane cannot be completed in succeeding operating day. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches; however, the joints in the final layer shall be at the lane lines of the travel way.

At locations designated in the contract or as specified by the Engineer, approaches shall be tacked in accordance with Section 4C-13, Tack Coat, and surfaced with a plant mix bituminous mixture. The bituminous surface shall be placed in accordance with the details shown on the typical section or as specified by the Engineer. Approaches shall not be surfaced until after the surface course adjacent to the entrance is completed. No direct payment will be made for any work required to condition and prepare the subgrade on the approaches.

The mixture shall be thoroughly compacted by at least three complete coverages over the entire area with either a pneumatic tire roller weighing not less than 10 tons, or a tandem-type steel wheel weighing not less than 10 tons. All rollers used shall be in satisfactory condition, capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roll or wheel. Rolling shall begin as soon after spreading the mixture as it will bear the weight of the roller without undue displacement. Final rolling shall be done by the steel wheel roller. Rolling shall be performed at proper time intervals and shall be continued until there is no visible evidence of further consolidation and until all roller marks are eliminated.

The finished course shall have the nominal thickness shown on the plans and shall be substantially free from waves or irregularities. The final riding surface, except on medians and similar areas, shoulders, and temporary bypasses shall not vary from a 10-foot straightedge, applied parallel to the center line, by more than 1/8 inch. At transverse construction joints, the surface of all other layers shall not vary from the 10-foot straightedge by more than 1/4 inch. Surfaces exceeding these tolerances shall be re-rolled, replaced, or otherwise corrected in a manner satisfactory to the Engineer.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture showing an excess of asphalt cement or that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with satisfactory mixture, which shall be immediately compacted to conform to the surrounding area.

It is the intent of these specifications that the combined thickness of the plant mix bituminous surface course and the plant mix bituminous base course will be measured, and where the total thickness is found to be deficient, corrective actions will be taken as indicated hereinafter.

The total combined thickness of the bituminous surface course and the bituminous base course will be measured and determined by average caliper measurement of cores. For the purpose of determining the constructed thickness, 10 cores per mile will be taken at random integrals in each traffic lane. In addition, cores may be taken at other locations as may be determined by the City or the City's Engineer. If the measurements of any core is deficient in excess of one-quarter (1/4) inch from the plan thickness, additional cores will be taken at 25-foot intervals parallel to center line ahead and back of the affected location until the extent of the deficiency has been determined.

It will be assumed that each core is representative of the total combined thickness for a distance extending one-half the distance to the next core, measured along center line, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section.

The areas of deficiency shall be corrected by the addition of plant mix bituminous surface course material and the areas shall be recompacted in accordance with these specifications. The limits of the area of deficiency shall be defined as the transverse distance from the outside edge of the pavement to the center line of the street and a minimum longitudinal distance of 15 feet in both directions from the deficient core. If the number of deficient pavement locations exceeds four (4) per 1/4 mile or if the total area of deficient pavement sections exceed five (5) percent of the total pavement area in 1/4 mile, the Contractor shall be required to resurface the entire 1/4 mile street surface area with a minimum thickness of one-half (1/2) inch of plant mix bituminous surface course. Additional test cores will be taken in order to determine if the deficiencies have been corrected. The costs of all such additional check cores will be at the Contractor's expense. The surface form which the cores have been taken shall be restored by the Contractor within 48 hours using a mixture acceptable to the City or the City’s Engineer.

**DIVISION 4**
**SECTION 4D - PLANT MIX BITUMINOUS BASE COURSE**

**4D-1 SCOPE OF WORK:** The work shall include all labor, equipment, and materials necessary for the furnishing, mixing, hauling, placing and consolidation of plant mix bituminous base course in accordance with the plans and contract documents.

**4D-2 MATERIALS:** Asphalt cement for Base Course shall meet, at minimum, PG grade 64-22, homogeneous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to all standard industry requirements.

**4D-3 FINE AGGREGATE:** Fine aggregate for bituminous surface course shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature. With written approval of the Engineer, chat sand produced from flint chat in the Joplin area, or fines manufactured from crushed limestone, igneous rock and chert gravel, or wet bottom boiler slag may be used as fine aggregate for plant mix bituminous surface course. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coatings or injurious material. The percentage of deleterious substances shall not exceed the following values:

| Item | Percent by Weight |
|---|---|
| Clay lumps and shale | 1.0 |
| Total lightweight particles, including coal and lignite | 0.5 |
| Other deleterious substances | 0.1 |

Lightweight sand particles are not considered deleterious lightweight particles. The total lightweight particles requirement shall not apply to wet bottom boiler slag, angular chert sand, or manufactured sand.

**4D-4 MINERAL FILLER:** Mineral filler shall consist of limestone dust, portland cement, or other suitable mineral matter. It shall be thoroughly dry and free of lumps of aggregations of fine particles. When tested in accordance with AASHTO T37 the mineral filler shall conform to the following gradation requirements:

| Sieve Size Passing | Percent |
|---|---|
| Passing No. 30 sieve | 100 |
| Passing No. 50 sieve | 95-100 |
| Passing No. 100 sieve | 90-100 |
| Passing No. 200 sieve | 70-100 |

**4D-5 GRADED AGGREGATE:** Graded aggregate for bituminous base shall consist of sound, durable rock particles, free from objectionable coatings. When tested in accordance with AASHTO T96, the percentage of wear shall not exceed 55. The percentage of deleterious substances shall not exceed the following values and the sum or percentages of all deleterious substances shall not exceed 8 percent.

| Aggregate Type | Percent Passing By Weight |
|---|---|
| Deleterious Rock | 8.0 |
| Mud Balls and Shale combined | 2.0 |
| Clay, uniformly dispersed | 3.0 |
| Other foreign material | 0.5 |

The gradation of the course aggregate shall be such that the total aggregate meets the gradation requirements specified hereafter in Section 4D-7, Job-Mix Formula, prior to being fed into the cold aggregate feeders.

**4D-6 COMPOSITIONS OF MIXTURES:** The bituminous base shall be composed of a mixture of crushed limestone or dolomite, except as hereinafter permitted, filler if needed, and asphalt cement. The aggregate prior to mixing with asphalt cement shall meet the following gradation requirements:

| Seive Size Passing | Percent by Weight |
|---|---|
| Passing 1 inch sieve | 100 |
| Passing 1/2 inch sieve | 60-90 |
| Passing No. 4 sieve | 35-65 |
| Passing No. 10 sieve | 25-45 |
| Passing No. 40 sieve | 10-30 |
| Passing No. 200 sieve | 5-12 |

At the option of the Contractor, fine aggregate having 100 percent passing the 3/8-inch sieve and not more than 6 percent passing the No. 200 sieve may be incorporated into the mixture. The total quantity of such fine aggregate shall not exceed 30 percent by weight of the combined aggregate.

The composition of the mixture shall be as direct by the Engineer and shall conform to the following limits by weight:

| Item | Percent |
|---|---|
| Total Mineral Aggregate | 94-97 |
| Asphalt Cement | 3-6 |

**4D-7 JOB-MIX FORMULA:** Prior to preparing any of the mixture on the project, the contractor shall submit for the City or the City Engineer's approval, a job-mix formula for the mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the City. The job-mix formula shall be within the gradation range specified for bituminous base and shall include the type and sources of all materials, the gradations of the aggregates and the relative quantity of each ingredient, if more than one, and shall state a definite percentage for each fraction of aggregate. No job-mix formula will be approved which does not permit within the limits specified in Section 4D-6, Composition of Mixtures, in the full tolerances

specified Section 4D-8, Changes in Proportions, in the full tolerances specified in Section 4D-9, Gradation Control, for material passing the No. 10 sieve and the material passing the No. 200 sieve. The job-mix formula approved for the mixture shall be in effect until modified in writing by the City or the City's Engineer. When unsatisfactory results or other conditions make it necessary, or should a source of material be changed, a new job-mix formula may be required.

**4D-8 CHANGES IN PROPORTIONS:** The City or the City's Engineer will make such changes in the proportions of asphalt cement and aggregates as he considers necessary within the limits of the specifications. The proposed mixture will be compacted and tested in the laboratory in accordance with AASHTO T167 and the bulk specific gravity will be determined in accordance with the procedures described in AASHTO T165. The mixture of mineral aggregate and asphalt cement shall result in a bituminous mixture which will be durable and retain satisfactory cohesion and stability in the presence of moisture. Chemical additions approved in writing by the City or the City's Engineer may be made to the asphalt, cement, or to the mixture.

**4D-9 GRADATION CONTROL:** In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls.

Total aggregated gradation shall be within the master range specified in Section 4D-6, Composition of Mixtures, herein.

Maximum variation from the approved job-mix formula shall be within the following tolerances:

| | |
|---|---|
| Passing No. 10 sieve | +/-5.0 percentage points |
| Passing No. 200 sieve | +/-2.0 percentage points |

Quality of Asphalt Cement introduced into the mixture shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt cement specified in the job-mix formula without written approval of the City or the City's Engineer. The quantity of asphalt cement determined by calculation or tests on the final mixture shall not vary more than +/-0.5 percentage points from the job-mix formula.

**4D-10 COMMERCIAL MIXTURE:** The Contractor may, at his option, use an approved commercial mixture. The Contractor shall, at least 7 days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture he proposes to furnish. The statement shall include (1) the types and sources of aggregates, percentage range of each, and range of combined gradation; (2) the percent and grade of asphalt; and (3) the mixing time and range of mixture temperature. The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. If the proposed mixture and plant are approved by the Engineer, the component materials and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with each truck load, a certification in triplicate that the materials and mixture delivered are in conformance with his approved proposal. The mixture shall be transported, placed and compacted as specified herinafter.

**4D-11 WEATHER LIMITATIONS:** Bituminous mixtures shall not be placed (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below

35 degrees F and, (2) on any wet or frozen surface, or (3) when weather conditions prevent the proper handling or finishing of the mixture.

**4D-12 SUBGRADE PREPARATION:** The subgrade shall be prepared in accordance with the requirements Section 4C-12, Subgrade Preparation, of these specifications.

**4D-13 PRIME COAT:** The asphalt cement material used for prime coat on base rock shall be Type MC, grade MC-30 and not be homogenous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to all standard industry requirements.

**4D-14 APPLICATION:** Bituminous material shall be applied to the width of the section to be primed by means of pressure distributor in a uniform, continuous spread. The application rate shall be as specified in the contract or as revised by the Engineer between 0.2 and 0.5 gallon per square yard. The primer shall be heated at the time of application to a temperature specified in the following table.

**APPLICATION TEMPERATURES FOR BITUMINOUS MATERIALS**
**Temperature, Degrees Fahrenheit**

| | Spraying | | Mixing | |
|---|---|---|---|---|
| Bituminous Material | Min. | Max. | Min. | Max. |
| Liquid Asphalt SS1 and MC Grade 30 | 70 | 150 | 50 | 110 |

Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified quantity. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed of. Pools of primer material remaining on the surface after the application shall be removed.

When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be routed to the treated portion and the remaining width of the section shall be primed.

If, after the application of the prime coat, the bituminous material fails to penetrate, and the roadbed must be used by traffic, sand blotter material shall be spread in the quantity required to absorb any excess bituminous material.

The primer shall be properly cured, and the primed surface shall be cleaned of all dirt and surplus sand before the next course is placed.

**4D-15 TRANSPORTATION:** The prepared base course mixture shall be transported from the paving plant to the work in tight vehicles previously cleaned of all foreign materials. The inside

of truck beds shall be lubricated with a thin oil to prevent the mixture from adhering to the bed but an excess of lubricant will not be permitted. Each load shall be covered with canvas or other suitable material of sufficient size to protect it from the weather. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be done during daylight.

**4D-16 SPREADING**: The base course, primed surface, or preceding course or layer shall be cleaned of all dirt, packed soil, or any other foreign material prior to spreading the bituminous mixture. When delivered to the roadbed, the mixture shall be at a temperature which will permit proper placement and compaction. It shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. The compacted thickness of a single layer shall not exceed 4 inches except the uppermost layer directly under the surface course for travel ways and auxiliary lanes shall be placed in a single layer not to exceed the width and thickness shown on the plans. In widening construction the material may be placed in two layers, provided the thickest layer is placed first and no individual layer has a compacted thickness greater than 7 inches. On base widening work, a succeeding layer of bituminous mixture may be placed the same day as the previous layer, if it can be shown that the desired results are being obtained. On small areas, and on areas which are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods if permitted by the City or the City's Engineer.

The mixture shall be spread without tearing the surface and struck off so that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. The outside edges of the base shall be constructed to an angle of approximately 45 degrees with the surface of the roadbed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

If required by the contract, a leveling course consisting of a layer of variable thickness shall be spread to the desired grade and cross section to eliminate irregularities in the existing surface. Spot-leveling operations over small areas, with featheredging at high points and ends of spot areas, may be required prior to placing the leveling course. Rigid control of the placement thickness of the leveling course will be required. The use of an approved finishing machine will be required on the spot-leveling and the leveling course, except that the spreading of the spot-leveling with a blade grader will be permitted if results indicate the mixture is practically free from segregation.

**4D-17 JOINTS:** Longitudinal and transverse joints shall be carefully made and well bonded. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer. The longitudinal joints in one layer shall offset those in layer immediately below by approximately 6 inches.

**4D-18 COMPACTION:** Rolling shall include the use of both a pneumatic tire roller and a steel wheel roller. Rolling shall begin as soon after spreading the mixture as it will bear the weight of the roller without undue displacement. All rollers shall be in satisfactory condition capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roller wheel. A trench roller shall be used on depressed areas inaccessible to regular width equipment. The compacted mixture shall have a density of not less

than 95 percent of that obtained by the laboratory compaction of a specimen made in the proportions of the approved mixture. Density will be determined by the direct transmission nuclear method or by a specific gravity method.

In lieu of roller and density requirements, mixtures used for shoulders adjacent to rigid pavement, shoulders adjacent to resurfaced rigid pavement, temporary bypasses to be maintained at the expense of the Contractor, and areas where a commercial mixture is used shall be thoroughly compacted by at least three complete coverages over the entire area with either a pneumatic tire roller weighing not less than 10 tons, a tandem-type steel wheel roller weighing not less than 10 tons, or an approved vibratory roller. Final rolling shall be done with the tandem-type steel wheel roller. Rolling shall be performed at proper time intervals on each layer and shall be continued until there is no visible evidence of further consolidation.

**4D-19 SURFACE TOLERANCES:** The finished layers shall be substantially free from waves or irregularities and shall be true to the established crown and grade. At transverse construction joints the surface of all layers shall not vary from a 10-foot straightedge, applied parallel to the centerline, by more than 1/4 inch, except that the entire surface of the final layer of plant mix bituminous base mixture shall not vary from the 10-foot straightedge by more than 1/8 inch if this layer is used as the final riding surface course. Areas exceeding this tolerance shall be re-rolled, replaced or otherwise corrected in a manner satisfactory to the City or the City's Engineer.

**4D-20 TOLERANCE IN PAVEMENT THICKNESS:** It is the intent of these specifications that the plant mix bituminous base course shall be constructed strictly in accordance with the thickness shown on the plans. The total thickness of the pavement will be measured by coring as indicated in Section 4D, Plant Mix Bituminous Base Course. Where any pavement is found deficient in thickness, corrective actions shall be taken as indicated in that section of the specifications.

No additional compensation will be allowed the Contractor for any plant mix bituminous base course constructed in excess of the thickness requirements of the plans and specifications. The surface from which the cores have been taken shall be restored by the Contractor within 48 hours using a mixture acceptable to the City or the City's Engineer.

**4D-21 METHOD OF MEASUREMENT:** Full depth pavement areas of plant mix bituminous base course will be measured to the nearest 1/10 square yard. Areas requiring a variable thickness bituminous base course will be measured on a per ton basis. The weight of the bituminous base course for the areas requiring a variable thickness will be determined from weight tickets for each truck delivering base course to the job site. Final measurement for variable thickness base course will be to the nearest 1/10 ton of acceptable base course.

**4D-22 BASIS OF PAYMENT:** Payment for all plant mix bituminous base course shall include all labor, materials and equipment necessary for the construction of the bituminous base course, in place. Prime coat will be considered incidental to said construction unless specified separately in the specifications.

Payment for full depth pavement areas of plant mix bituminous base course will be on a square yard basis. Payment for variable thickness bituminous base course will be on a per ton basis. In case a truck load of bituminous base course is to be spread in both areas of full depth pavement and variable depth pavement, the Contractor and City or the City's Engineer shall agree on the tonnage of that portion of the load used in the variable depth area, prior to its placement. The conversion from tons to square yards is based on 110 lbs/sq. yd/inch.

**DIVISION 4**
**SECTION 4E - AGGREGATE FOR BASE**

**4E-1 SCOPE OF WORK:** The work shall include all labor, equipment, and materials necessary for the furnishing, mixing, hauling and placing aggregate base course in accordance with the plans and contract documents.

**4E-2 SUB GRADE PREPARATION:** Shall be well drained and compaction of earthwork below street, sidewalk and driveway approaches by rolling, tamping or any combination of these methods to meet minimum 98 percent compaction. (reference MoDOT standards and specifications.)

**4E-3 TYPE 1 AGGREGATE:** Type 1 aggregate for base shall be essentially limestone of dolomite. It shall not contain more than 15 percent deleterious rock and shale. Sand may be added only for the purpose of reducing the plasticity index of the fraction passing the No. 40 sieve in the finished product. Any sand, silt and clay, and any deleterious rock and shale shall be uniformly distributed throughout the mass. The aggregates shall conform to the following gradation requirements:

| SIEVE SIZE | PERCENT |
|---|---|
| Passing 1-inch sieve | 100 |
| Passing 1/2-inch sieve | 60-90 |
| Passing No. 4 sieve | 40-60 |
| Passing No. 40 sieve | 15-35 |

The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six.

**4E-4 PLACEMENT AND COMPACTION:** Shall be well drained and compaction of aggregate below street, sidewalk and driveway approaches by rolling, tamping or any combination of these methods to meet minimum 95 percent compaction. (reference MoDOT standards and specifications section 209)

**4E-5 SURFACE TOLERANCES:** The finished layers shall be substantially free from waves or irregularities.

**4E-6 TESTING:** The City of Clever reserves the right to request testing of aggregates at its discretion. All samples collected for testing purposes shall be obtained in the presence of an authorized City of Clever employee. All costs associated with testing shall be borne by the contractor.

**DIVISION 4**
**SECTION 4F - GENERAL NOTES**

**4F-1 EXPANSION JOINTS ON CURB & GUTTER:** Expansion joints shall be placed on concrete curb & gutter at all driveway radii and intersection radii and at intervals of not more than two hundred (200) feet. Preformed expansion joint filler shall be of nonextruding type and shall conform to ASTM Designation D1751.

**4F-2 CONTRACTION JOINTS ON CURB & GUTTER:** Contraction joints shall be placed on concrete curb and gutter at intervals not greater than twenty-five (25) feet. Joints shall be filled with asphaltic material

**4F-3 CURB REMOVAL:** Where concrete curbs must be removed to facilitate drive entrances, curbs must be cut out prior to removal and the cut ends grouted to provide a pleasing appearance.

**4F-4 EXPANSION JOINTS ON CONCRETE PAVEMENTS:** Expansion joints shall be placed on concrete pavements as shown on the City of Clever standard joint location plan sheet for concrete pavements and concrete pavement with integral curb. Expansion joints shall be located on straight runs at intervals not exceeding 50 feet. Preformed expansion joint filler shall be of nonextruding type and shall conform to ASTM Designation D1751. See detailed drawing D7 and D8 in the City of Clever's Technical Specifications Book.

**4F-5 CONTRACTION JOINTS ON CONCRETE PAVEMENTS:** Contraction joints shall be placed on concrete pavement as shown on the City of Clever standard joint location plan sheet for concrete pavements and concrete pavement with integral curb. See detailed drawing D7 and D8 in the City of Clever's Technical Specifications Book.

**4F-6 DRAINAGE STRUCTURES UNDER PAVEMENTS:** All stormwater conveyance structures under paved areas shall be reinforced concrete unless otherwise permitted by the City of Clever.

**DIVISION 4**
**SECTION 4G- DESIGN STANDARDS FOR STREET AND ROADWAYS**

**4G-1 GRADES:** All street grades shall comply with the following minimum and maximum.

| CLASSIFICATION | MINIMUM | MAXIMUM |
|---|---|---|
| Alleys | 0.5% | 12% |
| Local | 0.5% | 12% |
| Collector | 0.5% | 10% |
| Arterials | 0.5% | 8% |
| Parkways | 0.5% | 8% |

**4G-2 VERTICAL CURVES:** The length of vertical curves shall be no less than that determined by the formula:

L = KA, where
L = Length of vertical curve, feet,
A = Algebraic difference in grades
K = Constant defined in the following table.

K VALUES

| CLASSIFICATION | CREST | SAG |
|---|---|---|
| Alleys | 10 | 20 |
| Local | 20 | 30 |
| Collector | 40 | 50 |
| Arterials | 80 | 70 |
| Parkways | 80 | 70 |

**4G-3 HORIZONTAL CURVES AND SUPERELEVATION:** The minimum centerline radii (R), maximum superelevation (E) and superelevation runout length (L) shall be in accordance with the following table:

K VALUES

| CLASSIFICATION | R | E | L |
|---|---|---|---|
| Alleys | 150 | N/A | N/A |
| Local | 150 | .02 | 80 |
| Collector | 250 | .04 | 100 |
| Arterials | 500 | .04 | 115 |
| Parkways | 500 | .04 | 115 |

## 4G-4 MINIMUM CURB RADII AT INTERSECTIONS:

| CLASSIFICATION | INTERSECTING LOCAL & COLLECTOR |
|---|---|
| Alleys | 15' |
| Local | 15' |
| Collector | 15' |
| Arterials | 30' |
| Parkways | 30' |

**4G-5 INTERSECTIONS:** All curb returns shall be designed with a wheel chair ramp meeting the requirements of Drawing D-10. No structures will be permitted in the ramp area.

Where the approach grades of either or both streets exceed four percent, a leveling area shall be provided. The leveling area shall be provided. The leveling area shall have a minimum length of 75 feet measured from the intersection of the edge of gutter flag or edge of road within which no grade shall exceed a maximum of three percent.

Right angle intersections shall be used whenever practical. The angle of intersection shall not be less than 75 degrees.

**4G-6 PAVEMENT DESIGN:** Pavement sections shall be in accordance with the Drawing D-1. Soils information and design calculations shall be submitted when deviating from the standards shown on Drawing D-1.

**4G-7 PAVEMENT INSPECTION AND TESTING:** It shall be the responsibility of the contractor to notify the Engineer and City of Clever personnel at least 24 hours in advance of the time and place that grading is completed, base rock is placed, and paving is performed. If requested by the City of Clever pavement testing for determining mix design and depths will be required and all costs associated with the testing shall be paid for by the contractor. All defects shall be repaired to the satisfaction of the City of Clever.

**DIVISION 4**
**SECTION 4H - STREET PERMIT AND INSPECTIONS**

**4H-1 STREET CUTS:** Prior to any street cut, bore or curb cut begins in connection with a project the contractor shall obtain approval from the City. Street cuts must be backfilled with 3/4-inch clean crushed limestone, installed in 6-inch compacted lifts to within 8-inches of final grade. The final 8 inches shall be filled with concrete. City inspection of the rock fill is required before concrete is placed.

**DIVISION 11**
**SECTION 11A - SUBMERSIBLE PUMP STATION**

**11A-1 SCOPE:** The pump station shall be furnished and installed complete as shown, including wet well, wet well cover, pumps, controls, valves, valve box, slide rails, supervisory system, high level alarms with lights and horn, chainlink fencing, access road, crushed rock surfacing, standby-by generator with automatic transfer switch, lifting crane, and all equipment and appurtenances required to provide a complete and satisfactory pumping installation. Potable water shall be extended to the pump station location and a frost proof yard hydrant with back flow prevention equivalent to the Woodford Model Y2 yard hydrant shall be provided.

**11A-2 GENERAL:** The complete pump station assembly including all equipment and appurtenances shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the sewage pumping station manufacturer unless exceptions are noted by the Engineer.

The station shall be designed to meet the requirements of all applicable regulatory agencies. The wet well shall have a grouted bottom with a minimum slope of one to one to the hopper bottom. Adequate venting shall be supplied with a minimum of twelve (12) air changes per hour if continuous ventilation is used or a minimum of thirty (30) air changes per hour if intermittent ventilation is used. Air shall be forced into the wet well rather than exhausted out. The wet well shall be of sufficient size and depth to allow for a cycle time of 5 to 10 minutes for motors under 50 hp and a cycle time of 10 to 15 minutes for larger motors. The station shall be designated to withstand soil pressure based on a soil weight of at least 120 pounds per cubic feet. All sizes, thickness, and deflection of the component parts shall be acceptable to the Engineer.

In addition to the emergency means of operation and the wet well, the following minimum retention time shall be provided:

For Facilities with a design average flow of 100,000 gpd or greater a storage capacity for two (2) – hour retention of peak hourly flow; or for facilities less than 100,000 gpd, a storage capacity for four (4) – hour retention of peak hourly flow.

**11A-3 WET WELL/VALVE BOX ACCESS:** A wet well cover and valve box cover shall be constructed of 1/4 " steel plate as shown. The wet well cover shall consist of a double door access opening provided in the top to allow removal of either the pump from the wet well or access to the float switch assembly. Each cover shall be provided with a continuous hinge welded to a support frame. Each cover at the wet well shall be reinforced to allow the total weight of a pump to be rested on it during removal. Each cover at the wet well shall be reinforced with an angle anchored to the circular wall to provide sufficient support if deemed necessary by the Engineer.

**11A-4 SEWAGE PUMPING EQUIPMENT:** The sewage pumping equipment to be furnished and installed in the pumping station shall consist of motor driven, nonclog sewage pumps, each complete with all specified accessories and appurtenances.

Pumps shall be non-clog submersible pumps. All pumps in a station shall be the same type and shall have parts common to a majority of other City lift stations or as determined acceptable by the City. Each pumping unit shall conform to the following requirements:

**11A-4.01** Performance and Design Requirements:

Number of pumps and motors..... 2 or more

Rated total head, feet.....As Required
Capacity at rated head, gpm .....As Required

Min. shutoff head, feet .....As Required

Min. total head for continuous operation, feet.....As Required

Max. bhp requirement of pump at any total head in excess
of min. head for continuous operation .....As Required

Operation speed, rpm .....As Required

Min. diameter of test sphere, inches.....As Required

Min. suction inlet diameter, inches.....As Required

Min. discharge outlet diameter, inches.....As Required

Head losses through the pump, including pump suction elbow losses, are not included in the total pumping heads stipulated in the foregoing design data tabulation.

11A-4.02 Pump Materials:

| Item | Material |
|---|---|
| Case | Cast iron, ASTM A48 |
| Impeller | Cast iron, ASTM A48 |
| Shaft | Stainless steel or carbon steel w/ stainless steel sleeve |
| Mechanical Seal | Durametallic "Dura Seal", double seal, carbon and ceramic with No. 9 or better carbon rings. |

**11A-4.03** Non-Clog Submersible Pump Construction:

1. Motor - Pump motor shall be of the sealed submersible type rated as necessary to meet the specified performance and design requirements. Motors shall be for 220 volt,

60 Hz, 3 phase power supply or as requested by the City of Clever. Stator winding to be of the open type with insulation good for 80 degrees C. Winding housing to be filled with a clean high dielectric oil that lubricates bearings and seals and transfers heat from winding and rotor to outer shell.

Motor shall have two heavy duty ball bearings to support pump shaft and take radial and thrust loads and a sleeve guide bushing directly above the lower seal to take radial load and act as flame path for seal chamber. Ball bearings shall be designed for 30,000 hours B-10 life. Stator shall be heat shrunk into motor housing.

A heat sensor thermostat shall be attached to and imbedded in the winding and be connected in series with the motor starter contactor coil to stop motor if temperature of winding is more than 220 degrees F. Thermostat to reset automatically when motor cools to safe operating temperature. Two heat sensors to be used on 3 phase motors. The common pump motor shaft shall be of 416 stainless steel.

2. Seals - Motor shall be protected by two mechanical seals mounted in tandem with a seal chamber between the seals. Seal chamber shall be oil filled to lubricate seal face and to transmit heat from shaft to outer shell. Seal face shall be carbon and ceramic and lapped to a flatness of one light band.

A double electrode shall be mounted in the seal chamber to detect any water entering the chamber through the lower seal. Water in the chamber shall cause a red light to turn on at the control panel. This signal shall not stop motor but shall act as a warning only, indicating service is required.

3. Impeller - Shall be cast iron and of the 2 vane non-clog enclosed type. Vane inlet tips shall be carefully rounded to prevent stringy material from catching in vanes. Pump-out vane shall be used in front and back chamber and impeller shall be dynamically balanced by grinding on shroud faces. No holes are to be drilled for balancing.

Impeller to be driven by stainless steel shaft key and impeller held in place with lock screw and washer.

Impeller and motor shall lift off of case as a unit without disturbing discharge piping.

Impeller neck shall run in bronze wear ring that is pressed into volute case.

4. Pump Case - The volute case shall be cast iron and have a flanged center line discharge. Discharge flange shall be 4 inch standard with bold holes straddling center line. Bronze wear ring to be pressed into case for guiding impeller neck and to prevent corrosion freeze up.

Wear ring to be held from rotating by locking with stainless steel set screw in end of ring.

5. Pump and Motor Casting - All castings shall be of high tensile cast iron and shall be treated with phosphate and chromate rinse.

6. Bearing End Cap - Upper motor bearing cap shall be a separate casting for easy mounting and replacement.

7. Power Cables - Power cord and control cord shall be double sealed. The power and control conductor shall be single strand sealed with epoxy potting compound and then clamped in place with rubber seal bushing to seal outer jacket against leakage and to provide for strain pull. Cords shall withstand a pull of 300 pounds to meet U.L. requirements.

Insulation of power control cords shall be type SO or STOW. Both control and power cords shall have a green carrier ground conductor that attaches to motor frame.

**11A-5 DATA TO BE SUBMITTED:** Each request from the Contractor for review of equipment shall be accompanied by complete descriptive, performance and engineering data covering equipment offered. Three copies of the following items are required information.

Pump Data:

Name of Manufacturer,
Type and Model,
Design rotative speed,
Size of pump section inlet,
Size of suction elbow outlet,
Type and number of bearings,
Maximum bhp requirement of pump at any total head
specified minimum for continuous operation,
Maximum diameter of test sphere,
Complete performance curves showing capacity, head, &
NPSH requirements, efficiency and bhp requirements,
Shaft diameter,
Type of pump seal.

Motor Data:

Name of manufacturer
Type designation
Rated size of motor (hp), service factor, and temperature rating
Full load rotative speed
Weight
Input-Output efficiency at:
(a) Full Load
(b) Rated pump condition
Full Load current
Locked rotor current
Shaft diameter
Type of lubricant

Description of special moisture resistant treatment of motor air gap surfaces

**11A-6 SHOP TESTS:** Each pump shall be shop tested for capacity, power requirement, and efficiency at specified minimum head for continuous operation, rated head, shutoff head, and at as many other points as necessary for accurate performance curve plotting in each case. All tests shall be made in conformity with the requirements and recommendations of the Hydraulic Institute. Shop tests shall be conducted by the pump manufacturer or by the pumping station manufacturer after installation in the pumping station.

Not less than two certified copies of a report covering each test, and capacity, power, and efficiency curves based on shop test results shall be prepared and delivered to the Engineer not less than 10 days prior to shipment of the equipment from the factory.

**11A-7 RESPONSIBILITY:** The manufacturer of the pumping station assembly shall be responsible for proper installation, alignment, and operating conditions of the pumping equipment when placed in service.

**11A-8 PUMPING STATION ELECTRICAL SYSTEM:** The pumping station shall be designed for 3 phase, 3 wire, 240 volt power service or as requested by the City of Clever. Single phase, 120 volt auxiliary power requirements and 24 volt control power requirements shall be provided for by furnishing suitably sized dry type transformers within the station. All wiring shall conform to the National Electrical Code and shall comply with local regulations and ordinances of the community for which the station is constructed.

**11A-8.01** Conduit: Except for plug-in cords and in control enclosures, all wiring shall be in rigid galvanized steel or aluminum conduit or enclosed galvanized steel or aluminum rectangular raceways. Conduit entering the wet well and control panel shall be caulked to prevent the movement of gases from the wet well into the control panel.

**11A-8.02** Cable: Except for continuation of exterior cables, cable and wiring shall be factory installed. On stations where the disconnect means employ more than one breaker, breaker cable lugs shall be sized to fully accommodate both service entrance conductors and branch service conductors. Removal of outer strands of conductors to make up branch connections will not be permitted. Where breaker lugs will not accommodate service, and branch conductors, T type connectors or double lugs shall be provided. Thermoplastic insulated neoprene covered service entrance conductors of the size required shall be provided.

All power and control cable installed in the station shall be copper, insulated for 600 volts, 75C, wet and dry locations, Underwriters Laboratories Type RHH for power cable and Type RHH or THW for control cable. Bare copper conductors shall be installed in all but lighting conduits for grounding connections.

**11A-8.03 Equipment:** All equipment and devices expressly intended as a means of switching, adjusting, or actuating shall be mounted within convenient reach of an attendant.

Externally operable circuit breaker type disconnect means shall permit disconnecting all phase

conductors in the station from service entrance conductors.

Control and switching equipment enclosures shall be NEMA Type 3 finished steel or rigid heavy-duty construction rated for outdoor use compatible with possible local weather conditions. Enclosures housing an assembly of switches, contactors, relays, starters, etc., shall have hinged doors with latches.

Each pump motor and auxiliary circuit shall be provided with thermal-magnetic circuit breakers. Breakers for 3 phase loads shall be 3 pole. All breakers shall be operable from outside the control panel. A three position selector switch with HAND-OFF-AUTO position shall be flush mounted on the panel door for operation of each pump motor. Auxiliary and control power may be supplied through a circuit breaker load center.

All equipment shall be identified by nameplates and device identifications in agreement with wiring diagrams.

**11A-8.04** Panel Wiring: All control wiring in switching and control assemblies shall be color coded or numbered. Color coding shall be such that electrically common interconnections of devices are the same color. The colors may be used more than once but not in the same circuit or cable grouping. Color of plug-in cord conductors does not need to comply with the color code. The power and control enclosure shall contain ground lugs or an AWG ground in the service entrance circuit and each ground cable to devices in the station. The enclosure shall be well grounded to the station shell by mounting or by an AWG band jumper.

**11A-8.05** Controls: Wet well level and alarm controls shall be 120 volt and shall be provided by sealed float type mercury switches. The mercury tube switches shall be sealed in a solid polyurethane float for corrosion and shock resistance. The support wire for each float switch shall have a heavy neoprene jacket. A weight shall be attached to each support cord above the float to hold the switch in place in the wet well. Weight shall be above the float to effectively prevent sharp bends in the cord when the float operates. Each float switch shall hang in the wet well supported only by the individual cord connected thereto.

Three level sensors (normally open) and an electric alternator shall provide automatic operation. The lower control shall be at the turn-off (STOP) level, the upper control is to be set at the turn-on (START #1) level required and the override control (START #2) is to be set above the upper control so both pumps will come on if the level rises above the upper control. If one pump fails for any reason, the other pump shall automatically operate on the override control until cause of failure is corrected. A fourth level sensor (normally open) shall operate a high level alarm and the supervisory system.

An automatic alternator with manual switch shall be provided to change the sequence of operation at the end of each pumping cycle. The manual switch shall allow for either pump to be selected as lead pump or for automatic alteration.

An explosion proof junction box, suitable for a corrosive environment and mounting outside the wet well, shall be furnished to connect the four control cords to cables connecting the wet well

controls to the pump station. This box shall be constructed so incoming control wires are individually sealed with mechanical rubber seal and so no sealing compounds are required to make explosion proof joints. Box shall be provided with terminal strip to connect incoming wires with control cords. Control cords shall be sealed in box with mechanical held rubber seal. Box cover shall be bolted on and sealed with rubber "O" ring. Box and all connections shall be completely explosion proof and waterproof and shall not leak under an outside pressure of 10 psi. A galvanized steel control cord support bracket shall be attached to the junction box and the outside of the wet well top slab. Cord snubbers shall be furnished to hold control cords at any set height.

**11A-8.06** Convenience Outlets: Convenience outlets for auxiliaries shall be 3 wire, polarized grounded type, 15 amp, 125 volt. At least one similar duplex convenience outlet shall be provided on a separate circuit for maintenance tools.

**11A-8.07** Wiring Diagrams: The manufacturer shall provide both connection diagrams and schematics, identifying all items in wiring connections in accordance with terminal identification of equipment.

**11A-8.08** Supervisory: An audio/visual supervisory system with a self-contained power supply shall be located at the pump station to monitor the occurrence of a high wet well level situation, power failure, pump failure, use of lag pump, unlawful entry, or any other cause of pump station malfunction. The supervisory information shall be provided by normally open switches which are wired into the control panel. Alarms shall be telemetered, including identification of alarm condition, to City Hall during normal working hours as posted by the City and to the home of the City's designated employee that is responsible for the lift stations maintenance during all other hours.

**11A-8.09** Elapsed Time Meters: An elapsed time meter capable of recording actual running time shall be provided for each motor. Elapsed time meters shall be mounted in the control panel of the pump station.

**11A-9 PIPING:** Except where otherwise shown, all sewage piping shall be cast iron. Cast iron pipe shall be ANSI Class 22 conforming to ANSI A21.6 or A21.8. Fittings shall conform to ANSI A21.10. Mechanical joints shall conform to ANSI A21.11 and flanges shall be ANSI 125 lb. All pipe and fittings shall be coated inside and out with the manufacturer's standard bituminous coating. Flange bolts and nuts shall be ASTM A307, Grade B, of such length that, after installation, bolts will project 1/8 to 3/8 inch beyond the outer face of the nut. Flange gaskets shall be of ring type made from 1/11 inch thick red rubber or other approved material. Flanged or mechanical joint pipe and fittings shall be used inside the pumping station, and mechanical joint type bells shall be provided outside the station walls.

**11A-10 VALVES:** Each pump discharge shall be provided with a check valve and an eccentric plug valve. The check valves shall be located between the pumps and the plug valve. In addition, the manufacturer shall provide an auxiliary valve, piping and a quick connect/disconnect coupling for connection to a portable gasoline powered sewage pump. The size of all connections shall be compatible with the City's current portable pumps which shall be confirmed with the City prior to construction and all piping/fittings shall be sufficient in size to allow for pumping of sewage at the

lift stations design rate in case of an emergency

**11A-10.01** Gate Valves: All 4 inch and larger gate valves shall conform to AWWA C500 as modified herein. Gate valves shall be double disc. AWWA gate valves shall have O-ring stem seals.

**11A-10.02** Eccentric Plug Valves: Eccentric plug valves shall have a port area of at least 80 percent of the cross-section of the connecting piping and shall be equivalent to DeZurik "Eccentric Valves". Eccentric plug valves shall be installed with the shaft horizontal and the plug in the upper half of the body.

**11A-10.03** Check Valves: All check valves shall be flanged, iron body, horizontal swing type with all seats, seat rings, pins, bushings and other parts subject to wear constructed of bronze. Vertical check valves and straight globe check valves will not be acceptable.

**11A-11 PAINTING AND CORROSION PROTECTION:** Preparation of surfaces to be painted and all painting shall be done in the shop before shipment of the station assembly so that field painting will be limited to coating joints or areas not previously painted, or damaged or abraded areas.

All pumps, motors, the control cabinet, explosion proof junction box and controls and other machines or equipment shall be painted in the shop using epoxy coating or machinery enamel.

Exposed surfaces of copper tubing, including fittings, and valves, inside the station shall have a natural finish obtained by cleaning and burnishing with "00" steel wool and applying a coat of clear lacquer or shall be painted with epoxy.

All joints in wrought metal piping, including exposed threads, to be buried underground, shall be painted with one heavy coat of Tnemec "Tnemecol 456", Koppers "Bitumastic 50" or equal.

All painted surfaces damaged during shipment or installation shall be repainted using the same or equivalent materials as used in the original application.

**11A-12 FACTORY TESTS:** Before shipment from the factory, the pumping station shall be operated to check alignment; faulty equipment and controls; proper wiring; leaks in piping, seals, or welds; and proper operation of the automatic control system and auxiliary equipment.

Pump suction and discharge lines shall be connected to a water tank and the sewage pumps operated at least one hour to simulate the field service conditions. The automatic control shall be adjusted to the specified levels. Defective equipment and materials disclosed by such tests shall be replaced and the station placed in satisfactory operating condition before shipment.

**11A-13 INSTALLATION OF PUMPING STATION:** Backfill around structures shall be placed as soon as the station installation is completed to the Engineer's satisfaction. Backfilling shall be performed in accordance with the requirements of the paragraph "STRUCTURAL BACKFILL" in Section "EXCAVATION AND TRENCHING".

**11A-14 SUPERVISORY SYSTEM:** The contacts and switches provided shall be compatible with the equipment to be furnished in the supervisory system in accordance with Section 11A-8.08.

**11A-15 ACCESS ROAD:** An access road shall be constructed from the nearest City street to the lift station to provide access. Road shall be fifteen feet wide and shall meet all requirements for base rock, bituminous base and asphalt as contained in these specifications.

**11A-16 POTABLE WATER:** A 1-inch PVC waterline shall be extended from the nearest City water main to the pump station. A frost proof hydrant shall be installed at the pump station for cleanup.

**11A-17 GRADING:** Maximum grading at the pump station shall be 3:1 for maintenance purposes. Any grades exceeding 3:1 shall be poured concrete 4-inches in thickness to a point where 3:1 slope can be achieved.

**11A-18 LIFTING CRANE:** A Lifting Crane shall be provided at the station and shall conform to Section 14A of these specifications.

**11A-19 STAND-BY GENERATOR AND AUTO-TRANSFER SWITCH:** A generator and automatic transfer switch compatible with the selected pumps shall be provided at the lift station site and shall conform to Section 11C of these specifications.

**11A-20 EMERGENCY STORAGE:** In addition to the emergency means of operation and the wet well, the following minimum retention time shall be provided:

For facilities with a design average flow of 100,000 gpd or greater, a storage capacity for two (2) – hour retention of peak hourly flow; or for facility less than 100,000, a storage capacity for four (4) – hour retention of peak hourly flow.

**11A-21 DRAWINGS AND DESCRIPTIVE DATA:** Shop drawings shall be submitted showing materials and assembly of all elements of the pump station. In addition to pump and motor data to be submitted in paragraph "Data to be Submitted" descriptive literature shall clearly indicate all information necessary to evaluate conformance with specification requirements for all features of the pump station including valves. Complete data for all electrical items, switches, enclosures, relays, motor starters and controls, and a drawing of the control panel layout and a schematic diagram of the control panel circuitry shall be included. Furthermore, three complete sets of operational instructions, including emergency procedures, all recommended maintenance schedules, required tools and spare parts shall be supplied to the City prior to construction.

**DIVISION 11**
**SECTION 11B - WET WELL MOUNTED VACUUM PRIMED PUMP STATION**

**11B-1 SCOPE:** Although some older wet well mounted vacuum primed pump stations may still exist within the City's wastewater collection system, no new systems of this type shall be allowed.

**DIVISION 11**
**SECTION 11C - STANDBY GENERATOR**

**11C-1 SCOPE:** This section covers the furnishing and installation of a standby generator system, complete including all control wiring, automatic transfer switch, etc., required for a complete installation.

**11C-2 GENERAL**: The generator set shall be as specified herein; with all accessories and transfer switch(es) as required, new and of current production, and as supplied by an authorized distributor of the engine generator set manufacturer who warrants and services the entire package, and having a service and parts organization within a reasonable distance of this project, backed up by a national sales and service organization. The generator and all related appurtenances shall be fully compatible with the selected pumps and pump controls and shall be coordinated with each applicable manufacturer.

The generator set shall be rated for continuous service at the required loading 80% power factor, 240/480 Volts AC, 3 Phase, at 60 Hertz, for operation at 38 degrees C ambient temperature, and 1500 meters altitude.

Approved manufacturers are, but not limited to Onan, Cummings and Caterpillar.

Dry-type transformer and all appurtenances shall be installed to carry required 120v systems installed with the project during generator operations.

**11C-3 ENGINE:** The engine shall be L.P./Diesel fueled, (as appropriate for the intended service and recommended by the generator manufacturer) liquid-cooled and capable of satisfactory performance operating on L.P./Diesel fuel unless otherwise requested by the City of Clever.

Engine speed shall be governed within 5 percent from no load to full rated output.

Engine shall be equipped with 12 Volt starting motor (or as recommended by manufacturer), battery charging alternator with automatic regulator, 50 degree C (122 degree F) ambient radiator with fan guards, engine coolant heater, 1500 watts minimum, thermostatically controlled to maintain engine block coolant temperature between 120 and 140 degrees F.

**11C-4 ALTERNATOR:** The alternator, having a single, maintenance free bearing, shall be direct connected to the engine and shall be a broad range, 12 lead reconnectable, four pole rotating field unit with rotating brushless exciter. It shall be self-ventilated, with skewed stator and full amourtissuer windings with, 2/3 pitch for smooth voltage wave form. Temperature rise shall be within NEMA MG1-22.40, IEEE, and ANSI standards for standby duty at rated output. The balanced telephone influence factor (TIF) shall not exceed 50. Insulation shall be within class F with vacuum pressure impregnated epoxy on both rotor and stator.

The voltage regulator shall be of the static type and regulation shall be within plus or minus two percent of rated voltage from no load to full load. The voltage regulator shall include under frequency protection and moisture resistance protection. On application of rated load at rated Power Factor, instantaneous voltage dip shall not exceed 20% with recovery within one second.

**11C-5 FUEL TANK:** The generator shall be equipped with a 250 gallon L.P./Diesel fuel tank or

other fuel as requested by the City and as compatible with the generator. The tank shall be equipped with level gauge. The tank shall be filled with L.P./Diesel as recommended by the manufacturer.

**11C-6 CONTROLS:** Set mounted controls shall include automatic start/stop control operable by a remote contact with a switch to select off, automatic or test (allowing set operation without interrupting the normal power supply) modes, a voltage adjustment rheostat, automatic shutdown protection against high engine coolant temperature, low engine oil pressure, engine cranking over 30-45 seconds, and overspeed by directly cutting off the fuel supply, and a lamp to indicate an engine failure has occurred.

**11C-7 INSTRUMENTS:** The following engine and generator instruments will be set mounted through vibration isolators in a weather proof, NEMA 1 enclosure and fully wired with appropriate reading lights: ENGINE: battery voltmeter, engine oil pressure and coolant temperature gauges and running time hourmeter. GENERATOR: A.C. voltmeter, A.C. ammeter, phase selector switch, and frequency meter.

**11C-8 MOUNTING:** The electric plant shall be equipped with vibration isolators mounted between the engine-generator and steel skid base.

**11C-9 ACCESSORIES:** All accessories required for a complete operating system shall be furnished. These shall include: one 12 volt lead acid battery sized per engine manufacturers requirements, battery cables and rack, automatic float charger (5 amp minimum), residential muffler, stainless steel flexible exhaust connector, fuel lines, 60 amp main line thermal magnetic circuit breaker, oil pan heater, and a weather protective housing with removable side panels.

**11C-10 TRANSFER SWITCH:** A manually operated transfer switch shall be provided by the generator set manufacturer, rated at 400 amperes, 480 volts and 60 hz or as required. The switch shall have closing, withstanding and interrupting ratings equal to the available short circuit current on the normal supply and shall be rated for continuous duty. It shall be housed in a NEMA-1 enclosure suitable for wall mounting, shall conform with Underwriters Laboratories 1008 Standards and all classes of load, and meet the National Electric Code (NEC) requirements for critical applications. The transfer mechanism shall be a circuit breaker type. Control circuitry shall be solid state.

The transfer switch shall be equipped with; normal push buttons, transfer push buttons, fixed 5 minute time delay for engine cool down, a test switch to simulate a normal power source failure, pilot lights to visually indicate the transfer switch position, and one set of normally open and normally closed contacts that indicate switch position. The switch shall also be equipped with the following; volt, amp, and frequency meters, 7-day exerciser clock for exercising with or without load.

**11C-11 TEST:** Certified final factory test report shall be provided to the City or the City's Engineer certifying the units full power rating, voltage stability, and frequency regulation.

**11C-12 START-UP INSTRUCTIONS:** A factory trained representative shall consult with the

contractor during installation and start-up. The representative shall fully instruct City personnel as to correct operating and testing procedures and supply a parts book and a complete operator's manual for installation, operation and maintenance.

**11C-13 SOUND ATTENUATING ENCLOSURE:** An enclosure shall be provided to limit noise emissions to an acceptable level for a residential area and shall be compatible and as recommended by the Generator manufacturer.

**11C-13 WARRANTY:** The generator set, transfer switch and accessories as furnished will carry a one-year guarantee (two years if installed in the U.S. or Canada) against defective parts and workmanship from date of field testing and acceptance by the first owner and shall include 100 percent parts and labor coverage.

**DIVISION 14**
**SECTION 14A - PORTABLE CRANES**

**14A-1 GENERAL:** Work under this section consists of furnishing and installing portable hand winch operated crane and base for removal of the submersible pumps at the pump station site.

**14A-2 PORTABLE CRANE:** Shall be geared hand winch operated, adjustable boom type having a minimum lift capacity of 1,000 pounds or as required to lift the selected pumps.. Boom shall be easily detachable for moving. Mast height shall be a minimum of 61 inches above base and boom shall be adjustable with a range of 41 to 65 inches of reach or as required to lift pumps, and shall rotate a minimum of 240 degrees. Winch shall be double geared with automatic safety brake handle for safe positive to lower load. Portable crane shall be Therm-o-matic Portacrane Model 533, Gilco Type Jt10 or equal. Winch shall have a minimum of 30 feet of 1/2 inch corrosion proof lift cable. Crane shall be located to achieve removal of pumps from wet well and to allow for easy access to a vehicle bed for pump removal.

**DIVISION 15**
**SECTION 15A - VALVES**

**S15A-1 SCOPE:** This section covers valves.

**15A-2 GENERAL:** All valves shall comply with the following:

**15A-2.01** Ends: All buried valves shall have push-on or mechanical joint ends and conform to ANSI A21.11.

**15A-2.02** Rotation**:** The direction of rotation of the wrench nut to open shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.

**15A-2.03** Shop Painting**:** The interior and exterior of all valves shall be shop painted for corrosion protection. The valve manufacturer's standard paint will be acceptable.

**15A-3 GATE VALVES:** Distribution valves in sizes through 12 inches shall be of the iron body, non-rising bronze stem, resilient seated wedge type manufactured to equal or exceed all applicable provisions of AWWA Standard C509. Gate valves shall be wedge type epoxy coated 200 psi or approved equal to Mueller Series A-2360.

**15A-4 FIRE HYDRANTS:** Fire hydrants shall be 6" mj shoe, 3'6" bury traffic model with non-freezing, cast iron bodies, full bronze mounted, suitable for a working pressure of 200 psi. Hydrants will be Mueller A-423, or approved equal. See Page 2B-5 of these specifications.

15A-4.1 Location and Spacing: Fire Hydrants shall be provided at each street intersection and at intermediate points between intersections to meet the current classification criteria of the Insurance Services Office (ISO). Generally, the fire hydrant spacing shall be 500 feet in residential areas or 300 feet to 350 feet in commercial areas. The number of hydrants required shall be based on use/occupancy type, required fire flow, along with distance and access considerations. The maximum distance from any structure's access point to a hydrant in a commercial area shall not exceed 200 feet, as measured along the required access. Final approval of fire hydrant spacing shall be by the City of Clever

15A-4.2 Valves and Nozzels: Fire hydrants shall be as manufactured by Clow, Mueller or approved equal and shall have a minimum bottom valve opening of at least 5 1/4 inches and one 4 ½ inch pumper nozzle and two 2 ½ inch nozzles. See Page 2B-5.

15A-4.3 Hydrant Leads**:** The hydrant lead shall be a minimum of six inches in diameter and contain a shutoff valve.

15A-4.4 Drainage: A gravel pocket or dry well shall be provided unless the natural soils will provide adequate drainage for the hydrant barrel. Hydrant drains shall not be connected to or located within ten feet of sanitary sewers or storm drains.

15A-4.5 Installation: Installation of fire hydrants shall meet the following requirements.

a. The weight of the hydrant shall not be carried by the pipe. Hydrants, lead valves, fittings, and branch connections shall be provided with proper support, such as crushed stone, concrete pads or a well compacted trench bottom.
b. Drainage shall be provided for dry barrel hydrants. This is generally washed stone extending at least one foot on all sides of the hydrant.
c. Hydrants shall be plumb.
d. The center of a hose outlet shall be not less than 18 inches above final grade and so that the final hydrant installation is compatible with the final grade elevation.
e. As a rule, hydrants are either oriented with the pumper outlet perpendicular to the curb which faces the street, or with the pumper outlet set at a 45-degree angle to the street.
f. Hydrants shall be protected if subject to mechanical damage. The means of protection shall be arranged in a manner that will not interfere with the connection to, or operation of, hydrants.
g. A clearance space of at least three feet (3 ft.) surrounding the hydrant body should be provided around every hydrant.
h. Utility poles, vaults, walls, plants and other landscape materials should be kept outside the hydrant's clearance space.
i. In poor load-bearing soil, special construction such as support collars may be required.

**15A-5 VALVE BOXES:** All gate valves in water lines shall be provided with valve boxes. Valve boxes shall be a cast iron, extension sleeve type or Sch 40 PVC, suitable for the depth of cover required by the drawings. Valve boxes shall not be less than 5 inches in diameter, shall have a minimum thickness at any point of 3/16 inch, and shall be provided with suitable cast iron bases and covers.

**15A-6 FLANGED JOINTS:** Whenever screwed-on flanges are used, the pipe shall extend completely through the flange. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.

When bolting flange joints, care shall be taken to insure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell and spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate, so that gasket compression is uniform.

Special care shall be taken when connecting to pumping equipment to insure that no stresses are transmitted to the pump flanges by the connected piping. All such piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of abutting pump and piping flanges are obtained before installation of any bolts in those flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal centerline while the bolts are tightened.

**15A-7 CONNECTIONS WITH EXISTING PIPELINES:** Where connections are made between new work and existing piping, such connections shall be made using suitable fittings for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by the Owner. Live tapping will be required. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines without damage to adjacent property.

**15A-8 REACTION ANCHORAGE AND BLOCKING:** All piping exposed in interior locations and subject to internal pressure in which mechanical or similar type joints are installed shall be blocked, anchored, or harnessed to preclude separation of joints. All steel clamps, rods, bolts, and other metal accessories used in reaction anchorages or joint harnesses shall be painted with two coats (in addition to a prime coat) of paint acceptable to the Engineer.

**15A-9 LEAKAGE:** All joints shall be watertight and free from leaks. Each leak which is discovered within one year after final acceptance of the work by the City shall be repaired by and at the expense of the Contractor.

**DIVISION 15**
**SECTION 15B - METER SERVICES**

**15B-1 METER PITS AND COVERS:** All 5/8 x 3/4 meters shall be housed in an 18" diameter by 30" deep "White" PVC meter pit with a notched bottom for tube entry into the pit.

Lids for meter pits shall be a cast iron, two piece raised similar to Crouch Foundry Model C-104 with two inch transducer hole or hanger underneath, or approved equal.

**15B-2 METER BRASS:** All 5/8 x 3/4 meters shall be supplied with a brass service saddle similar to a Ford S70 series or equal.

Service corporation stops shall be similar to Mueller H-15000 series or approved equal.

Meter setters shall be a 5/8 x 3/4 x 7 setter similar to Mueller H-1404 and will have a ball valve with lockwing. Yoke connectors will be Mueller 3/4 H-14227 or similar.

Where meter services are split, all services shall be 1" from the service corporation stop to a service wye similar to Ford Y44-243 or approved equal.

**15B-3 SERVICE TUBE:** All service tubing shall be as follows:

WATER SERVICES: All water services shall be made with 200 psi High Density Polyethylene (HDPE) pipe equal to copper tubing size (CTS) SDR 9 potable water pipe. Service pipe shall meet the requirements of ASTM 2737, AWWA C901 and NSF Standards 14 and 61.

1. Typical Water Service: (See Detail Drawing B-8 in the City of Clever's - Technical Specifications Book)

    a. Crossings Serving Single Lot: Water service crossing shall be made using 1 inch diameter High Density Polyethylene (HDPE) pipe.

    Water services on same side as water main shall be High Density Polyethylene (HDPE) pipe.

    b. Crossings serving Twin lots: Water service crossing shall be made using a single 2 inch diameter or 2 - 1" diameter High Density Polyethylene (HDPE) pipes. Dual Services on same side as water main shall be High Density Polyethylene (HDPE) pipe.

2. Typical Water Meter Box: (See Detail Drawing B-7 in the City of Clever's Technical Specifications Book)

L. PROTECTION OF WATER METER BOXES: It shall be the responsibility of the contractor to place a metal fence post at each meter box to prevent damage to the meter after installation.

**15B-4 METERS:** For all meters less than 1 inch, the city shall provide a Badger M25 meter with HRE-LCD and Orion ME, or equal. The Contractor shall be responsible for meter 1 inch and greater, and shall coordinate with City of Clever.

**DIVISION 16 - ELECTRICAL**
**SECTION 16A - ELECTRICAL GENERAL REQUIREMENTS**

**16A-1 GENERAL:** The Developer/Owner shall make application to the power company having jurisdiction over the work and shall comply with all applicable rules and regulations established by the company for providing primary and secondary distribution facilities.

Street light installation shall conform to all applicable standards of the power company having jurisdiction over the work and these specifications. All associated street lighting costs, including but not limited to, installation costs, maintenance, and fees, will be the responsibility of the developer.

**16A-2 STREET LIGHTS, SPACING AND DESIGN:**

A. There shall be a street light at each street intersection and at or within one hundred feet (100') of a cul-de-sac and no closer than a distance of four hundred feet (400') or further apart than a distance of five hundred feet (500'). All distances shall be measured along outer edge of the pavement or curb.

The City of Clever may require spacing of less than four hundred feet (400') when needed for traffic safety, such as location of abrupt horizontal or vertical grade changes.

The City of Clever may require additional lighting on the basis of high concentrations of pedestrian traffic such as downtown, schools, or similar areas or where there exists serious traffic hazards or a high incidence of crime based upon the recommendations of the Chief of Police. Nothing in this section should be construed as relieving the property owner or occupier of the duty to provide security lighting.

B. The developer shall be required to provide for the erection of streetlights at the time any street, which is served by the light is paved. The costs for erection of street lighting and providing electric service to the light shall be borne by the developer.

# STORMWATER MANAGEMENT PLAN

# PART I

# GUIDELINES AND DESIGN

# PART I - GUIDELINES AND DESIGN

## GENERAL PROVISIONS

### A. SCOPE

The design criteria set forth the minimum standards for design of storm drainage facilities on public right-of-way and private property in the City of Clever.

### B. AUTHORITY

The design criteria and standards set forth herein have been adopted by the Clever Planning and Zoning Commission, and the Clever Board of Alderman.

Any development or grading begun after the date of the passage of these criteria and standards which does not comply with the requirements set forth herein shall be subject to enforcement of measures and penalties as set by the Clever Board of Alderman.

### C. INTERPRETATIONS

Where any of the provisions contained herein may be unclear or ambiguous as they pertain to a particular site or situation, interpretations of the policies, criteria, and standards set forth herein shall be made in writing by the City of Clever.

Such written interpretations shall be kept on file for future reference for use in similar situations, and shall be incorporated in subsequent revisions for the standards, if deemed necessary for general reference.

### D. APPEALS

Where disagreements may arise over the interpretations of the requirements set forth herein by the City of Clever, appeals may be made to the City of Clever upon written request.

Requests for appeals in subdivisions shall be addressed to the City of Clever.

Information and supporting documentation for the appeal shall be submitted with the request.

### E. VARIANCES

In the event that compliance with the standards and criteria set forth herein is not practical or feasible, and that reasonable alternative measures can be proposed, application for a variance can be made.

Requests for variances shall be made in writing to the City of Clever.

## F. AMENDMENTS AND REVISIONS

By the first day of February of each year the City shall issue any updates or revisions which have been made during the previous calendar year.

Revisions or interpretations made by the City of Clever during the calendar year shall be mailed to interested parties who have requested such notification at the City.

1. Notices

Persons, firms or agencies wishing to be notified of the revisions or updates in these criteria shall notify the City of Clever in order to be placed on the mailing list.

## G. APPROVALS AND PERMITS REQUIRED

1. GRADING PERMIT

Storm drainage facilities may not be constructed or altered without review and approval of the plans by the City of Clever and issuance of a Grading Permit by the City for subdivisions or for commercial or other sites. A copy of the grading permit application can be obtained at City Hall.

In addition, 10 CSR 20-6~~.200~~ requires land disturbance activities of one acre or more to obtain a Missouri State Operating Permit to discharge storm water. The permit requires Best Management Practices sufficient to control runoff and sedimentation to protect waters of the state. Land disturbance permits may only be obtained by means of the Department of Natural Resources ePermitting system available online at:

www.dnr.mo.gov/env/wpp/wpermit/help.htm.
See www.dnr.mo.gov/env/wpp/wtormwater/sw-land-disturb-permits.htm for more information.

2. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) STORMWATER PERMIT

Provisions of the 1987 Clean Water Act require that certain stormwater discharges obtain an NPDES stormwater permit. In Missouri, these permits are administered by the Missouri Department of Natural Resources.

Federal rules for NPDES stormwater discharges are contained in 40 CFR Parts 122, 123 and 124 of the Code of Federal Regulations.

State NPDES stormwater regulations are contained in 10 CSR 20- 6~~.200~~ of the Code of State Regulations.

Additional provisions for NPDES stormwater permits for land disturbance activities and information regarding the City of Clever General Permit for land disturbance activities are contained in Section 257 of these Criteria.

3. "404" PERMIT

For certain activities which involve the discharge of dredged or fill materials into the waters of the United States, a Department of the Army permit may be required as set forth in Section 4040 of the Clean Water Act. Rules for 404 permits are contained in 33 CRF Parts 320 through 330 of the Code of Federal Regulations.

Determination of applicability for Section 404 requirements are generally made by the Little Rock District office of the Corps of Engineers for the James River and its tributaries which are located within the White River drainage basin. Questions regarding the Department of the Army Permits may be directed to:

Chief, Permits Branch
Little Rock District
U.S. Army Corps of Engineers
P.O. Box 867
Little Rock, AR 72203-0867
Phone: 501-378-5296

A brochure regarding the Corps of Engineers regulatory program may be obtained from the Corps offices.

## H. COORDINATION WITH OTHER JURISDICTIONS

Where proposed storm drainage facilities are located on property adjoining to other local government jurisdictions design of storm drainage facilities shall include provisions to receive or discharge storm water in accordance with the requirements of the adjoining jurisdiction, in addition to meeting City requirements.

In these cases 2 additional sets of plans shall be submitted and will be forwarded to the adjoining jurisdiction for review and comment.

No grading or construction of storm drainage facilities may commence without prior notification of the Missouri One Call utility warning system at 1-800-DIG-RITE, as required by law.

## I. COMMUNICATIONS AND CORRESPONDENCE

Communications and correspondence regarding storm water plan review, policies, design standards, criteria, or drainage complaints shall be directed to the City of Clever , P.O. Box 52, Clever, Missouri 65631, Phone 417-743-2544.

## J. STORMWATER PLAN REVIEW

1. SUBDIVISIONS

a. Sketch Plat

A sketch plat shall be submitted to the City of Clever showing the location of improvements to the subject property and shall meet the requirements as set forth by the City of Clever.

b. Preliminary Plat & Engineering Report

Storm drainage Requirements for the preliminary plat and engineer's report shall be as set forth by the City of Clever.

The City of Clever will review the plat and report and will forward written comments to the to the engineer within three working days.

c. Construction Plans

General Requirements for submittal of construction plans shall be as set forth by the City of Clever.

d. Final Plat

The City of Clever shall review the final plat for conformity with storm drainage requirements and return written comments to the engineer within fourteen calendar days following receipt.

2. GRADING AND BUILDING PERMITS

a. Pre-Construction Conference

A pre-construction conference may be required by the City of Clever if warranted by the scope of construction. The developer shall contact the City of Clever to set a time and location for the conference. The City of Clever will notify interested parties.

b. Inspection

Inspection of sediment and erosion control measures, and storm drainage facilities located on private property will be made by the City of Clever as set forth in this article.

All required Best Management Practices (BMPs) listed on the Sediment and Erosion Control Plan (SECP) or the Stormwater Pollution Prevention Plan (SWPPP) shall be maintained by the Owner / Contractor until time of Final Acceptance of the improvements. The Contractor shall also be responsible for maintaining the SWPPP and all provisions included in this documents until the time of Final Acceptance.

c. Final Inspection and Acceptance of Improvements

After all storm drainage improvements are constructed, the consultant shall perform as-built surveys and prepare as-built drawings in accordance with the requirements of Section 254.

Construction record drawings shall be submitted to the City of Clever.

Upon receipt of the construction record drawings, the City of Clever shall, within seven calendar days review the same for conformity with the plans and conduct a field inspection in the presence of the developer and/or his authorized representative.
The developer will be notified in writing of any deficiencies discovered during review of the construction record drawings or field inspection.

Upon correction of the noted deficiencies, the developer shall notify the City of Clever and schedule a field inspection. When all deficiencies have been corrected, the consultant shall submit one set of reproducible construction record drawings.

Occupancy permits shall not be issued until construction record drawings are approved and construction of required storm drainage improvements accepted.

d. Release of Security

Escrow or other required security may be released by the City of Clever after acceptance of the constructed improvements.

## K. OWNERSHIP AND MAINTENANCE

1. IMPROVEMENTS ON PUBLIC ROAD RIGHT-OF-WAY

   Storm drainage improvements on public right-of-way shall, upon acceptance of the constructed improvements, become the property of and shall be maintained by the City of Clever.

2. IMPROVEMENTS ON PRIVATE PROPERTY

   Storm drainage improvements on private property shall be maintained by the owner of the lot upon which the improvements are located or by the Homeowners' Association for improvements located in common areas.

   All such improvements which serve a drainage area of 5 acres or more shall be located in drainage easement and the public shall have such rights of access to repair or maintain such facilities.

## B. GENERAL PLANNING AND DESIGN PRINCIPLES

### A. STORMWATER MANAGEMENT GOALS

In order to ensure protection of the general health and welfare of the citizens of the City of Clever, planning and design of stormwater management measures shall meet the following:

1. Prevent damage to residential dwellings and other building structures from flood waters.

2. Maintain emergency vehicle access to all areas during periods of high water.

3. Prevent damage to roads, bridges, utilities, and other valuable components of the community's infrastructure from damage due to flood waters and erosion.

4. Prevent degradation of surface and ground water quality from stormwater runoff; preserve and protect quality of the environment; and promote conservation of the City's natural resources.

5. Minimize flood water and erosion damage to lawns, recreational facilities, and other outdoor improvements.

6. Minimize traffic hazards from runoff carried in streets and roads.

7. Comply with applicable State and Federal laws and regulations.

8. Meet the foregoing goals in a manner which is cost effective and which minimizes the cost of housing and development while encouraging sound development.

9. Encourage innovative and cost effective planning and design of stormwater management facilities.

10. Encourage multiple purpose design of stormwater management facilities, to provide opportunities for recreational use, and other benefits to the community wherever possible.

The standards and criteria set forth herein provide the minimum standards for planning and design of stormwater facilities. Where a particular plan or design may be found to be in conflict with a specific standard, achievement of the goals set forth above will have precedence.

### B. GENERAL PLANNING AND DESIGN

The City of Clever recognizes that stormwater management is an important component of overall land use planning.

The City of Clever further recognizes that proper stormwater planning significantly reduces the long term costs to the community both in terms of infrastructure cost and property losses due to flood damage.

It is much more cost effective to prevent flood damage by proper design and construction, than to repair and remediate problems which have occurred through poor planning and design.

The following general principles must be followed in preparing the grading and storm drainage plans for all development sites;

1. RECOGNIZE THE EXISTING DRAINAGE SYSTEMS

The storm drainage system differs from other utility systems in very important ways:

a. There is an existing natural drainage system.

b. It is only needed when runoff occurs.

c. The capacity of the system varies greatly depending upon how much it rains.

d. The system does not have to be constructed of man-made components in order to function.

Because of these characteristics there has been a historic inclination for fragmented planning and design of storm drainage facilities.

Proper planning of storm drainage facilities must begin with the recognition of the existing system, and include necessary provisions for preserving or altering the existing system to meet the needs of proposed development or construction.

Methods of delineating existing watercourses are outlined under Stormwater Runoff Calculations.

2. ALLOW FOR INCREASE IN RUNOFF RATES DUE TO FUTURE URBANIZATION

As areas urbanize, peak rates of runoff increase significantly. The City of Clever may require temporary detention and storage of increased volumes of urban runoff in order to minimize increased in flow rates as urbanization occurs. However, the cumulative effects of on-site detention are difficult to predict and control, and development of comprehensive basin-wide runoff models to determine these effects does not appear likely in the foreseeable future.

For this reason, design of storm drainage improvements must be based upon the assumption of fully urbanized conditions in the area under consideration. No reduction in peak flow rates due to detention, unless an approved runoff model has been developed for the drainage basin under consideration. Any detention storage facilities whose effects are considered must be located within approved drainage easements.

3. PROVIDE FOR ACCEPTANCE OF RUNOFF FROM UPSTREAM DRAINAGE AREAS

It is critical that provisions must be made to receive runoff from upstream drainage areas. Drainage easements or public right-of- way must extend to a point where the upstream drainage areas is no greater than 5 acres. Drainage easements or public right-of-way must extend to the point where existing watercourses enter the site. Where the upstream drainage area is 5 acres or greater, but does not discharge onto the site through a defined watercourse, the drainage easement shall extend to the point of lowest elevation.

4. PROVIDE A MEANS TO CONVEY RUNOFF ACROSS THE SITE

Stormwater shall be conveyed across the site in a system of overland drainageways and storm sewers. Overland drainageways consists of streets, open channels, swales, and overland flow within drainage easements.

5. DISCHARGE OF RUNOFF TO DOWNSTREAM PROPERTIES

Concentrated runoff shall be discharged only into existing watercourses, drainage easements, or public road rights-of-way. Where none of these exist, a drainage easement which extends to the nearest watercourse, drainage easement or public road right-of-way must be obtained from the downstream property owner, and proper provisions made for conveyance of the peak flow from the 4% Annual Probability storm within the drainage easement.

One of the typical results of urbanization is that diffuse surface flow or "sheet flow" is replaced with concentrated points of discharge. Where concentrated flows are discharged to downstream properties proper provisions must be made to:

a. Allow the flow to spread over the same area as would have occurred for the same rate of flow prior to the development, and

b. Reduce the rate of velocity to rates at least equal the pre-development values at the same rate of flow.

6. ASSESS POTENTIAL DOWNSTREAM FLOODING PROBLEMS

It is important that a determination of conditions in the watershed downstream of each development site to determine whether there are existing structures which are subject to an unacceptable flooding hazard (10% annual probability or greater).

If areas having an unacceptable flooding hazard occur downstream of a development site, either on-site detention for peak flow control, or mutually agreed off-site improvements will be required, as set forth in Part V Detention.

7. ASSESS POTENTIAL WATER QUALITY IMPACTS ON RECEIVING WATERS

   Sediment, erosion and other water quality controls are required as set forth in Part IV.

8. PROVIDE FOR OPERATION AND MAINTENANCE OF DRAINAGE FACILITIES

## C. THE MAJOR-MINOR STORM APPROACH

The amount of water that the storm drainage system must carry varies greatly depending upon the amount of precipitation which may occur.

The degree of flooding protection desired and the cost of providing that level of protection must be balanced against the risk and potential costs to life and property.

The City of Clever recognizes that it is neither cost effective nor necessary to require construction of a conveyance system for large infrequent floods in all cases.
Design of storm drainage systems can be made much more cost effective while providing desired levels of property protection by taking a major-minor storm approach to design of drainage facilities.

1. MAJOR STORM

   The major storm is defined as a storm with an annual probability of 4% (a "25-year storm").

   The combination of all overland and underground conveyance systems shall have sufficient capacity to convey the peak flow from the major storm without resultant flooding of any new building structures, and without exceeding maximum flooding depths in streets necessary to allow passage of emergency vehicles.

   It is recommended that the floor elevations of all new structures be located at least 1 foot above the estimated high water elevation resulting from the peak flow from the 4% annual probability storm.

2. MINOR STORM

   The minor storm is defined as a storm with an annual probability of 20% (a"5-year storm"). Inlets and storm sewers must have sufficient capacity to maintain acceptable flooding depths in street and road rights-of-way during the minor storm as required in “Drainage of Streets and Roadway” Section.

## D. DRAINAGE EASEMENTS

All areas subject to inundation during the major storm must be included in drainage easements Specific standards for drainage easements to be provided for storm sewers, open channels, and detention facilities are set forth under Storm Sewer, Open Channels, and Detention Facilities, respectively.

**C. RESERVED**

## D. STORM WATER RUNOFF CALCULATIONS

This section outlines acceptable methods of determining storm water runoff.

### A. GENERAL GUIDELINES

For watersheds with a total tributary area less than 200 acres and a one percent annual probability fully developed discharge less than 300 cfs, the design storm runoff may be analyzed using the rational formula.

For watersheds with a total tributary area greater than 200 acres or with a one percent annual probability fully developed discharge greater than 300 cfs, the design storm runoff shall be analyzed using an approved hydrograph method.

### B. RATIONAL FORMULA

The rational formula, when properly understood and applied, can produce satisfactory results for urban storm sewer design. The rational formula is as follows:

$$Q = CIA$$

Where:

$Q$ = Peak discharge in cubic feet per second

$C$ = Runoff coefficient which is the ratio of the maximum rate of runoff from the area to the average rate of rainfall intensity for the time of concentration.

$I$ = Average rainfall intensity in inches per hour for a duration equal to the time of concentration.

$A$ = Contributing watershed area in acres.

The basic assumptions made when applying the rational formula are:

1. The rainfall intensity is uniform over the basin during the entire storm duration.
2. The maximum runoff rate occurs when the rainfall lasts as long or longer than the basin time of concentration.
3. Runoff response characteristics are relatively uniform over the entire basin.
4. The time of concentration is the time required for the runoff from the most hydraulically remote part of the basin to reach the point of interest.

The drainage basin should be divided into sub-basins of a size where all of the basic assumptions apply.

## C. TIME OF CONCENTRATION

Time of concentration, tc, is calculated by:

tc = ti

Where:

ti = initial, inlet or overland flow time in minutes,
tt = shallow channel and open channel flow time in minutes

Overland flow (sheet flow) time shall be calculated as:

ti = ( (n x L)0.8)/4.64 x S0.4 where
ti = initial, inlet or overland flow time in minutes
n = Manning's n for sheet flow (from the following table),
L = Overland flow length in feet, (maximum of 300 feet),
S = Slope in feet per foot.

Roughness coefficients (Manning's n) for sheet flow

| SURFACE DESCRIPTION | |
|---|---|
| Smooth surfaces (concrete, asphalt, gravel or bare soil) | 0.011 |
| Fallow (no residue) | 0.05 |
| Cultivated soils: | |
| Residue cover less than or equal to 20 percent | 0.06 |
| Residue cover greater than or equal to 20 percent | 0.1 |
| Grass: | |
| Short grass prairie | 0.15 |
| Dense Grasses | 0.24 |
| Bermuda Grass | 0.41 |
| Range (natural) | 0.13 |
| Woods: | |
| Light underbrush | 0.40 |
| Dense underbrush | 0.80 |

1 Includes species such as weeping lovegrass, blue grass, buffalo grass, glue grama grass and native grass mixtures.

2 When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

Shallow channel velocities may be estimated from Figure 3-1 in Reference 11.

Open channel flow velocities may be estimated from Manning's equation. Open channel velocities are generally estimated under bank full conditions.

The basin time of concentration calculation techniques are described in detail in TR-55, Chapter 3 (Reference 11).

D. HYDROGRAPH METHODS

Methodologies. The most common hydrograph techniques are those developed by Corps of Engineers and the Soil Conservation Service. These methods are preferred; however other proven techniques will be accepted.

The Corps of Engineers HEC-1 Flood Hydrograph Package (Reference 18) and Soil Conservation Service TR-55 computer models (Reference 11) are the preferred runoff models. Other models may be used with approval from the City.

The runoff model must include the entire drainage basin upstream of the proposed development. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate.

The runoff model shall be developed for the following cases:

Case 1: Existing conditions in the drainage basin prior to development of the Applicant's property.

Case 2: Existing conditions in the drainage basin with developed conditions on the Applicant's property.

Case 3: Fully developed conditions in the entire drainage basin.

RAINFALL

Rainfall depth-duration-frequency and intensity-duration-frequency curves for the Clever area are included in the Standard Drawing Section of this document. The design rainfall intensities were developed from the U.S. Department of Commerce, National Weather Service, Technical Paper 40 (Reference 19) and the National Oceanic and Atmospheric Administration Publication "HYDRO-35" (Reference 9).

Rainfall shall be distributed in time using the SCS Type II distribution (Reference 11) or the Pilgrim-Cordery Distribution adapted to local rainfall data (References 20 and 21) as shown in the following table. Other distributions may be used upon approval from the City.

PILGRIM-CORDERY METHOD
SYNTHETIC RAINFALL MASS CURVES

| Cumulative Fraction of Storm Duration | | | | | |
|---|---|---|---|---|---|
| 1-Hour | 2-Hour | 3-Hour | 4-Hour | 6-Hour | |
| .00 | .00 | .00 | .00 | .00 | .00 |
| .05 | .03 | .03 | .03 | .02 | .05 |
| .10 | .07 | .05 | .05 | .03 | .09 |
| .15 | .11 | .10 | .06 | .05 | .14 |
| .20 | .14 | .17 | .09 | .06 | .20 |
| .25 | .17 | .22 | .11 | .08 | .28 |
| .30 | .23 | .25 | .13 | .14 | .35 |
| .35 | .29 | .27 | .19 | .20 | .41 |
| .40 | .35 | .29 | .31 | .27 | .43 |
| .45 | .41 | .30 | .39 | .33 | .46 |
| .50 | .47 | .31 | .44 | .38 | .49 |
| .55 | .56 | .41 | .47 | .47 | .60 |
| .60 | .65 | .51 | .54 | .56 | .70 |
| .65 | .73 | .60 | .64 | .64 | .80 |
| .70 | .82 | .69 | .70 | .74 | .86 |
| .75 | .91 | .78 | .73 | .83 | .89 |
| .80 | .93 | .82 | .81 | .87 | .93 |
| .85 | .95 | .87 | .89 | .90 | .96 |
| .90 | .97 | .92 | .94 | .93 | .97 |
| 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

# PART II

# EFFECTS OF DRAINAGE ON NATURAL FEATURES

## PART II - EFFECTS OF DRAINAGE ON NATURAL FEATURES

### A. SINKHOLES AND KARST FEATURES

A. GENERAL

The City of Clever is located on the Springfield Plateau of the Ozarks physiographic region. This area is underlain by Mississippian Age limestone which is highly susceptible to solutional weathering. As a result, sinkholes, springs and caves are common.

In many areas of the City special consideration must be given to flood hazards and potential for ground water contamination due to the presence of sinkholes, caves, losing streams, springs, and other features associated with karst geology.

The requirements set forth herein are intended to provide specific criteria for design and construction for any site upon which sinkholes or other karst features are located.

B. POLICY

Development in sinkhole areas will be based upon the following axioms:

1. Avoidance

2. Minimization

3. Mitigation

Construction in sinkholes shall be avoided. Exceptions will be made only in situations where it can be conclusively demonstrated that there are no practical alternative to such construction.

These situations are most likely to arise where:

1. An underground cavity has caused a collapsed sinkhole to form, after subdivision approval or building construction.

2. A sinkhole has been altered or filled either unknowingly or prior to passage of these regulations.

3. Maintenance and operation is required for existing roads and utilities.

4. Location of existing streets or utilities would render access or utility service to property impractical or cost prohibitive.

In these types of cases, measures which will have minimal impact of the sinkhole or receiving water may be proposed. Plans for minimal alteration can be approved provided it is conclusively demonstrated that the proposed plan is the minimum practical alternative.

In these cases potential impacts of construction on the sinkhole and receiving waters must be studied and assessed, and recommendations made for mitigation of potential impacts upon surface flooding and ground water quality before the plans can be approved. The degree and sophistication of study required will increase in proportion to the potential impacts.

C. DEFINITIONS

1. Sinkhole: Any depression in the surface of the ground, with or without collapse of adjacent rock that provides a means through which surface water can come into contact with subsurface water.

   Sinkhole depressions may be gradual or abrupt; they may or may not have a well-defined eye. While most sinkholes can be defined as the area within a "closed contour," some sinkholes such as those located on the sides of hills may not.

   All sinkholes provide discreet point of recharge to ground water.

2. Sinkhole Watershed: The ground surface area that provides drainage to the sinkhole.

   This area extends beyond the sinkhole depression, and generally crosses property boundaries.

3. Unaltered Sinkhole: A sinkhole which has never been alter or disturbed.

4. Altered Sinkhole: A sinkhole which has been filled, excavated or otherwise disturbed.

5. Collapsed Sinkhole: A subsidence or cave-in of the ground surface caused when soil overburden can no longer be supported by underlying strata due to the presence of subsurface solution cavities.

6. Sinkhole Eye: Generally, a visible opening, cavity or cave in the bottom of a sinkhole, sometimes referred to as a swallow hole.

7. Sinkhole Rim: The perimeter of the sinkhole depression. The sinkhole rim will generally vary in elevation.

8. Sinkhole Cluster Area: An area containing 2 or more sinkholes located in close proximity, generally interconnected by ground water conduits.

9. Terminal Sinkhole: The lowest sinkhole in a sinkhole cluster to which any surface water overflowing from other sinkholes in the cluster will flow.

10. Sinkhole Flooding Area: The area inundated by runoff from a storm with an annual exceedance probability of 1% and duration of 6 hours.

11. Qualified Geologist: A person who has met or exceeded the minimum geological educational requirements and who can interpret and apply geologic data principles, and concepts and who can conduct field or laboratory geologic investigations (per RSMo); and who by reason of experience and education, has an understanding of local karst geology.

12. Qualified Professional Engineer: A person registered to practice engineering according to the laws of the State of Missouri, and who by reason of technical education and experience has a background in the fundamentals of storm drainage and karst geology.

13. Heavy Equipment: Motorized equipment having a gross weight of more than 6 tons.

14. Light Equipment: Motorized equipment weighing 6 tons or less.

D. PERMITS REQUIRED

1. Grading Permit: A grading permit must be obtained prior to any alteration of sinkholes associated with new subdivision construction.

E. GENERAL PLAN REQUIREMENTS

General requirements for grading and drainage plans shall be as set forth by the City of Clever.

F. SINKHOLE EVALUATION

An evaluation including the following information shall be made for all sites upon which sinkholes are fully or partially located:

1. The site plan for the proposed development must show the following items with respect to location of proposed construction, proposed or existing property lines and existing structures:

a. Sinkholes

1. Location and limits of the area of the sinkhole depression as determined by field surveys or other reliable sources as may be approved. Location of sinkholes based solely upon USGS 7-1/2 Minute Series Quadrangle Maps will not be considered sufficient unless field verified.

2. Location and elevation of the sinkhole eye where visible or known.

3. Topographic contours at maximum intervals of 2 feet, and spot elevations sufficient to determine the low point on the sinkhole rim and the profile of the potential overflow area.

4. Minimum entry elevations of any existing structures located within the sinkhole rim.

5. Elevation of any roadway located within or adjacent to the sinkhole.

b. Water Supply Sources

1. The approximate location of public or private water supply sources such as spring or wells, as determined from information available from the City and Missouri Department of Natural Resources.

2. Boundaries of any known recharge areas to wells or springs as determined from information available from the City and Missouri Department of Natural Resources.

c. Other Geologic Features

Locations of caves, springs, faults and fracture trends, geologic mapping units based upon information from the City or other reliable sources.

d. Flooding Limits

For the sinkholes determined as set forth in this section.

1. A drainage area map showing the sinkhole watershed area.

Where the site is located in a sinkhole cluster area, this map shall be extended to include the watershed area any sinkholes located downstream of the site which may receive overflow drainage from the site.

2. Assessment of potential impacts on ground water quality and proposed water quality management measures as provided in this section.

G. FLOODING CONSIDERATIONS

1. Minimum Flooding Analysis

Maximum estimated flooding elevations shall be determined for each sinkhole for both pre-development and post development conditions, assuming no subsurface outflow from the sinkhole.

Where the estimated volume of runoff exceeds the volume of the sinkhole depression, the depth, spread and path of overflow shall be estimated using methods set forth in the Storm Water Runoff Calculations Section and shown on the map.

The overflow volume shall be included determining the maximum estimated flooding elevations in the next downstream sinkhole. This analysis shall continue downstream until the lowest sinkhole of the sinkhole cluster is reached or overflow reaches a surface watercourse.

The volume of runoff considered shall be that which results from a rainstorm with an annual probability of 1% (100-year storm) and a duration of 6 hours (5.8 inches for Clever).

The runoff volume shall be determined by the method set forth in Chapter 2 of the SCS TR-55 Manual (Reference 11).

No further flooding analysis will be required provided that:

a. The post-development flooding area of any sinkhole which receives drainage from the site is located entirely on the site.

b. A drainage easement covering the post-development flooding area is provided for any off-site sinkhole or portion of a sinkhole which receives increased peak rates of runoff from the site. If the receiving sinkhole is not contiguous to the site, an easement must also be provided for the waterway which connects the site to the sinkhole.

c. The minimum entry elevation of any existing structure is at least 1 foot higher than the estimated flooding elevation from the 1% annual probability 6-hour storm.

d. The flooding depth on any existing public road does not exceed the maximum depths set forth in Section 262.

2. Detailed Flooding Analysis

In cases where the conditions set forth in Section 257, G-1 cannot be met, a detailed flooding analysis will be required if any increase in runoff volume is proposed. For detailed flooding analysis a runoff model must be made for the sinkhole watershed and reservoir routing analysis performed using hydrograph techniques as set forth in Section 256.

The following alternative methods may be used singly or in combination to keep flooding levels at pre-development levels:

a. Diversion of Excess Runoff to Surface Watercourses

Where feasible, increased post-development runoff may be diverted to a surface watercourse, provided that:

1. Any increase in peak runoff rate in the receiving watercourse does no crater worsen existing flooding problems downstream and;

2. The diverted storm water remains in the same surface watershed.

Storm sewers, open channels and other appurtenances provided for diversions shall be designed in accordance with the applicable sections of these Design Criteria.

The effect of diverted water on downstream watercourses and developments, and requirements for additional detention facilities prior to release of runoff to the surface watercourse shall be determined as set forth in Part V, Detention Facilities.

Effects of the diversion shall be shown by reservoir routing analysis. Routing of excess runoff shall be considered satisfactory when it can be demonstrated that the post-development flooding elevation in the sinkhole does not exceed the pre-development flooding elevation within reasonable tolerance (generally 0.1 ft.).

b. Determination of outflow Capacity of Sinkhole

The stage-discharge characteristics of the sinkhole shall be estimated by monitoring the sinkhole during at least two storm events exceeding 1" of runoff in a 6-hour period.

In sinkhole complexes, receiving or terminal sinkholes must also be analyzed if they receive overflow from upstream sinkholes.

Input rainfall hydrographs shall be determined either by a recording rain gage or readings from an approved rain gage at 15-minute intervals.

The outflow rate shall be estimated by adjusting the stage-discharge relationship of the reservoir routing model until the maximum reservoir stage in the model correlates with the maximum observed stage in the sinkhole. The maximum stage shall be determined to the nearest 0.1 foot by field survey.

Stages may be determined by field instrumentation at the consultant's option. Information regarding the instrumental used shall be submitted with the report.

Where debris lines are used as evidence of maximum stage, photographs shall be provided.

If by accounting for the outflow from the sinkhole, the conditions set forth in this section can be met, no further flooding analysis is necessary.

The volume of runoff storage in the sinkhole(s) can be counted toward storm water detention requirements, provided that proper sediment and erosion control measures are provided as set forth in Part IV and water quality considerations as set forth in this section can be met.

If in the opinion of the City, the outflow capacity of the sinkhole may be adversely affected by ground water conditions, the effects of which may not be adequately determined by observing surface water stages, the City may require installation of a monitoring well in each sinkhole, for the purpose of monitoring ground water levels in comparison with surface water levels.

c. Storage of Excess Runoff within the Sinkhole Watershed

Where feasible, detention facilities may be constructed within the sinkhole watershed or in perimeter areas of the sinkhole. These detention facilities must be located outside the sinkhole flooding area determined for post-development conditions.

The flooding considerations set forth in this Section will be met if it can be demonstrated that:

1. Inflow rates to the sinkhole can be reduced to a degree that, in conjunction with the observed outflow rate, the post-development flooding elevation in the sinkhole does not exceed the pre-development flooding elevation within reasonable tolerance (generally 0.1ft).

2. Sediment & erosion control and water quality considerations as set forth elsewhere in this section can be satisfied.

## H. WATER QUALITY CONSIDERATION

Sinkholes provide direct recharge routes to ground water. As a result water quality in wells, caves and springs may be affected by discharge of runoff from developed areas.

The Sinkhole Evaluation must consider potential impacts of the proposed construction of receiving ground waters and propose measures to mitigate such impacts.

Four primary factors must be considered:

- Receiving Ground water Use.
- Relative ground water contamination hazard associated with the proposed development.
- Ability to capture pollutants.
- Management measures to be provided to reduce pollutant levels.

1. Receiving Ground Water Use

   The Sinkhole Evaluation Report shall identify whether the site lies within a critical area based upon information available from the City.

   Where disagreements may arise over whether a site is located within a particular recharge area dye tracing may be required for confirmation of the destination of water discharges through a sinkhole.

a. Critical Areas

The following areas are classified as critically sensitive to contamination from urban runoff:

1. Recharge areas of domestic water supply wells

2. Recharge areas of springs used for public or private water supply

3. Recharge areas of caves providing habitat to are or endangered species such as the Ozark cave fish

b. Sensitive Areas

All other sinkhole areas will be classified as sensitive to contamination from urban runoff.

2. Ground Water Contamination Hazard

The relative potential for ground water contamination will be classified as low, moderate, or high depending upon the type of land use, development density and amount of directly connected impervious area. The Sinkhole Evaluation shall identify whether the proposed development poses a low, moderate, or high hazard to ground water uses, as defined below:

a. Low Hazard

The following land uses are classified as posing a relatively low hazard to ground water contamination:

1. Wooded areas and lawns.

2. Parks and recreation areas.

3. Residential developments on sewer, provided directly connected impervious areas discharging to the sinkhole are less than 1 acre.

4. Low density commercial and office developments provided directly connected impervious areas discharging to the sinkhole and less than 1 acre.

5. Discharge from graded areas less than 1 acre having required sediment controls per Part IV.

b. Moderate Hazard

1. Concentrated discharge from streets and parking lots and roofs and other directly connected impervious areas having an area greater than 1 acre and less than 5 acres.

2. Multifamily residential developments and higher intensity office developments provided the directly connected impervious areas discharging to the sinkhole are less than 5 acres.

3. Discharge from graded areas greater than 1acre and less than 5 acres having required sediment controls per Part IV.

c. High Hazard

1. Collector and arterial streets and highways used for commercial transport of toxic materials.

2. Railroads

3. Concentrated discharge from streets and parking lots and roofs and other directly connected impervious areas having an area greater than 5 acres.

4. Commercial, industrial and manufacturing areas.

5. Individual waste water treatment systems.

6. Commercial feedlots or poultry operations.

7. Discharge from graded areas greater than 5 acres having required sediment controls per Part IV.

3. Capturing and Filtering Pollutants

The majority of sinkholes drain a limited watershed area. For sinkholes where the surrounding drainage area is small enough that the area draining to the sinkhole flows predominantly as "sheet flow", potential impacts on water quality can be addressed by erecting silt control barriers around the sinkhole during construction and providing a vegetative buffer area around the sinkhole to filter out potential contaminants.

When the volume of runoff into the sinkhole increases to the point where flow becomes concentrated, the degree of effort required to capture and filter out contaminants increases significantly.

Concentration inflow occurs naturally when the sinkhole watershed area reaches a sufficient size for watercourses leading into the sinkhole to form. Concentrated surface flows result as urbanization occurs due to construction of roads, storm sewers, drainage channels. Subsurface flows can become concentrated through utility trenches.

The Sinkhole Evaluation shall include maps showing any existing watercourse which flows into the sinkhole and location of any proposed concentrated storm water discharges into the sinkhole.

4. Water Quality Management Measures

a. Sediment and Erosion Control

1. Non-Concentrated Flow (sheet flow)

a. In critical areas, existing ground cover shall not be removed within 25 feet of the sinkhole rim and a silt barrier shall be provided around the outer perimeter of the buffer area.

2. Concentrated Flow

a. Sediment basin will be required at each point where concentration flows are discharged into the sinkhole. Sediment basins shall be designed according to the procedures set forth in Part IV.

b. Minimizing Directly Connected Impervious Area

The ground water contamination hazard category for impervious areas may be reduced by reducing the amount of Directly Connected Impervious Area. This is the area of roofs, drives, streets, parking lots, etc. which are connected via paved gutters, channels, or storm sewers.

Directly Connected Impervious Areas can be reduced by providing properly sized grass swales, vegetative filter strips or other Best Management Practices to separate paved areas.

c. Diversion of Runoff

Concentrated discharges to sinkholes can be reduced to manageable levels or avoided by diverting runoff from impervious areas away from sinkholes where possible.

Diversions shall be done in a manner that does not increase flooding hazards on downstream properties and, generally, shall not be directed out of the surface watershed in which the sinkhole is located.

d. Filtration Areas

For areas having a low or moderate ground water contamination hazard and where flow into the sinkhole occurs as sheet flow, water quality requirements can be satisfied by maintaining a permanent vegetative buffer area with a minimum width of 30 feet around the sinkhole.

Use of pesticides and fertilizers will not be permitted within the buffer area. Animal wastes will not be permitted to accumulate in the buffer area.

e. Grassed Swales and Channels

For areas having a low ground water contamination hazard concentrated flows from directly connected impervious areas of less than one acre may be discharged into the sinkhole through grassed swales and channels.

Swales and channels shall be designed for non-erosion velocities and appropriate temporary erosion control measures such as sodding or erosion control blankets provided.

f. Storage and Infiltration

Storage and infiltration will be required in the following cases:

1. All areas having a high ground water contamination hazard.

2. Areas having a moderate ground water contamination hazard where concentrated inflow occurs.

Storage and infiltration basins shall be designed to capture the runoff from storms up to 1 inch in 6 hours and release runoff over a minimum period of 24 hours. Standard outlet structures for sedimentation and infiltration basins are shown in Appendix F.

I. DEVELOPMENT REQUIREMENTS

1. Storm Water Detention in Sinkholes

Where flooding considerations set forth in Part I, General Provisions Section and water quality considerations as set forth in Part IV can be met, the volume of runoff storage in sinkholes can be counted toward storm water detention requirements, provided that proper sediment an erosion control measures are provided as set forth in Part IV.

The volume of required detention storage shall be determined as set forth in Part V.

Excavation within the sinkhole flooding area to provide additional detention storage will not be allowed.

2. Modification of Sinkholes to Increase Outflow Rates

Increasing outflow rates in sinkholes by excavating the sinkhole eye or installing disposal wells for diverting surface runoff to the ground water system is prohibited, unless clear and imminent danger to the public health and safety can be demonstrated.

3. Setbacks and Use Restrictions

a. No new construction of any of the following shall be permitted within 30 feet of the sinkhole rim:

1. Residential, commercial, or industrial structures.

2. Swimming Pools.

3. Streets, highways, or parking lots.

4. Storage yards for materials, vehicles, and equipment.

5. Sanitary sewer lines.

b. Use of pesticides and fertilizers within 30 feet of the sinkhole rim is prohibited.

c. Use of heavy construction equipment in unaltered sinkholes is prohibited.

d. Construction of underground utilities is prohibited within the sinkhole rim.

e. Recreational facilities such as hiking, jogging, and bicycle trails, playgrounds, exercise courses, and grass playing fields are permitted within the sinkhole are provided they are not located within the eye of the sinkhole.

f. Golf courses are permitted subject to approval of a Management Plan for use of pesticides and fertilizers.

g. Clearing and pruning of trees and undergrowth, and limited grubbing of roots is permitted.

h. Landscaping and minor gardening is permitted outside of the sinkhole eye provided erosion and sediment discharge is limited through use of minimum tillage and mulch.

i. Construction of light incidental landscaping and recreational structures such as gazebos, playground equipment, etc. is permitted except in the sinkhole eye.

4. Collapsed Sinkholes

Collapsed sinkholes may be stabilized and filled using approved techniques. A Grading Permit must be issued prior to performing the construction.

The probable cause of the collapse and potential adverse impacts of filling the collapse shall be investigated and information submitted with the Grading Permit Application.

5. Altered Sinkholes

Filing or altering of sinkholes without a Grading Permit constitutes a violation of this ordinance. No corrective or remedial measures shall be undertaken until the proposed remediation plan has been reviewed by the City and a Grading Permit issued.

No Building Permits will be issued, or zoning or subdivision approvals granted until the remedial measures specified in the Grading Permit have been completed.

# PART III

# DRAINAGE STRUCTURES

## PART III - DRAINAGE STRUCTURES

## A. INLETS

A. INLET LOCATION

Inlets shall be provided at locations and intervals, and shall have a minimum inflow capacity such that maximum flooding depths set forth in General Provisions and Drainage of Streets and Roadways are not exceeded for the major or minor storm; and at all sump locations where ponding of water is not desired, and drainage cannot be released at the ground surface.

B. INLET INTERCEPTION CAPACITIES

Inlet capacities shall be determined in accordance with the Federal Highway Administration HEC-12 Manual or HEC-22 Manual.

Nomographs and methods presented in the Neenah Inlet Grate Capacities report (Reference 12) may also be used where applicable.

The use of commercial software utilizing the methods of HEC-12 is acceptable. It is recommended that software be pre-approved for use by the city.

Clogging Factors. The inlet capacities determined as required in this section must be reduced as follows, in order to account for partial blockage of the inlet with debris:

| INLET TYPE & LOCATION | CLOGGING FACTOR |
|---|---|
| Type SS Curb Opening | 0.08 |
| Grated Inlets | |
| on grades | 0.06 |
| in sumps | 0.50 |

Inlet lengths or areas shall be increased as required to account for clogging.

C. INTERCEPTION AND BYPASS FLOW

It is generally not practical for inlets on slopes to intercept 100% of the flow in gutter. Inlets must intercept sufficient flow to comply with street flooding depths requirements. Bypass flows shall be considered at each downstream inlet, until all flow has entered approved storm sewers or drainage ways.

D. TYPES OF INLETS ALLOWED

1. Public Streets

a. Curb Opening Inlets

Type "SS" standard curb opening inlets as shown in Drawing F-4 shall be used for public streets with curb and gutter.

b. Grated Inlets

In general, the use of grated inlets in streets, which require adjustments when streets are repaved will not be permitted.

Where conditions are such that curb inlets cannot intercept the required rate of flow, necessary to control street flooding depth or to provide diversion of flow to detention, sedimentation or infiltration basins, "trench inlets" with vaned grates may be specified with approval of the City.

Other types of inlets will not be permitted unless approved by the City.

2. Outside of Public Right-of-Way

The type of inlets specified outside of public right-of-way is left to the discretion of the designer provided the following criteria are met:

a. Maximum flooding depths for the major or minor storm as set forth in Drainage of Streets and Roadways are not exceeded.

b. General safety requirements set forth in Stormwater Planning and Design are met.

c. All inlets shall be depressed a minimum of 2" below the surrounding grade to allow proper drainage to the inlet and prevent inadvertent ponding in the area around the inlet.

d. Inlets in pavements shall be provided with a concrete apron.

E. GENERAL SAFETY REQUIREMENTS

All inlets openings shall:

1. To provide for the safety of the public from being swept into the storm drainage system; the maximum allowable opening shall not exceed 6" in width.

2. Be sufficiently small prevent entry of debris which would clog the storm drainage system;

3. Be sized and oriented to provide for safety of pedestrians, bicyclists, etc.

## B. STORM SEWERS

A. PURPOSE

This section outlines acceptable methods of determining storm water runoff.

B. DESIGN CRITERIA

1. Design Storm Frequency: The storm sewer system, beginning at the upstream and with inlets, is required when the allowable street capacity or overflow capacity is exceeded for the design storm. The "design storm" has two connections in the City of Clever: the design storm for the minor system and the design storm for the major system, the 5-year and 25-year storm respectively, as noted in The Stormwater Runoff Calculations Section. Thus, the storm sewer system should be designed for the larger of the following two events:

a. The peak flow from a 5-year storm or;

b. The difference in the peak flow from a 25-year storm and the allowable street capacity.

2. Construction Materials: Storm sewers may be constructed using reinforced concrete, corrugated metal (steel or aluminum) or plastic pipe except for those areas under roadways which shall be reinforced concrete. The materials, pipes, or appurtenances shall meet one or more of the following standards:

| PIPE MATERIAL | STANDARD |
|---|---|
| Reinforced Concrete Pipe-Round M-170 | ASTM C-76 or AASHTO |
| Reinforced Concrete Pipe-Elliptical M-207 | ASTM C-507 or AASHTO |
| Reinforced Concrete Pipe-Joints M-198 | ASTM C-443 or AASHTO |
| Reinforced Concrete Pipe-Arch M-206 | ASTM C-506 or AASHTO |
| Pre-Cast Concrete Manhole M-199 | ASTM C-478 or AASHTO |
| Pre-Cast Concrete Box Pipe | ASTM C-789/C-850 or AASHTO M259/M-273 |

(CONTINUED FROM PREVIOUS PAGE)

| PIPE MATERIAL | STANDARD |
|---|---|
| Corrugated Steel Pipe-Metallic for Sewers and Drains | AASHTO M-36 |
| Corrugated aluminum Alloy Pipe and Underdrains | AASHTO M-196 |
| Bituminous Coated Corrugated Metal Pipe and Pipe Arches | AASHTO M-190 |
| Corrugated PVC Pipe F-679 | ASTM D-3034 and ASTM |
| Corrugated Polyethylene Pipe | ASTM D-1248 |

3. Vertical Alignment:

The sewer grade shall be such that a minimum cover is maintained to withstand AASHTO HS-20 loading on the pipe. The minimum cover depends upon the pipe size, type and class, and soil bedding condition, but shall not be less than 1 foot from the top of pipe to the finished grade at any point along the pipe. If the pipe encroaches of the street subgrade, approval is required.

Manholes will be required whenever there is a change in size, direction, elevation grade and slope or where there is a junction of two or more sewers. The maximum spacing between manholes for storm sewers (cross sectional are less than 25 square feet) shall be 400 feet. For large storm sewers (cross sectional area greater than 25 square feet), manholes for maintenance access need only be placed a minimum of every 500 feet; access to the lateral can be obtained from within the larger storm sewer.

The minimum clearance between storm sewer and water main (for new construction), either above or below shall be 18 inches. In addition, when an existing sanitary sewer main lies above a storm sewer, or within 18 inches below, then sanitary sewer shall have an impervious encasement or be constructed of structural sewer pipe for a minimum of 10-feet on each side of the storm sewer crossing. Siphons or inverted siphons are not allowed in the storm sewer system.

4. Horizontal Alignment: Storm sewer alignment between manholes shall be straight except when approved by the City. Approved curvilinear storm sewers may be constructed by using radius pipe. The radius requirements for pipe bends are dependent upon the manufacture's specifications.

A minimum horizontal clearance of 10 feet is required between sanitary and water utilities and the storm sewer.

The permitted locations for storm sewer within a street ROW are: a) on centerline, b) between centerline and curb and c) behind the curb. Storm sewer shall not be placed on the area within the wheel lanes of the pavement.

5. Pipe Size: The minimum allowable pipe size for storm sewers is dependent upon a diameter practical from the maintenance standpoint. For storm sewers less than 50 feet in length the minimum allowable diameter is 15 inches. All other pipe shall have a minimum diameter of 18 inches.

6. Storm Sewer Capacity and Velocity: Storm sewers should be designed to convey the design storm (5-year) flood peaks without surcharging the storm sewer. The sewer may be surcharged during larger floods and under special conditions when approved by the City.

The capacity and velocity shall be based on then-values presented in Table 259-1. The maximum full flow velocity shall be less than 15 fps. Higher velocities may be approved by the City if the design includes adequate provisions for uplift forces, dynamic impact forces and abrasion. The minimum velocity in a pipe based on full flow shall be 2.5 fps to avoid excessive accumulations of sediment.

The energy grade line (EGL) for the design flow shall be no higher than six inches below the final grade at manholes, inlets, or other junctions. To insure that this objective is achieved, the hydraulic grade line (HGL) and the energy grade line (EGL) shall be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses will include friction, expansion, contraction, bend, manhole and junction losses. The methods for estimating these losses are presented in the following sections.

7. Storm Sewer Outlets: All storm sewer outlets into open channels shall be constructed with a headwall and wingwalls or a flare-end-section. Riprap or other approved material shall be provided at all outlets.

8. Hydraulic Evaluation: Presented in this section are the general procedures for hydraulic design and evaluation of storm sewers. The user is assumed to possess a basic working knowledge of storm sewer hydraulics and is encouraged to review the text books and other technical literature available on the subject (Reference -3, -4, -6, -7, -10, and -40).

9. Pipe Friction Losses: Pipe friction losses are estimated using Equation 259-1 and Manning's formula (Equation 259-2) which are expressed as follows:

(Equation 259-1)

$$Hf = Sf \times L$$

where $Hf$ = head loss due to friction (feet)

$Sf$ = Friction slope from Manning's

equation (feet per foot)

$$Sf = \frac{29.1 * n2}{r * 1.33} \cdot \frac{v2}{2g}$$

L = length of pipe segment (feet)

(Equation 259-2)

$$V = \frac{1.49}{n} \times R^{2/3} \times Sf^{1/2}$$

Where:

V = velocity of flow (ft per second)

R = hydraulic radius = A/WP (feet)

Sf = friction slope (feet per foot)

A = area of flow (square feet)

WP = wetted perimeter (feet)

n = Manning's roughness coefficient (refer to Table 259-1)

10. Pipe Form Losses: Generally, between the inlet and outlet, the flow encounters, in the flow passageway, a variety of configuration such as changes in pipe size, branches, bends, junctions, expansions, and contractions. These shape variations impose losses in addition to those resulting from pipe friction. Form losses are the result of fully developed turbulence and can be expressed as follows:

(Equation 259-3)

$$HL = K (V^2/2g)$$

Where: HL = head loss (feet)

K = loss coefficient

$V^2/2g$ = velocity head (feet)

g = gravitation acceleration (32.2 $ft/sec^2$ ).

The following discussion presents an abbreviated listing of the common types of form losses encountered in storm design. The reader is referred to Reference 1 and 6 for additional discussion.

11. Expansion Losses: Expansion losses in a storm sewer will occur when the sewer outlets into a channel. The expansion will result in a shearing action between the incoming high velocity jet and the surrounding outlet boundary. As a result, much of the kinetic energy is dissipated by eddy currents and turbulence. The loss head can be expressed as:

(Equation 259-4)

$$HL = Kx\ (V1^2/2g) * (1-(A1/A2))2$$

Where: A = cross section area in square feet

V1 = average upstream pipe flow velocity, feet per second

Kx = expansion loss coefficient

Subscripts 1 and 2 denote the upstream and downstream sections respectively. The value of Kx is about 1.0 for a sudden expansion (such as an outlet to a channel) and about 0.2 for a well-designed expansion transition. Table 259-2 presents the expansion loss coefficient for various flow conditions.

12. Contraction Losses: The form loss due to contraction is:

(Equation 259-5)

$$HL = Kc\ (V^2/2g)(1-(A2/A1)2)2$$

Where: Kc = contraction loss coefficient

Kc is equal to 0.5 for a sudden contraction and about 0.1 for a well-designed transition. Subscripts 1 and 2 denote the downstream sections respectively. Table 259-2 presents the contraction loss coefficient for various flow conditions.

13. Bend Losses: The head losses for bends, in excess of that caused by an equivalent length of straight pipe, may be expressed by the relation:

(Equation 259-6)

$$HL = Kb\ (V^2/2g)$$

Where: Kb = Bend coefficient

The bend coefficient has been found to be a function of:

a) the ratio of the radius of curvature of the bend to the width of the conduit, b) deflection angle of the conduit, c) geometry of the cross section of flow, and d) the Reynolds Number and relative roughness. Recommended bend loss coefficients for standard bends, radius pipe, and bends through manholes are presented in Table 259-2.

14. Junction and Manhole Losses: A junction occurs where one or more branch sewer enters a main sewer, usually at manholes. The hydraulic design of a junction is in effect the design of two or more transitions, one for each flow path.

Allowances should be made for head loss due to the impact at junctions. The head loss at a junction for each pipe entering the junction can be calculated from:

(Equation 259-7)

$$HL = \frac{(V2^2/2g) - Kj\,(V12)}{2g}$$

Where: V2 = the outfall flow velocity

V1 = the inlet velocity

Kj = junction loss coefficient

Because of the difficulty in evaluating hydraulic losses at junctions (Reference-6) due to the many complex conditions involving pipe size, geometry of the junction and flow combinations, a simplified table of loss coefficients has been prepared. Table 259-2 presents the recommended energy loss coefficients for typical manhole or junction conditions encountered in the urban storm sewer system. The coefficients are based on a review of the available data in References -1, -3, -6 and -7.

Case I is for an inlet or a manhole with a straight-through sewer. The recommended loss under this condition is 5% of the velocity head, which typically will be between 0.05 and 0.1 feet. Cases II and III are for junctions with an additional branch line entering the inlet or manhole. For these cases, the losses are dependent on the entry angle of the branch line. The inlet condition, Case II, will have a slightly higher loss than the manhole, because of the flow entering from the top, which results in additional turbulence loss.

Case IV defines the losses for a lateral pipe in which the only flow is from the inlet itself. If a straight-through sewer makes a bend at the manhole, Case V, the losses are calculated from the figure portion of Table 259-3, Sheet 2 of 2. Case VI illustrates flow conditions of connector pipes.

15. Partially Full Pipe Flow: When a storm sewer is not flowing full, the sewer acts like an open channel and the hydraulic properties can be calculated using open channel techniques in the Open Channels Section.

16. Storm Sewer Outlets: When the storm sewer system discharges into an open channel, additional losses, in the form of expansion losses, occur at the outlet. For a headwall and no wingwall, the loss coefficient Kx is 1.0. For a headwall with 45 degree wingwalls, the loss coefficient is about 1.14. For a flared-end-section (which has a Dc/D1 ratio of 2 and a theta angle of around 30 degrees) the loss coefficient is approximately 0.5.

17. Connection Pipe: Connector pipes are used to convey runoff from an inlet to the storm sewer. If, however, the storm sewer runs through the inlet, then a connector pipe is not needed. Connector pipes can connect a single inlet to the storm sewer or they can be connected in a series. Both cases are illustrated in Table 259-3.

As is illustrated in Table 259-2(c), water has a vertically downward velocity component after entering the inlet. The water is conveyed in the connector pipe in a roughly horizontal direction and then travels roughly horizontally again through the storm sewer after making a sharp bend from the connector pipe.

TABLE 259-1
RECOMMENDED
MANNING'S n-VALUES

| | |
|---|---|
| Closed Conduit | |
| Concrete pipe | .013 |
| Corrugated steel pipe | .024 |
| | |
| Open Channels | |
| gabions | .035 |
| concrete | .015 |
| riprap | $.0395d_{50}^{0.17}$ |
| grouted riprap | .027 |
| gunite | .028 |
| earth lined | .020 to .040 |
| grass lined | .029 to .100 |
| natural streams | .025 to .100 |

TABLE 259-2
LOSS COEFFICIENTS

A. EXPANSION LOSS COEFFICIENTS

| COEFFICIENT, KX EXPANSION ANGLE | D2/D1=3 | D2/D1=1.5 |
|---|---|---|
| 10 | .17 | .17 |
| 20 | .40 | .40 |
| 45 | .86 | 1.06 |
| 60 | 1.02 | 1.21 |
| 90 | 1.06 | 1.14 |
| 120 | 1.04 | 1.07 |
| 180 | 1.00 | 1.00 |

Where D2 = downstream diameter and
D1 = upstream diameter

B. CONTRACTION LOSS COEFFICIENTS

| ENTRANCE | COEFFICIENT, Kc |
|---|---|
| Bell-mouthed | .04 |
| Square-edged | .50 |
| Groove-edged | .20 |

| D2/D1 | COEFFICIENT, Kc |
|---|---|
| <.4 | .5 |
| .4 | .4 |
| .6 | .3 |
| .8 | .1 |

C. BEND LOSS COEFFICIENTS

| PIPE BENDS | DEFLECTION ANGLE | COEFFICIENT, KB |
|---|---|---|
| | 90 | .50 |
| | 60 | .43 |
| | 45 | .35 |
| | 22.5 | .20 |

BENDS AT MANHOLES (no special shaping)

| DEFLECTION ANGLE | COEFFICIENT, KB |
|---|---|
| 90 | 1.30 |
| 60 | 0.68 |
| 45 | 0.44 |
| 22.5 | 0.14 |

BENDS AT MANHOLES (Curved or defection)

| DEFLECTION ANGLE | COEFFICIENT, KB |
|---|---|
| 90 | 1.04 |
| 60 | 0.48 |
| 45 | 0.32 |
| 22.5 | 0.10 |

These bends, turns, and flows through the connector pipe give rise to three hydraulic losses: a change from static to kinetic energy to get the water moving through the connector pipe, an entrance loss from the inlet to the connector pipe, and a friction loss along the length of the connector pipe. The total head loss in the connector pipe can be calculated from the following equation:

(Equation 259-8)

$$Hcp = Hv + Ke \times Hv = Sf \times L$$

Where:

Hcp = head loss in the connector pipe (feet)

Ke = Entrance loss coefficient

Hv = velocity head in the pipe, assuming full pipe flow (feet) and the other variables are as previously defined.

The value of the entrance loss coefficient is determined from Table 259-2.

If the connector pipes are connected in series, the head loss in each pipe is calculated from Equation 259-B and the total head loss is the summation of the individual head losses.

## C. EASEMENTS

Easements shall be provided for all storm sewers constructed in the City of Clever that are not located within public rights-of-way. The minimum easement widths are as follows:

For pipes 48 inches or less in diameter or width the required easement width is 15 feet.

For pipes and boxes greater than 48 inches in width the required easement width is 10 feet plus the width of the proposed storm sewer.

Storm sewers greater than 8 feet in depth to the flow line may require additional easement width.

All easements required for construction which are not included on the final plat shall be recorded and filed with the City prior to approval of the construction drawings.

## C. BRIDGES AND CULVERTS

A. PURPOSE

This section outlines the criteria for the allowable drainage encroachment within public streets.

B. GOALS & OBJECTIVES

Urban streets are a necessary part of the city drainage system. The design for the collection and conveyance of storm water runoff is based on a reasonable frequency and degree of traffic interference. Depending on the street classification, (i.e.: local, collector, etc.) portions of the street may be inundated during storm events. Drainage of streets is controlled by both the minor and major storm events. The minor system is provided to intercept and convey nuisance flow.

Flow depths are limited for the major storm to provide for access by emergency vehicles during most flood events.

C. DESIGN STANDARDS FOR CULVERTS

1. Structural Design: All culverts shall be designed to withstand an HS-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges". The designer shall also check the construction loads and utilize the most severe loading condition. The minimum allowable cover is one foot.

2. Design Capacity: Culverts shall be designed to pass the major storm with one foot of freeboard prior to overtopping the road or driveway.

3. Headwater: The maximum headwater for the major storm design flow shall be 1.5 times the culvert diameter for round culverts or 1.5 times the culvert rise dimension for shapes other than round.

4. Inlet and Outlet Protection: For road and driveway culverts larger than 15 inches, culverts are to be designed with protection at the inlet and outlet areas as provided in Section 264 of this criteria. Headwalls or end sections are to be located a sufficient distance from the edge of the shoulder or the back of walk to allow for a maximum slope of 3H:1V to the back of the structure. The type of outlet protection required is as follows:

| V < 7 FPS | 7 FPS < V < 15 FPS | V > 15 FPS |
|---|---|---|
| Minimum Riprap Protection (Part V) | Riprap protection or Energy Disipator | Energy Disipator |

5. Velocity Limitations: The maximum allowable discharge velocity is 15 feet per second.

6. Culvert Hydraulics: It is recommended that the procedures outlined in the publication "Hydraulic Design of Highway Culverts" reference 4, be used for the hydraulic design of culverts. Backwater calculations demonstrating the backwater effects of the culvert may be required.

## D. DESIGN STANDARDS FOR BRIDGES

1. Structural Design: All bridges shall be designed to withstand and HS-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges" Reference 13. The designer shall also check the construction loads and utilize the most severe loading condition.

2. Design Capacity: Bridges shall be designed to pass the major storm with one foot of freeboard between the water surface and the bridge low chord.

3. Backwater: Backwater is defined as the rise in the water surface due to the constriction created by the bridge approach road fills. The maximum backwater for the major storm design flow shall be one foot.

4. Velocity Limitations: Discharge velocities through bridge openings shall be limited to 15 feet per second. Abutment and channel scour protection shall be provided at all bridges.

5. Bridge Hydraulics: All bridge hydraulics shall be evaluated using the procedures presented in the publication "Hydraulics of Bridge Waterways" Reference 14. Backwater calculations demonstrating the effects of the bridge and approach fills compared to the existing flood stages shall be submitted for all bridges.

## D. OPEN CHANNELS

### A. PURPOSE

Presented in this section are the technical criteria for the hydraulic evaluation and hydraulic design of open channels including natural channels, grass, concrete or rock lined channels, composite channels, and roadside ditches.

### B. GOALS & OBJECTIVES

The open channel is generally the main facility of major drainage system. If the natural drainage path is preserved, the construction costs for the system can be minimized. The natural route along with minimum alteration of the existing channel is recommended for all drainage ways. In some instances, however, the land use of the property can be improved by relocation or straightening the natural drainage path. Altering the channel alignment and shape may require the addition of grade control structures to control the flow velocities and erosion resulting from increased flows due to urbanization.

### C. GENERAL DESIGN GUIDELINES

#### 1. Natural Channels

The hydraulic properties of natural channels vary along the channel reach and can be either controlled to the extent desired or altered to meet the given requirements. Natural channels used as part of the drainage system must be evaluated for the effect of increased peak flow, flow duration and volume of runoff due to urbanization.

#### 2. Lined Channels

Grass lined channels are the most desirable of the artificial channels. The channel storage, lower velocities, and the greenbelt multiple use benefits obtained create significant advantages over other artificial channels. Unless existing development restricts the availability of right of way, channels lined with grass should be given preference over other artificial types.

#### 3. Concrete Lined Channels

Concrete lined channels are sometimes required where right of way restrictions within existing development prohibit grass lined channels. The lining must be designed to withstand the various forces and actions which tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining and erode unlined areas.

#### 4. Rock Lined Channels

Rock lined channels are constructed from ordinary riprap or wire enclosed riprap (gabions etc.) The rock lining permits higher design velocity than for grass lined channels. Rock linings

will normally be used only for erosion control at culvert/storm sewer outlets, at sharp channel bends, at channel confluences and at locally steepened channel sections.

5. Other Lining Types

The use of fabrics and other synthetic materials for channel linings has increased over the past several years. Proposed improvements of this type will be reviewed on an individual basis as for applicability and performance.

D. HYDRAULICS

An open channel is a conduit in which water flows with a free surface. The calculations for uniform and gradually varied flow are relatively straight forward and are based upon similar assumptions (e.g. parallel streamlines). The basic equations and computational procedures are presented in this section.

1. Uniform Flow

Open channel flow is said to be uniform if the depth of flow is the same at every section of the channel. For a given channel geometry, roughness, discharge and slope, there is only one possible depth, the normal depth. For a channel of uniform cross section the water surface will be parallel to the channel bottom for uniform flow.

The computation of normal depth for uniform flow shall be based upon Manning's formula as:

(Equation 261-1)

$$Q = AV$$

Where:

Q = Discharge in cubic feet per second (cfs)
V = Velocity in feet per second as determined by equation 259-2
A = Cross sectional flow area in square feet

For channels with a uniform cross section the EGL slope and the bottom slope are assumed to be the same.

2. Critical Flow

The design of earth or rock channels in the critical flow regime (Froude numbers from 0.9 to 1.2) is not permitted. The Froude number is defined as follows:

(Equation 261-2)

$$F = V/(gD)^{0.5}$$

Where:

F = Froude number
V = Velocity in feet per second (fps)
g = Acceleration of gravity, 32.2 ft/sec$^2$
D = Hydraulic depth in feet = A/T
A = Cross sectional flow area in square feet
T = Top width of flow area in feet

The Froude number shall be calculated for the design of all open channels.

3. Gradually Varied Flow

The most common occurrence of gradually varied flow in storm drainage is the backwater crated by culverts, storm sewer inlets or channel constrictions. For these conditions the flow depth will be greater than normal depth in the channel and the water surface profile must be computed using backwater techniques.

Backwater computations can be made using the methods presented in Chow (Reference 1). Many computer programs are available for computation of backwater cures. The most widely used program is HEC-2, Water Surface Profiles, developed by the U.S. Army Corps of Engineers (Reference 2) and is the program recommended for backwater profile computations. Another program by the Federal Highway Administration is WSPRO (Reference 15) and is acceptable for use in backwater computations.

E. DESIGN STANDARDS

1. Flow Velocity

Maximum flow velocities shall not exceed the following:

| Channel Type | Max. Velocity |
|---|---|
| Grass lined* | 5 fps |
| Concrete | 15 fps |
| Rock Lined | 10 fps |

* Refer to Section E6.

2. Maximum Depth

The maximum allowable channel depth of flow is three feet for the design flow.

3. Freeboard Requirements

Freeboard is defined as the vertical distance between the computed water surface elevation for the design flow and the minimum top of bank elevation for a given cross section.

For all channels one foot minimum of freeboard is required.

Freeboard shall be in addition to super elevation.

4. Curvature

The minimum channel centerline radius shall be three times the top width of the design flow.

5. Super Elevation

Super elevation shall be calculated for all cures. An approximation of the super elevation h, may be calculated from the following formula:

(Equation 261-3)

$$h = V2T/(g \times r)$$

Where:

h = Super elevation in feet
V = Velocity in feet per second (fps)
T = Top width of flow area in feet
g = Acceleration of gravity, 32.2 ft/sec2
r = radius of curvature in feet

6. Grass Channels

Side slopes shall be 3 (horizontal) to 1 (vertical) or flatter. Steeper slopes may be used subject to additional erosion protection and approval from the City.

For design discharges greater than 50 cfs, grade checks shall be provided at a maximum of 200' horizontal spacing.

Channel drops shall be provided as necessary to control the design velocities within acceptable limits.

Vertical drops may be used up to three feet in height. Drops greater than three feet shall be baffled chutes or similar structures.

The variation of Manning's n with the retardance, and the product of mean velocity and hydraulic radius as shown in Figure 7.23 in Reference 17 shall be used in the capacity calculations. Retardance curve C shall be used to determine the channel capacity and retardance cure D shall be used to determine the velocity.

## F. EASEMENTS

Easements shall be provided for all open channels constructed in the City of Clever that are not located within public rights of way. The minimum easement width for open channels is the flow width inundated by a 25-year event plus 15 feet.

All easements required for construction which are not included on the final plat shall be recorded and filed with the City prior to approval of the construction drawings.

## E. DRAINAGE OF STREETS AND ROADWAYS

A. PURPOSE

This section outlines the criteria for the allowable drainage encroachment within public streets.

B. GOALS & OBJECTIVES

Urban streets are a necessary part of the city drainage system. The design for the collection and conveyance of storm water runoff is based on a reasonable frequency and degree of traffic interference. Depending on the street classification, (i.e.: local, collector, etc.) portions of the street may be inundated during storm events. Drainage of streets is controlled by both the minor and major storm events. The minor system is provided to intercept and convey nuisance flow.

Flow depths are limited for the major storm to provide for access by emergency vehicles during most flood events.

When the depths of flow exceed the criteria presented in this section, a storm sewer or open channel system is required.

C. GENERAL DESIGN GUIDELINES

1. Allowable flow depths. Flow in the street is permitted with allowable depths of flow as follows:

a. Local Streets: Top of curb for the runoff from a 5-year rainfall (minor storm), maximum of six inches at crown for a 25-year event (major storm).

b. Collector Streets: Top of curb for the minor storm, maximum of six inches at the crown for the major storm.

c. Arterials and Parkways: Top of curb for the minor storm. For the major storm, a maximum of 6 inches at the crown, depth at the gutter shall not exceed 1 inch

Where allowable depths are exceeded, a storm sewer system must remove the excess water.

2. Cross Flow: Cross flow at intersections is permitted up to the following depths:

| STREET CLASSIFICATION | MINOR STORM ALLOWABLE DEPTH | MAJOR STORM ALLOWABLE DEPTH |
|---|---|---|
| LOCAL | 6" in cross pan | 12" at gutter flow line |
| COLLECTOR | 6" in cross pan | 12" at gutter flow line |

| | | |
|---|---|---|
| ARTERIAL OR PARKWAY | No cross flow permitted | No cross flow permitted |

D. HYDRAULICS

The allowable storm capacity of each street section with curb and gutter is calculated using the modified Manning's n formula for both the minor and major storm event.

(Equation 262-1)

$$Q = 0.56(Z/n)\, S^{1/2}\, d^{8/3}$$

Where: Q = discharge in cubic feet per second

Z = reciprocal of the cross slope of the street in feet per foot

d = depth of flow at the gutter in feet

s = longitudinal slope of the street in feet per foot

n = Manning's roughness coefficient

# PART IV

# SEDIMENT & EROSION CONTROL

# PART IV - SEDIMENT & EROSION CONTROL

## A. PURPOSE, GOALS & OBJECTIVES

A. PURPOSE

The purpose of this section is to provide detailed design criteria and standards to supplement the regulation.

B. GOALS AND OBJECTIVES

The goal of the regulation is to effectively minimize erosion and discharge of sediment by application of relatively simple and cost-effective Best Management Practices.

This goal can be attained by meeting the following objectives:

1. Minimize the area disturbed by construction at any given time.

2. Stabilize disturbed areas as soon as possible by re-establishing sod, other forms of landscaping, and completing proposed structures, pavements and storm drainage systems.

3. Provide for containment of sediment until areas are stabilized.

4. Provide permanent erosion controls.

## B. GENERAL DESIGN GUIDELINES

The following items must be considered in preparing a sediment and erosion control plan.

### A. TEMPORARY VS. PERMANENT CONTROLS

The greatest potential for soil erosion occurs during construction. Temporary controls are those which are provided for the purpose of controlling erosion and containing sediment until construction is completed.

Temporary controls include straw or hay bale dikes, silt fences, erosion control blankets etc., which are not needed after the area is stabilized.

Permanent controls consist of riprap, concrete trickle channels, detention basins, etc., which will remain in place through the life of the development.

It is possible for the same facility to serve both a temporary and permanent purpose. The difference between temporary and permanent erosion control should be clearly recognized in preparing a sediment and erosion control plan.

### B. SHEET FLOW VS. CONCENTRATED FLOW

In areas where runoff occurs primarily as sheet flow, containment of sediment is relatively simple. In these areas straw or hay bales, silt fences and vegetative filter areas can be very effective.

Where concentrations of flow occur containment of sediment becomes more difficult as the rate and volume of flow increases. In these areas more sophisticated controls such as sedimentation basins must be provided.

### C. SLOPE

Control of erosion becomes progressively more difficult as the slope of the ground increases. Areas with steeply sloping topography, and cut and fill slopes must be given special consideration.

### D. SOILS AND GEOLOGIC SETTING

Area soils and the geologic setting must be considered in preparing the plan and any special considerations deemed necessary for a particular site provided.

### E. ENVIRONMENTALLY SENSITIVE AREAS

Where construction occurs within the vicinity of permanent streams, springs, sinkholes, lakes or wetland, special attention must be given to preventing discharge of sediment.

## C. GRADING PERMITS

A. PERMIT REQUIREMENTS

Grading permits are required for all construction sites with the following exceptions:

1. Grading for single family or duplex residences constructed in subdivisions where approved sediment and erosion controls have been constructed.

2. Construction sites which have received an individual storm water discharge permit or water quality certification from the Missouri Department of Natural Resources (MDNR) in accordance with the Clean Water Act. Activities that require a General Permit from MDNR (MORA00000) are not excluded from obtaining a Grading Permit from the City of Clever.

3. Emergency construction required to repair or replace roads, utilities, or other items affecting the general safety and well-being of the public.

For emergency construction sites which would otherwise be required to obtain a permit, and for which remedial construction will take more than 14 calendar days, application for the permit must be made within 3 calendar days from the start of construction.

4. The following activities provided that they are not located within 25 feet of a spring, sinkhole, wetland, or watercourse:

a. Gardening or landscaping normally associated with single family residences which cover less than 1/2 acres.

b. Grading and repair of existing roads or driveways.

c. Cleaning and routine maintenance of roadside ditches or utilities.

d. Utility construction where the actual trench width is 2 feet or less.

5. Sites which were graded prior to passage of this document provided that they do not provide an imminent threat to the general health, safety and welfare of the public in the opinion of the city.

B. PERMIT PROCEDURES

The following items must be received prior to issuance of a Grading Permit:

1. Completed Site and Grading Permit application. (Available at City Hall)

2. An approved grading, sediment and erosion control plan.

3. A performance bond or other security.

The submittal and approval procedure is as follows:

Subdivisions, Commercial and Other Sites

The sediment and erosion control plan shall be submitted for review along with the plans for the proposed improvements.

Grading permits for subdivisions will be issued by the City after approval of the plans for the subdivision improvements.

C. PLAN REQUIREMENTS

Plans must be prepared by and bear the seal of an engineer registered to practice in the State of Missouri.

Plan requirements are set forth in the Stormwater Planning and Design Section, and in this Section.

Plans will not be required in the following cases:

1. Grading associated solely with a single-family residence and which is not exempt from the permit requirement.

2. Grading or filling of less than 1 acre if located outside of allowable building areas and not located within 25 feet of a spring, sinkhole, wetland, or watercourse.

In these instances, a grading permit can be issued following an inspection of the site by a representative of the City if it does not reveal any conditions which would warrant preparation of a detailed plan in the opinion of the City.

D. BOND REQUIREMENTS

1. Subdivisions, Commercial and Other Sites

Grading, erosion and sediment control items will be included in the amount of security required for public improvements which must be received by the City before the final plat can be filed.

2. Amount of Security

The following minimum amounts shall apply:

Sites less than 1 acre: $500.00

Sites one acre or more: $500 per acre of disturbed area

## D. OTHER PERMITS

A. NPDES STORM WATER PERMIT

Effective July 1, 2022, construction sites where the area to be disturbed is 1 acre or more must apply for a Land Disturbance Permit from the Missouri Department of Natural Resources.

Permit requirements are set forth in 10 CSR20-6.200 of the Code of State Regulations.

B. "404" PERMIT

Grading activities in streams or wetlands may require a Department of the Army Permit under Section 404 of the Clean Water Act.

## E. DESIGN STANDARDS AND CRITERIA

A. GRADING

1. Maximum grades

Cut or fill slopes shall not exceed 3:1.

4:1 slopes are preferred where possible.

2. Maximum Height

Cut or fill slopes shall not exceed 15 feet in vertical height unless a horizontal bench area at least 5 feet in width is provided for each 15 feet in vertical height.

3. Minimum Slope

Slope in grassed areas shall not be less than 1%.

4. Construction Specifications

Construction for streets must comply with specifications set forth by the City of Clever.

For all other areas, construction specifications stating requirements for stripping, materials, subgrade compaction, placement of fills, moisture and density control, preparation and maintenance of subgrade must be included or referenced on the plans, or accompanying specifications submitted.

5. Spoil Areas

Broken concrete, asphalt and other spoil materials may not be buried in fills within proposed building or pavement areas.

Outside of proposed building and pavement areas, broken concrete or stone may be buried in fills, provided it is covered by a minimum of 2 feet of earth.

Burying of other materials in fills is prohibited.

6. Stockpile Access

Location of proposed stockpile areas shall be outlined on the plans, and specifications for proper drainage included.

7. Borrow Areas

The proposed limits of temporary borrow areas shall be outlined in the plans and a proposed operating plan described on the grading plan.

Temporary slopes in borrow areas may exceed the maximums set forth above. At the times that borrow operations are completed, the area shall be graded in accordance with the criteria set forth above, and reseeded.

B. SEDIMENT CONTAINMENT

1. Existing Vegetative Filter Area

Existing vegetative filter areas may be used where:

a. unconcentrated sheet flow occurs,

b. an area of existing vegetation a minimum of 25 feet in width can be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland or classified lake,

c. existing ground slope is no greater than 5:1 (20%),

d. the existing vegetative growth is of sufficient density and in sufficiently good condition to provide for filtration of sediment.

Containment areas constructed of hay or straw bales, or silt fence may be provided in areas where:

a. unconcentrated sheet flow occurs,

b. an area of existing vegetation, a minimum of 25 feet in width cannot be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland or classified lake,

c. existing ground slope is no greater than 5:1 (20%),

d. concentration flow form an area no greater than 1 acre occurs and a minimum volume of 100 cubic feet per acre is contained behind the dike.

Either cereal grain straw or hay may be used for bale dikes.

Silt fence may be used in lieu of hay or straw bales.

Straw/hay bake dikes and silt fences are temporary practices.

3. Temporary Containment Berms

Temporary containment berms may be provided for areas where concentrated flow from areas greater than 1 acre and less than 5 acres occurs. Temporary containment berms must contain a volume of 1000 cubic feet per acre of drainage area.

Temporary containment berms and accumulated sediment may be completely removed after the tributary area is stabilized, and must be removed prior to final acceptance and release of escrow.

4. Sedimentation Basin

Sediment basins shall be provided for all areas where concentrated flow occurs from an area of 5 or more acres. Sediment basins shall be designed to detain the runoff from 1" of rainfall, for a period of at least 24 hours. Runoff shall be calculated using the methods contained in Chapter 2 of TR-55 (Reference 11), using the recommended curve number for newly graded areas from Table 2-2a.

Note: For construction sites in Clever an average value of runoff volume from 1" of rainfall is approximately 1000 cubic feet per acre, using a curve number of 90, as indicative of type B & C soils. This value may be used in sizing sediment basins or the runoff volume determined using the values from Figure 2-1 of TR-55.

Sediment basins shall be provided with:

a. An outflow structure consisting of,

1. a flow restriction device which provides for the required detention time,

2. an outfall pipe sized to carry the maximum estimated outflow rate,

3. protective structures at the pipe outlet to prevent crushing or damage of the end of the pipe,

4. protective structures to prevent blockage of the pipe with debris,

5. erosion protection at the pipe outlet.

b. An overflow spillway capable of discharging the peak flow rate for the annual 4% annual probability (25-year) storm while maintaining a minimum freeboard of 1 foot.

Overflow spillways may be sodded where the depth of flow at the crest is limited to no greater than 6" and outlet channel velocities do not exceed 5 feet per second for the minor (5-year) storm.

Overflow spillways not meeting these restrictions must be constructed of riprap, concrete or other approved, non-erodible material.

C. EROSION PROTECTION

1. SEEDING AND MULCHING (Also see Division 2 - Section 2M of the Specifications in this document)

a. Permanent Seeding

Permanent seeding fertilizer and mulch shall be applied at the rate set forth in Drawing F-1 or according to other specifications which are approved with the Grading Permit. Permanent seeding seasons are from March 1 to May 15, and August 15 to October 15.

b. Mulching

Where slopes are less than 4:1, cereal grain mulch is required at the rate of 100 pounds per 1000 square feet (4500 pounds per acre). Cereal grain mulch shall meet the requirements of Section 802 of the State Specifications (Reference 17) for Type 1 mulch.

Where slopes are 4:1 or greater Type 3 mulch ("hydromulch") meeting the requirements of Section 802 of the State Specifications (Reference 17) shall be used.

c. Temporary Seeding

Whenever grading operations are suspended for more than 30 calendar days between permanent grass or seeding periods all disturbed areas must be reseeded with temporary cover according to Drawing F-1.

Temporary seeding season runs from May 15 to November 15.

d. Overseeding

During the winter season (November 15 to March 1) temporary seed and mulch shall be placed in on all completed areas or areas where grading is suspended for more than 30 days. During this period seed, mulch and soil amendments shall be applied at the following rates:

| | |
|---|---|
| Lime: | 100% of specified quantity.* |
| Fertilizer: | 75% of specified quantity. |
| Seed: | 50% of specified quantity. |
| Mulch: | 100% of specified quantity. |

* Per Drawing F-1

e. Maintenance

Seeded areas must be maintained for one year following seeding.

2. CUT AND FILL SLOPES

Cut and fill slopes shall be protected from erosion by construction of straw bale dikes, silt fences, diversion berms, or swales along the top of the slope.

Where drainage must be carried down the slopes, pipe drains, concrete flumes, riprap chutes, or other impervious areas must be provided. Suitable erosion control measures such as riprap stilling basins must be provided at the bottom of the slope.

Diversions shall be maintained until permanent growth is firmly established on the slopes.

3. CHANNELS AND SWALES

Permanent channels and swales shall be provided with a stabilized invert consisting of one of the following materials:

a. Sod

Where the average velocity of flow is 5 feet per second or less and there is no base flow, the channel shall be lined with sod.

For channels with a bottom width less than 15 feet, sod shall extend up the side slope to a minimum height of 6" above the toe.

Channels with a bottom width of 15 feet or greater, shall be lined with sod.

The remainder of the channel slopes shall be seeded and mulched as provided above.

b. Erosion Control Blanket

Commercial erosion control blankets may be used in lieu of sod provided that samples are submitted and approved by the City. The guaranteed maintenance period shall be one year.

c. Non-erosive lining

In grass channels where base flow occurs, a non-erosive low-flow channel of riprap or concrete must be provided. Low flow channels shall have a minimum capacity of 5 cubic feet per second. Other suitable non-erosive materials may be specified with approval of the City.

For channels which have an average velocity of 5 feet per second or greater a non-erosive lining of riprap concrete or other approved material must be provided.

4. STORM SEWER AND CULVERT OUTLETS

Erosion protection shall be provided at storm sewer and culvert outlets. Minimum erosion protection shall consist of a concrete toe wall and non-erosive lining.

Flared end sections and headwalls are not required, but may be provided at the discretion of the designer to meet grading or aesthetic requirements. The required length of non-erosive lining will not be decreased where flared and sections or headwalls are provided unless calculations and data to support the decrease in length are submitted and approved. Non-erosive lining shall consist of riprap, unless otherwise specified and approved. Field stone, gabions, or Riprap shall extend to the point at which average channel velocity for the peak flow rate from the minor (5-year) storm has decreased to 5 feet per second maximum.

The length of riprap to be provided shall be as follows:

Average outlet velocity less than 5 feet per second:

L = 3 times the pipe diameter or culvert width.

Average outlet velocity less than 5-10 feet per second:

L = 5 times the pipe diameter or culvert width .

Average outlet velocity greater than 10 feet per second:

Use MHTD standard energy dissipater headwall. (Reference 17)

Where headwalls or flared end sections are specified, toewalls must be provided at the downstream end.

5. CURB OPENINGS

Where drainage flows from paved areas to grass areas through curb openings erosion protection shall be provided.

6. DITCH CHECKS & DROP STRUCTURES

In grass channels grades and velocities may be controlled by use of ditch checks and drop structures.

Riprap ditch checks may be required in natural channels where average velocity for the peak flow rate from the minor storm exceeds 5 feet per second for post-development conditions.

7. SPILLWAYS

Erosion protection must be provided at spillways and outlet structures for detention ponds. Erosion protection shall extend to the point where flow has stabilized and average velocity in the outlet channel is 5 feet per second or less.

D. TEMPORARY CONSTRUCTION ENTRANCE

A minimum of one temporary construction entrance is required at each site. Additional temporary entrances may be provided if approved. The location of each construction entrance shall be shown on the plan. Only construction entrances designated on the sediment and erosion control plan may be used. Barricades shall be maintained if necessary to prevent access at other points until construction is complete.

Construction entrances shall be constructed of crushed limestone meeting the following specifications:

Construction entrances shall be a minimum of 25 feet wide and 50 feet long.

Minimum thickness of crushed limestone surface shall be 6". Additional 2" lifts of crushed limestone shall be added at the discretion of the City if the surface of the initial drive deteriorates or becomes too muddy to be effective.

In location where an existing drive or street extends at least 50 feet into the site, the existing drive may be designated as the construction entrance, and construction of a new gravel entrance is not required, unless job conditions warrant as set forth in the preceding paragraph.

E. CLEANING STREETS

Streets both interior and adjacent to the site shall be completely cleaned of sediment at the end of construction and prior to release of security.

F. DUST CONTROL

The contractor will be required to use water trucks to water haul roads and construction areas to minimize dust leaving the site when conditions warrant.

G. SEQUENCING AND SCHEDULING

Costs of sediment and erosion control can be minimized if proper consideration is given to sequencing and scheduling construction.

Any special sequencing and scheduling considerations should be noted in the grading plan.

A detailed schedule must be received from the contractor at the Pre-Construction Conference.

# PART V

# DETENTION

## PART V - DETENTION

### A. DETENTION FACILITIES

A. PURPOSE

Detention facilities are used to reduce storm water runoff rates by storing excess runoff.

The usual function of detention facilities is to provide sufficient storage such that peak runoff rates are not increased when development occurs.

B. POLICY

The primary goal of the City of Clever storm water management program is the prevention of flood damage to residential, commercial and public property.

In adopting this policy, the City of Clever recognizes that:

- there are many areas in the city where residential flooding occurs because of inadequately sized drainage ways,

- flooding depths and frequency will increase as development occurs upstream of these areas,

- detention basins are the only effective "on-site" means which can be used to control peak runoff storm water rates as areas develop.

City of Clever further recognizes that:

- the best means to assure effective performance of a detention basin utilize is perform reservoir routing calculations using hydrographs,

- such methods have not been in widespread use in this area, but rather a method known as the "Simplified Volume Formula" has been the basis of City detention policy,

- use of the Simplified Volume Formula frequently does not result in adequately sized detention facilities,

- the inaccuracy of the Rational Method, upon which the Simplified Volume Formula is based, increases as the area under consideration increases,

- even though the Simplified Volume Formula has severe limitations, requirements of detailed analytical methods may not be justified in all cases,

- detention basins designed using the simplified Volume Formula do provide a minimal amount of flooding protection and potential water quality benefits by functioning as sediment basins.

Therefore, in order to provide a reasonable level of flood protection to homes and businesses, while maintaining a climate favorable for development and economic growth, the City of Clever has established the following policy for design of detention facilities:

C. METHODS OF ANALYSIS

The method of analysis to be required for the design of detention facilities will be determined as follows:

1. Detailed Analysis will be required in the following cases:

a. In areas where residences or other structures located downstream of a development can be shown to have an imminent flooding hazard a detailed analysis using hydrographs and reservoir routing techniques will be required.

Residences or other structures will be defined as having an imminent flooding hazard when the lowest point, at which surface runoff may gain entry, is located at, or below, the estimated flooding level which would result from a storm with an annual probability of 10% or greater under conditions existing in the basin prior to development of the applicant's property. (i.e. affected by the "10-year storm).

b. Detailed analysis will be required for all detention facilities where the peak runoff rate from the area upstream of the detention facility (off site and on site) exceeds 250 cfs (cubic feet per second) for a storm with an annual probability of 1% (the "100-year storm") under fully developed conditions.

(Note: This would be the rate of flow from approximately 40 acres for residential areas or 15 acres for fully paved commercial areas)

2. Simplified Analysis will be permitted in the following cases:

For areas where there are no imminent downstream flooding problems, and where the peak runoff rate from the drainage area (off site and on site) upstream of the detention facility does not exceed 150 cfs for the 1% annual probability ("100-year) storm under fully developed conditions, the Simplified Volume Formula may be used.

3. Alternatives to Detention

In cases where channelization or other improvements can be shown to be more effective than detention in reducing the flooding hazard to downstream properties, and where no adverse effect to downstream properties will result from construction of such improvements, the City may, upon written recommendation by the Storm water Engineer, and approval of the City,

enter into an agreement with the applicant to accept compensation in lieu of constructing on-site detention facilities. The fee would be paid to the City either when the development was completed and the final plat approved or when a performance bond is issued to the City for that development.

The City has established the following formula for the fee in lieu of detention:

(Equation 268-1)

Fee = (K x Ia)

Where: Ia = the increase in impervious area (roofs, pavement, driveways, patios, etc.) in acres and

K = 8000

K is a factor determined by the city. This factor will be determined based upon the net financial gain which the developer would realize if the detention facility is not built. This amount will generally be equal to the construction cost of the detention facility plus revenue from sale of additional lots or increased value of lots, less the cost of developing the lots, including utilities and streets, financing cost, sales costs, and reasonable profit. The City shall evaluate this formula annually and make the appropriate adjustments.

4. Innovation in design

It is the desire of the City that detention facilities be designed and constructed in a manner to enhance aesthetic and environmental quality of the City as much as possible.

City of Clever therefore encourages designs which utilize and enhance natural settings, and minimize disturbance and destruction of wooded areas, natural channels, and wetlands.

5. Interpretation

Interpretations of the detention policy will be made by the City in writing.

Appeals of the decision of the City may be made to a designated Review Board. Request for appeals should be made in writing to the City.

## B. DESIGN CRITERIA

### A. GENERAL

Detention facilities shall discharge into a drainage easement or public right of way.

One foot of freeboard shall be provided between the maximum water surface elevation (maximum stage for a 1% annual probability event) and the minimum top of berm or wall elevation.

Embankment slopes steeper than three horizontal to one vertical (3H:1V) are not permitted.

In certain instances, such as when the existing development conditions runoff from a watershed would exceed the capacity of the existing downstream facilities, retention basins (i.e., no outlet or with a release rate at the capacity of the downstream facilities) for the storm runoff may be required by the City.

Dry detention basins shall maintain a minimum bottom slope of two feet per hundred feet (2%).

Trickle channels shall have a minimum slope of one half foot per hundred feet (0.5%).

The maximum allowable depth of ponding for parking lot detention is 12 inches.

Parking lot detention may not inundate more than 10% of total parking area.

All parking lot detention areas shall have a minimum of two signs posted identifying the detention pond area. The signs shall have a minimum area of 1.5 square feet and contain the following message:

| **WARNING** |
| --- |
| **This area is a storm water detention pond and is subject to periodic flooding to a depth of 18 inches.** |

Any suitable materials and geometry of the sign are permissible, subject to approval by the City.

### B. DETAILED ANALYSIS

Detailed analysis shall be performed using hydrograph methodologies and reservoir routing techniques.

The most common techniques are those developed by the Corps of Engineers and the Soil Conservation Service. These methods are preferred; however, other proven techniques will be accepted.

Detention basins designed by detailed methods shall be designed on the basis of multiple storm recurrence frequencies to ensure that they function properly for both frequent storms and large infrequent storms.

A minimum of three recurrences frequencies, the 50%, 10% and 1% annual probability storms (the "2-year, 10-year and 100-year" storms) must be considered.

The runoff model must include the entire drainage basin upstream of the proposed detention pond. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate.

The runoff model shall be developed for the following cases:

Case 1: Existing conditions in the drainage basin prior to development of the applicant's property.

Case 2: Existing conditions in the drainage basin with developed conditions on the applicant's property.

Case 3: Fully developed conditions in the entire drainage basin.

Cases 1 & 2 are utilized to determine the required detention volume and the type of outlet structure to be provided, and shall be analyzed for the three storm recurrence frequencies required above.

The detention facility shall be designed such that peak outflow rates from the facility for Case 2 are no greater than the rates determined in Case 1 for each of the three storm recurrence frequencies required.

The storage volume provided shall not be less than the difference in total runoff volume between Case 1 and Case 2.

Case 3 is used to determine the size of the overflow spillway. Case 3 need only be analyzed for the 1% annual probability (100-year).

The overflow spillway will, in most cases, be combined with the outlet structure.

C. SUBMITTALS

The following information must be submitted for detention ponds designed by detailed methods:

1. Information regarding analytical methods and software to be used, including:

- Name of software to be used.
- Type and distribution of precipitation input.
- Method of determining precipitation losses.
- Type of synthetic hydrograph.
- Method for routing hydrographs.
- Method used for reservoir routing.

2. Maps(s) showing sub basin delineation, topography, presumed flow routes, and pertinent points of interest; soil types; existing basin development conditions used in the model; fully developed conditions used in the model.

3. Routing diagram for the runoff model.

4. A summary of sub basin characteristics used for program input.

5. Stage-area or stage-storage characteristics for the basin in tabular or graphic form.

6. Stage-discharge characteristics for the outlet structure and overflow spillway in tabular or graphic form; hydraulic data for weirs, orifices, and other components of the control structure.

7. A printout of the input data file.

8. A summary printout of program.

D. SIMPLIFIED ANALYSIS

Method of Evaluation

Differential runoff rates shall be evaluated by equation:

(Equation 269-1)

$$R = (Cd \times I_{100}) - (Cu \times I_{100})$$

Where:

R = Differential Runoff Factor
Cd = Runoff Coefficient for developed conditions
Cu = Runoff Coefficient for undeveloped conditions
$I_{100}$ = Intensity for 100-year storm

"C" values shall be determined from the following table:

SUGGESTED RUNOFF COEFFICIENTS

| "C" VALUE | SURFACE CONDITIONS |
|---|---|
| .10 - .15 | - Tall grass, brush |
| .15 - .20 | - Parks, golf courses, farms and one-acre single family residences |
| .35 | - Single family residences on lots of not less than 15,000 sq. ft. |
| .45 | - Single family residences on lots of not less than 10,000 sq. ft. |
| .47 | - Single family residences on lots of not less than 7,500 sq. ft. |
| .49 | - Single family residences on lots of not less than 6,000 sq. ft. |
| .90 | - Gravel surfaces. |
| .95 | - Asphalt and concrete surfaces. |
| 1.00 | - Buildings and other structures. |

Volume of Detention

Volume of detention shall be determined according to the "Simplified Volume Formula", as follows:

(Equation 269-2)

$V = R \times A \times tc \text{ (min.)} \times 60 \text{ (sec./min.)}$

Where: V = Total volume of detention (cu. ft.)
R = Differential Runoff Factor
A = Area of Project in acres
tc = Time of concentration

Time of Concentration

SCS Method

The preferred method for determining time of concentration shall be the method set forth in Chapter 3 of the Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds", 2nd Edition, 1986.

Other Methods

Time of concentration used in the foregoing formula may also be determined by the formula or other accepted methods providing reasonable results.

The time of concentration used in the formula shall be determined based upon existing conditions.

Rainfall Intensity

Rainfall intensity shall be determined from the chart in Drawing F-2.

Required Volume

The required volume of detention shall be determined from the following Table:

REQUIRED VOLUME OF DETENTION

| Calculated Volume | Required Volume |
|---|---|
| 1 c.f. thru 500 c.f. | 500 c.f. |
| 501 c.f. thru 5,999 c.f. | Round up to nearest 500 c.f. |
| 5,000 c.f. thru 49,999 c.f. | Round up to nearest 1,000 c.f. |
| 50,000 c.f. thru 99,999 c.f. | Round up to nearest 5,000 c.f. |
| Above 100,000 c.f. | Round up to nearest 10,000 c.f. |

* c.f. = cubic feet

# PART VI

# ENGINEERING AND RELATED TERMS

## PART VI - ENGINEERING AND RELATED TERMS

The definitions set forth in this Glossary are for general use in this MANUAL to provide a universal understanding of the text. Certain specialized definitions are defined in each individual part where they apply.

1. Alternate Depths: For a given rate of flow and a given specific head two depths of flow are possible, one lower than critical and one higher than critical. These are known as alternate depths. See also Critical Depths.

2. Applicant: A person, partnership, corporation, or public agency requesting permission to engage in construction.

3. Apron: A floor or lining of concrete, timber, or other suitable material at the toe of a dam, discharge side of a spillway, a chute, or other discharge structure, to protect the waterway from erosion, form falling ware or turbulent flow.

4. Backfill: (1) The operation of filling an excavation after it has once been made, usually after some structure has been placed therein and (2) The material placed in an excavation in the process of backfilling.

5. Backwater: The water regarded above a dam, bridge, or culvert or backed up into a tributary by a flood in the mainstream.

6. Backwater Curve: The term applied to the longitudinal profile of the water surface in an open channel when flow is steady but non-uniform.

7. Baffle Chute: Deflector vanes, guides, grids, gratings, or similar devices constructed or placed in flowing water, to:

   (1) check or effect a more uniform distribution of velocities;
   (2) absorb energy;
   (3) divert, guide, or agitate the liquids;
   (4) check eddy currents.

8. Berm: A horizontal strip or shelf built into an embankment or cut, to break the continuity of an otherwise long slope, usually for the purpose of reducing erosion, improving stability, or to increase the thickness or width of cross section of an embankment.

9. 9. Bridge: A structure, consisting of abutments and a superstructure, used to carry traffic over a channel. A bridge is distinguished from a culvert in that the invert of a culvert is generally earth and/or rock and the superstructure is not integrally attached to the abutments.

10. Carry Over: A basin combined with a storm sewer inlet to trap solids.

11. Catch Basin: A basin combined with a storm sewer inlet to trap solids.

12. Catchment Area: See Drainage Area.

13. Channel: (1) A natural or artificial watercourse of perceptible extent which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. It has a definite bed and banks which serve to confine the water. (2) The deep portion of a river or waterway which is used by watercraft. Also see Watercourse.

14. Channel Storage: The volume of water stored in a channel. Generally considered in the attenuation of the peak of a flood hydrograph moving downstream.

15. Check Drop: A structure of concrete, rock, wood or other materials used to flatten the grade of a channel to reduce erosion tendencies of the flow.

16. Chute: An inclined conduit or structure used for conveying water at a high velocity to lower levels. For vertical structures see Drop.

17. Coefficient of Roughness: A factor, in the Manning formula for computing the average velocity of flow of water in a watercourse of conduit, which represents the effect of roughness of the confining material of the watercourse or conduit upon the energy losses in the flowing water.

18. Construction: Any alteration of land for the purpose of achieving its development or changed use, including particularly any preparation for, building of, or erection of a structure.

19. Construction Plans: These drawings delineating for the construction details of the city approve drainage facilities required for development.

20. Course: A natural or artificial channel for passage of water.

21. Critical Depth: The particular depth of flow in an open channel with a given discharge at which the specific energy is at a minimum; i.e., the depth at which a given discharge flows in a given channel with a minimum specific energy. The given discharge may flow at an alternate depth above or below critical in the given channel but the specific energy of the flow at either alternate depth will be greater than for the flow at critical depth.

22. Critical Flow: Flow at a critical depth.

23. Cross-Street Flow: Flow across the traffic lanes of a street from external sources, as distinguished from sheet flow of water falling on the pavement surface.

24. Culvert: A closed conduit used for the passage of water under an embankment such as a road, a railroad dike, or other transportation facility. Culverts can be a rectangular, round, elliptical, arch, or other shapes and made from concrete, metal, wood, or other material. A culvert is different from a storm sewer since a culvert: (a) alignment is more perpendicular to the street

centerline, whereas a storm sewer is more parallel to the street centerline, (b) generally intercepts and discharges the runoff through a large opening rather than by a catch basin type of inlet, and (c) is discontinuous and extends for longer distances.

25. Culvert Box: Generally a rectangular or square concrete structure for carrying large amounts of water under a roadway. This term is sometimes applied to long underground conduits.

26. Dam: A barrier constructed cross a watercourse for the purpose of (1) creating a reservoir; (2) diverting water therefrom to a conduit or channel.

27. Datum: A plane, level or line from which heights and depths are calculated or measured.

28. Debris Basin: A basin formed behind a low dam, or an excavation in a stream basin, to trap debris or bed load carried by a stream. The value of a basin depends on cleaning out of debris periodically to restore its capacity.

29. Detention: A temporary storage of a determined quantity of water for a specified period of time with a release rate that is either fixed or variable.

30. Developer: Any person, persons, corporation, or other entity that is in his or her own behalf, or as an agent or another, engages in development, subdivision, construction of structures, or alteration of land in preparation therefore.

31. Development: Any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling grading, paving, berming, diking excavating, or drilling operations.

32. Discharge: In its simplest concept discharge means outflow; therefore, the use of this term is not restricted to course or location, and it can be applied to describe the flow of water from a pipe or from a drainage basin. If the discharge occurs in some course or channel, it is correct to speak of the discharge of a channel or a river. It is also correct to speak of the discharge of a canal or stream into a lake, stream, or an ocean.

33. Drainage: (1) A general term applied to the removal of surface or sub-surface water from a given area either by gravity or by pumping. The term is commonly applied herein to surface water. (2) The area served by a drainage system receiving storm and surface water; or by a watercourse.

34. Drainage Basin: See Drainage Area

35. Drainage System: The surface and subsurface system for the removal of water from the land, including both the natural elements of streams, marches, swales, and ponds whether of an intermittent or continuous nature, and the man-made element which includes culverts, ditches, channels, retention facilities, detention facilities, gutters, streets, and storm sewer systems.

36. Drainage Way: A route or course along which water moves or may move to drain an area.

37. Drop Inlet Culvert: A culvert installed with a drop inlet on one end and daylighted at the other end.

38. Drop Structures: See Check Drop.

39. Easements: Land set aside for the limited use of another's adjacent property.

40. Energy Gradient: The total energy level of water at all points along a longitudinal line. It is the sum of velocity head, pressure head and elevation of a flowing body of water.

41. Erosion: Wearing away of the lands by running water and waves, abrasion and transportation.

42. Facilities: Any drainage and/or flood control structure including but not limited to storm inlets, storm sewers, manholes, junction boxes, outlet structures, channels, erosion control structures and devices, culverts, bridges, dams and detention reservoirs.

43. Flood: Water from a river, stream, watercourse, ocean, lake, or other body of standing water that temporarily overflows or inundates adjacent lands and which may affect other lands and activities through stage elevation, backwater, and/or increased ground water level.

44. Flood Control: The elimination or reduction of flood losses by the construction of flood storage reservoirs, channel improvements, dikes and levees, by-pass channels, or other engineering works. Sometimes called the structural alternate.

45. Flood Frequency: The chance of occurrence each year of a flood expressed as a percent or in years. For example:

    a 100-year flood has a 1 percent chance of occurrence each year.

    a 50-year flood has a 2 percent chance of occurrence each year.

46. Floodplain: The relatively flat or lowland area adjoining a river, stream, watercourse, ocean, lake, or other body of standing water which has been or may be covered temporarily by flood water.

47. Flood Probability: The probability of a flood of given size being equaled or exceeded in a given period. A probability of one percent would be the flood expected to be equaled or exceeded once in 100 years; a probability of ten percent would be a 10-year flood.

48. Flood Proofing: A combination of structural changes and adjustments to properties subject to flooding primarily for the reduction of flood damage.

49. Flood Storage: Storage of water during floods to reduce downstream peak flows.

50. Flood Storage Area: Flood storage area is that portion of the regulatory area that may serve as a temporary storage area for flood waters from the 100-year flood and that lies landward of the floodway.

51. Freeboard: The vertical distance between the normal maximum level of the surface of the liquid in a conduit, reservoir, tank, basin, canal, etc., and the top of the confining structure, which is provided so that waves and other movements of the liquid will not overtop such confining structures.

52. Froude Number: A flow parameter, which is a measure of the extent to which gravitational action affects the flow. A Froude number greater than 1 indicates supercritical flow and a value less than 1 subcritical flow.

53. Gabion: A wire basket containing earth or stones, deposited with others to provide protection against erosion.

54. Grades: (1) The inclination or slope of a channel, canal, conduit, etc., or natural ground surface, usually expressed in terms of the percentage of number of units of vertical rise (or fall) per unit of horizontal distance. (2) The elevation of the invert of the bottom of a conduit, canal, culvert, sewer, etc. (3) The finished surface of a canal bed, road bed, top of an embankment, or bottom of an excavation.

55. Gradient: The rate of change of any characteristic per unit of length. The term is usually applied to such things as elevation, velocity, pressure, etc.

56. Gutter: See Street nomenclature.

57. Gutter Flow: Flow in a gutter.

58. Headwater: (1) The upper reaches of a stream near its sources. (2) The region where groundwaters emerge to form a surface stream. (3) The water upstream from a structure.

59. Hydraulics: A branch of science that deals with practical applications of the mechanics of water movement.

60. Hydraulic Gradient: A hydraulic profile of the piezometric level of the water, representing the sum of the depth of flow and the pressure. In open channel flow it is the water surface.

61. Hydraulic Jump: The hydraulic jump is an abrupt rise in the water surface which occurs in an open channel when water flowing at supercritical velocity is regarded by water flowing at subcritical velocity. The transition through the jump results in a marked loss of energy, evidenced by turbulence of the flow within the area of the jump. The hydraulic jump is often used as a means of energy dissipation.

62. Hydroplaning: The phenomenon of a vehicle tire being supported by a thin film of water between it and the pavement.

63. Hydrograph: A graph showing stage, flow, velocity or other property of water versus time at a given point on a stream or conduit.

64. Hydrology: The science that deals with the processes governing the occurrence and movement of the water resources of the land areas of the earth.

65. Impervious: A term applied to a material through which water cannot pass, or through which water passes with great difficulty.

66. Infiltration: The entering of water through the voids or pores of a soil or other porous medium.

67. Infiltrometer: A device by which the rate and amount of water entering the soil is determined by measuring the difference between the amount of water applied and that which runs off. Infiltration of amount absorbed by the soil is usually expressed in inches of water per standards interval of time.

68. Inlet: (1) An opening into a storm sewer system for the entrance of surface storm runoff, more completely described as storm sewer inlet. (2) A structure at the diversion end of a conduit. (3) The upstream connection between the surface of the round and a drain or sewer, for the admission of surface or storm water.

69. Inlet Backwater: The surface water accumulated over and adjacent to the inlet that cannot enter the inlet for any one of various reasons.

70. Inlet Gratings:

a. Longitudinal Bar Grate: A grate in which the bars are oriented parallel to the direction of flow.

b. Transverse Bar Grate: A grate in which the bars are located at some angle, usually perpendicular to the direction of flow.

71. Inlet Types:

a. Combination Inlet: An inlet composed of a curb opening and a grated gutter opening inlet acting as a unit. Usually the gutter opening is placed directly in front of the curb opening. This arrangement is called a contiguous combination inlet or more simply a combination inlet. When the curb and gutter opening are placed in an overlapping, or end to end position, the arrangement is called an overlapping, offset or special combination inlet.

b. Curb Opening Inlet: A vertical opening in a curb through which the gutter flow passes. The gutter may be depressed in the area of the curb opening.

c. Deflector Inlet: A special type of curb opening inlet which has flow deflectors in the gutter adjacent to the opening.

d. Grated Inlet: An opening in the gutter covered by one or more grates through which the water falls. As with all inlets, grated inlets may be depressed and location either on a continuous grade or in a sump.

e. Multiple Inlet: Two or more closely spaced inlets acting as a unit. The two inlets may be of any of the types mentioned above.

72. Intensity: As applied to rainfall is a rate usually expressed in inches per hour.

73. Invert: The floor, bottom, or lowest portion of the internal cross section of a conduit. Used particularly with reference to aqueducts, sewers, tunnels and drains.

74. Left Bank: The left-hand bank of a stream or dam when the observer is facing downstream.

75. Lining: Impervious material such as concrete, clay, grass, plastic, puddled earth, etc., placed on the sides and bottom of a ditch, channel, and reservoir to prevent or reduce seepage of water through the sides and bottom and/or to prevent erosion.

76. Manhole: A hole through which a person may pass, especially to gain access to an underground or enclosed structure.

77. Natural Drainage: The dispersal of surface water through ground absorption and by drainage channels formed by the existing surface topography which exist at the time of adoption of this MANUAL or formed by any natural or approved man-made changes in the surface topography.

78. Natural State: The cover and topography of land before any development; or in areas where there has already been development, the state of the area and topography of land on the date of December 2, 1977.

79. Orifice: (1) An opening with closed perimeter, and of regular form in a plate, wall, or partition, through which water may flow. (2) The end of a small tube, such as a pitot tube, piezometer, etc.

80. Outfall: The point of location where storm runoff discharges from a sewer, or drain. Also applies to the outfall sewer or channel which carries the storm runoff to the point of outfall.

81. Peak Rate of Runoff: The maximum rate of runoff during a given runoff event.

82. Percolation: To pass through a permeable substance such as ground water flowing through an aquifer.

83. Permeability: The property of a material which permits movement of water through it when saturated and actuated by hydrostatic pressure.

84. Pervious: Applied to a material through which water passes relatively freely.

85. Pollution: A state of physical impurity or uncleanness, usually brought about by the addition of sanitary sewer, harmful industrial wastes or other harmful materials to water which affect the intended use.

86. Porosity: (1) An index of the void characteristics of a soil or stratum as pertaining to percolation; degree of perviousness. (2) The ration, usually expressed as a percentage, of (a) the volume of the voids in a given quantity of material, to (b) the total volume of the materials.

87. Precipitation: Moisture that falls from the atmosphere, including snow, sleet, rain and hail.

88. Probability Curve: A curve which expresses the relation of the accumulative frequency of occurrence of a given event, based upon an extended record of past occurrences. The curve is usually plotted on specially prepared coordinated paper, with ordinates representing magnitude equal to, or less than, the event, and abscissas representing probability, time or other units of incidence.

89. Rainfall, Effective: As applied to runoff analysis, refers to the portion of rainfall which becomes surface runoff or runoff excess.

90. Rainfall Intensity Curve: A curve which expresses the relation between rate of rainfall and duration. each curve is generally for a period of years during which time the intensities shown will not, on the average, be exceeded more than once.

91. Rational Formula: A formula for estimating the peak rate of runoff from a given drainage basin. The formula is: $Q = CIA$.

92. Reach: Any length of river or channel. Typically used to refer to sections which are uniform with respect to discharge, depths, area or slope, or sections between gaging stations.

93. Record Drawings: Those drawings which show the "as constructed" information on the construction plans.

94. Recurrence Interval: The average interval of time within which a given event will be equaled or exceeded once. For an annual series (as opposed to a partial duration series) the probability of occurrence in any one year is the inverse of the recurrence interval. Thus a flood having a recurrence interval of 100 years has a 1 percent probability of being equaled or exceeded in any one year.

95. Retention: Long term storage of stormwater runoff with no controlled released during or after a storm, except for evaporation and infiltration.

96. Return Period: See Recurrence Interval.

97. Reynold's Number: A flow parameter which is a measure of the viscous effect on the flow.

98. Riprap: Broken stones or boulders placed compactly or irregularly on dams, levees, ditches, dikes, channels, etc., for protection of earth surfaces against the erosive action of water.

99. Right Bank: The right-hand bank of a stream or dam when the observed is facing downstream.

100. Routing, Hydraulic: (1) The derivation of an outflow hydrograph Of a channel or stream from known values of upstream inflow. (2) The process of determining progressively the timing and shape of a flood wave at successive points along a stream or channel.

101. Runoff: That part of the precipitation which reaches a stream, drain, sewer, etc., directly or indirectly.

a. Direct Runoff: The total amount of surface runoff and subsurface runoff which reaches stream channels.

b. Overland Runoff: Water flowing over the land surface before it reaches a definite stream channel or body of water.

102. Runoff Coefficient: A decimal number used in the Rational Formula which defines the runoff characteristics of drainage area under consideration. It may be applied to an entire drainage basin as a composite representation or it may be applied to a small individual area such as one residential lot.

103. Runoff Total: The total volume of flow from a drainage area for a definite period of time such as a day, month, or year, or it may be for the duration of a particular storm.

104. Scour: The erosive action of running water in streams or channels in excavating and carrying away material from the bed and banks.

105. Sediment: Material of soil and rock origin transported, carried, or deposited by water.

106. Sewage: The contents of a sewer or drain.

107. Sewerage: The collection and treatment of the liquid waste such as from a community, institution, or industrial establishment.

108. Sill, Dentated: A notched sill installed at the end of an apron, to reduce the velocity of flowing water and the resulting scour below the apron.

109. Sill Basin: A basin or reservoir installed in a storm drainage system to retard velocity, causing sedimentation and providing storage for deposited solids.

110. Siphon: A closed conduit, a portion of which lies above the hydraulic grade line. This results in a pressure less than atmospheric in that portion, and hence requires that a vacuum be created to start flow.

111. Slope: See Grade

112. Slope, Critical: The slope or grade of a channel that is exactly equal to the loss of head per foot resulting from flow at a depth that will give uniform flow at critical depth; the minimum slope of conduit which will produce critical flow.

113. Slope, Friction: The friction head or loss per unit length of channel or conduit. For uniform flow the friction slope coincides with the energy gradients, but where a distinction is made between energy losses due to bends, expansion, impacts, etc., a distinction must also be made between the friction slope and the energy gradient. The friction slope is equal to the bed or surface slope only for uniform flow in uniform open channels.

114. Spillway: A waterway in or about a dam or other hydraulic structures, for the escape of excess water.

115. Spillway, Side Channel: A spillway in which the initial and final flow are approximately at right angles to each other.

116. Storage with respect to Channel Design:

Offstream Storage: The temporary storage of storm runoff water away from the main channel flow.

Channel Storage: Storm runoff water present in a channel at any given time.

Onstream Storage: The temporary storage of storm runoff water behind embankment or dams located on the channel.

117. Storage with Respect to Runoff Analysis:

Detention Storage: That water that is discharged on the surface during a storm and does not become runoff until some time after the storm has ended.

Depression Storage: That portion of the rainfall that is collected and held in small depressions and does not become part of the general runoff.

118. Storm: The time variation of rainfall. For analysis purposes, a "design storm" or pre-determined rainfall pattern is based on "typical" Oklahoma storms.

119. Storm Frequency: See Flood Frequency.

120. Storm Sewer: A closed conduit for conduction of storm water that has been collected by inlets or collected by other means. A storm sewer is different from a culvert since a culvert: (a) alignment is more perpendicular to the street centerline, whereas a storm sewer is more parallel to the street centerline, (b) generally intercepts and discharges the runoff through a

large opening rather than by a catch basin type of inlet, and (c) is discontinuous and relatively short, whereas a storm sewer is continuous and extends for longer distances.

121. Storm Runoff: The water from precipitation running off from the surface of a drain area during and immediately following a period of rain.

122. Stream: A body of water. The term is usually applied to a body of water flowing in a natural surface channel, but is also applied to a body of water flowing in a well-defined, open or closed conduit, a jet of water issuing from any opening, such as a nozzle, a fissure in rock, etc.

a. Continuous: A stream which habitually flows or contains water throughout its entire course, or between any two points on its course.

b. Effluent: A stream or stretch of stream which receives water from ground water in the zone of saturation. The water surface of such a stream stands at a lower level than the water or piezometric surface of the groundwater body from which it receives water.

c. Ephemeral: (1) One that flows only in direct response to precipitation. Such a stream receives no water from springs, and no long-continuous supply from melting snow or other surface source. Its channel is at all times above water table. (2) The term may be arbitrarily restricted to streams or stretches of streams that do not flow continuously during periods of as such as one month.

d. Influent: A stream or stretch of stream which contributes water to the zone of saturation. The water surface of such stream stands at a higher level than the water table or piezometric surface of the ground waterbody to which it contributes water.

e. Intermittent: A stream which flows during protracted periods, but not continually, when it receives water from springs or surface runoff.

f. Perennial: A stream which flows continuously at all times of a year, during dry as well as wet years. Such streams are usually fed by ground water, and their water surface generally stands at a lower level than that of the water table in the locality.

123. Stream Flow: A term used to designate the water which is flowing in a stream channel, ditch, etc.

124. Street Flow: The total flow of storm runoff in a street, usually being the sum of the gutter flows on each side of the street. Also, the total flow where there are not curbs and gutters.

125. Watershed: The contributing drainage area to drainage facility expressed as acres, square miles or other unit of area. Also see "Drainage Area".

# PART VII

# REFERENCES

## PART VII - REFERENCES


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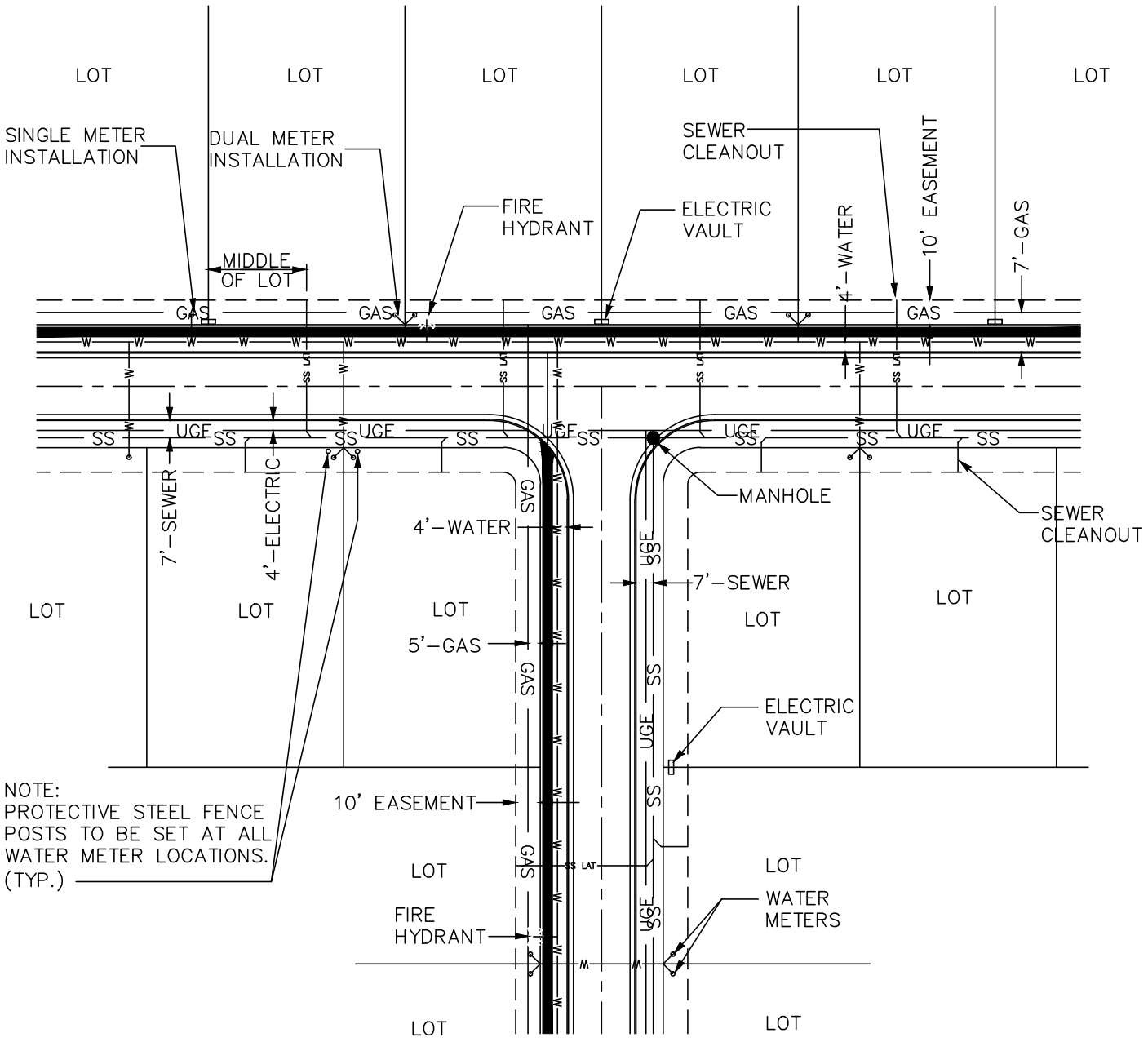
# CITY OF CLEVER

# STANDARD DRAWINGS
# AND DETAILS

# SECTION A – GENERAL




W–WATER–SET 4' FROM CURB ON ONE SIDE.
G–GAS–SET 7' FROM CURB ON WATER SIDE.
E–ELECTRIC–SET 4' FROM CURB ON OPPOSITE SIDE OF WATER.
S–SEWER–SET 7' FROM CURB ON ELECTRIC SIDE.

WATER METERS EVERY OTHER LOT LINE & ELECTRIC ON LOT LINES WHERE WATER METERS ARE NOT LOCATED.

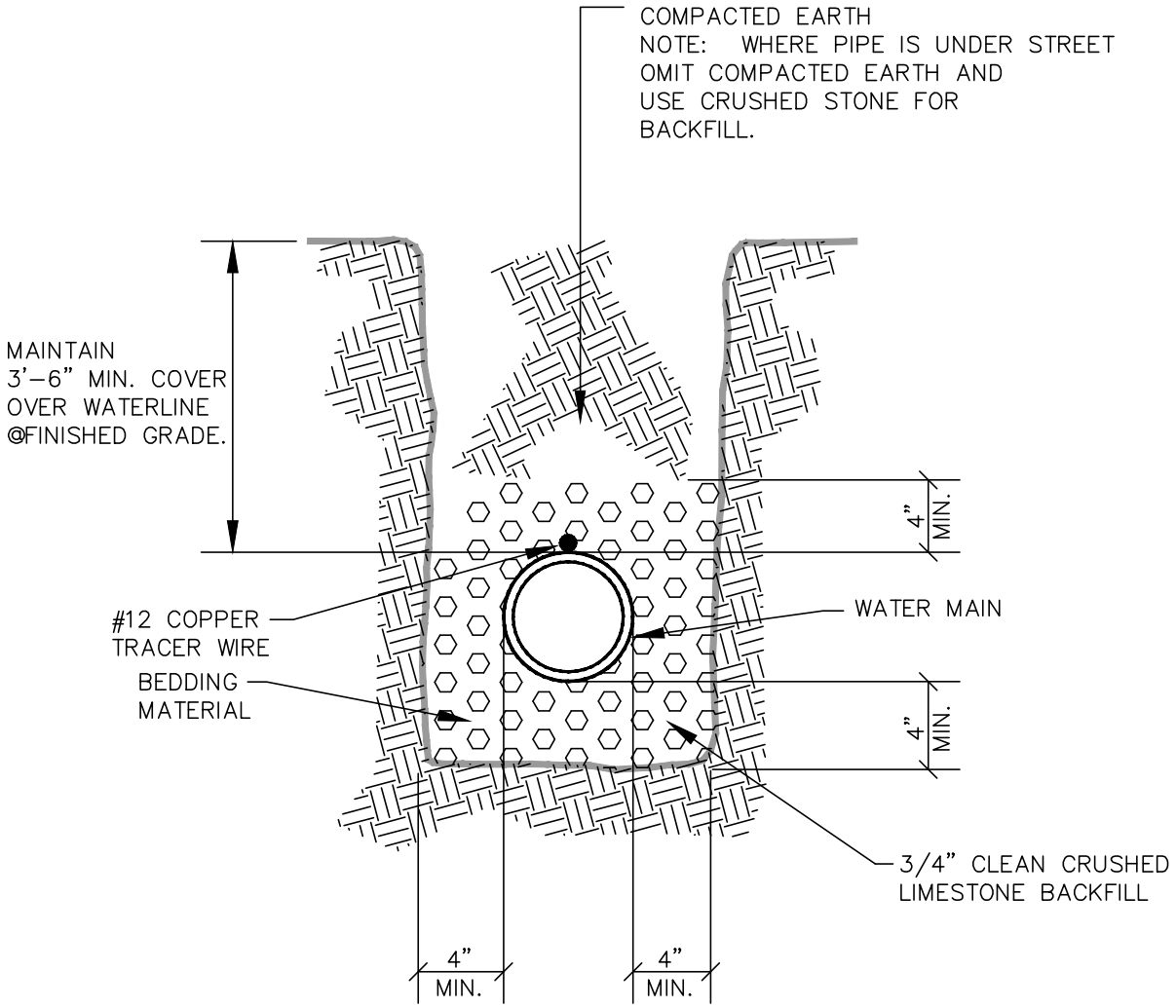
CITY OF CLEVER MISSOURI

# TYPICAL UTILITY LOCATION DETAIL

DATE: 05/13/22

DWG: A1

# SECTION B – WATER



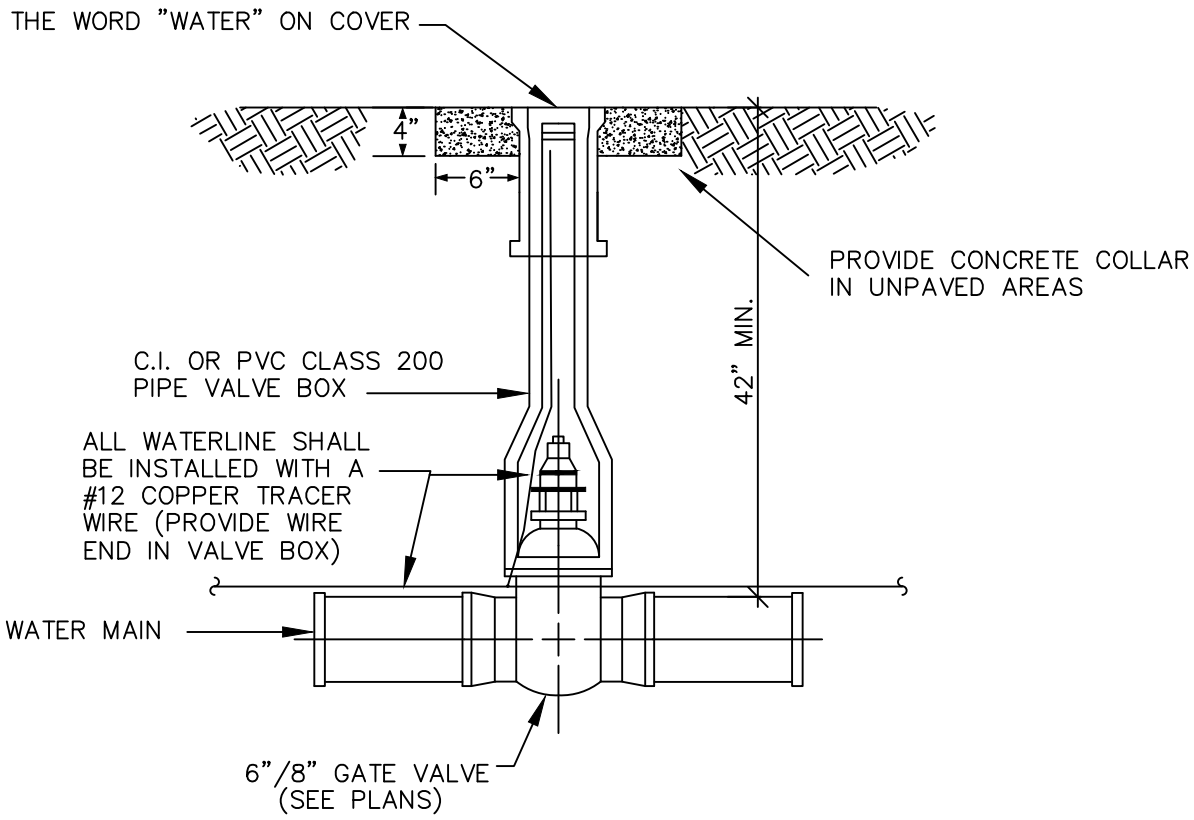

CITY OF CLEVER MISSOURI

# TYPICAL WATERLINE EMBEDMENT DETAIL

DATE: 05/13/22

DWG: B1

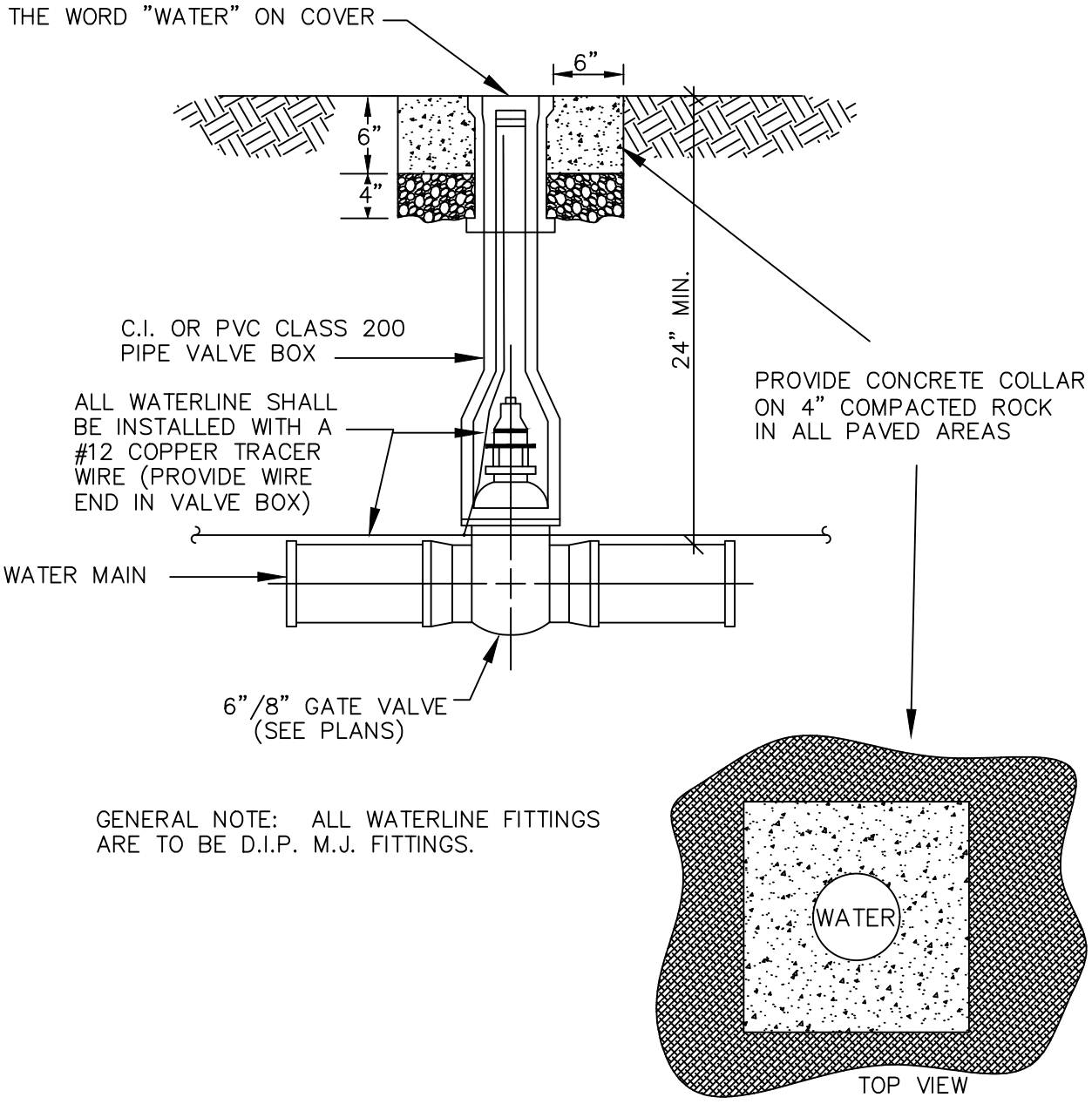
NOTE:
IN LIEU OF C.I. VALVE BOX SHOWN AN ALTERNATIVE PVC VALVE BOX ACCEPTABLE TO THE CITY WILL BE ALLOWED.




GENERAL NOTE: ALL WATERLINE FITTINGS ARE TO BE D.I.P. M.J. FITTINGS.

| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | TYPCIAL VALVE DETAIL (UNPAVED AREAS) | DATE: 5/13/22<br>DWG: B2 |

NOTE:
IN LIEU OF C.I. VALVE BOX SHOWN AN ALTERNATIVE PVC VALVE BOX ACCEPTABLE TO THE CITY WILL BE ALLOWED.

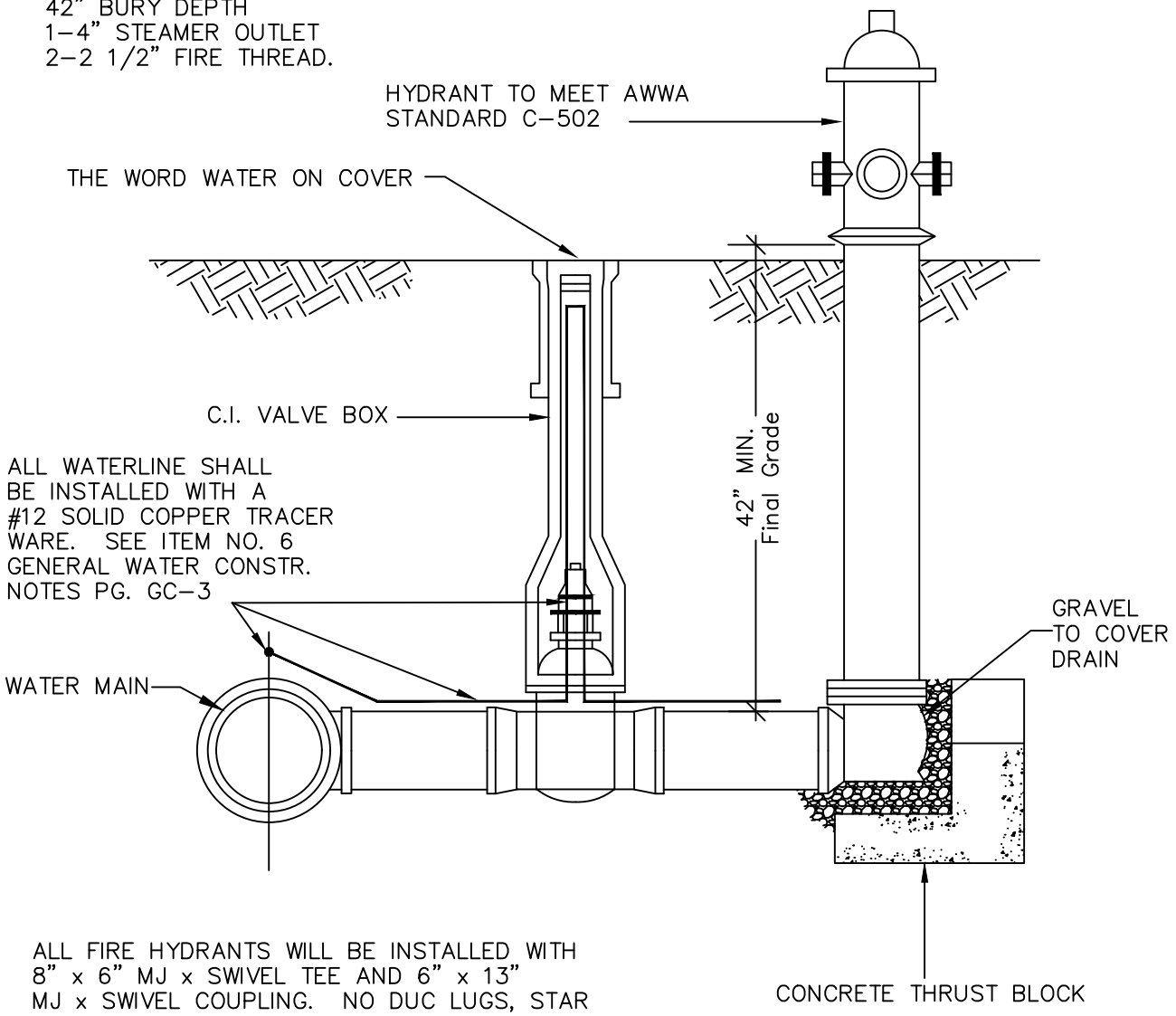



GENERAL NOTE: ALL WATERLINE FITTINGS ARE TO BE D.I.P. M.J. FITTINGS.

| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | TYPICAL VALVE DETAIL (PAVED AREAS) | DATE: 5/13/22 |
| | | DWG: B3 |

HYDRANT TO BE 3–WAY
6" SHOE TRAFFIC MODEL
5 1/4" VALVE OPNG.
42" BURY DEPTH
1–4" STEAMER OUTLET
2–2 1/2" FIRE THREAD.

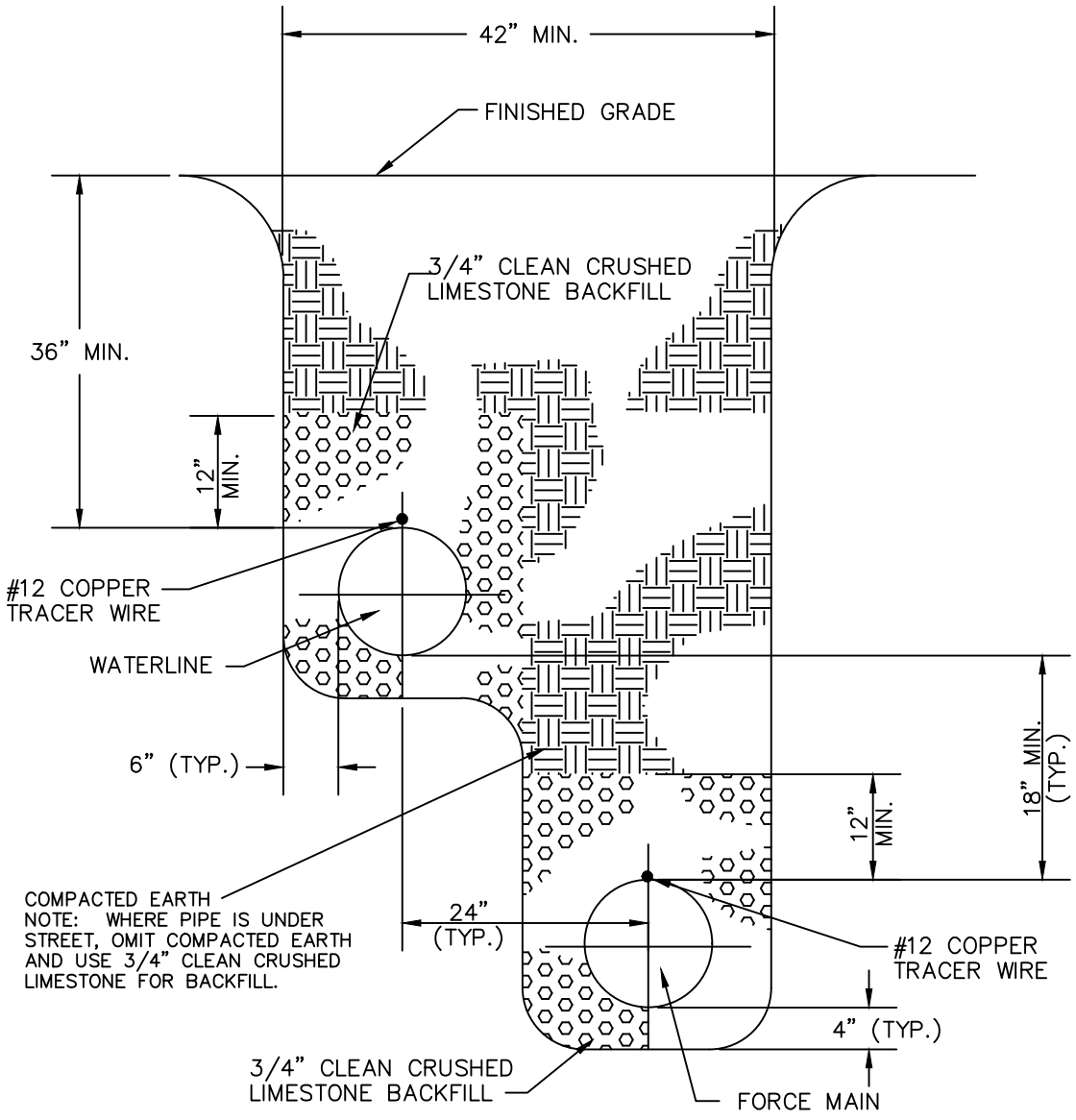
HYDRANT TO BE PLACED WITH
NOZZLES FACING STREET




ALL FIRE HYDRANTS WILL BE INSTALLED WITH
8" x 6" MJ x SWIVEL TEE AND 6" x 13"
MJ x SWIVEL COUPLING. NO DUC LUGS, STAR
BOLTS, ALL THREAD ROD, MEGA–LUGS OR
RETAINER GLANDS WILL BE ALLOWED.

GENERAL NOTE: ALL WATERLINE FITTINGS
ARE TO BE D.I.P. M.J. FITTINGS.

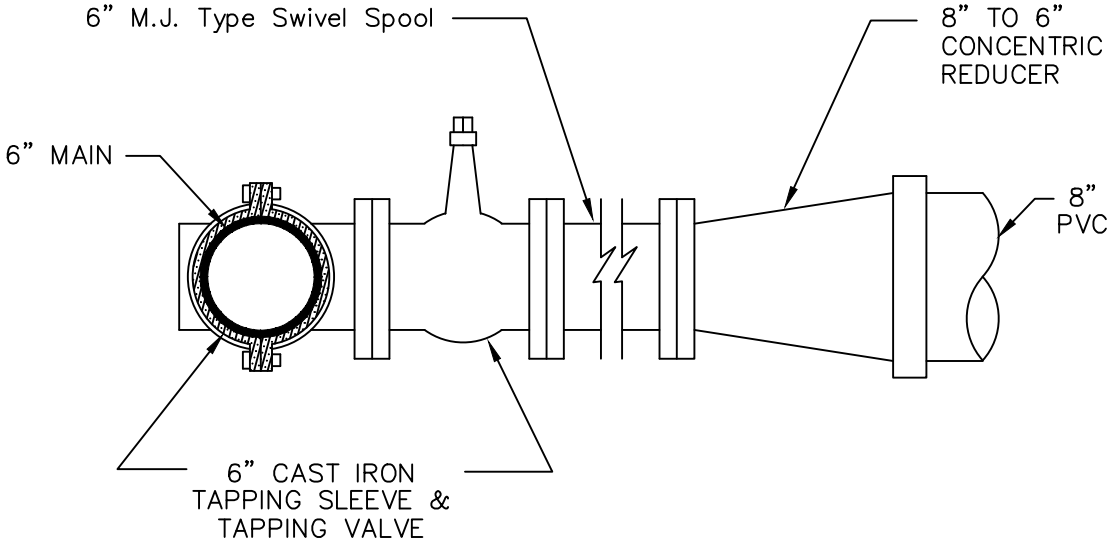
| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | FIRE HYDRANT DETAIL | DATE: 5/13/22<br>DWG: B4 |




* PRIOR WRITTEN APPROVAL MUST BE OBTAINED FROM THE MISSOURI DEPT. OF NATURAL RESOURCES BEFORE USING THIS ARRANGEMENT.

| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | COMMON TRENCH DETAIL | DATE: 5/13/22<br>DWG: B5 |

ALL WATERLINE SHALL BE INSTALLED WITH A #12 COPPER TRACER WIRE




GENERAL NOTE: ALL WATERLINE FITTINGS ARE TO BE D.I.P. M.J. FITTINGS

| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | 6-INCH LIVE TAP DETAIL | DATE: 5/13/22 |
| | | DWG: B6 |

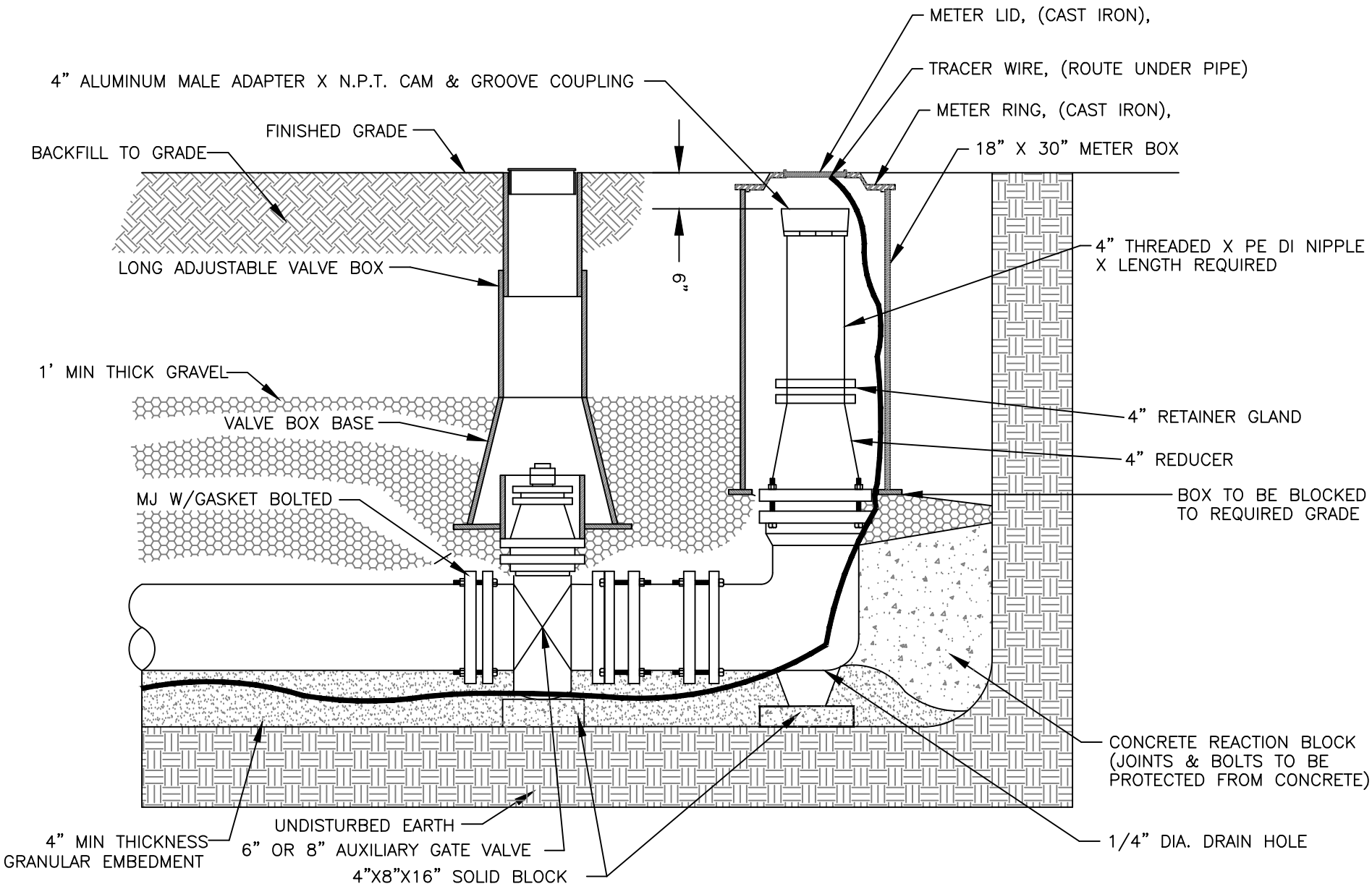
CITY OF CLEVER MISSOURI

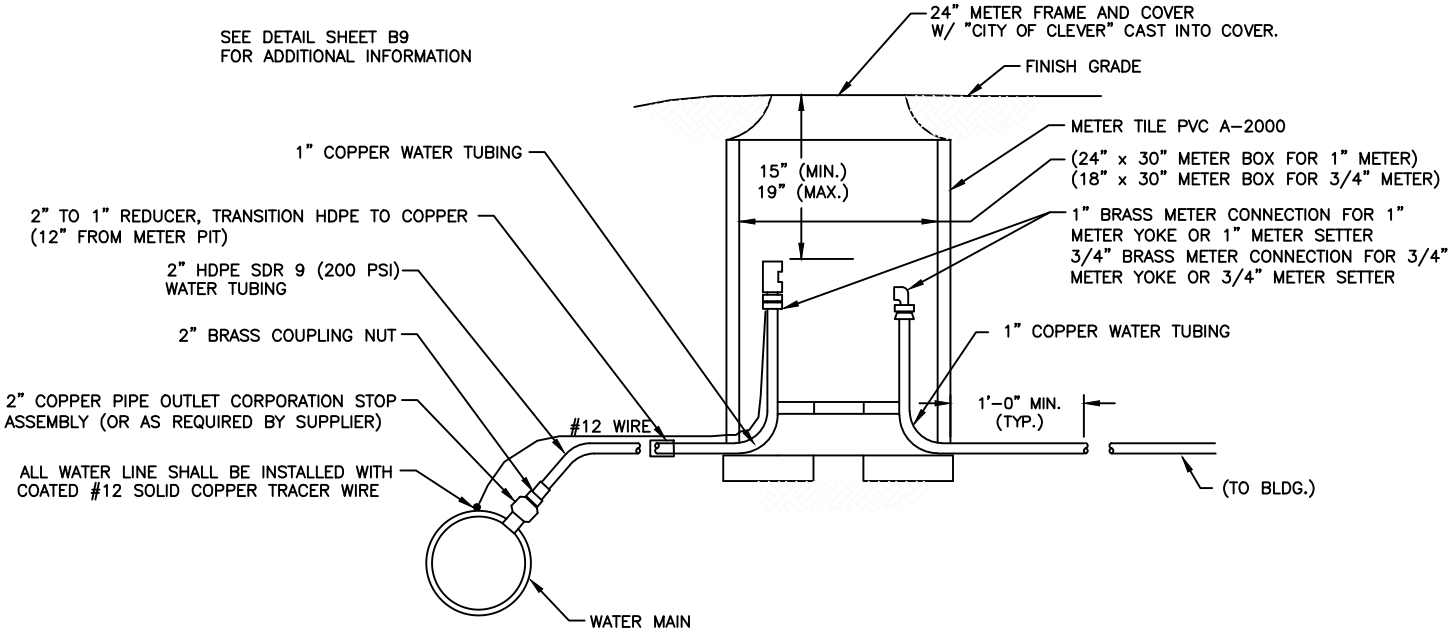
# TYPICAL FLUSH VALVE DETAIL

DATE: 5/13/22

DWG: B7

NOTES:
1. BLOW OFF WILL BE USED ONLY BY PERMISSION OF THE CITY OF CLEVER
2. WATER VALVES LOCATED IN TRAFFICWAYS SHALL BE ENCASED IN 4" MINIMUM THICKNESS CONCRETE.
3 ALL VALVE BOXES SHALL BE CAST IRON.
4. VALVE COVER AND METER LID SHALL MATCH FINISH GRADE.






GENERAL NOTE: ALL WATERLINE FITTINGS SHALL BE D.I.P., M.J. FITTINGS.

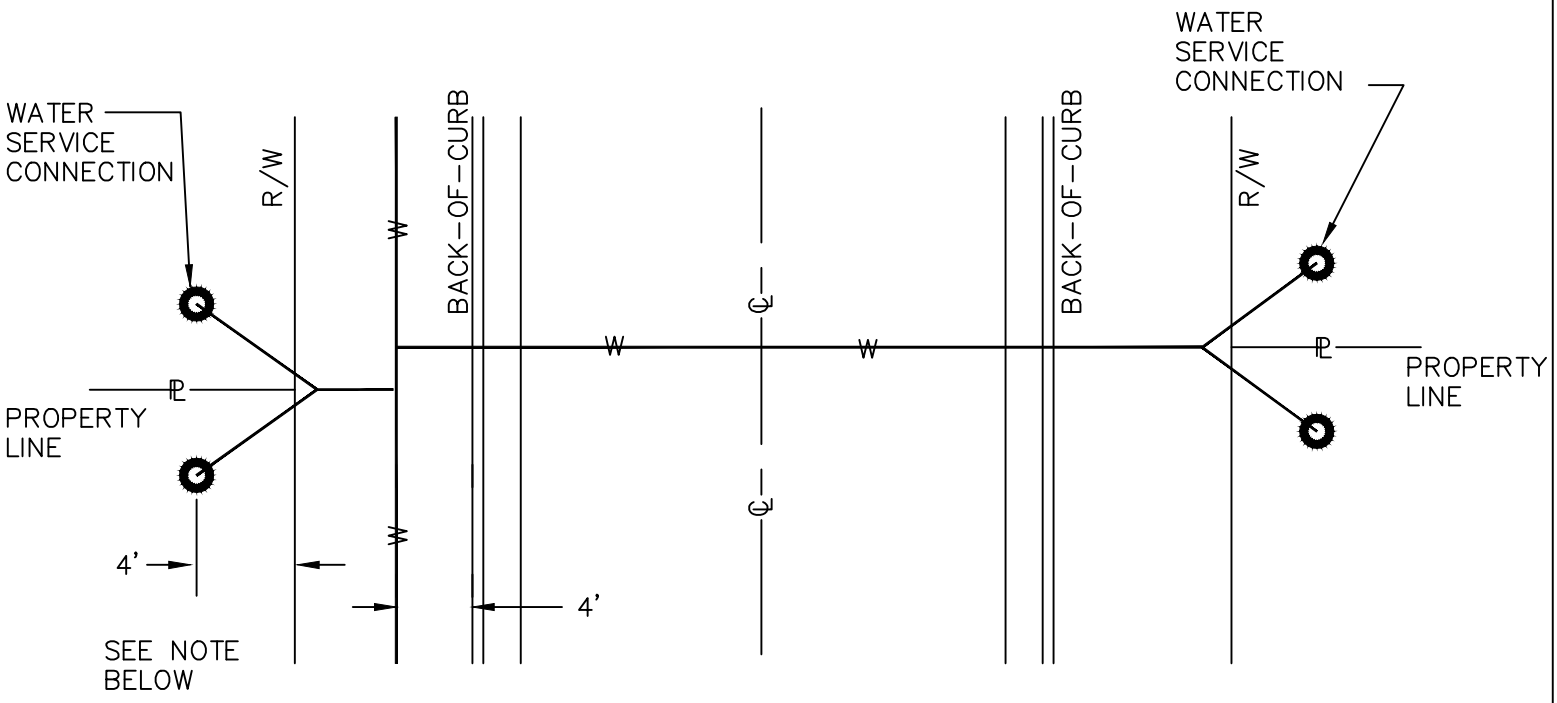
| METER SIZE | METER BOX DIAMETER | METER YOKE |
|---|---|---|
| 3/4" | 18" | 3/4" |
| 1" | 24" | 1" |
| 1 1/2" | 30" | 1 1/2" |
| 2" | 36" | 2" |

CITY OF CLEVER MISSOURI

# TYPICAL WATER SERVICE CONNECTION

DATE: 5/13/22

DWG: B8




NOTE:
PLACE THE CENTER OF THE METER PIT
4'-0" FROM THE EDGE OF THE R/W LINE
UNLESS OTHERWISE NOTED OR INDICATED.

A. CROSSING SERVING SINGLE LOT

1. CROSSING SHALL BE MADE USING 3/4" TYPE K COPPER TUBING.

2. SERVICES ON SAME SIDE AS WATER MAIN SHALL BE ALL COPPER, NO POLYETHYLENE WILL BE ALLOWED.

B. CROSSING SERVING TWIN LOTS

1. CROSSING SHALL BE MADE USING 1" TYPE K COPPER TUBING.

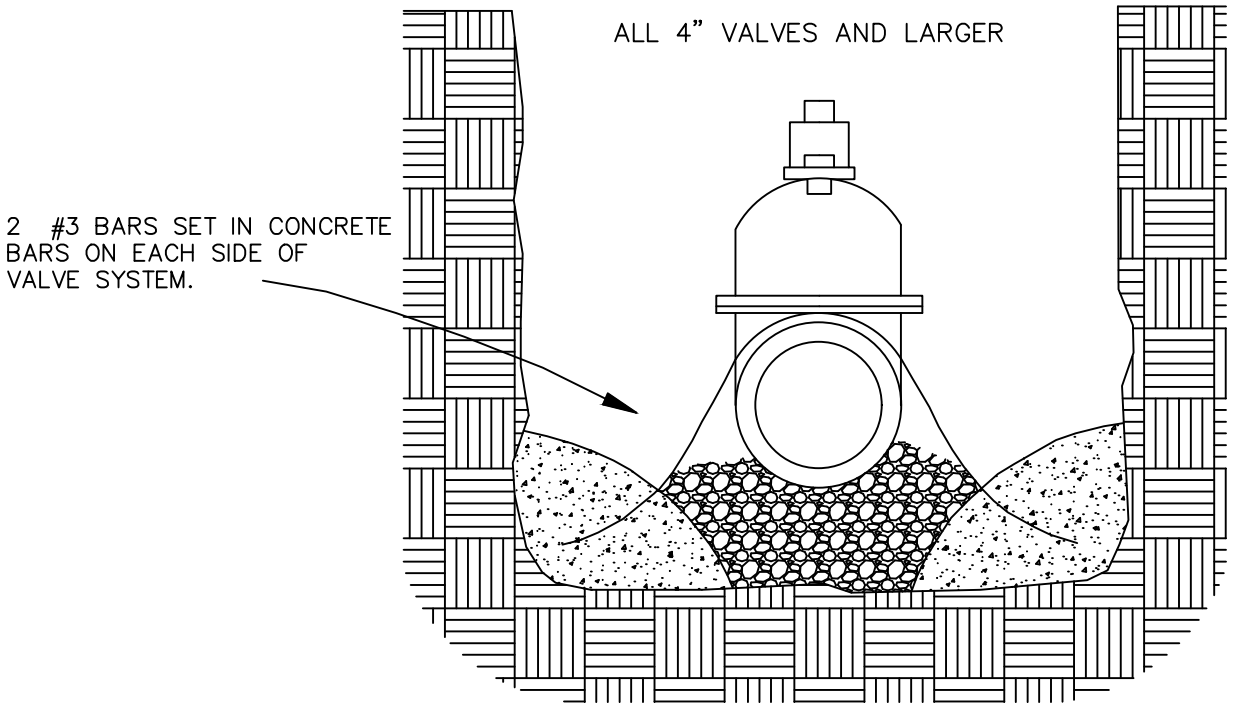
2. DUAL SERVICES ON SAME SIDE AS WATER MAIN SHALL BE ALL COPPER, NO POLYETHYLENE WILL BE ALLOWED.

CITY OF
CLEVER
MISSOURI

# TYPICAL WATER SERVICE LOCATION

DATE: 5/13/22

DWG: B9



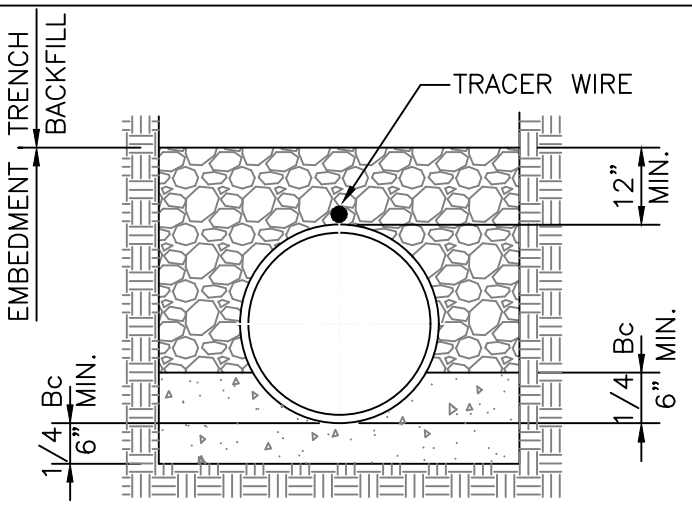

CITY OF
CLEVER
MISSOURI

# ANCHOR FOR GATE VALVE

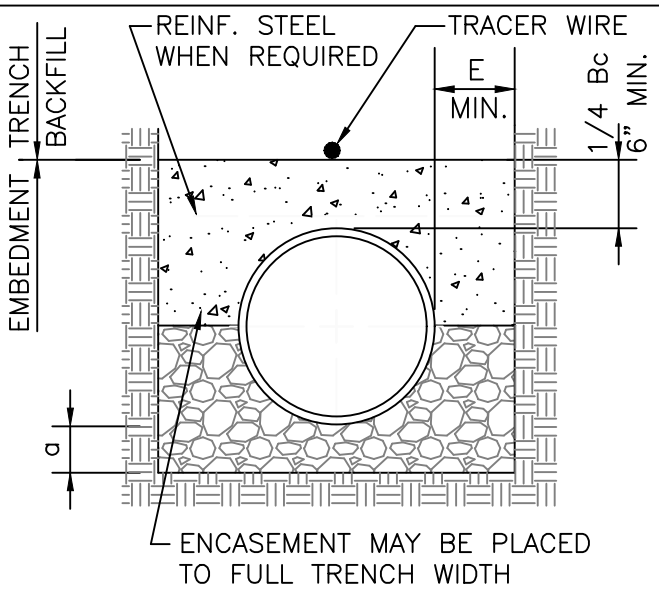
DATE: 5/13/22

DWG: B10

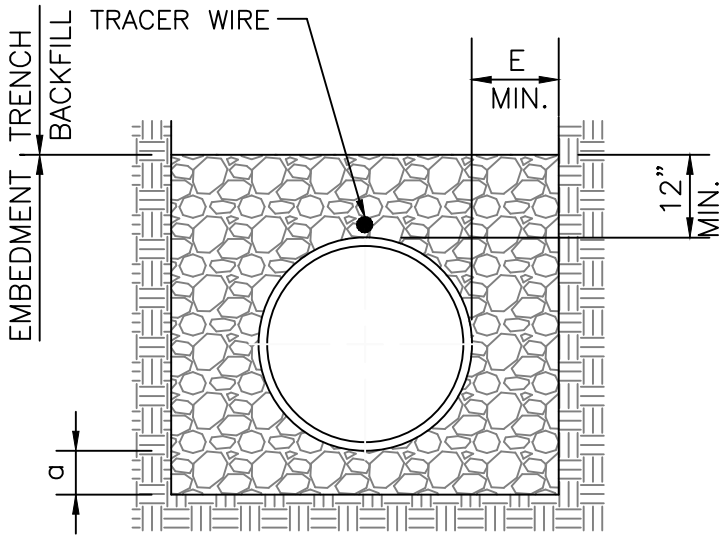
# SECTION C – SEWER



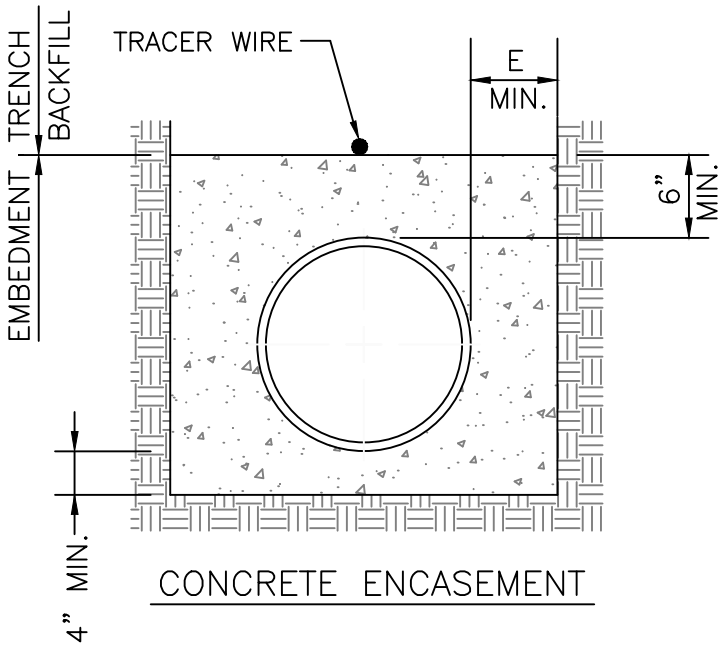

CLASS A
CONCRETE CRADLE




CLASS A
CONCRETE ARCH




CLASS B
FIRST CLASS BEDDING




CONCRETE ENCASEMENT

## TABLE OF EMBEDMENT DEPTHS BELOW PIPE

| SOIL TRENCH | | |
|---|---|---|
| BEDDING CLASS | PIPE O.D. | a MIN. |
| A AND B | 16" AND SMALLER | 4" |
| A AND B | LARGER THAN 16" | 1/4 O.D. |

| ROCK TRENCH | | |
|---|---|---|
| BEDDING CLASS | PIPE O.D. | a MIN. |
| A AND B | 24" AND SMALLER | 6" |
| A AND B | LARGER THAN 24" | 1/4 O.D. |

E = 6" (LESS THAN 27" DIA. PIPE)
E = ID/2 (27" TO 60" PIPE)
E = TO BE DETERMINED (LARGER THAN 60" PIPE)

## LEGEND

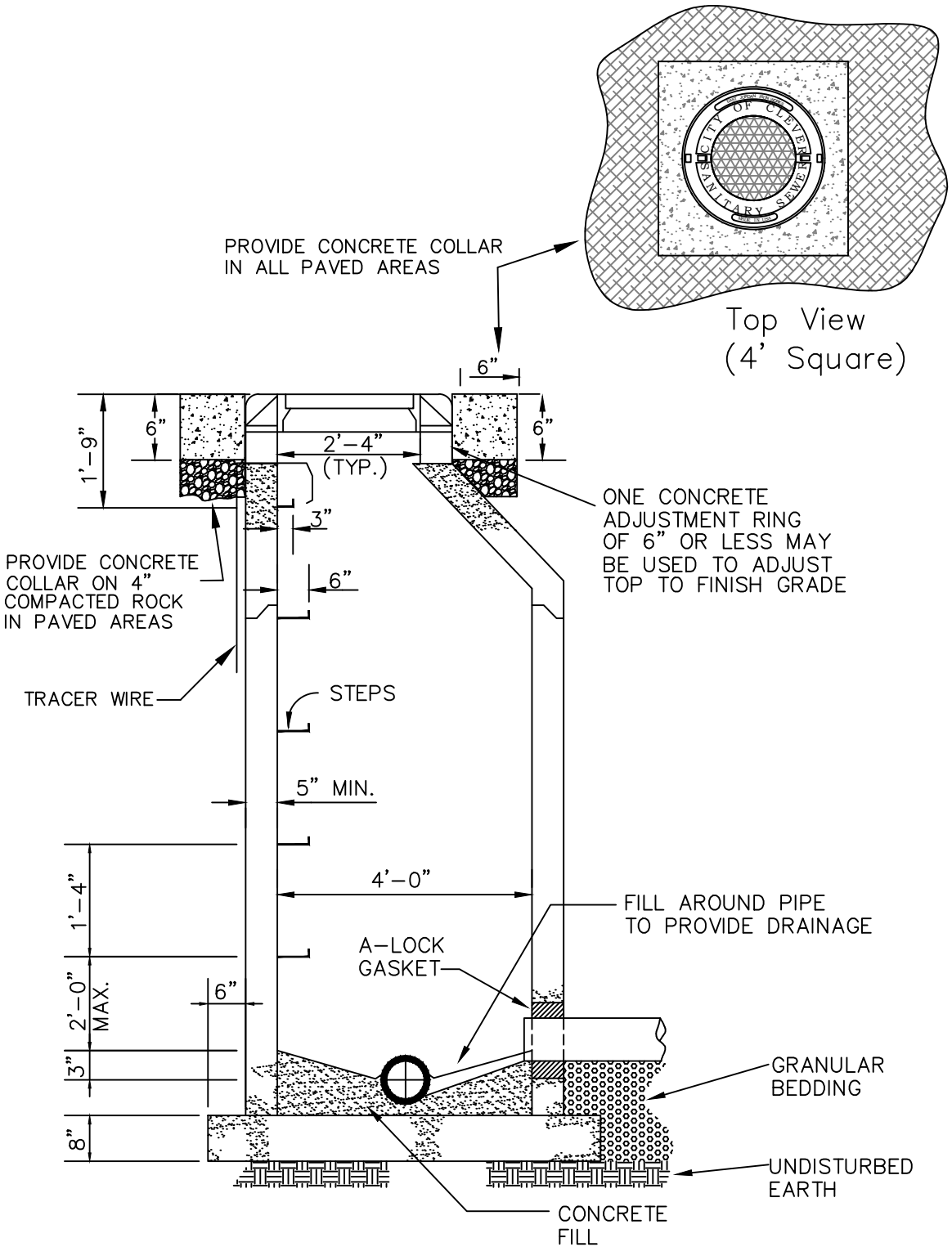
Bc — OUTSIDE DIA. OF PIPE
a — EMBEDMENT BELOW PIPE
GRANULAR EMBEDMENT
CONCRETE
UNDISTURBED EARTH

NOTE:
1. ALL UTILITIES SHALL BE INSPECTED AND APPROVED BY THE CITY OF CLEVER PRIOR TO BACKFILLING.
2. EXTEND GRANULAR EMBEDMENT MATERIAL TO THE BASE MATERIAL UNDER IMPROVED SURFACES
3. COMPACT GRANULAR EMBEDMENT IN 6" MAX. LIFTS TO 95% STANDARD PROCTOR DENSITY.
4. COMPACT TRENCH BACKFILL IN 12" MAX. LIFTS TO 85% OF THE MAX. DENSITY FOR UNIMPROVED AREAS AND 95% OF THE MAX. DENSITY FOR IMPROVED AREAS.
4. PROVIDE TRACER WIRE ABOVE ALL MAINS AND SERVICES. GROUND ALL ENDS OF TRACER WIRE AND ALSO AT 500' MAXIMUM INTERVALS.
5. PROVIDE APPROPRIATE WARNING TAPE 12" ABOVE ALL WATER, SEWER AND FORCE MAINS.

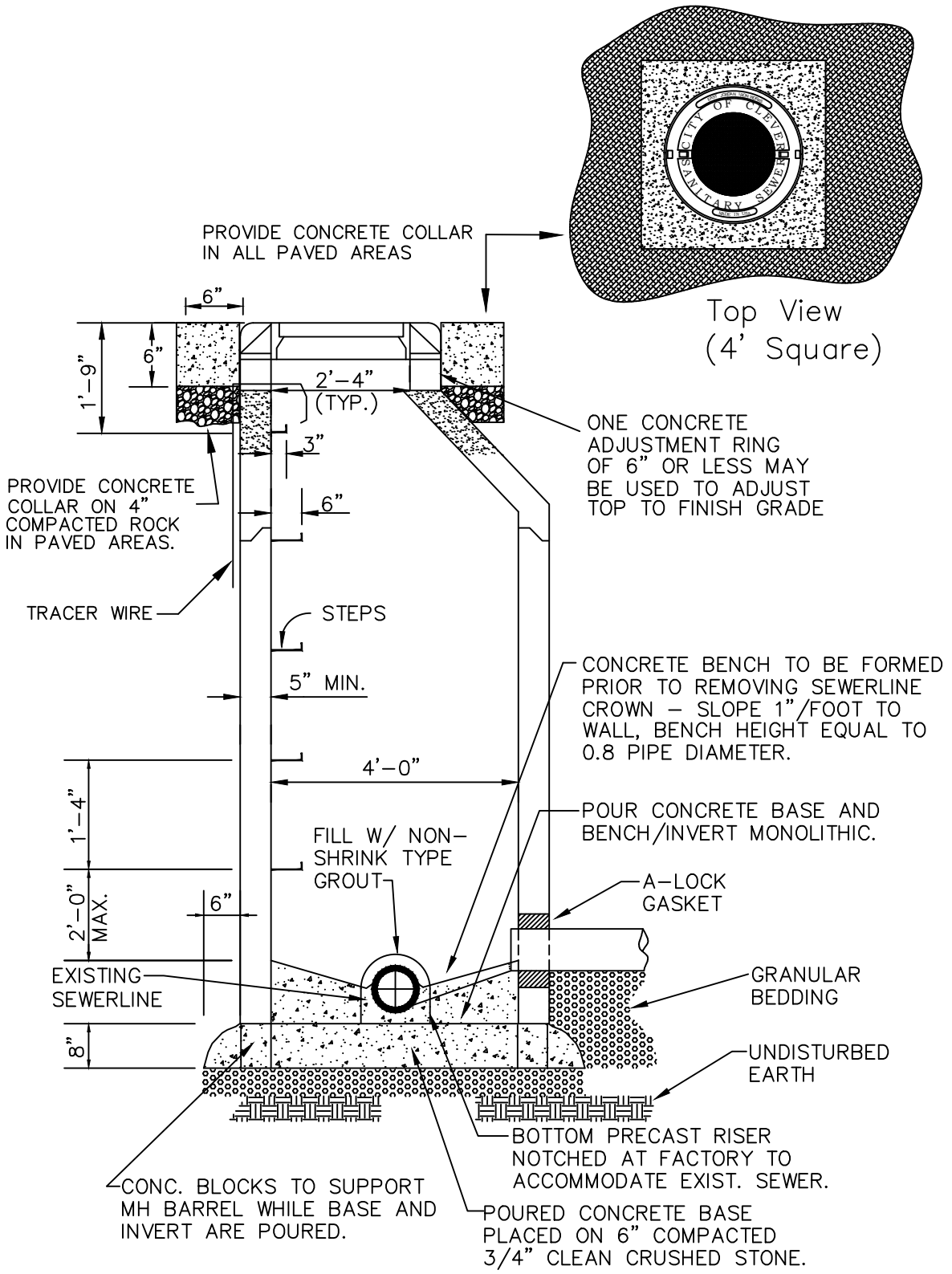
CITY OF CLEVER MISSOURI

# TYPICAL EMBEDMENT DETAIL

DATE: 05/13/22
DWG: C1




| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | STANDARD MANHOLE DETAIL | DATE: 05/13/22<br>DWG: C2 |

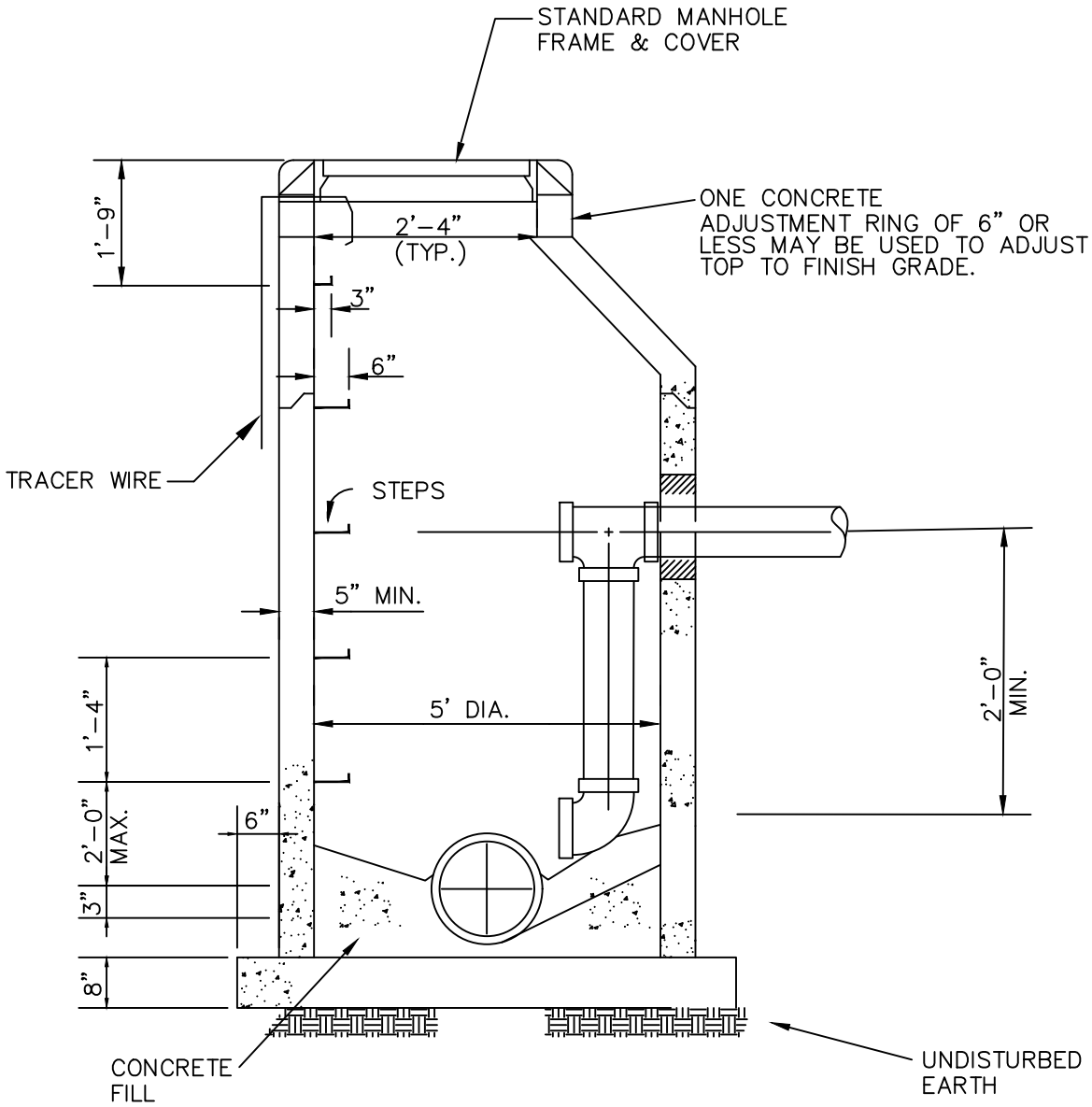



CITY OF CLEVER MISSOURI

# STANDARD MANHOLE OVER EXISTING SEWER DETAIL

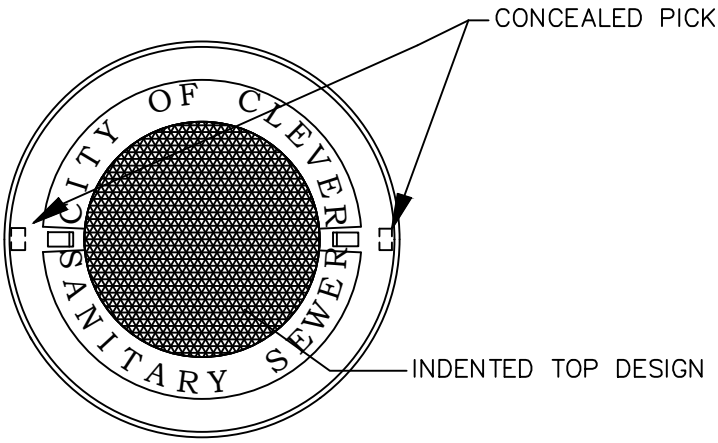
DATE: 05/13/22

DWG: C3

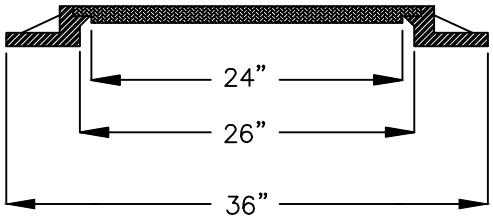



| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | STANDARD INSIDE DROP MANHOLE DETAIL | DATE: 05/13/22<br>DWG: C4 |

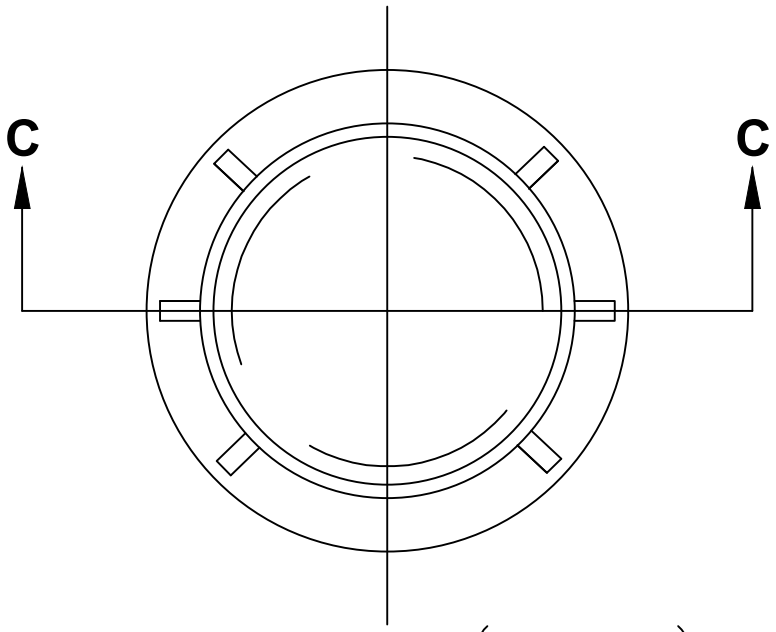
CASTING IN LID
SHALL READ
"CITY OF CLEVER
SANITARY SEWER"




PLAN VIEW (COVER)



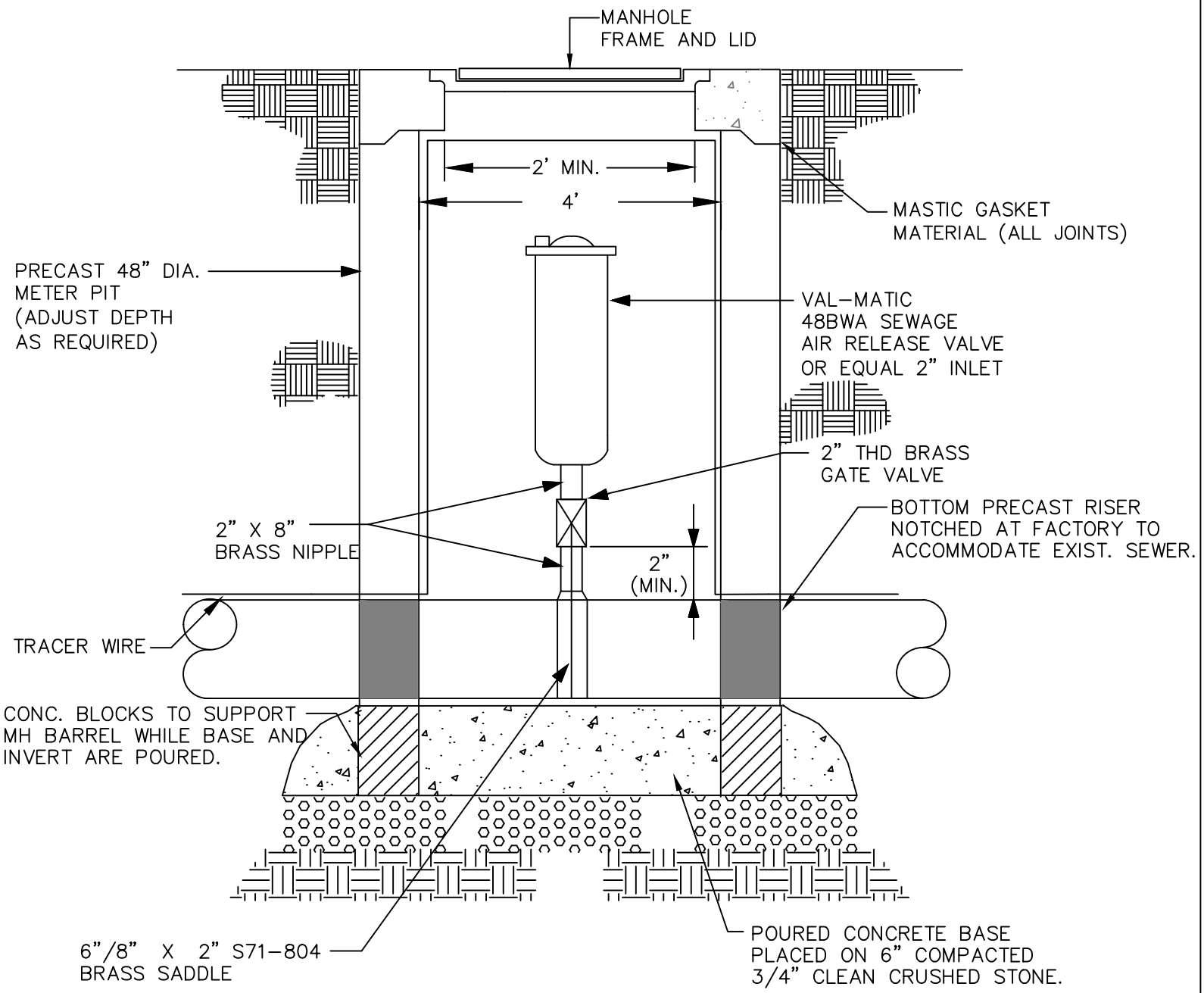

SECTION "CC"




PLAN VIEW (FRAME)

NEENAH R–1642, DEETER 1247, EJ 1045 FRAME WITH 1040 AGS COVER
NOTE: BOLT DOWN WATERTIGHT FRAME & COVER SHALL BE REQUIRED IN DETENTION AREAS & DRAINAGE WAYS.

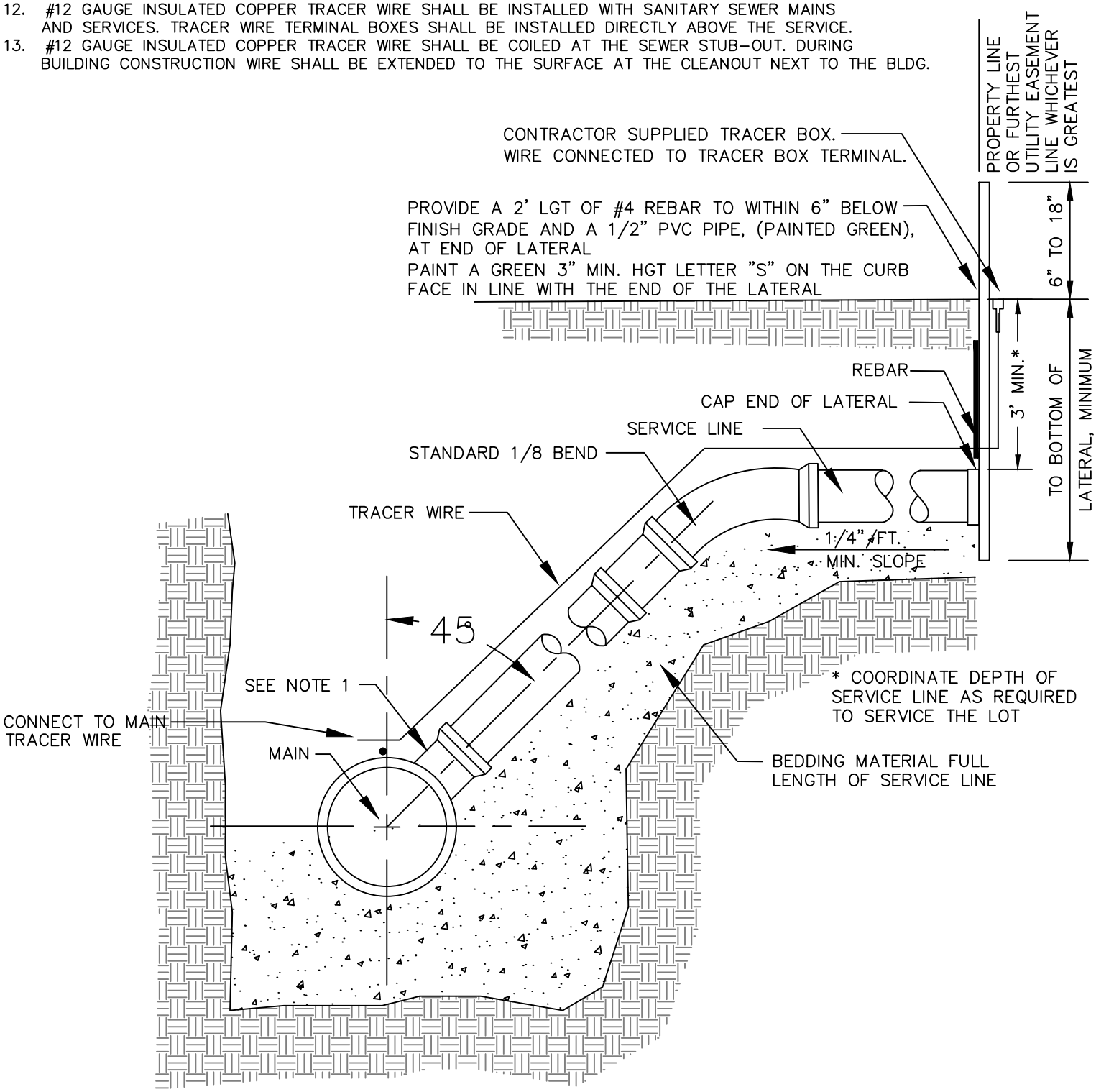
| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | STANDARD MANHOLE FRAME AND COVER | DATE: 05/13/22 |
| | | DWG: C5 |




| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | AIR RELEASE VALVE DETAIL | DATE: 05/13/22<br>DWG: C6 |

NOTES:

1. STANDARD 'Y' OR 'T' CONNECTION PLACED AT 45 DEGREE ANGLE.
2. SDR-26 HEAVY WALL TEES SHALL BE USED FOR SDR-35 MAINS.
3. SDR-21 TEES SHALL BE USED FOR SDR-21 MAINS.
4. WHEN A 'T' SADDLE IS USED, IT SHALL BE INSTALLED AT A 45 DEGREE ANGLE.
5. WHEN TAPPING MAIN, DO NOT ALLOW BEDDING MATERIAL OR BORED PLUGS TO FALL INTO MAIN.
6. JOINTS SHALL BE GLUED WITH AN APPROVED ADHESIVE.
7. SERVICE LINES SHALL BE SCHEDULE 40 PVC.
8. SEWER SERVICES SHALL NOT BE INSTALLED WITHIN 5' OF A MANHOLE WALL.
9. LATERAL SHALL EXTEND TO PROPERTY LINE OR EASEMENT LINE OR A MINIMUM OF 5' BEYOND THE WATER MAIN, WHICHEVER IS GREATER.
10. SEWER SERVICE SHALL BE PROVIDE TO EVERY BUILDABLE PLATTED LOT WITHIN THE SUBDIVISION.
11. MAXIMUM NUMBER OF UNITS TO BE CONNECTED ON A 4" SEWER SERVICE SHALL BE ONE.
12. #12 GAUGE INSULATED COPPER TRACER WIRE SHALL BE INSTALLED WITH SANITARY SEWER MAINS AND SERVICES. TRACER WIRE TERMINAL BOXES SHALL BE INSTALLED DIRECTLY ABOVE THE SERVICE.
13. #12 GAUGE INSULATED COPPER TRACER WIRE SHALL BE COILED AT THE SEWER STUB-OUT. DURING BUILDING CONSTRUCTION WIRE SHALL BE EXTENDED TO THE SURFACE AT THE CLEANOUT NEXT TO THE BLDG.

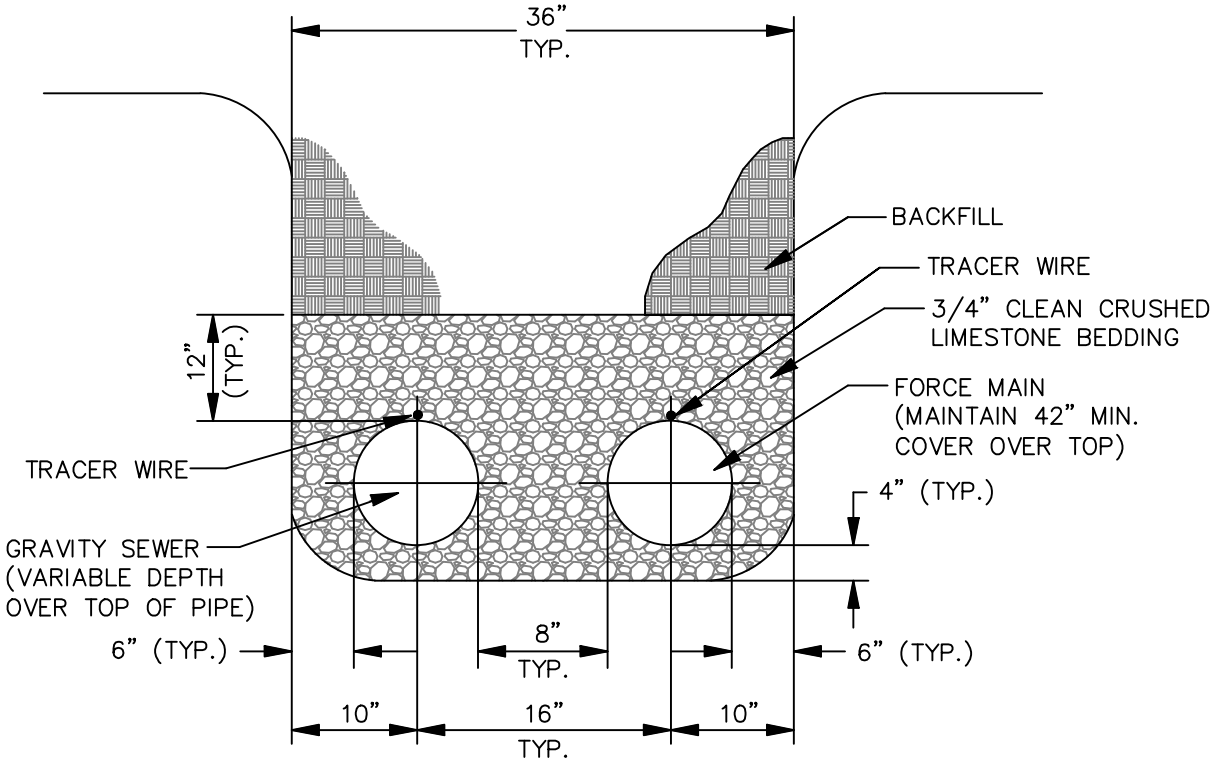



CITY OF CLEVER MISSOURI

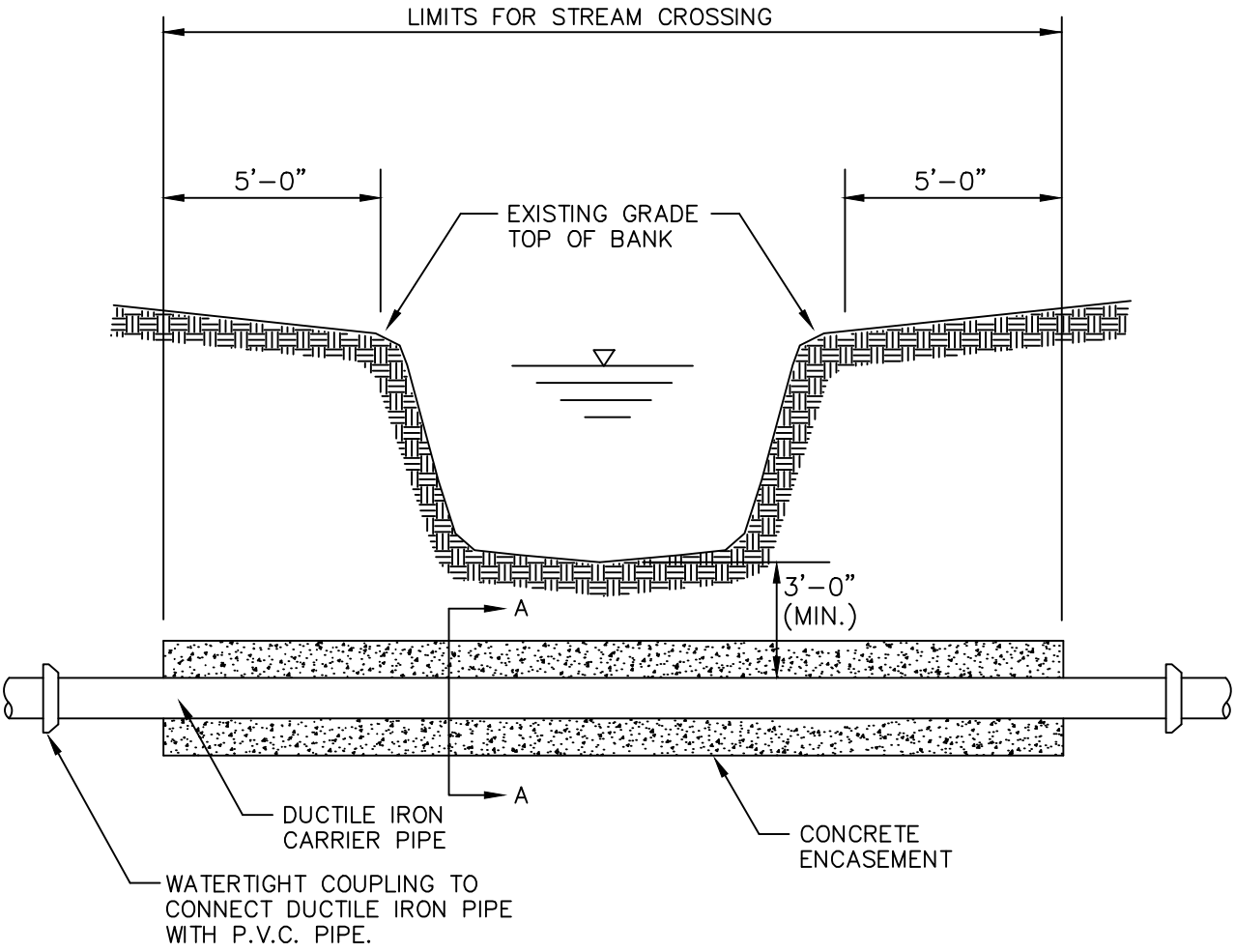
# STANDARD SEWER SERVICE CONNECTION DETAIL

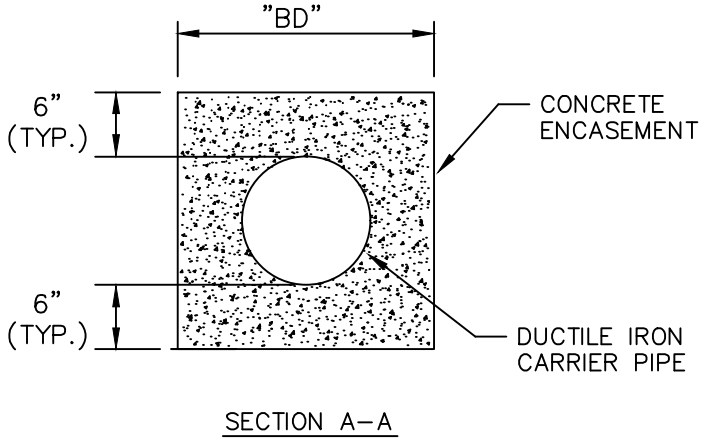
DATE: 05/13/22

DWG: C7




| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | TYPICAL COMMON TRENCH DETAIL | DATE: 05/13/22 |
| | | DWG: C8 |




SECTION A–A

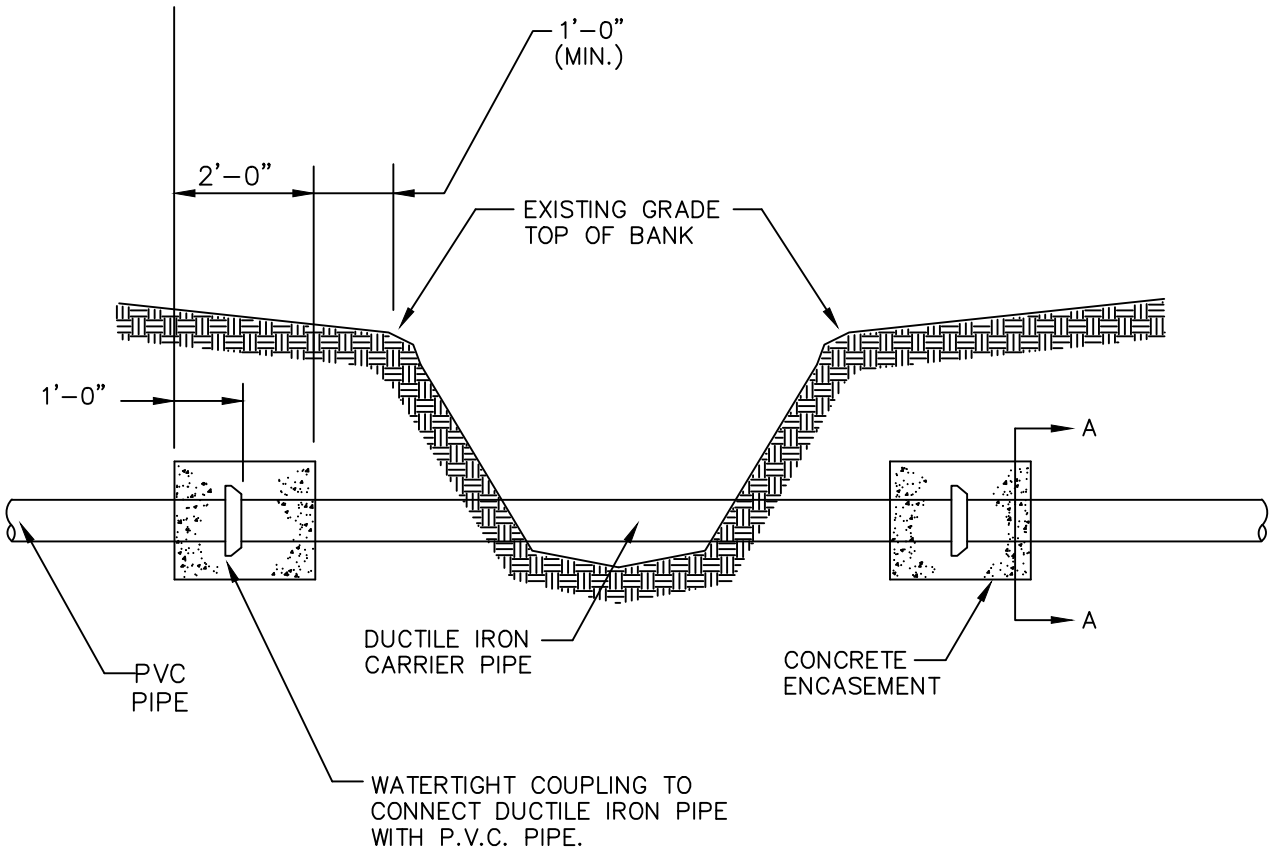
| PIPE SIZE "D" (IN.) | TRENCH WIDTH "BD" (FT.) |
|---|---|
| 6 | 2.00 |
| 8 | 2.33 |
| 10 | 2.50 |
| 12 | 3.00 |
| 15 | 3.25 |
| 18 | 3.83 |
| 24 | 4.42 |

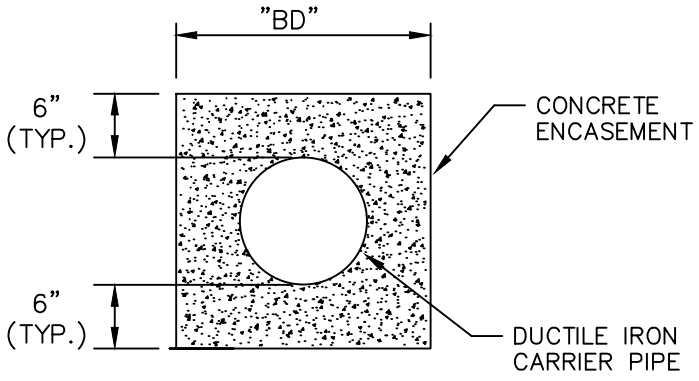
CITY OF
CLEVER
MISSOURI

# SANITARY SEWER
# STREAM CROSSING DETAIL

DATE: 05/13/22

DWG: C9




SECTION A-A

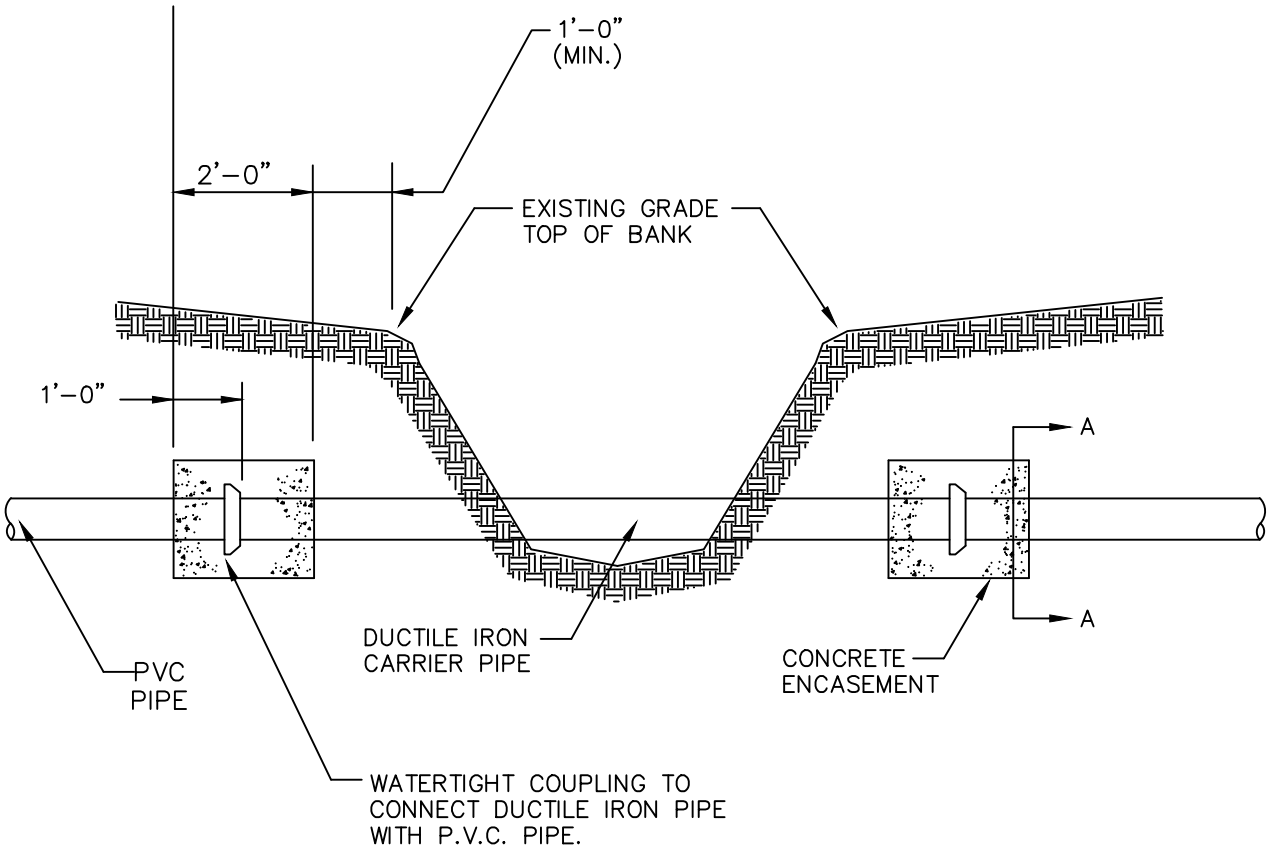
| PIPE SIZE "D" (IN.) | TRENCH WIDTH "BD" (FT.) |
|---|---|
| 6 | 2.00 |
| 8 | 2.33 |
| 10 | 2.50 |
| 12 | 3.00 |
| 15 | 3.25 |
| 18 | 3.83 |
| 24 | 4.42 |

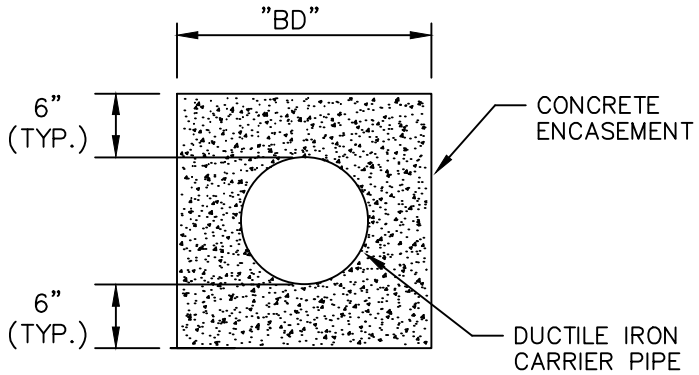
CITY OF
CLEVER
MISSOURI

# SANITARY SEWER DITCH CROSSING DETAIL

DATE: 05/13/22

DWG: C10




SECTION A-A

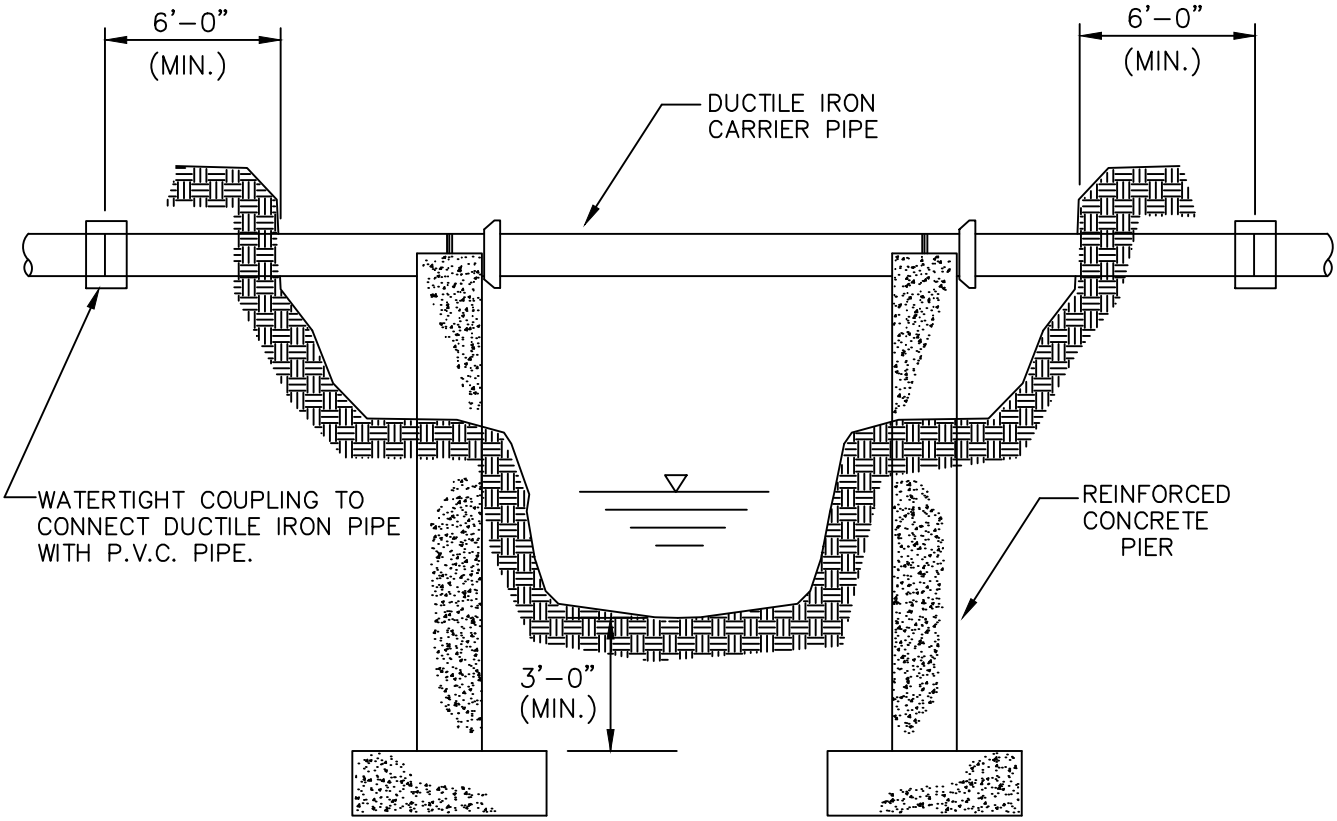
| PIPE SIZE "D" (IN.) | TRENCH WIDTH "BD" (FT.) |
|---|---|
| 6 | 2.00 |
| 8 | 2.33 |
| 10 | 2.50 |
| 12 | 3.00 |
| 15 | 3.25 |
| 18 | 3.83 |
| 24 | 4.42 |

CITY OF
CLEVER
MISSOURI

# SANITARY SEWER AERIAL CROSSING DETAIL

DATE: 05/13/22

DWG: C11




NOTE:

1. WHENEVER POSSIBLE NO PIERS SHALL BE PLACED WITHIN NORMAL FLOW OF CREEK. FOOTINGS SHALL BE PLACED A MINIMUM OF 3 FEET BELOW THE CREEK BED.

2. REINFORCED CONCRETE PIERS SHALL BE PLACED BEHIND THE BELL OF EACH JOINT OF DUCTILE IRON PIPE.

3. ALL PIER PLACEMENT SHALL BE APPROVED BY CITY OF NIXA PUBLIC WORKS DEPARTMENT.

4. DISTURBED AREA SHALL BE RIP–RAPPED AS REQUIRED TO ELIMINATE EROSION.

5. CONCRETE PIERS ARE NOT REQUIRED FOR AERIAL SPANS LESS THAN 20'–0" IN LENGTH.

CITY OF
CLEVER
MISSOURI

# SANITARY SEWER AERIAL CROSSING W/ PIER DETAIL

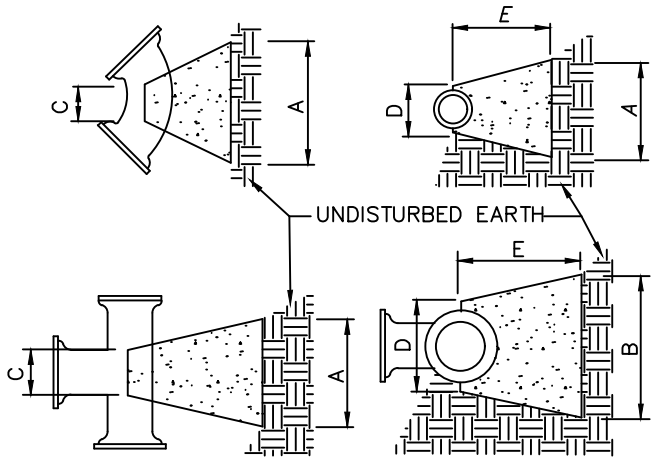
DATE: 05/13/22

DWG: C12

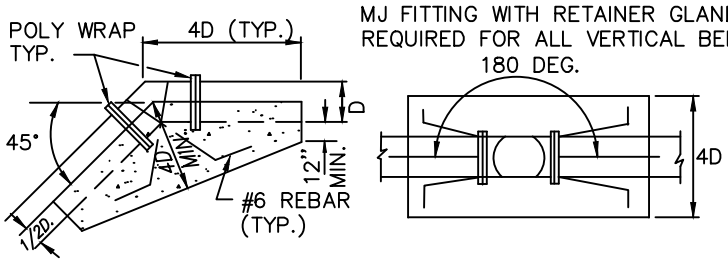
| PIPE SIZE | FITTING | DISTANCE IN INCHES | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | E |
| 4" AND SMALLER | 11.25 & 22.5° | 32 | 28 | 3 | 7 | 14 |
| | 45° | 32 | 28 | 4 | 7 | 14 |
| | 90° | 34 | 28 | 6 | 7 | 14 |
| | TEE/PLUG | 36 | 28 | 7 | 7 | 14 |
| 6" | 11.25 & 22.5° | 35 | 29 | 4 | 9 | 15 |
| | 45° | 36 | 29 | 6 | 9 | 15 |
| | 90° | 38 | 29 | 7 | 9 | 15 |
| | TEE/PLUG | 40 | 29 | 9 | 9 | 15 |
| 8" | 11.25 & 22.5° | 38 | 31 | 5 | 11 | 17 |
| | 45° | 40 | 31 | 6 | 11 | 17 |
| | 90° | 52 | 34 | 9 | 11 | 22 |
| | TEE/PLUG | 44 | 31 | 11 | 11 | 17 |
| 10" & 12" | 11.25 & 22.5° | 44 | 34 | 7 | 15 | 19 |
| | 45° | 47/59 | 37 | 10 | 15 | 24 |
| | 90° | 70/91 | 38/44 | 13 | 15 | 30/39 |
| | TEE/PLUG | 57/71 | 35/39 | 15 | 15 | 22/28 |
| 14" & 16" | 11.25 & 22.5° | 53 | 38 | 7 | 19 | 23 |
| | 45° | 72/85 | 45 | 10 | 19 | 31/37 |
| | 90° | 108/129 | 49/55 | 18 | 19 | 46/56 |
| | TEE/PLUG | 88/102 | 47 | 19 | 19 | 35/41 |
| 18" | 11.25 & 22.5° | 61 | 41 | 9 | 22 | 26 |
| | 45° | 98 | 50 | 11 | 22 | 44 |
| | 90° | 142 | 58 | 20 | 22 | 61 |
| | TEE/PLUG | 118 | 52 | 22 | 22 | 48 |

NOTES:

1. THRUST BLOCKS ARE BASED ON A WORKING PRESSURE OF 200 P.S.I. 36" COVER, & 2000 P.S.F. ALLOWABLE SOIL BEARING PRESSURE.
2. FOR PIPE SIZES NOT SHOWN USE DIMENSIONS FOR NEXT LARGER SIZE.
3. USE 3/8" PLYWOOD SEPARATOR BETWEEN BLOCKS AND PLUGS TO PROVIDE FOR FUTURE REMOVAL.
4. ALL THRUST BLOCKS TO BE INSPECTED BY CITY OF CLEVER BEFORE BACKFILLING.




CONCRETE THRUST BLOCK DETAIL
NOT TO SCALE




NOTE; ALSO PROVIDE MEGALUG RETRAINED JOINTS ON BOTH SIDES OF VERTICAL THRUST BLOCK.

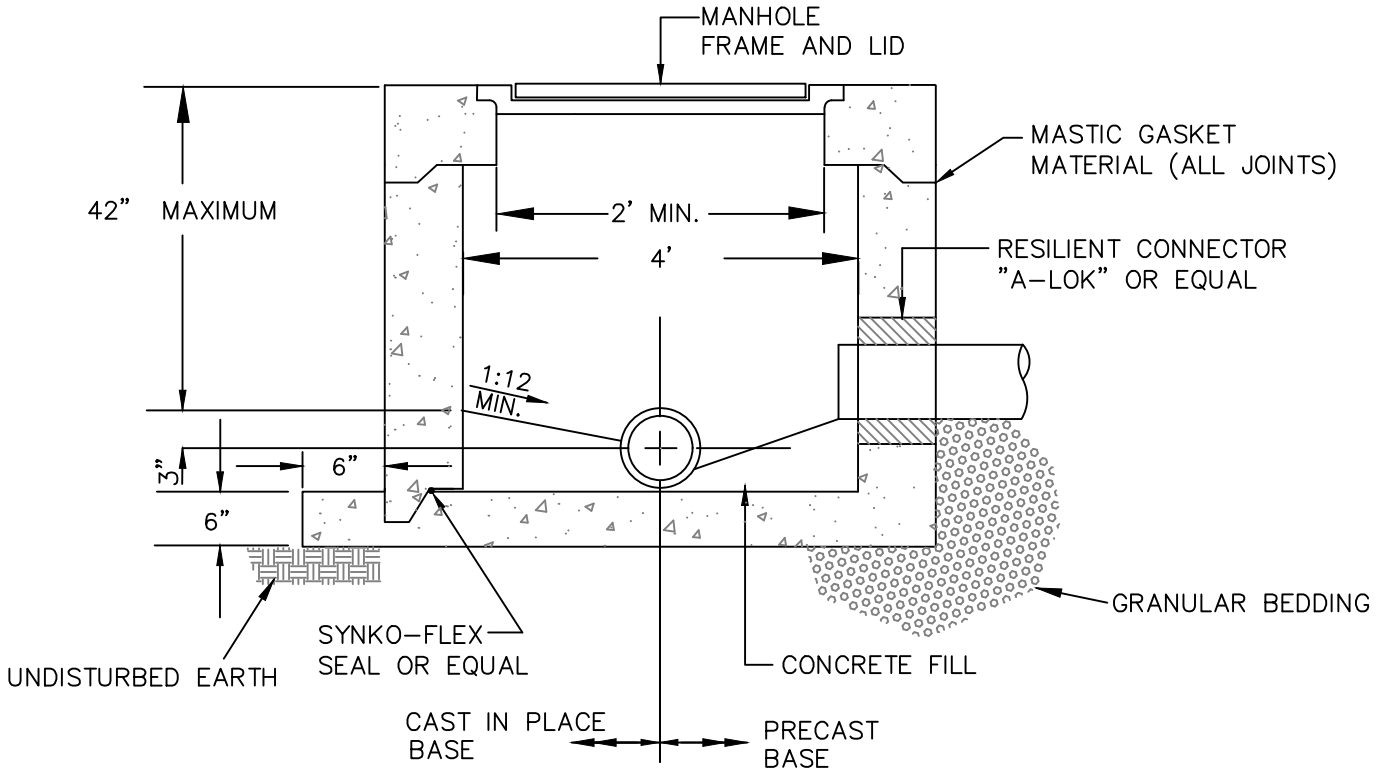
VERTICAL BEND THRUST BLOCK DETAIL
NOT TO SCALE

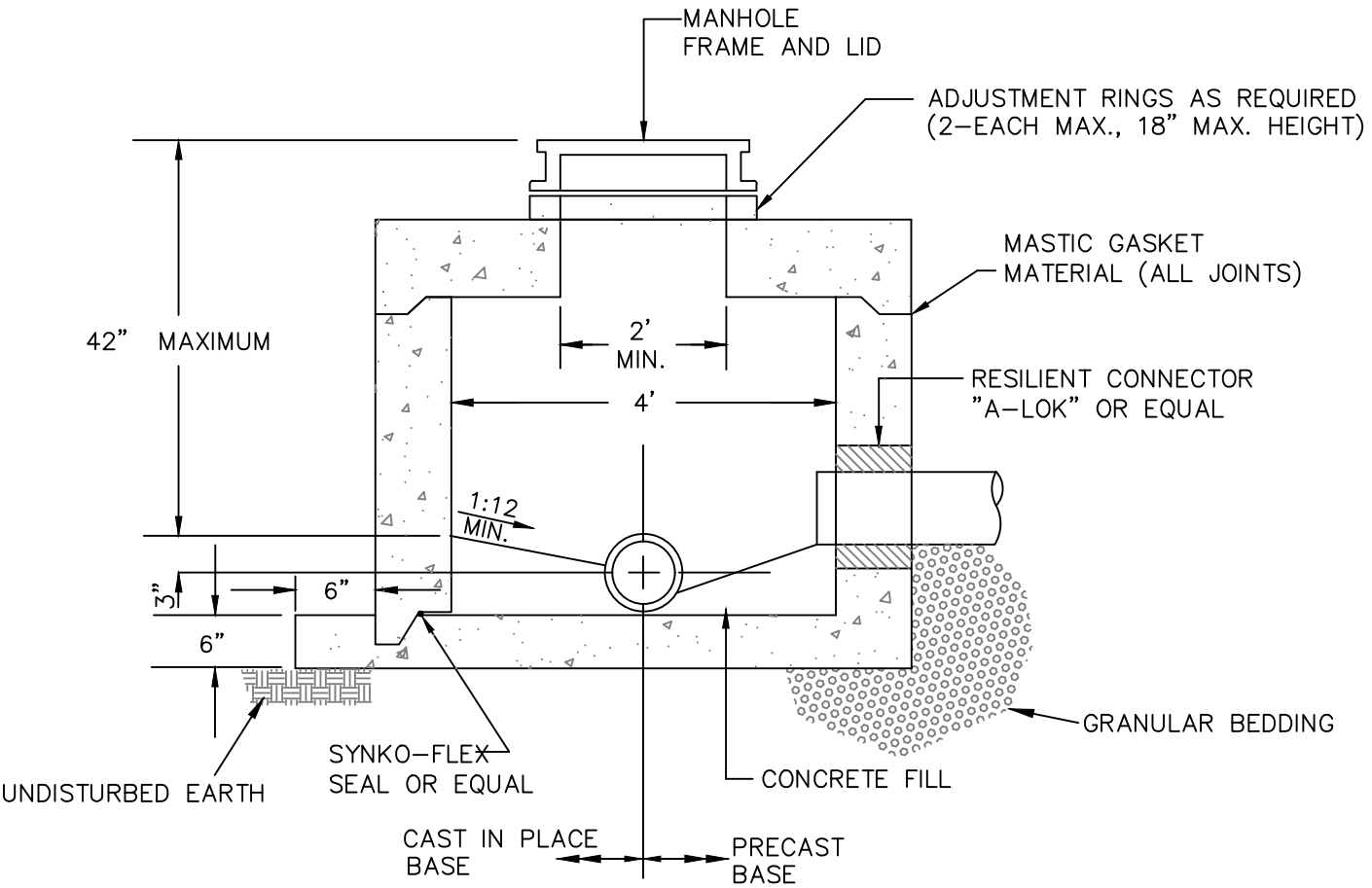
CITY OF CLEVER MISSOURI

# TYPICAL THRUST BLOCK DETAILS

DATE: 05/13/22

DWG: C13



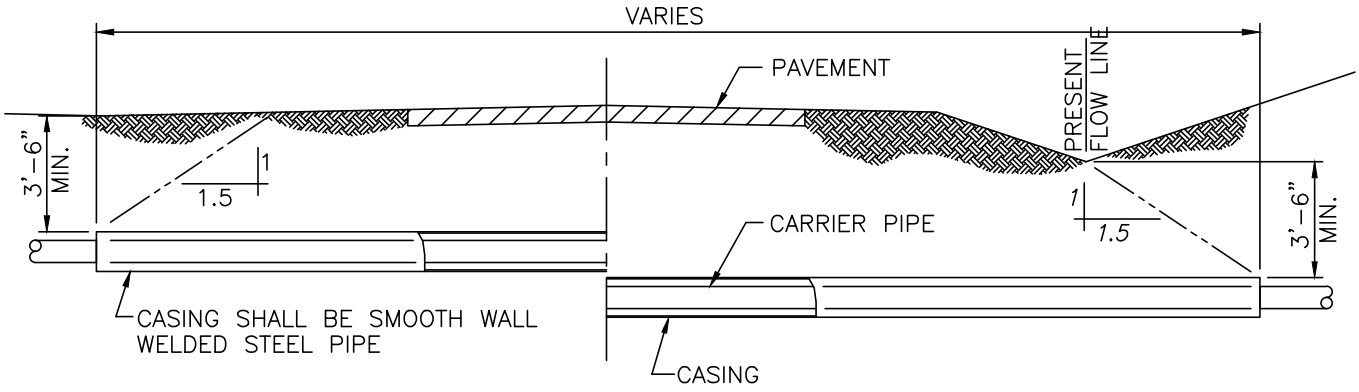

PROVIDE A MIMIMUM DROP OF 0.2' OF INVERT FROM INLET TO OUTLET.

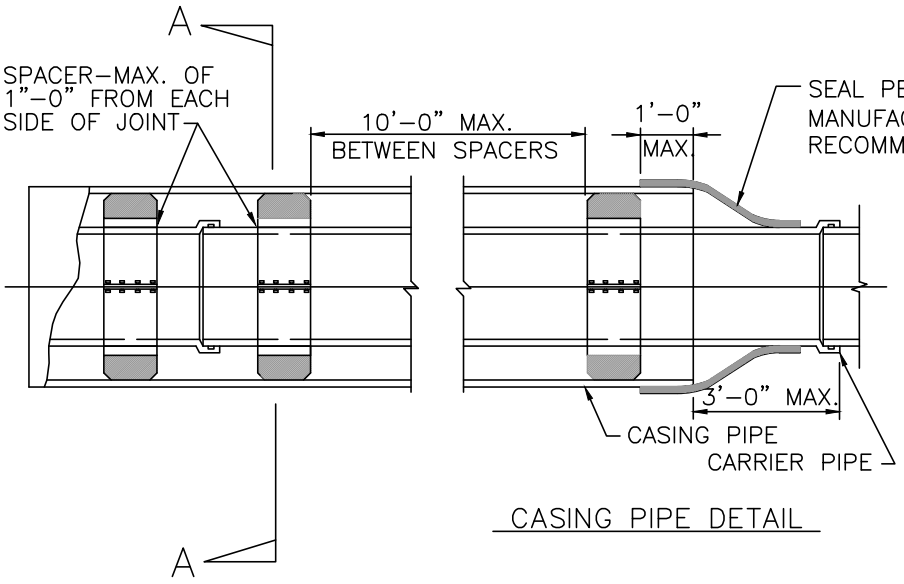
CITY OF CLEVER MISSOURI

# TYPICAL SHALLOW MANHOLE DETAIL

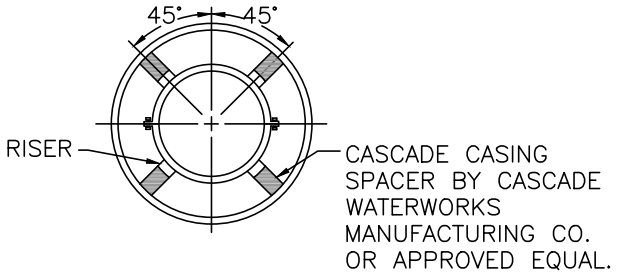
DATE: 05/13/22

DWG: C14




CASING PIPE DETAIL




SECTION A-A

DETAIL NOTES:

1. DEPTH OF BORING PIT SHALL BE AS REQUIRED.
2. THE DRILLED HOLE FOR THE CASING PIPE SHALL BE SLIGHTLY UNDERSIZED AND THE PIPE JACKED THROUGH TO ELIMINATE VOIDS BETWEEN PIPE AND HOLE.
3. BOTH ENDS OF CASING WILL BE SEALED AS PER MANUFACTURER'S RECOMMENDATION.

SMOOTH WALL, WELDED STEEL PIPE WITH A MINIMUM WALL THICKNESS AS FOLLOW WILL BE PERMITTED:

| CASING DIAMETER (INCHES) | MINIMUM WALL THICKNESS |
|---|---|
| LESS THAN 6 | 0.188 (PREFERRED) |
| 6, 8, 10, 12, 14, 16 | 0.188 |
| 18, 20, 22 | 0.250 |
| 24, 26 | 0.281 |
| 28, 30, 32, 34 | 0.312 |
| 36, 38, 40, 48 | 0.344 |

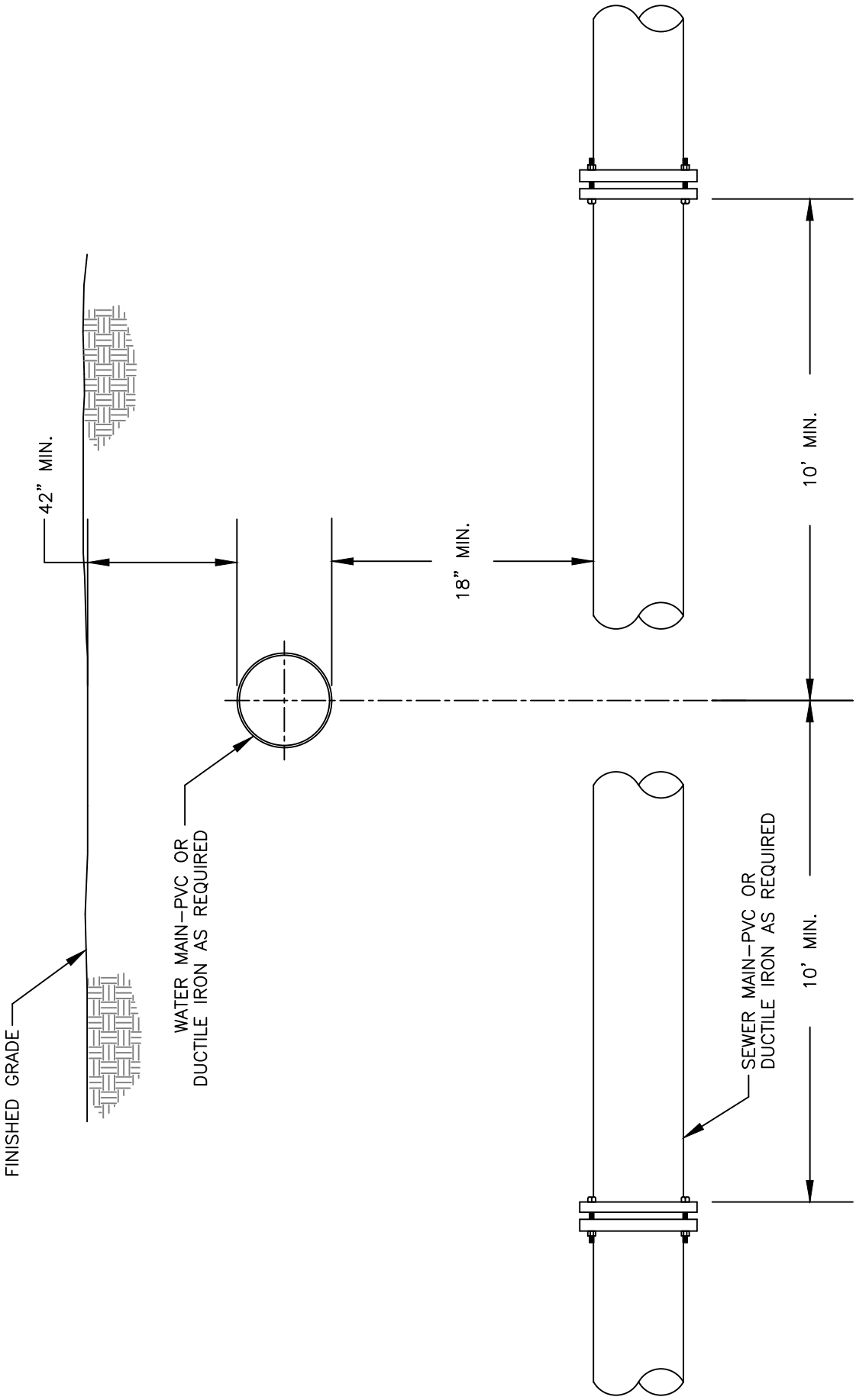
CITY OF CLEVER MISSOURI

# TYPICAL BORE/ ENCASEMENT DETAIL

DATE: 05/13/22

DWG: C15

NOTES:
1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED
2. IN AREAS WHERE THE RECOMENDED SEPARATIONS CANNOT BE OBTAINED, EITHER THE WATER LINE OR THE SEWER LINE SHALL BE CONSTRUCTED OF MECHANICAL JOINT PIPE OR CASED IN A CONTINUOUS CASING.




CITY OF
CLEVER
MISSOURI

# TYPICAL CROSSING DETAIL
# WATER OVER SEWER

DATE: 05/13/22

DWG: C16

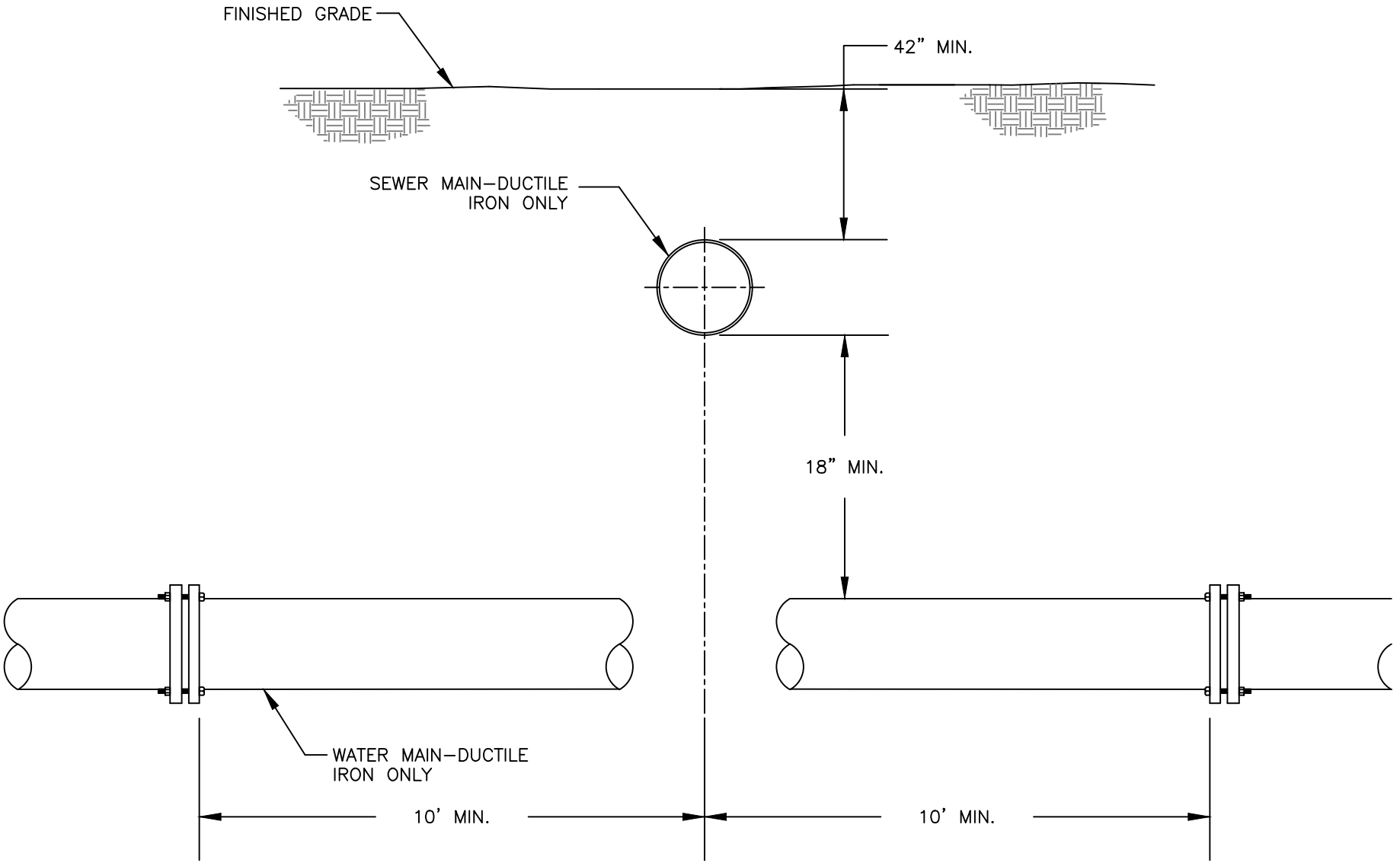
CITY OF CLEVER MISSOURI

# TYPICAL CROSSING DETAIL SEWER OVER WATER

DATE: 05/13/22

DWG: C17

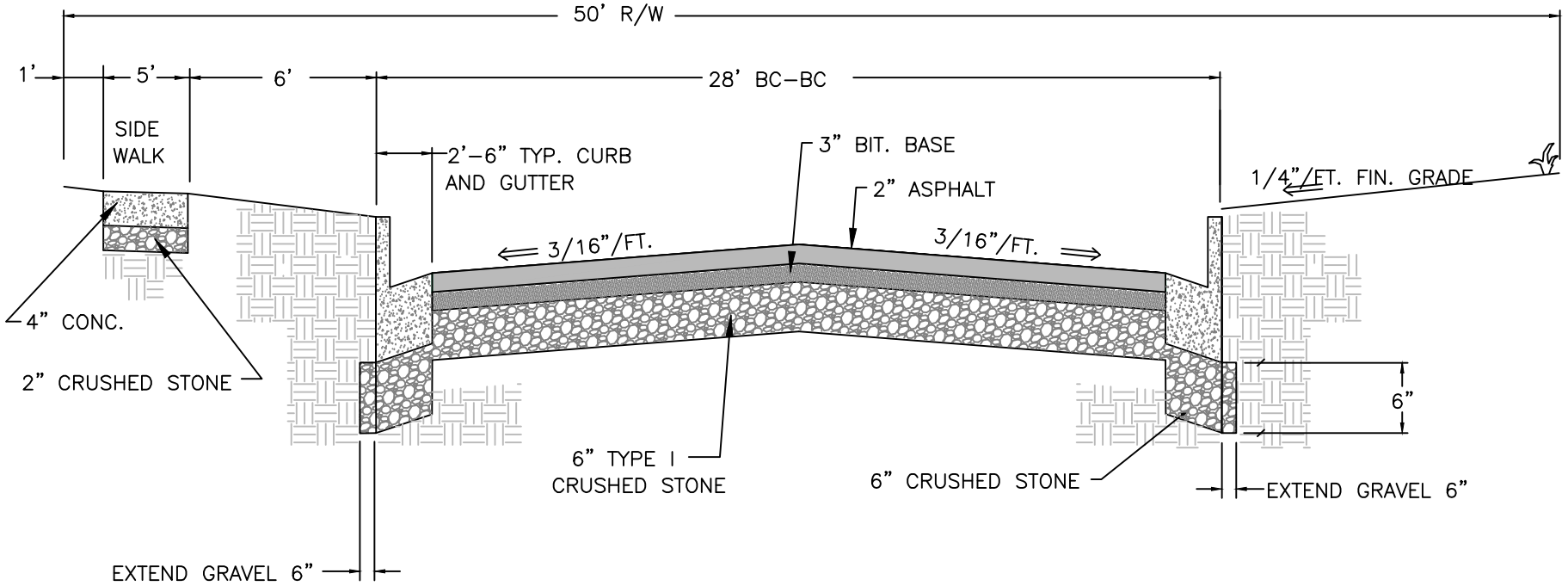
NOTES:
1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED
2. IN AREAS WHERE THE RECOMENDED SEPARATIONS CANNOT BE OBTAINED, EITHER THE WATER LINE OR THE SEWER LINE SHALL BE CONSTRUCTED OF MECHANICAL JOINT PIPE OR CASED IN A CONTINUOUS CASING.



# SECTION D – STREETS

CITY OF CLEVER MISSOURI

# TYPICAL STREET DETAIL



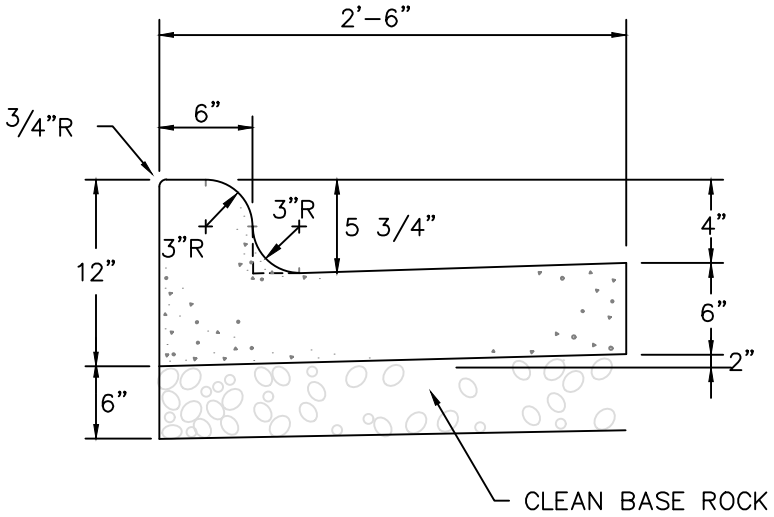

STREET CROSS–SECTION – LOCAL
N.T.S.

NOTE: TOP OF CURB IS 0.19 FEET ABOVE CENTERLINE ELEV.

NOTE: CONTRACTOR IS RESPONSIBLE FOR COMPACTION OF SUBGRADE AND SUITABILITY OF BASE MATERIALS. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COMPACTION AND QUALITY CONTROL TESTS REQUESTED BY THE CITY.

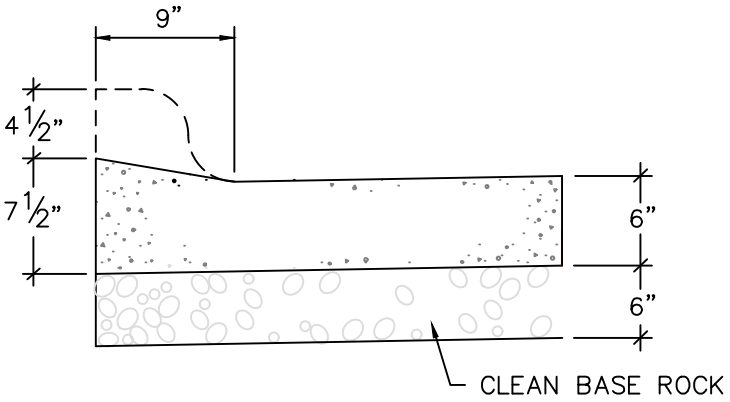
DATE: 05/13/22

DWG: D1




## TYPICAL CURB DETAIL

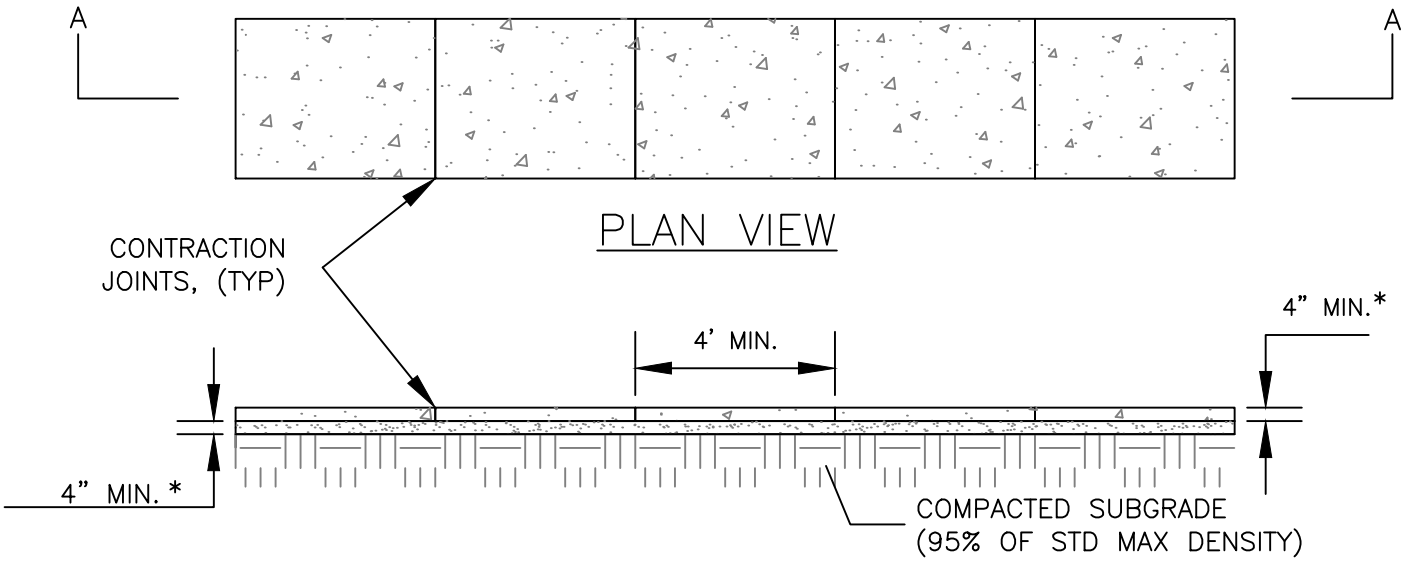
N.T.S.



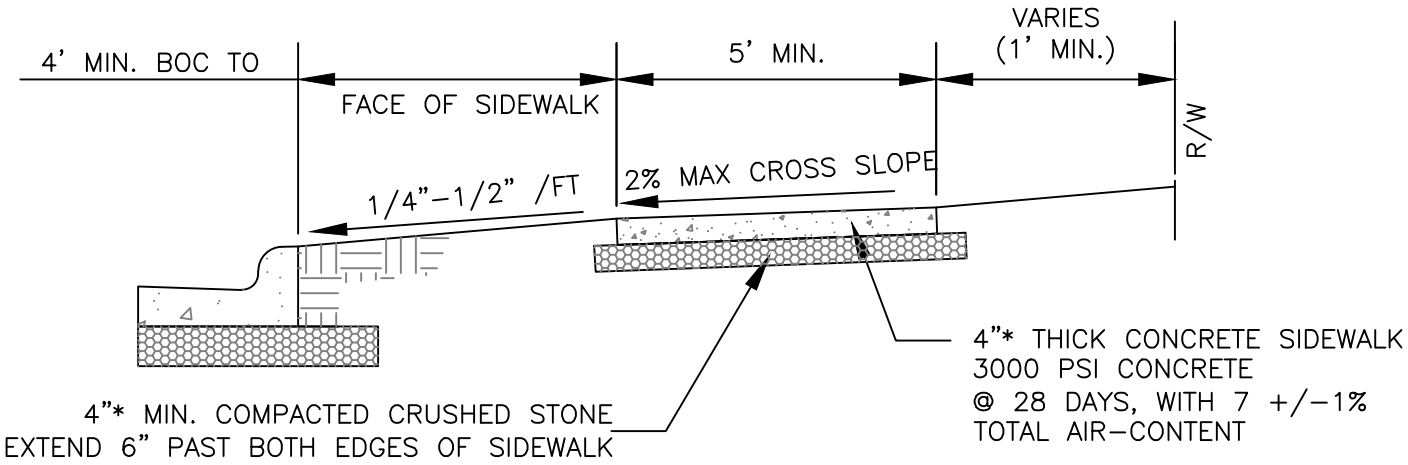

## GUTTER VALLEY

N.T.S.

| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | TYPICAL CURB & GUTTER DETAIL | DATE: 05/13/22<br>DWG: D2 |




## SECTION A–A




* 4" THICKNESS SHALL BE CHANGED TO 6" AT DRIVEWAYS

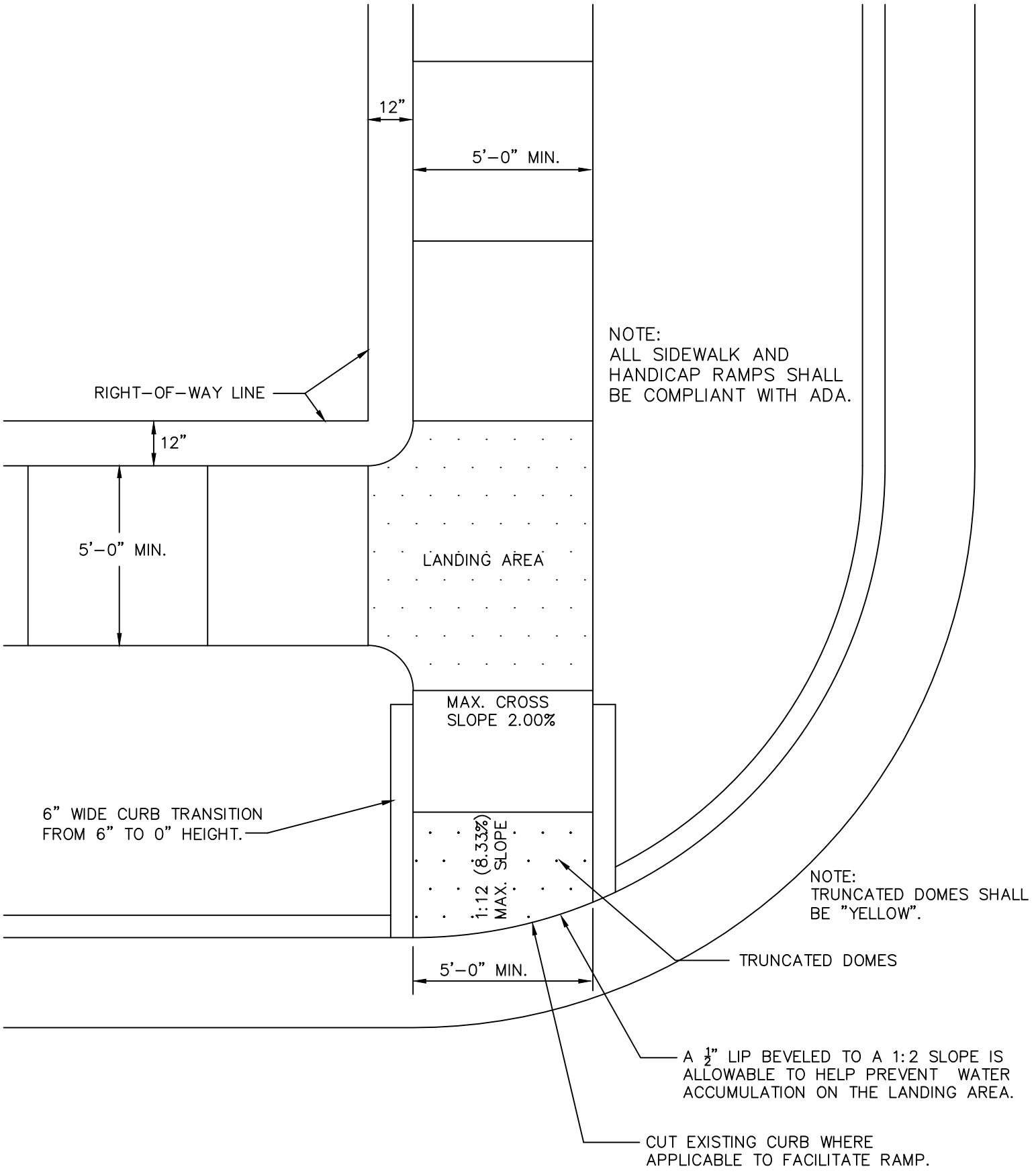
# 5' CONCRETE SIDEWALK DETAIL

NOT–TO–SCALE

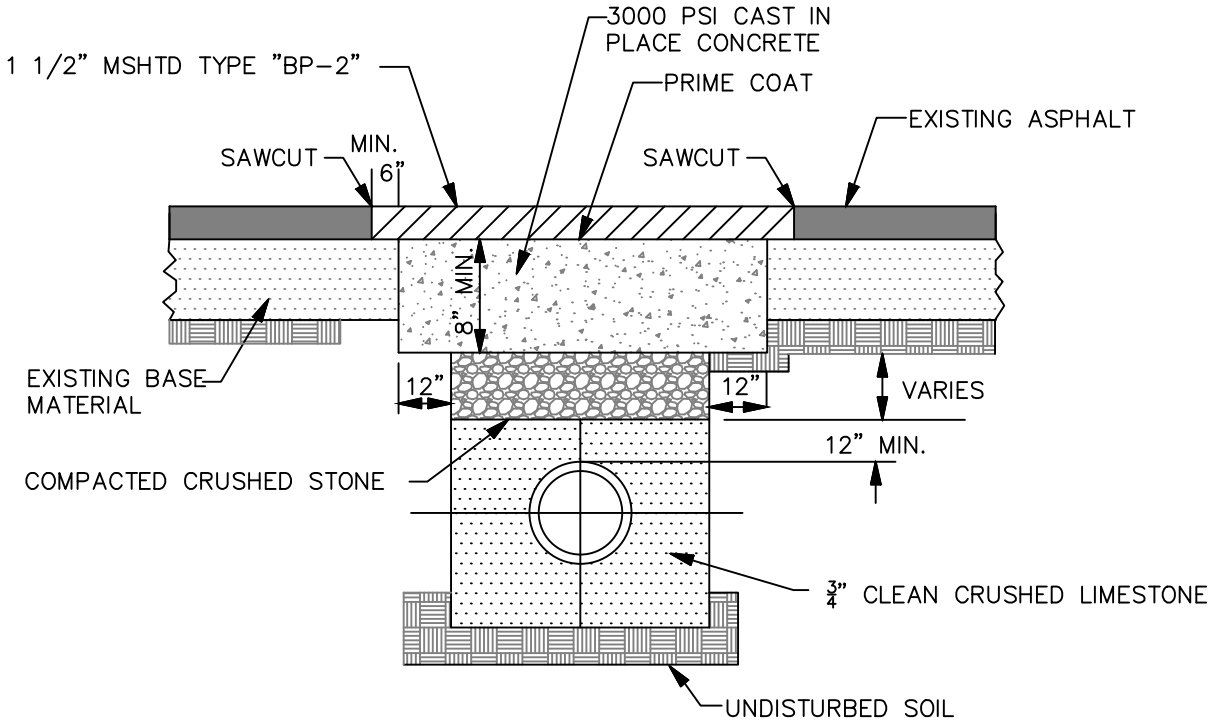
NOTES:

1. JOINTS SHALL BE FORMED AT RIGHT ANGLES TO THE ALIGNMENT OF THE SIDEWALK AND TO THE DEPTHS INDICATED BELOW.
2. THE SIDEWALK SHALL BE MARKED OFF INTO SQUARE STONES BY CONTRACTION JOINTS. CONTRACTION JOINTS SHALL BE ONE EIGHTH (1/8) INCH WIDE BY ONE FOURTH (1/4) OF SECTION THICKNESS AND SHALL BE FORMED BY TOOLING.
3. EXPANSION JOINTS SHALL BE PLACED WHERE SIDEWALK ABUTS OTHER STRUCTURES AND SHALL NOT BE SPACED MORE THAN 50 FEET APART ON STRAIGHT RUNS FOR HAND LAID SIDEWALK AND NOT MORE THAN 100 FEET APART ON STRAIGHT RUNS FOR MACHINE LAID SIDEWALKS. EXPANSION JOINTS SHALL BE FORMED BY A THREE–FOURTH, (3/4) INCH THICK PREFORMED JOINT FILLER, EXTENDING THE FULL DEPTH OF THE SLAB, AND SECURED SO THAT THEY ARE NOT MOVED BY DEPOSITING AND COMPACTING THE CONCRETE AT THESE JOINTS.
4. ALL SIDEWALKS SHALL BE CONSTRUCTED AND APPROVED PRIOR TO THE APPROVAL OF THE FINAL PLAT.

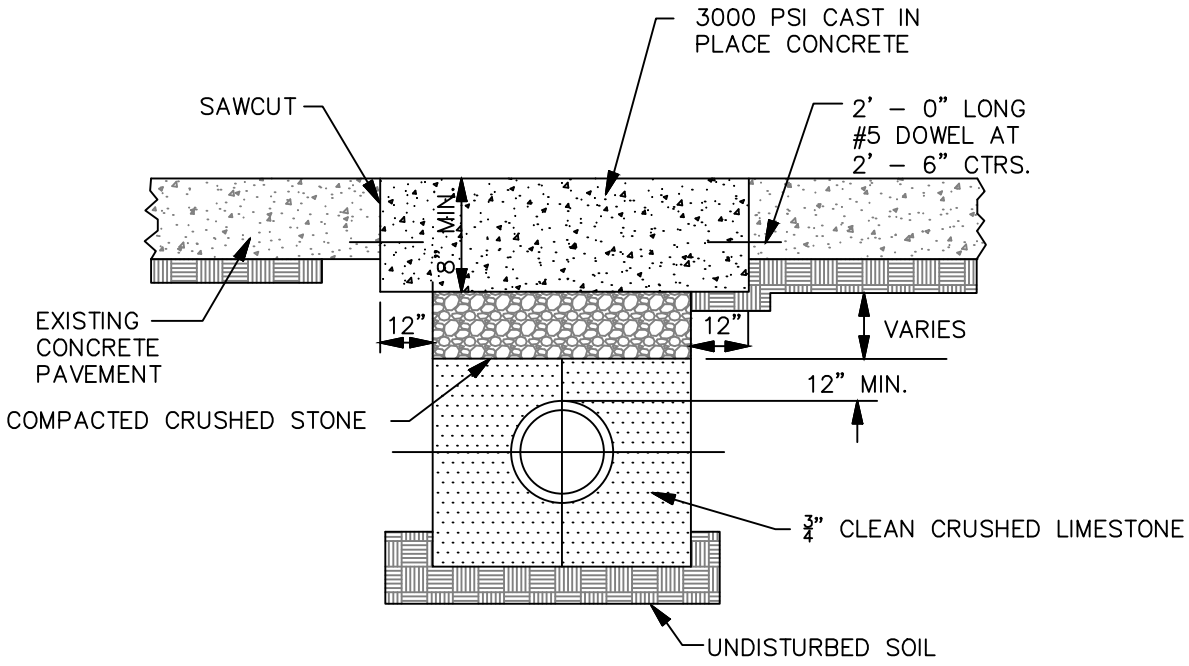
| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | TYPICAL 5' CONCRETE SIDEWALK DETAIL | DATE: 05/13/22<br>DWG: D3 |



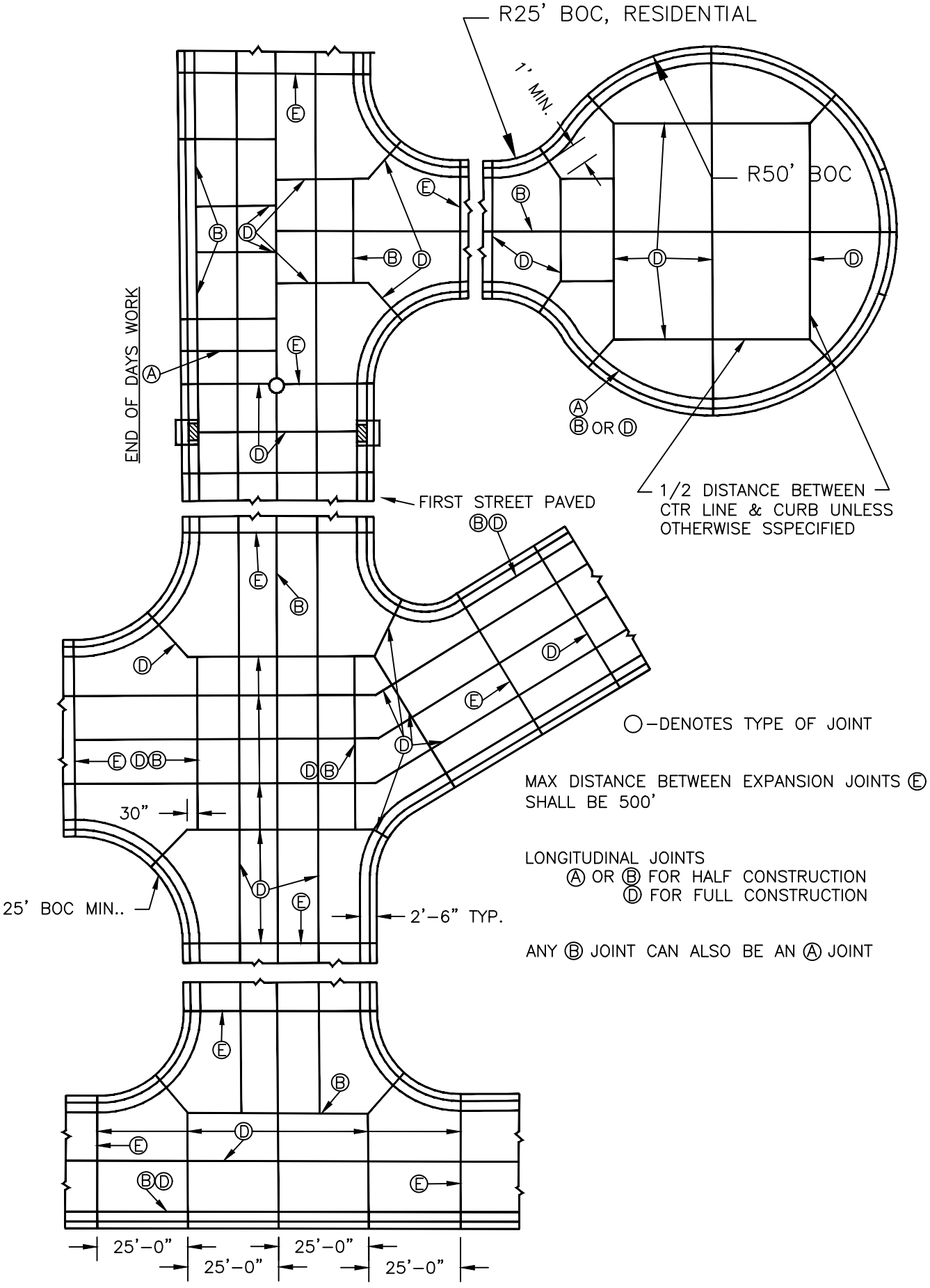

| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | TYPICAL CURB RAMP DETAIL | DATE: 05/13/22<br>DWG: D4 |




| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | ASPHALT STREET REPAIR DETAIL | DATE: 05/13/22<br>DWG: D5 |




| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | CONCRETE STREET REPAIR DETAIL | DATE: 05/13/22<br>DWG: D6 |




○—DENOTES TYPE OF JOINT

MAX DISTANCE BETWEEN EXPANSION JOINTS Ⓔ SHALL BE 500'

LONGITUDINAL JOINTS
Ⓐ OR Ⓑ FOR HALF CONSTRUCTION
Ⓓ FOR FULL CONSTRUCTION

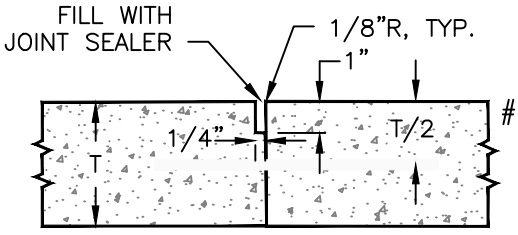
ANY Ⓑ JOINT CAN ALSO BE AN Ⓐ JOINT

CITY OF CLEVER MISSOURI

# CONCRETE STREET JOINT LOCATIONS

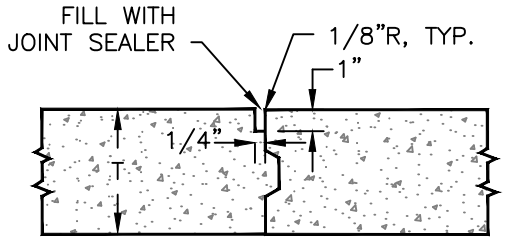
DATE: 05/13/22

DWG: D7



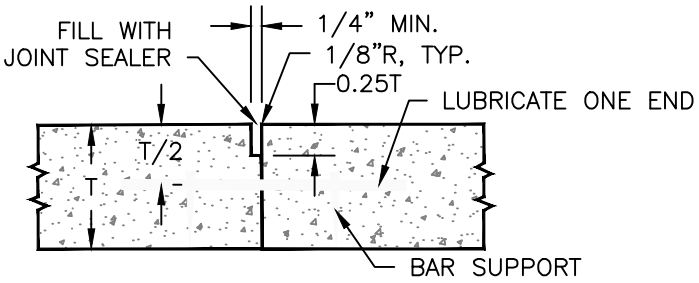

DOWELED LONGITUDINAL JOINT
WITH 24" NO. 6 DEFORMED BAR AT 24" O.C.

## TYPE "A"



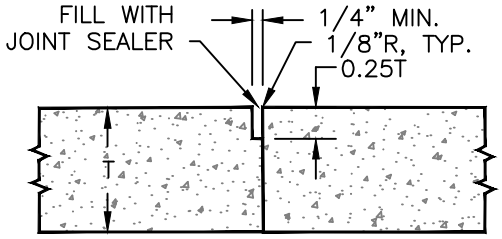

KEYED LONGITUDINAL JOINT

## TYPE "B"



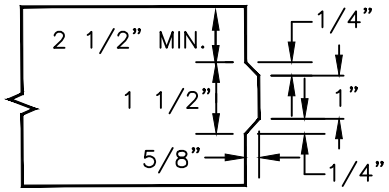

SAWED CONTRACTION JOINT WITH
1" X 18" DOWEL BAR AT 24" O.C.

## TYPE "C"

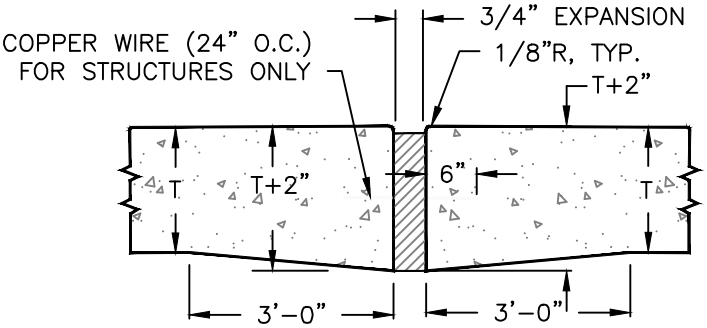



SAWED CONTRACTION JOINT

## TYPE "D"

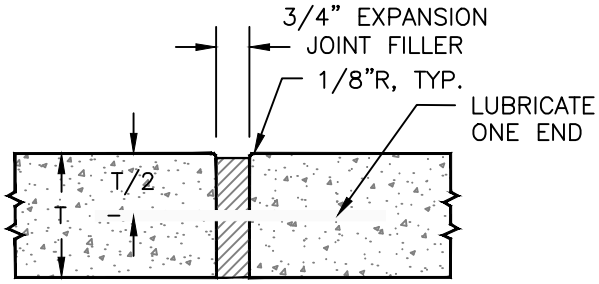



DETAIL KEY
KEYWAY FORMED BY FASTENING KEY TO FORM



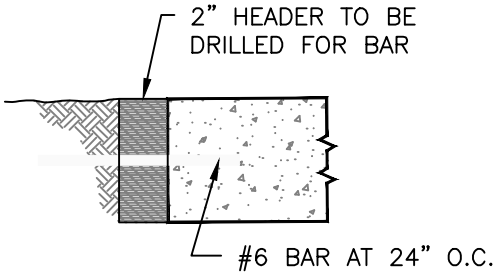

EXPANSION JOINT

## TYPE "E"




DOWELED EXPANSION JOINT
3/4" X 15" DOWEL BAR AT 24" O.C.

## TYPE "F"




CONSTRUCTION HEADER CONCRETE

DEPTH OF SAW JOINT

6" PAV. = 1-1/2"
7" PAV. = 1-3/4"
8" PAV. = 2"

CITY OF
CLEVER
MISSOURI

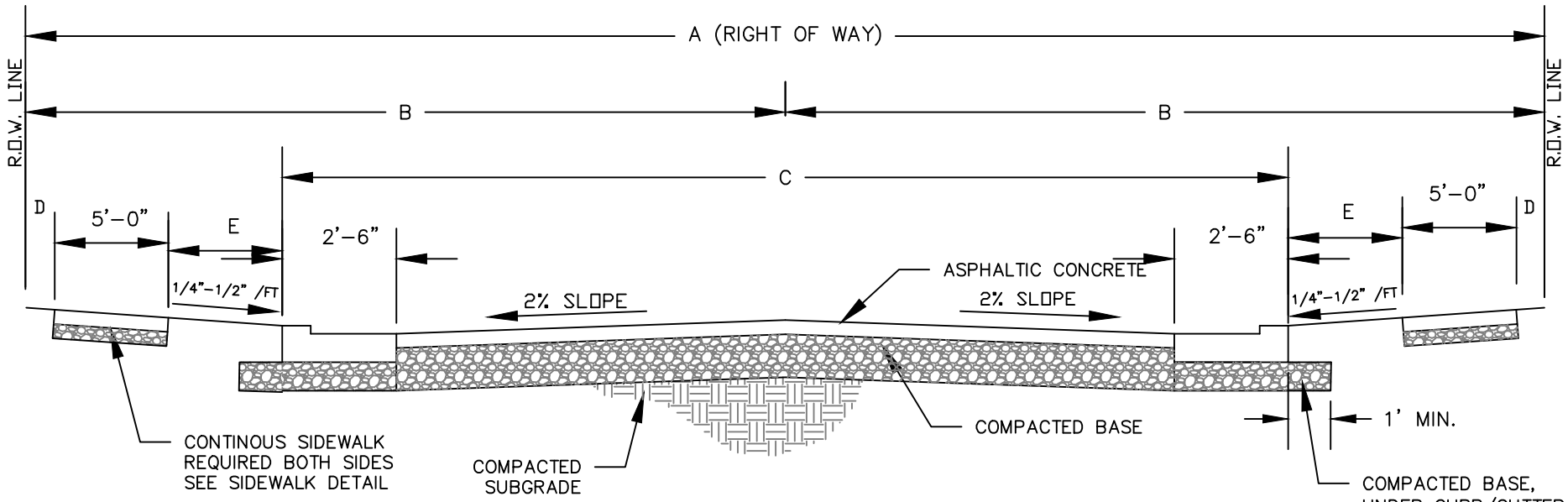
# CONCRETE STREET JOINT DETAILS

DATE: 05/13/22

DWG: D8

CITY OF CLEVER MISSOURI

# TYPICAL PAVEMENT DETAILS

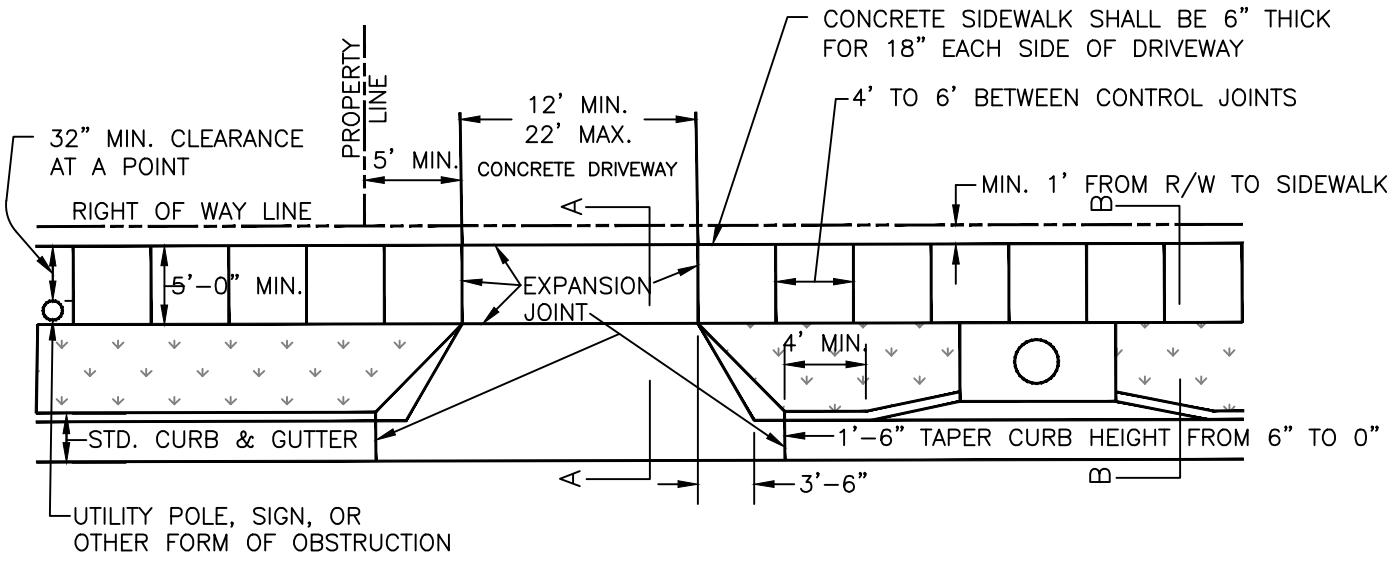



NOTES;
1. THE EARTH SUBGRADE SHALL BE SCARIFY TO A DEPTH OF 8" FOR BOTH CUT AND FILL AREAS, HAVE THE MOISTURE CONTENT ADJUSTED TO A RANGE OF +/- 2% FROM OPTIMUM MOISTURE CONTENT FOR STABILITY AND COMPACTED TO A MINIMUM OF 95% STANDARD PROCTOR DENSITY PER ASTTM D-698.
2. THE AGGREGRATE BASE MATERIAL SHALL BE SPREAD IN 6" MAXIMUM LIFTS WITH MOISTURE APPLIED AS NECESSARY TO OBTAIN A DENSITY OF NOT LESS THAN 95% OF STANDARD MAXIMUM DENSITY AS DETERMINED BY ASTM D-698.
3. BITUMINOUS BASE AND SURFACE SHALL BOTH BE COMPACTED TO A DENSITY OF NOT LESS THAN 95% OF THAT OBTAINED BY THE LABORATORY COMPACTION OF A SPECIMEN OF THE APPROVED MIXTURE.

| STREET CLASSIFICATION | A (R.O.W.) | B | C. PVMT W BOC TO BOC | D | E | BASEROCK (MIN DEPTH) | BITUMINOUS ASPHALT, (MIN. THK.) BLACK BASE | SURFACE | CONCRETE EQUIVALENT |
|---|---|---|---|---|---|---|---|---|---|
| RESIDENTIAL STREETS | 50' | 25' | 28' | VARIES | 4' MIN. | 6" | 3" | 2" | 4" |
| RESIDENTIAL COLLECTOR | 50' OR 60'** | 25' OR 30'** | 28' OR 35'** | VARIES | 4' MIN. | 6" | 7" | 2" | 6" |
| PRIMARY COLLECTOR | 65' OR 70'** | 32.5' OR 35'** | 37' OR 42'** | VARIES | 4' MIN. | 6" | 7" | 2" | 6" |
| SECONDARY ARTERIAL | 80' | 40' | 41' OR 46'** | VARIES | 4' MIN. | * | * | * | * |
| PRIMARY ARTERIAL | 110' | 55' | 29' EA SIDE | VARIES | 4' MIN. | * | * | * | * |

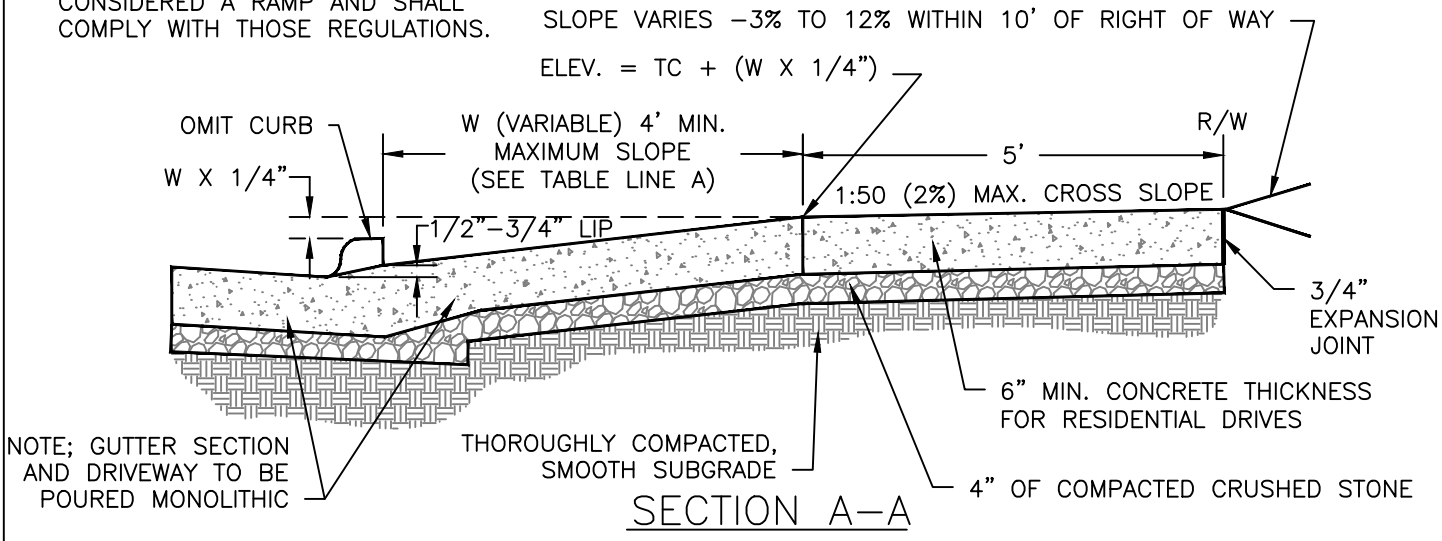
*TO BE INDIVIDUALLY DESIGNED.
** WITH BICYCLE ROUTE

DATE: 05/13/22
DWG: D9

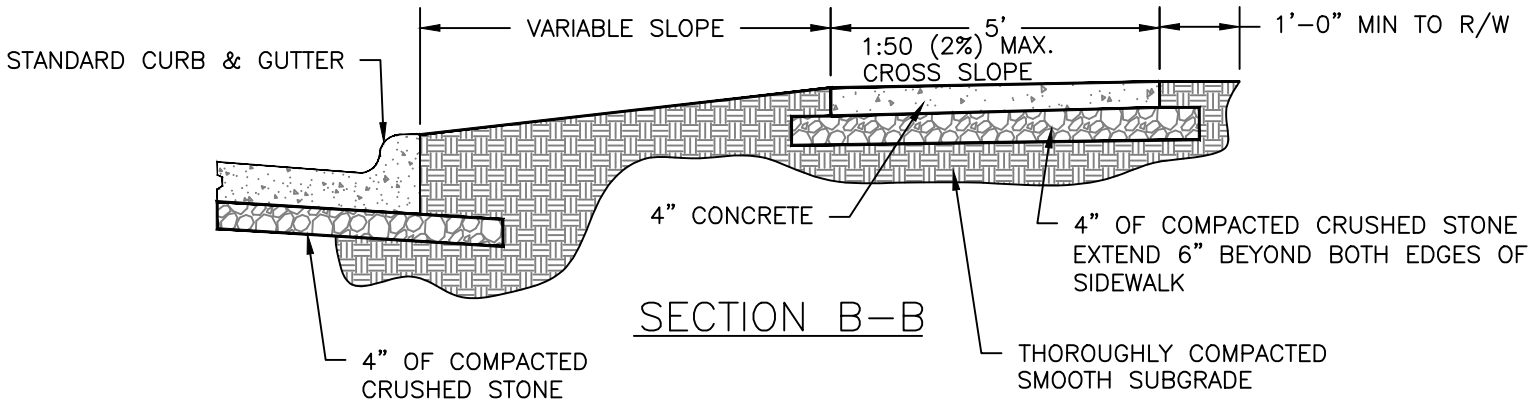



## TYPICAL DRIVEWAY PLAN VIEW

NOTE;
ANY PART OF AN ACCESSIBLE ROUTE WITH A RUNNING SLOPE GREATER THAN 1:20 SHALL BE CONSIDERED A RAMP AND SHALL COMPLY WITH THOSE REGULATIONS.




## SECTION A-A




## SECTION B-B

NOTES:
1. POSITIVE GUTTER FLOW SHALL BE MAINTAINED ACROSS ALL DRIVEWAYS.
2. REMOVAL OF EXISTING CURB/GUTTERS FOR DRIVEWAYS SHALL BE ACCOMPLISHED AT THE NEXT EXISTING JOINT.
3. DRIVEWAYS SHALL NOT BE LOCATED WITHIN 15' OF FIRE HYDRANTS. THEY SHALL ALSO NOT BE LOCATED OVER METER BOXES, VALVE BOXES NOR MANHOLES. LOCATIONS OF DRIVEWAYS SHALL NOT INTERFERE WITH ANY OTHER UTILITY.

CITY OF CLEVER MISSOURI

# RESIDENTIAL DRIVEWAY AND SIDEWALK DETAILS

DATE: 05/13/22

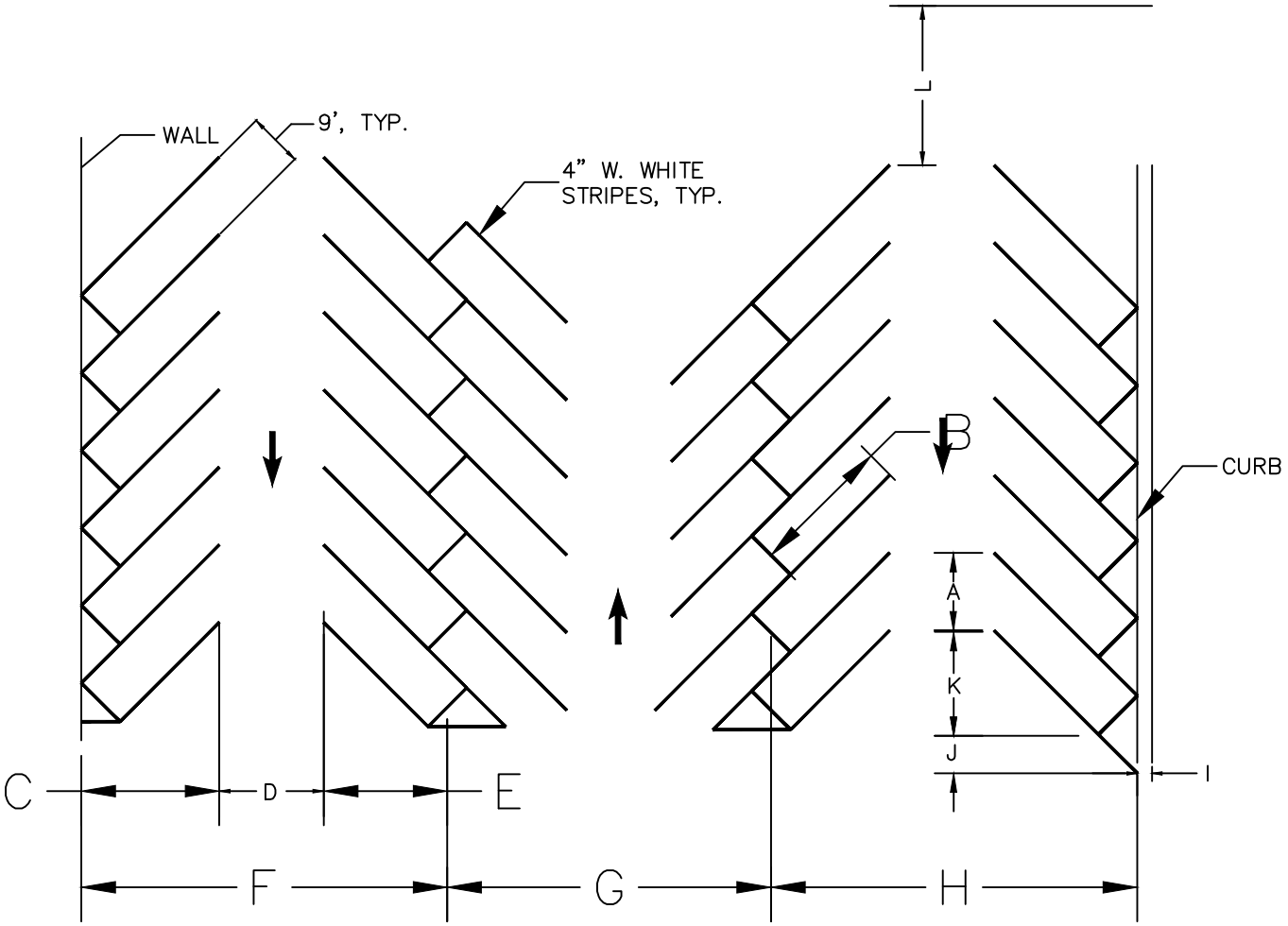
DWG: D10

MINIMUM REQUIREMENTS FOR LAYOUT ELEMENTS

NOTES;

1. ON STREET ANGLE PARKING SHALL COMPLY WITH THE LAYOUT BELOW. PARALLEL PARKING STALLS SHALL PROVIDE A MINIMUM STALL WIDTH OF 9' AND LENGTH OF 22'.

2. FOR COMMERICAL AND INDUSTRIAL USES, 10' WIDE STALLS MAY BE SUBSTITUTED FOR 9' WIDE STALLS AT THE RATE OF 1.11 PER 1. THEREFORE, FOR EVERY 10 TOTAL 9' WIDE STALLS REQUIRED, THE PROPERTY OWNER/DEVELOPER MAY SUBSTITUTE 9 TOTAL 10' WIDE STALLS AND STILL MAINTAIN COMPLIANCE WITH THE CITY OF CLEVER CODE FOR OFF-STREET REQUIRED MINIMUM PARKING SPACES,




PARKING LAYOUT DIMENSIONS (IN FEET) FOR 9' WIDE STALLS AT VARIOUS ANGLES

| DIMENSIONS | SYMBOL | 90 | 75 | 60 | 45 | 30 |
|---|---|---|---|---|---|---|
| STALL WIDTH, PARALLEL TO AISLE | A | 9.0 | 9.3 | 10.4 | 12.7 | 18.0 |
| STALL LENGTH OF LINE | B | 18.5 | 20.0 | 22.0 | 25.0 | 34.1 |
| STALL DEPTH TO WALL | C | 18.5 | 19.5 | 19.0 | 17.5 | 17.1 |
| AISLE WIDTH BETWEEN STALL LINES | D | 26.0 | 23.0 | 16.0 | 12.0 | 10.0 |
| STALL DEPTH, INTERLOCK | E | 18.5 | 18.8 | 17.5 | 15.3 | 13.2 |
| MODULE, WALL TO INTERLOCK | F | 63.0 | 61.3 | 52.5 | 44.8 | 40.3 |
| MODULE, INTERLOCKING | G | 63.0 | 61.0 | 51.0 | 42.6 | 36.4 |
| MODULE, INTERLOCK TO CURB FACE | H | 60.5 | 58.8 | 50.2 | 42.8 | 38.8 |
| BUMPER OVERHANG (TYPICAL) | I | 2.5 | 2.5 | 2.3 | 2.0 | 1.5 |
| OFFSET | J | 0.0 | 0.5 | 2.7 | 6.3 | 13.5 |
| SETBACK | K | 0.0 | 5.0 | 8.3 | 11.0 | 16.0 |
| CROSS AISLE, ONE-WAY | L | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| CROSS AISLE, TWO-WAY | L | 24.0 | 24.0 | 24.0 | 24.0 | 24.0 |

CITY OF CLEVER MISSOURI

# PARKING STALL LAYOUT DETAILS

DATE: 05/13/22

DWG: D11

# SECTION E – LIFT STATIONS

CITY OF
CLEVER
MISSOURI

# TYPICAL PUMP STATION
# PLAN DETAIL

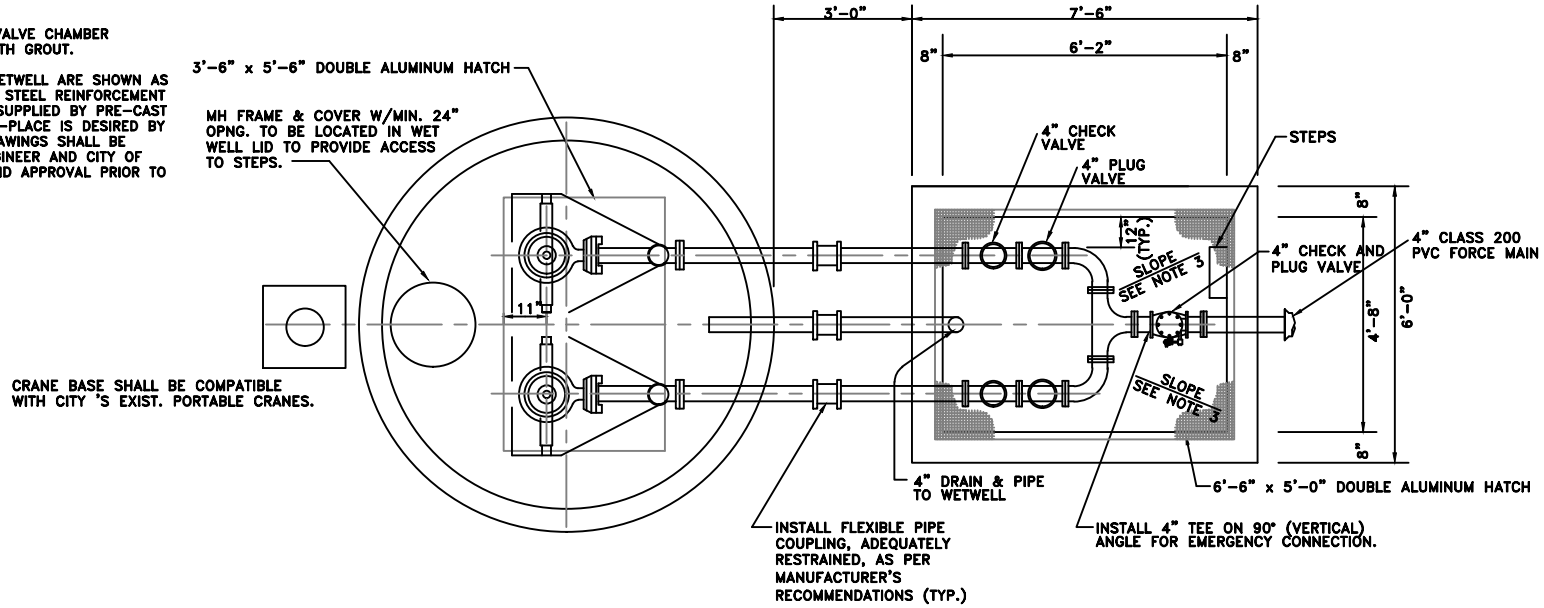
DATE: 05/13/22
DWG: E1

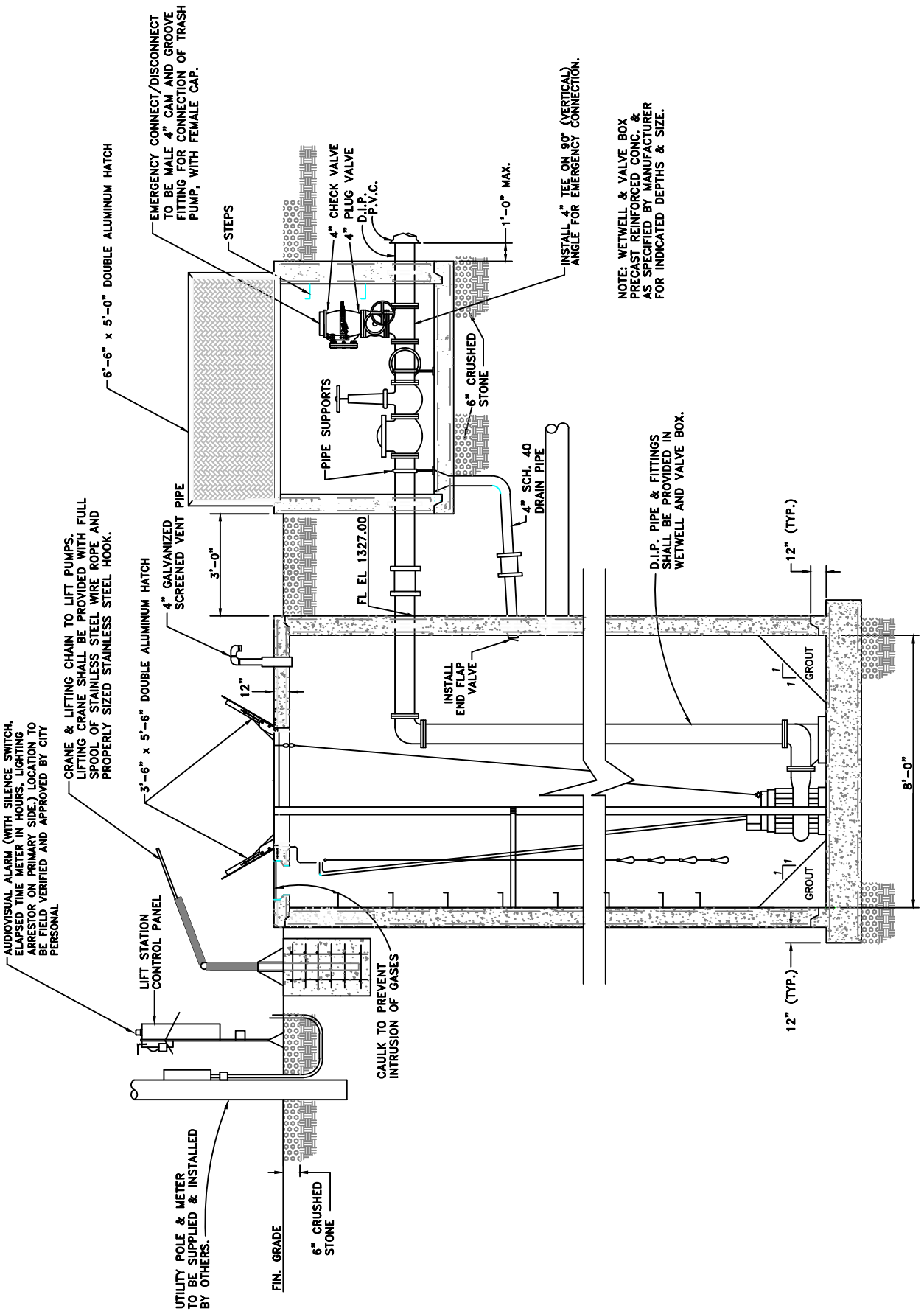
NOTE:
1. LIFT STATION SHALL BE CONSTRUCTED PER CITY OF CLEVER CONSTRUCTION STANDARDS FOR PUBLIC IMPROVEMENTS.

2. CONTRACTOR SHALL SEAL WETWELL STRUCTURE AND JOINTS W/RAMNEK OR OTHER MATERIAL AS RECOMMENDED BY MANUFACTURER AND ANY OTHER PROVISION AS REQUIRED TO MINIMIZE POTENTIAL FOR LEAKAGE.

3. SLOPE FLOOR OF VALVE CHAMBER TOWARD DRAIN LINE WITH GROUT.

4. VALVE BOX AND WETWELL ARE SHOWN AS PRE-CAST UNITS. ALL STEEL REINFORCEMENT TO BE DESIGNED AND SUPPLIED BY PRE-CAST SUPPLIER. IF CAST-IN-PLACE IS DESIRED BY CONTRACTOR, SHOP DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER AND CITY OF CLEVER FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.



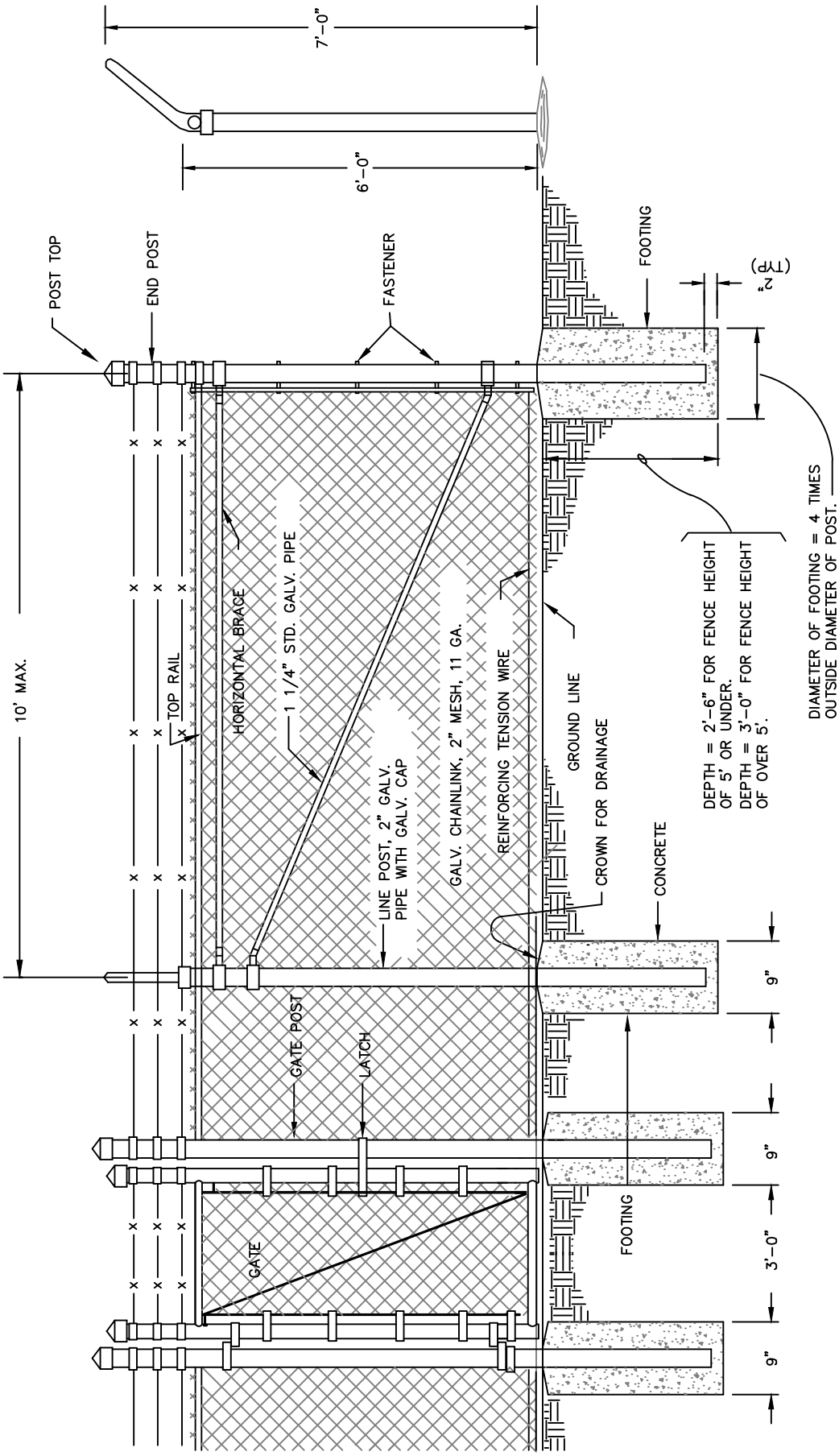



CITY OF
CLEVER
MISSOURI

# TYPICAL PUMP STATION PROFILE DETAIL

DATE: 05/13/22

DWG: E2




CITY OF CLEVER MISSOURI

# TYPICAL PUMP STATION FENCING DETAIL

DATE: 05/13/22

DWG: E3

# SECTION F – STORMWATER

| SEEDING RATES | BROADCAST | DRILLED SODDED |
|---|---|---|
| Tall Fescue | 30 lbs./acre | 25 lbs./acre solid |
| Kentucky Bluegrass | 3 lbs./acre | 2 lbs./acre solid |
| Red Fescue | 10 lbs./acre | 7 lbs./acre |
| Wheat or Rye | 120 lbs./acre | 100 lbs./acre |
| Annual Ryegrass | 100 lbs./acre | 100 lbs./acre |

**SEEDING DATES**

| | |
|---|---|
| Perennial Grasses: | March 1 to May 15 or August 15 to October 15 |
| Temporary Cover: | May 15 to November 15 |
| Overseeding: | November 15 to March 1 |

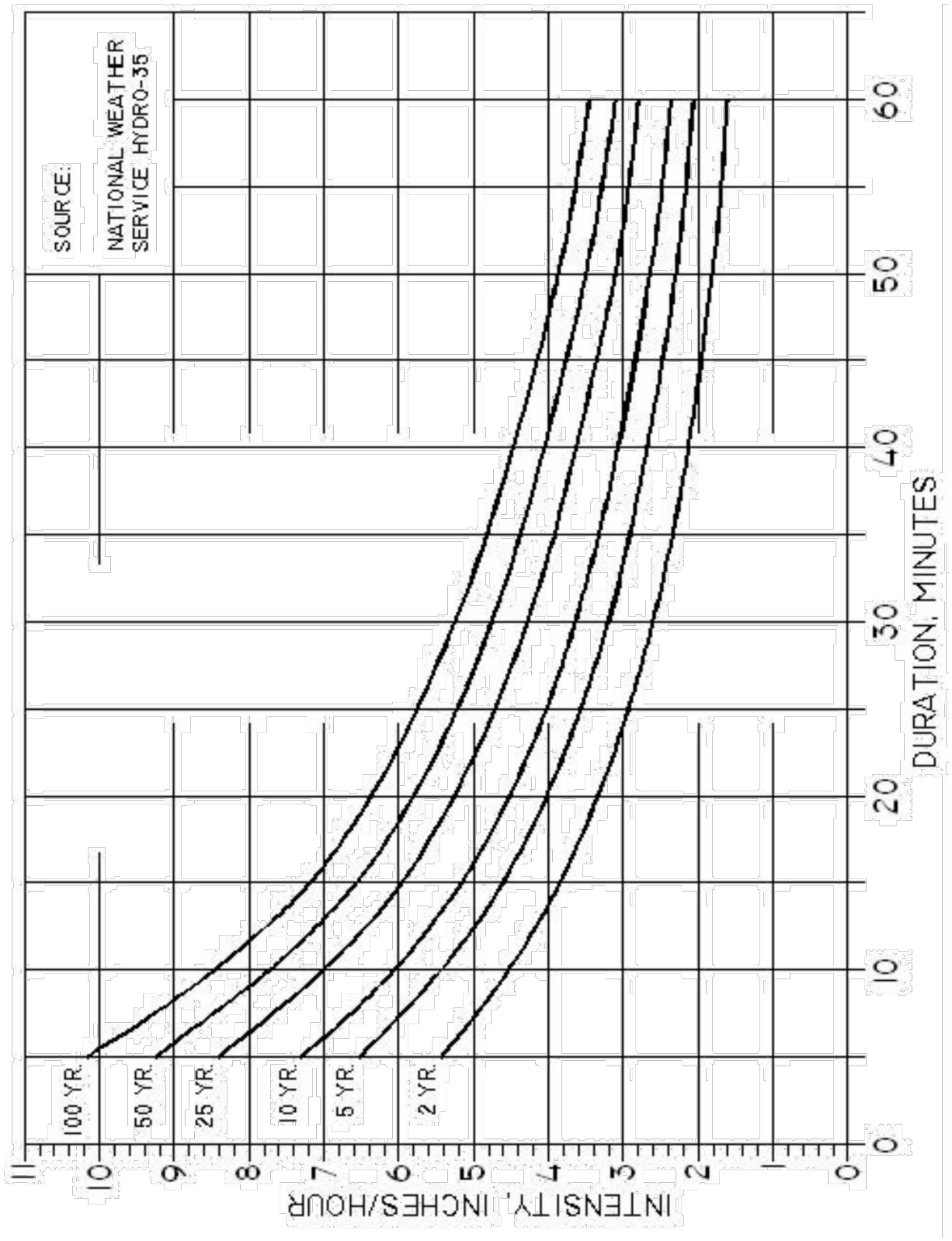
**MULCH RATES**

Wheat straw: 100 lbs. Per 1000 square feet (4,500 lbs./acres)

**FERTILIZER RATES**

| | |
|---|---|
| Nitrogen: | 90 lbs./acre |
| Phosphate: | 90 lbs./acre |
| Potassium: | 90 lbs./acre |
| Lime: | 1500 lbs./acre ENM* |

*ENM-Effective Neutralizing Material as per State evaluation of quarried rock.

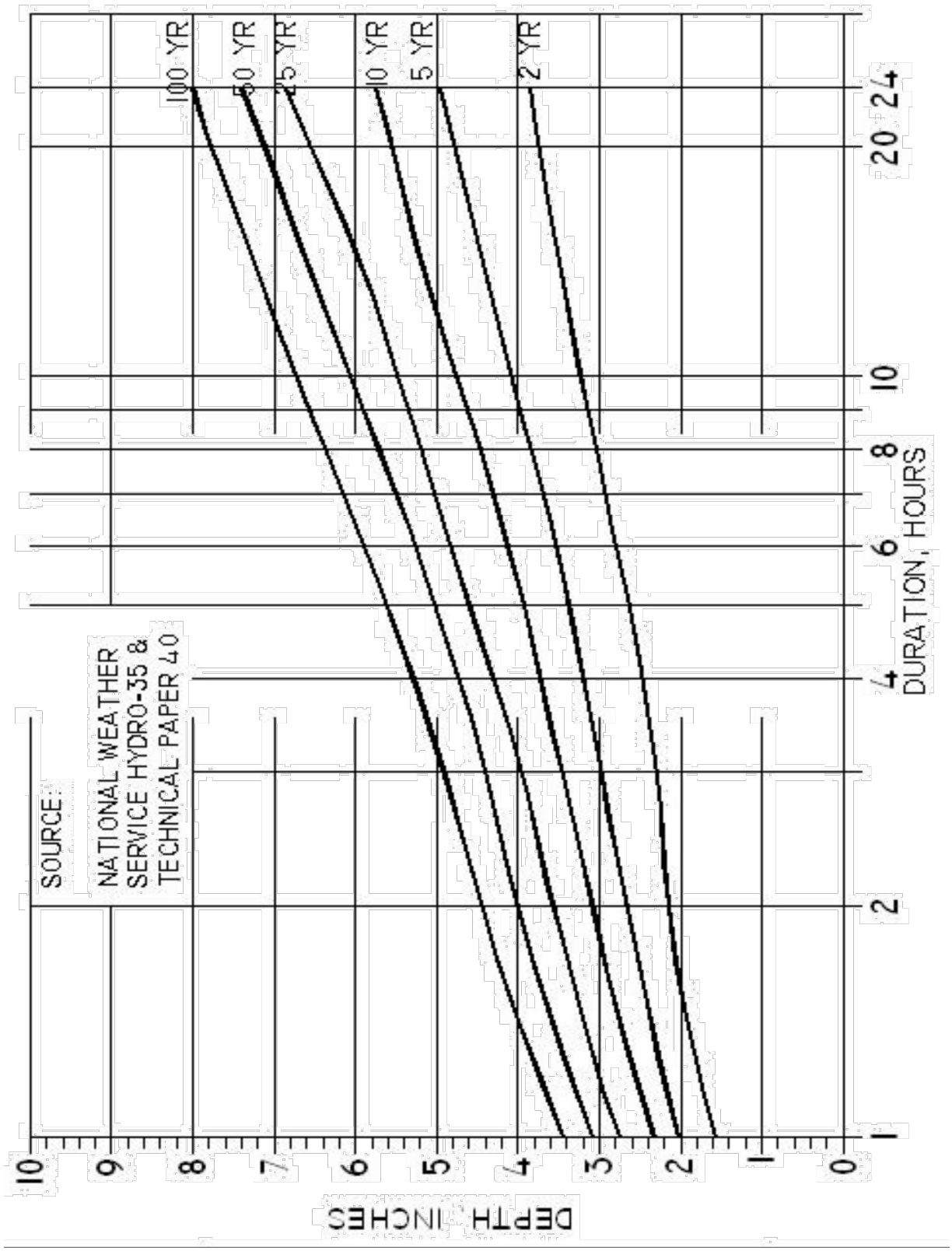



CITY OF CLEVER MISSOURI

# RAINFALL INTENSITIES
# DURATION < 60 MINUTES

DATE: 05/13/22

DWG: F2

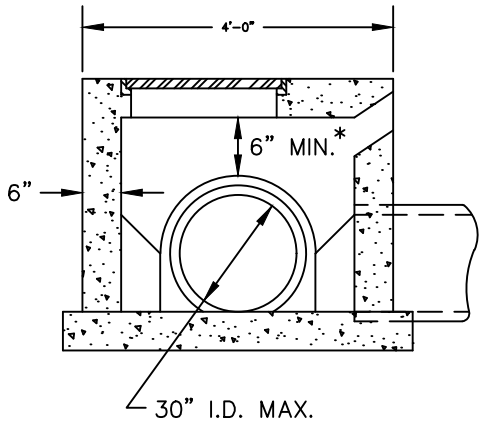



CITY OF
CLEVER
MISSOURI

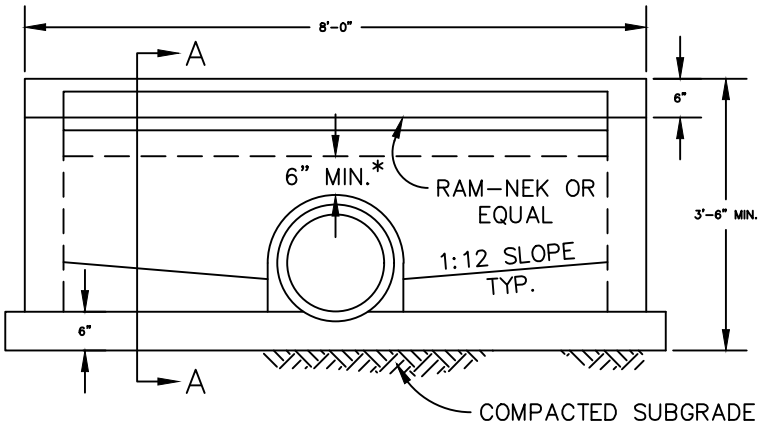
# RAINFALL DEPTHS FOR DURATIONS OF 1 TO 24 HOURS

DATE: 05/13/22

DWG: F3



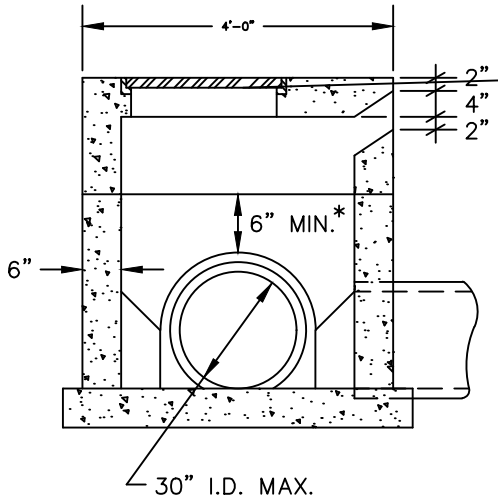

SECTION A–A



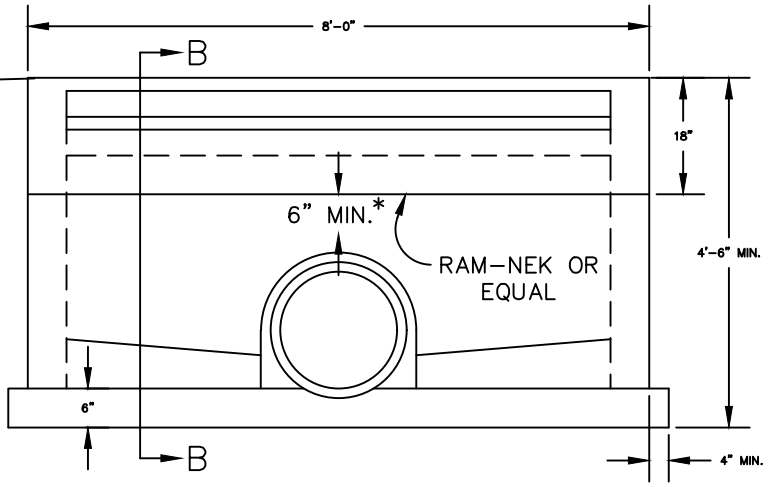

NOTE: #4 ø @ 10" C.C. (ALL WALLS, VERT. & HOR.)
SEE DET. G6 FOR TOP SLAB REINFORCEMENT

## 6" PRECAST TOP

*NOTE: LESS CLEARANCE MAY BE ALLOWED PROVIDED ADEQUATE STRUCTURAL PROVISIONS ARE MADE TO PREVENT THE UNIT FROM CRACKING DURING DELIVERY AND INSTALLATION.




SECTION B–B



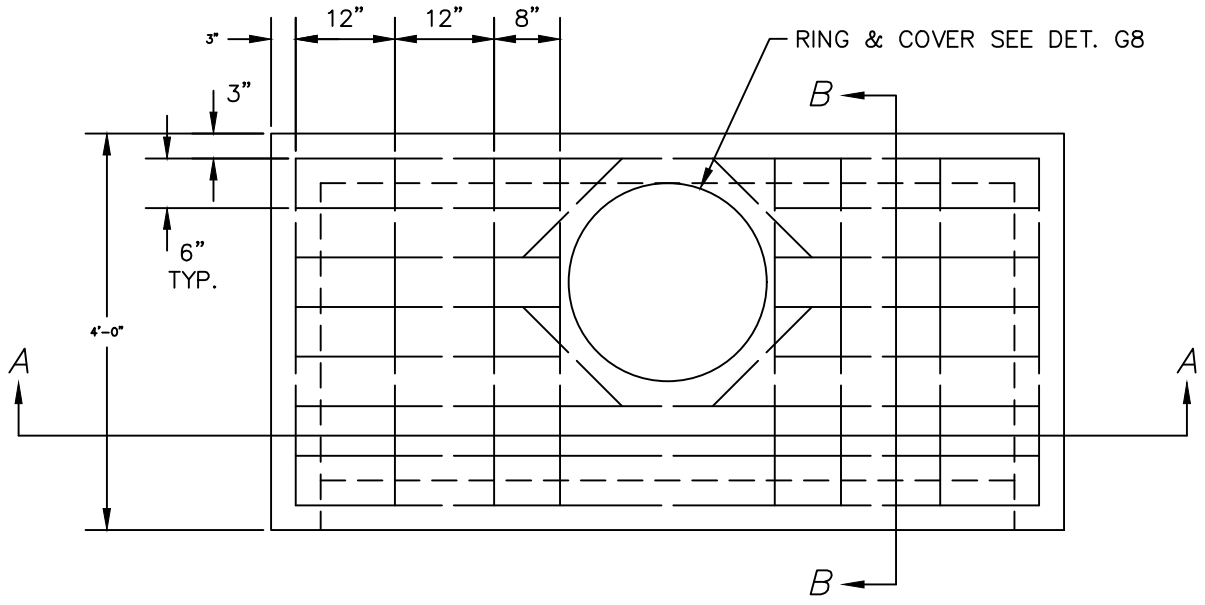

NOTE: #4 ø @ 10" C.C. (ALL WALLS, VERT. & HOR.)
SEE DET. G6 FOR TOP SLAB REINFORCEMENT

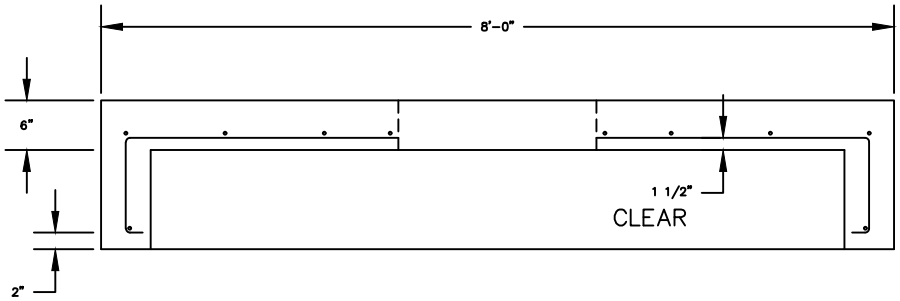
## 18" PRECAST TOP

NOTES:

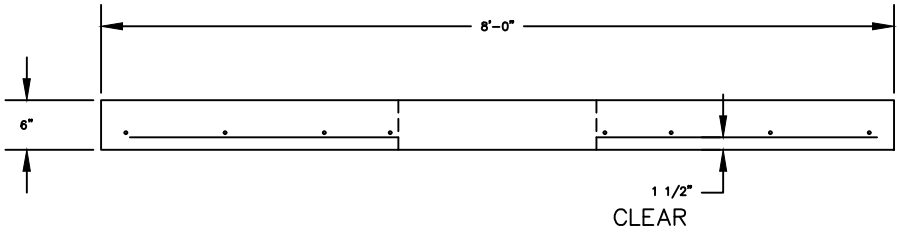
1. BOTTOM TO BE CAST IN PLACE.
2. PIPE TO BE ON GRADE BEFORE BOTTOM IS CONSTRUCTED.
3. TOP SHALL RECEIVE 4 – #4 ø DOWELS; ONE IN EACH CORNER W/ RAM–NEK OR EQUAL.
4. RAM–NEK ALL JOINTS (OR EQUAL).
5. 6" INVERT REQUIRED TO PREVENT SEDIMENTATION.
6. STANDARD CURB AND GUTTER SHALL BE TRANSITIONED TO INLET OPENING AT LEAST 4 FEET ON EACH SIDE OF CURB INLET.

| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | CURB INLET DETAIL | DATE: 05/13/22<br>DWG: F4 |

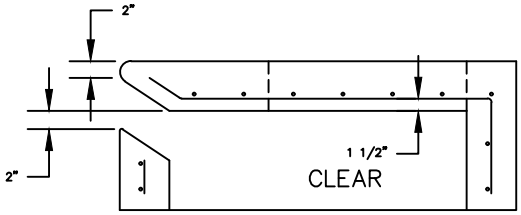



SECTION A–A (18" TOP)




SECTION A–A (6" TOP)

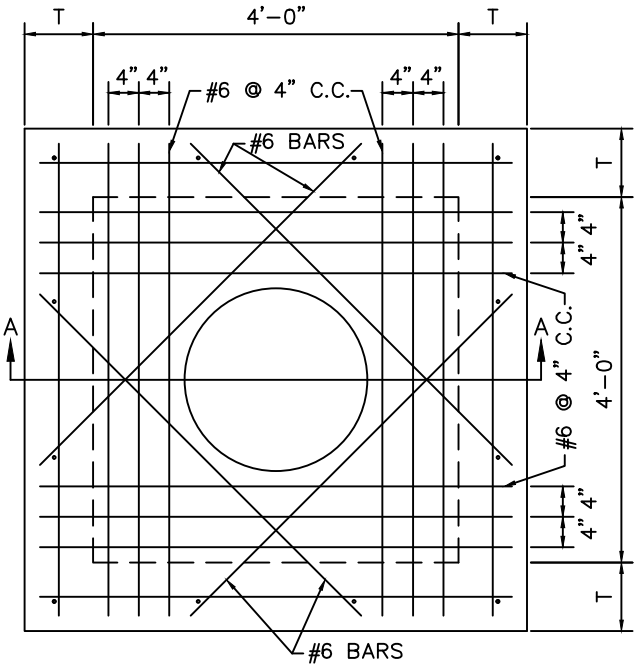



SECTION B–B

NOTES:

1. REINFORCEMENT IS THE SAME IN THE TOP SLAB OF THE 6" AND 18" TOPS.
2. USE NO. 4 REBAR THROUGHOUT.
3. FOR 6" TOP USE 4 – #4 ø DOWELS; ONE IN EACH CORNER W/ RAM–NEK OR EQUAL.
4. RAM–NEK ALL JOINTS (OR EQUAL).

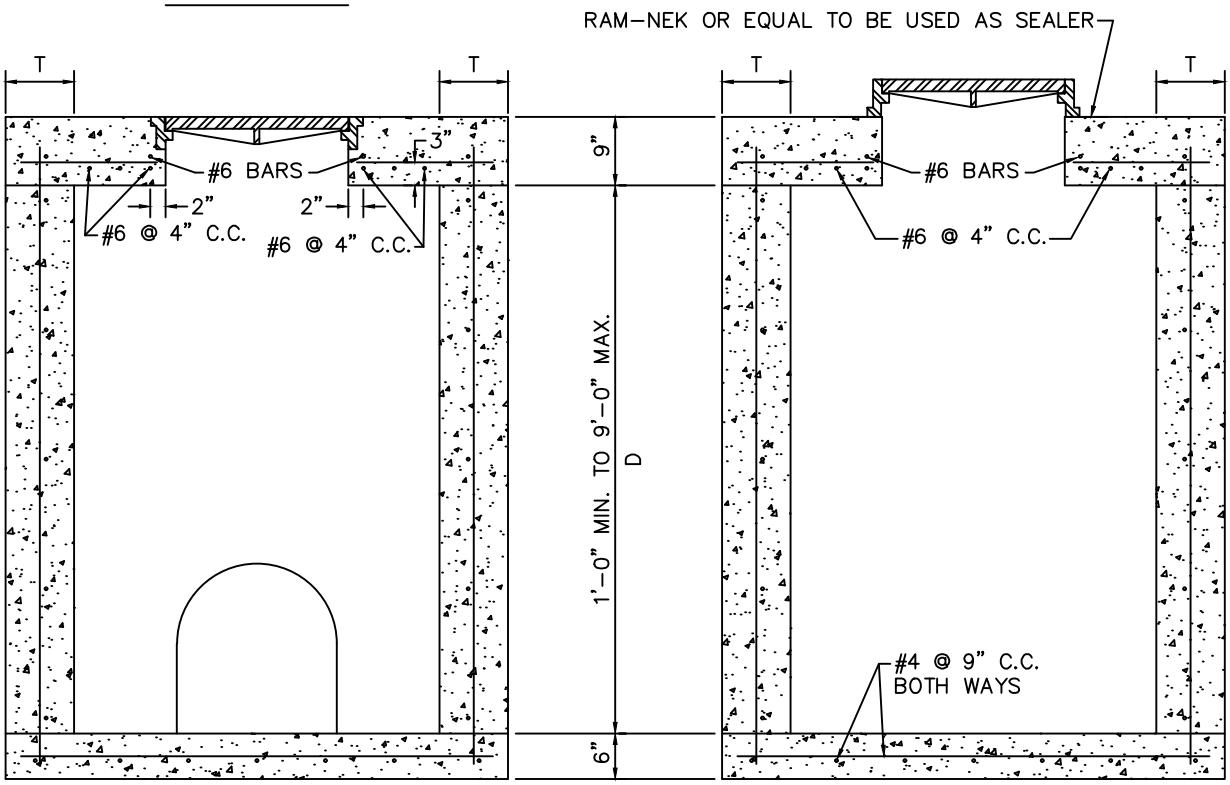
| | | |
|---|---|---|
| CITY OF CLEVER MISSOURI | PRECAST INLET LIDS | DATE: 05/13/22 |
| | | DWG: F5 |




PLAN

| STANDARD JUNCTION BOX | | | | |
|---|---|---|---|---|
| TABLE OF REINFORCEMENT | | | WALL THICK. | CONC. |
| "D" | VERT. BARS | HOR. BARS | "T" | CU. YDS. |
| 1'-0" | NONE | NONE | 9" | 1.93 |
| 2'-0" | " | " | 9" | 2.45 |
| 3'-0" | " | " | 9" | 2.98 |
| 4'-0" | " | " | 9" | 3.50 |
| 5'-0" | 12 #5 @ 18" C.C. 5'-11" EACH | 20 #4 @ 14" C.C. 5'-2" EACH | 9" | 4.03 |
| 6'-0" | 12 #5 @ 18" C.C. 6'-11" EACH | 20 #4 @ 17" C.C. 5'-2" EACH | 9" | 4.55 |
| 7'-0" | 20 #5 @ 12" C.C. 7'-11" EACH | 24 #4 @ 16" C.C. 5'-2" EACH | 9" | 5.08 |
| 8'-0" | 20 #5 @ 12" C.C. 8'-11" EACH | 28 #4 @ 15" C.C. 5'-2" EACH | 9" | 5.61 |
| 9'-0" | 20 #5 @ 12" C.C. 9'-11" EACH | 28 #4 @ 17" C.C. 5'-2" EACH | 9" | 6.14 |

STEEL IN TOP SLAB 16 #6 5'-2" EACH
4 #6 5'-0" EACH
STEEL IN BOTTOM 14 #4 5'-2" EACH
SEE DRAWINGS FOR STEEL PLACEMENT




SECTION AA

1. DIAGONAL BARS IN TOP SLAB PLACED NEAR BOTTOM OF SLAB.
2. REINFORCING BARS SHALL BE CUT OR BENT AT PIPE OPENINGS.
3. ALL PIPES SHALL FIT FLUSH WITH INSIDE FACE OF BOX.
4. MAXIMUM PIPE SIZE FOR BOX IS 42". FOR LARGER PIPES INCREASE INSIDE BOX DIMENSIONS TO THE INSIDE PIPE DIAMETER PLUS 6". USE GIVEN BAR SPACING FOR LARGER BOXES. MAXIMUM ALLOWABLE BOX SIZE IS 72".
5. BOTTOM OF BOX TO BE FILLED WITH CONCRETE TO MID-DEPTH OF PIPE FORMING CHANNELS TOWARD OUTLET PIPE FROM ALL INLET PIPES.
6. ALL CONCRETE SHALL HAVE 28 DAY COMPRESSIVE STRENGTH OF 3000 PSI
7. ALL REINFORCING BARS TO BE DEFORMED BARS AND MEET REQUIREMENTS OF ASTM A-615 MIN. GRADE 40.
8. 4" BEDDING MATERIAL TO BE USED UNDER BOX.
9. IF BOX IS GREATER THAN 9' DEEP, MUST BE SPECIAL DESIGN.

CITY OF CLEVER MISSOURI

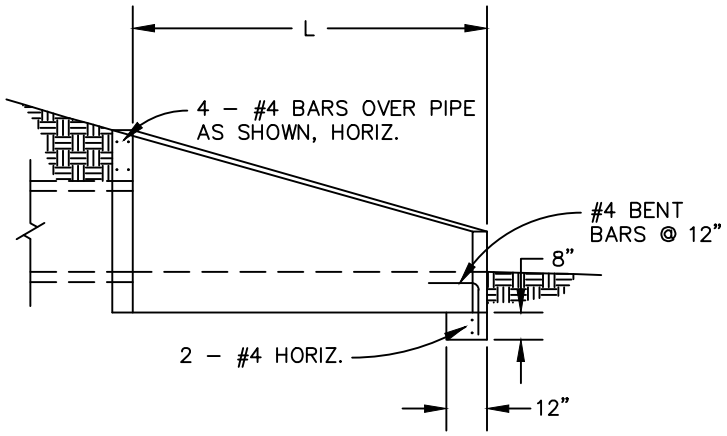
# JUNCTION BOX DETAIL

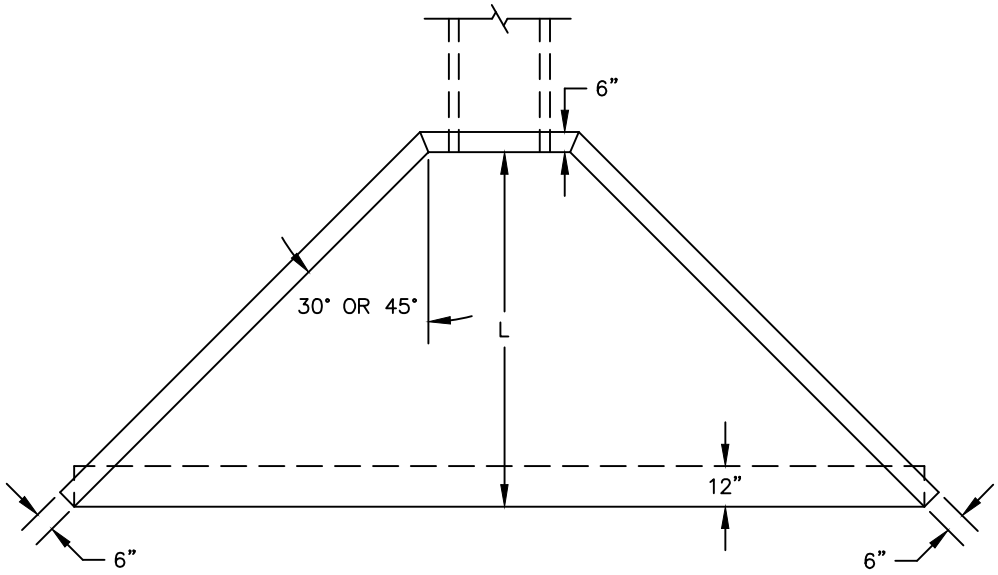
DATE: 05/13/22

DWG: F6

CITY OF CLEVER MISSOURI

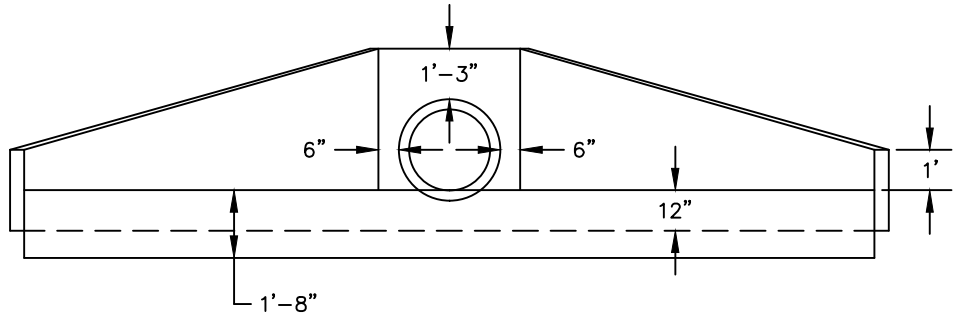
# PIPE HEADWALL & WINGWALL 30° AND 45°




| CULVERT HEIGHT OR DIAMETER | L |
|---|---|
| 15" | 6'–9" |
| 18" | 7'–6" |
| 21" | 8'–3" |
| 24" | 8'–9" |
| 27" | 9'–3" |
| 30" | 10'–3" |
| 36" | 11'–6" |
| 42" | 13'–0" |
| 48" | 14'–3" |

L IS BASED ON A 2.5:1 SLOPE

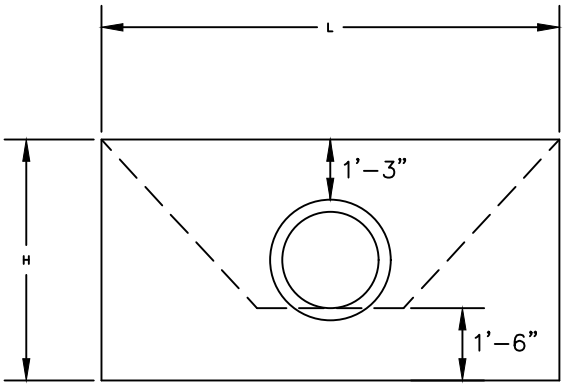



HEADWALL AND WINGWALLS TO BE CAST IN PLACE AROUND END OF RCP PIPE. STEEL IN HEADWALL TO BE #4 BARS @ 12" O.C. EACH WAY.

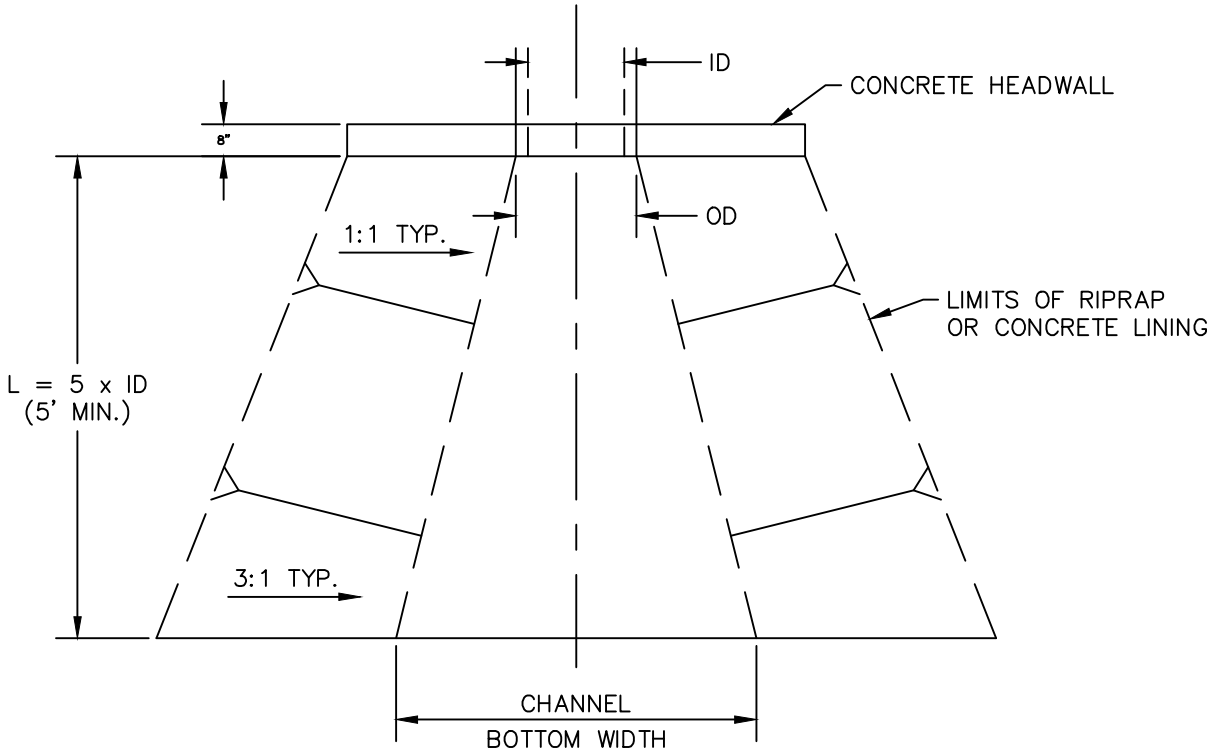
DATE: 05/13/22

DWG: F7

| PIPE DIAMETER | L | H |
|---|---|---|
| 15" | 7'–0" | 4'–3" |
| 18" | 8'–0" | 4'–6" |
| 21" | 8'–9" | 4'–9" |
| 24" | 9'–6" | 5'–0" |
| 27" | 10'–6" | 5'–3" |
| 30" | 11'–6" | 5'–6" |
| 36" | 13'–0" | 6'–0" |
| 42" | 14'–6" | 6'–6" |
| 48" | 16'–0" | 7'–3" |




REINFORCEMENT: #4's @ 12", EACH WAY



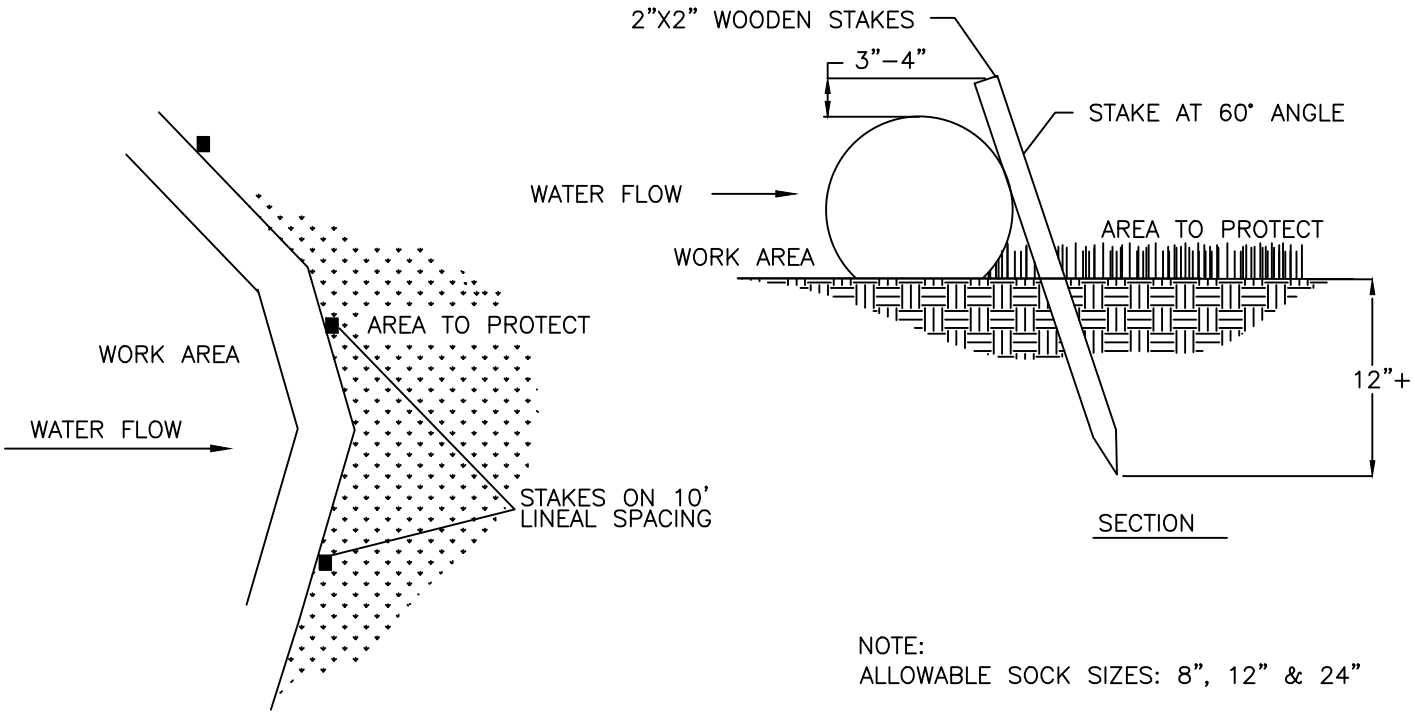

NOMINAL RIP RAP SIZE SHALL BE DESIGNED BY THE ENGINEER ACCORDING TO THE MAXIMUM OUTLET VELOCITIES AND SHEAR STRESSES.
GEOTEXTILE FABRIC SHALL BE INSTALLED UNDERNEATH RIP RAP PAD.

CITY OF CLEVER MISSOURI

# STRAIGHT HEADWALL & RIP RAP PROTECTION

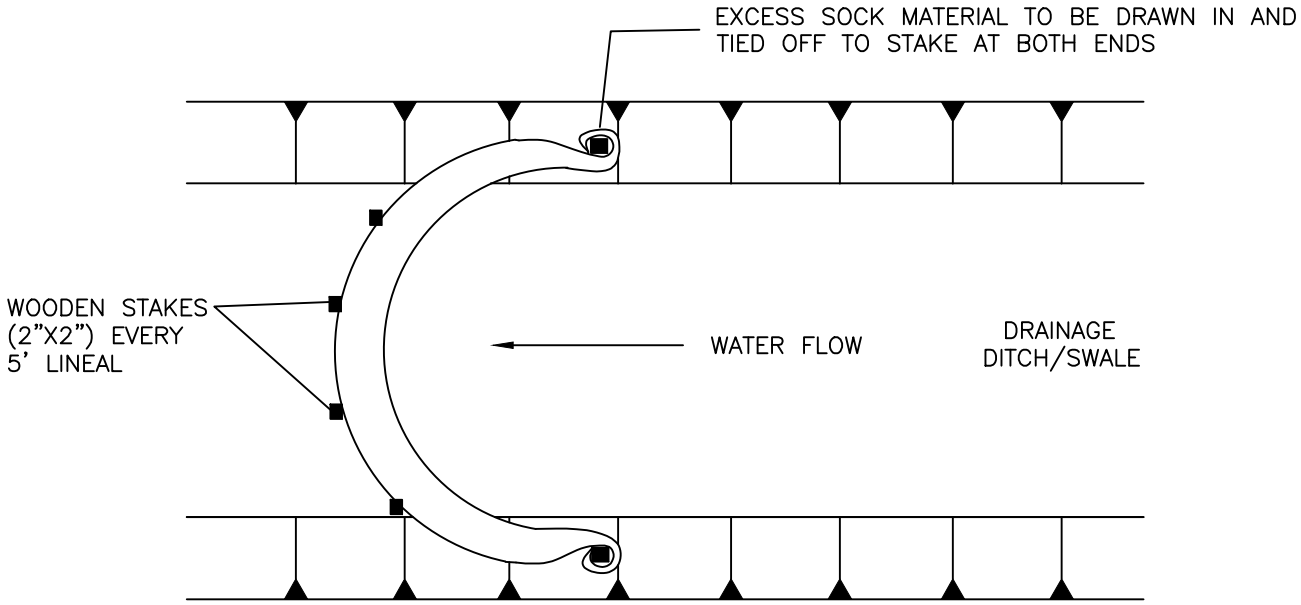
DATE: 05/13/22

DWG: F8




NOTE:
ALLOWABLE SOCK SIZES: 8", 12" & 24"

PERIMETER CONTROL




DITCH CHECK

NOTES;

1. FOLLOW THE MANUFACTURER'S SPECIFICATIONS.
2. INSPECTION SHALL BE FREQUENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS REQUIRED.
3. SILT SOX MAY BE REMOVED WHEN IT HAS SERVED IT'S USEFULNESS, SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.
4. ACCUMULATED SILT AND SEDIMENT SHALL BE REMOVE WHEN IT REACHES A DEPTH OF 6" AND DISPOSED OF IN AN APPROVED SPOIL SITE.

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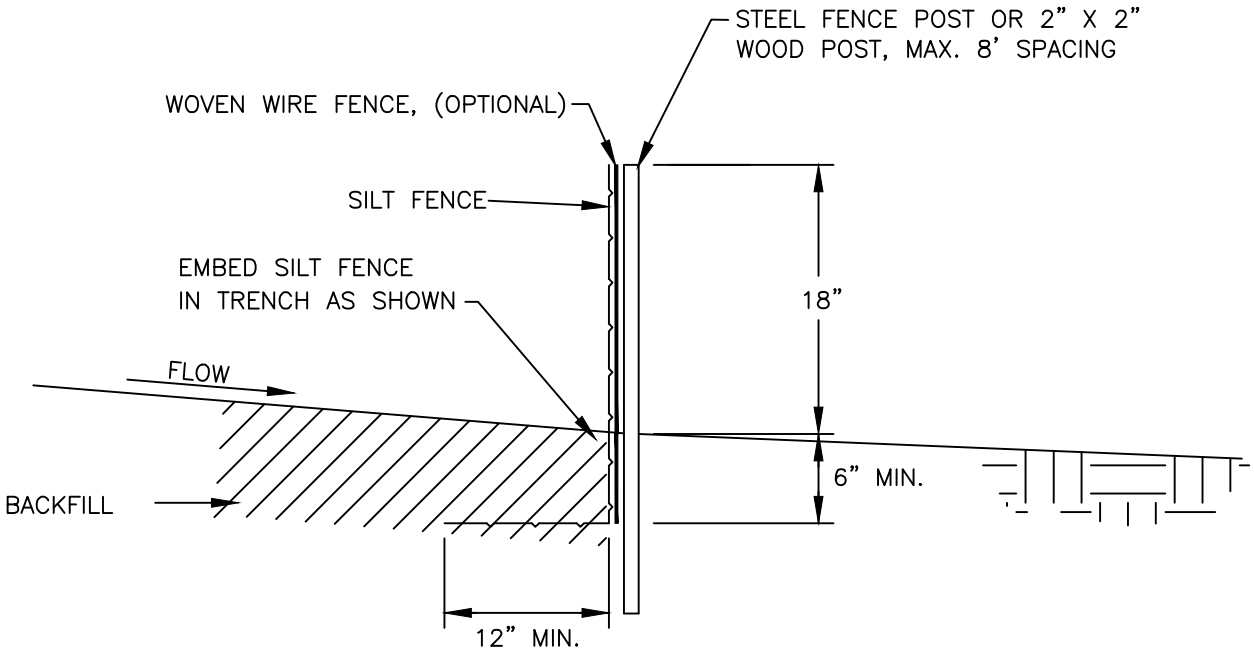
|---|---|---|
| CITY OF CLEVER MISSOURI | SILT SOCK EROSION CONTROL DETAIL | DATE: 05/13/22 |
| | | DWG: F9 |




NOTES:

1. PLACE SILT FENCE AT DOWNSLOPE LIMIT OF AREA TO BE GRADED.
2. SILT FENCE SHOULD BE SECURELY FASTENED TO EACH SUPPORT POST OR TO WOVEN WIRE WHICH IS IN TURN ATTACHED TO THE SUPPORT POSTS.
3. INSPECTION SHALL BE FREQUENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS REQUIRED.
4. SILT FENCE SHALL BE REMOVED WHEN IT HAS SERVED ITS USEFULNESS, SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.
5. ACCUMULATED SILT/SEDIMENT SHALL BE REMOVE WHEN IT REACHES A DEPTH OF 6" AND DISPOSED OF IN AN APPROVED SPOIL SITE.
6. AT EACH END OF SILT FENCE, TURN FENCE UPSLOPE AND EXTEND UNTIL GROUND SURFACE RISES 18".
7. PRE-FABRICATED SILT FENCE PRODUCTS MAY BE SUBSTITUTED IF APPROVED BY THE CITY OF CLEVER.
8. SILT-SOX IS AN APPROVED SUBSTITUTE.

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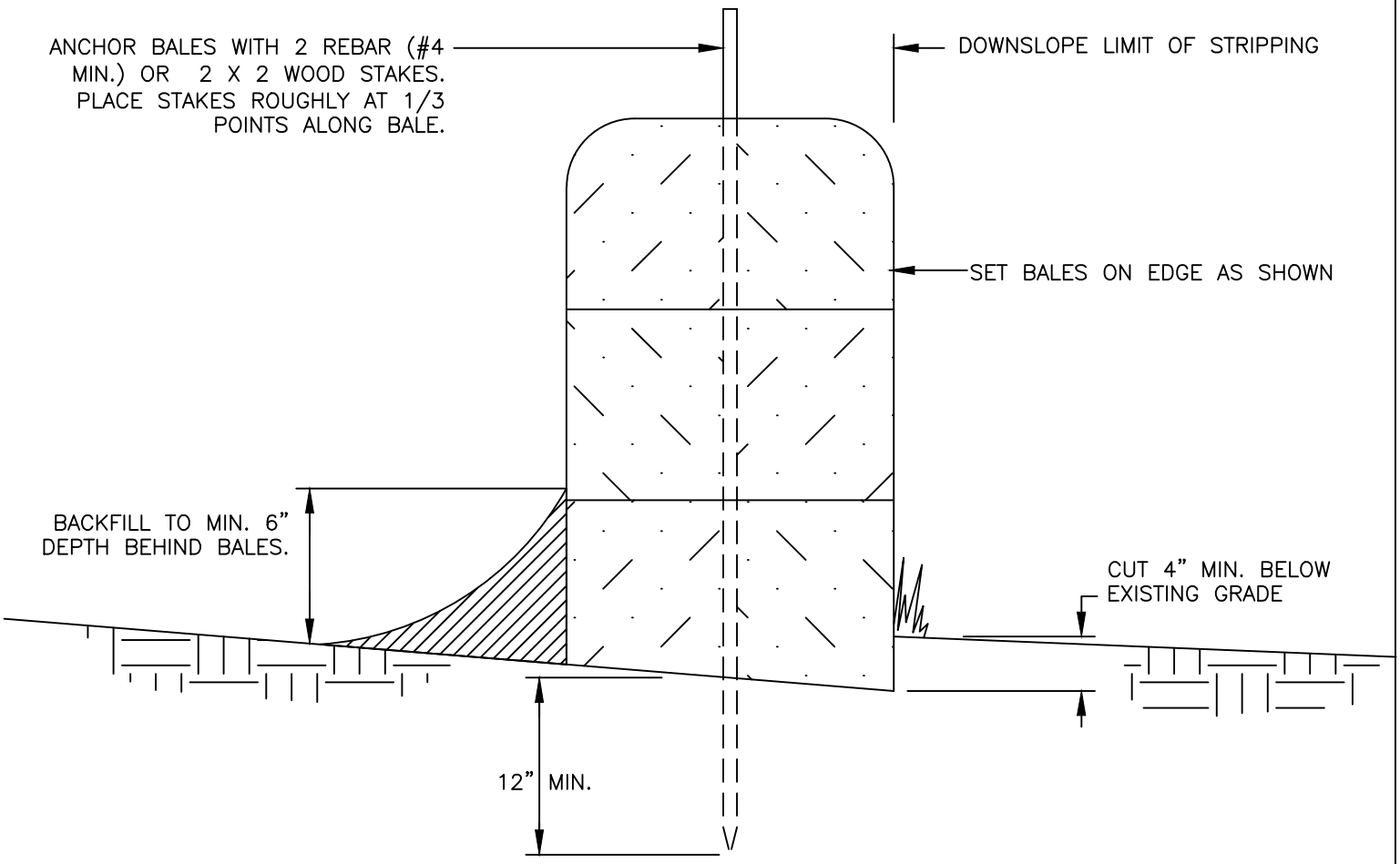
| CITY OF CLEVER MISSOURI | SILT FENCE EROSION CONTROL DETAIL | DATE: 05/13/22 |
| | | DWG: F10 |




NOTES:

1. BALES SHALL BE PLACED IN A ROW WITH ENDS TIGHTLY ABUTTING THE ADJACENT BALES.
2. EACH BALE SHALL BE EMBEDDED IN THE SOIL A MINIMUM OF FOUR INCHES, WHERE POSSIBLE.
3. BALES SHALL BE SECURELY ANCHORED IN PLACE BY STAKES OR RE-BARS DRIVEN THROUGH THE BALES.
4. INSPECTION SHALL BE FREQUENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
5. BALES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS TO NOT BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.
6. ACCUMULATED SILT SHALL BE REMOVED WHEN IT REACHES A DEPTH OF 6" AND DISPOSED OF IN AN APPROVED SITE.
7. AT EACH END OF DIKE, TURN DIKE UPSLOPE AND EXTEND UNTIL GROUND SURFACE RISES 18".

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| CITY OF CLEVER MISSOURI | STRAW BALE EROSION CONTROL DETAIL | DATE: 05/13/22 |
| | | DWG: F11 |