



**City of Phoenix
Water Services Department**

**LIGHT RAIL DESIGN STANDARDS MANUAL
FOR
WATER AND WASTEWATER SYSTEMS**

2018

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APPENDIX A - WEBSITE LINKS

The following is a list of useful website links that are referenced in the design manual and other related items to water and sewer.

WATER SERVICES DEPARTMENT'S MAIN WEBSITE

<https://www.phoenix.gov/waterservices>

WATER SERVICES DEPARTMENT'S WATER AND WASTEWATER DEVELOPMENT INFORMATION

<https://www.phoenix.gov/waterservices/devinfo>

WATER SERVICES DEPARTMENT'S DESIGN MANUALS, CHECKLISTS, ENGINEERING DETAILS, POLICIES AND PROCEDURES

Design Manuals

- Design Standards Manual for Water and Wastewater Systems
- Water Remote Facilities Design Guidance Manual
- Wastewater Lift Station Design Manual

Checklist Requirements for Water and Sewer Plans

Water and Wastewater Engineering Details

Water and Wastewater Engineering Policies

Requirements for Corrosion Protection Design Standards Development Report for Large Diameter Ductile Iron, Steel, CCP and RCP Water Transmission Pipelines

Standard Details for 18" and Large Pipe developed by the City of Phoenix Water Services Department

Revision and Public Comments

<https://www.phoenix.gov/waterservices/publications/design-manuals/systems>

SPECIFICATIONS AND DETAILS

Maricopa Association of Governments (**MAG**) Specifications and Details

<http://www.mag.maricopa.gov/publications.cms>

City of Phoenix Supplement Standards, Specifications

<https://www.phoenix.gov/streets/reference-material/autocad>

Maricopa County Environmental Services Department (**MCESD**) – Environmental Forms

<http://www.maricopa.gov/ENVSVC/>

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY (ADEQ)

Arizona Administrative Code Title 18, Water Pollution Control

<http://www.azsos.gov/rules/arizona-administrative-code>

Arizona Pollutant Discharge Elimination System (**AZPDES**) Permit

<http://www.azdeq.gov/environ/water/permits/azpdes.html>

CITY OF PHOENIX WATER AND SEWER CHAPTER CODES

Chapter 19A	Residential Development Occupational Fee – Sewer
Chapter 19B	Commercial and Industrial Development Occupational Fee – Sewer
Chapter 19C	Residential Development Occupational Fee – Water
Chapter 19D	Commercial and Industrial Development Occupational Fee – Water
Chapter 28	Sewer
Chapter 30	Water Resources Acquisition Fee
Chapter 37	Water

<http://www.codepublishing.com/az/phoenix/>

PLANNING AND DEVELOPMENT DEPARTMENT WEBSITE

A to Z Topics – All topics relating to development

<https://www.phoenix.gov/pdd/topics>

Civil Topics – Applications, checklists, forms, etc.

<https://www.phoenix.gov/pddsite/Pages/civilindex.aspx>

Fee Schedule

https://www.phoenix.gov/pddsite/Documents/dsd_trt_pdf_00042.pdf

Boundary Map for City's Infill Development District

https://www.phoenix.gov/pddsite/Documents/infill_gpa_map_r-21189.pdf

STREET TRANSPORTATION DEPARTMENT WEBSITE

Standard Utility Locations Manual

<https://www.phoenix.gov/streets/designmgmt/utility-coordination>

APPENDIX B - DEFINITIONS AND TERMS

Whenever in this manual the following terms are used, the intent and meaning shall be interpreted as follows:

ADEQ: The Arizona Department of Environmental Quality.

Auto Court Cluster (Cluster): A single-family detached development with lots having a shared or common access drive between single-family detached lots. Clusters typically have six or eight lots with only one point of access.

AZPDES Permit: An Arizona Pollutant Discharge Elimination System permit, issued to the City or other operating entity by the ADEQ, which imposes federal standards governing the quality of the treated effluent discharged from the Publicly Owned Treatment Works (POTW).

Backfill: Material placed in an excavated space to fill such space. For trenches, this space will be the area from one (1) foot above the top of the pipe or conduit to the existing or proposed finished grade of pavement.

Backflow: The flow of water or other liquids, mixtures, gases, or other substances into the distributing pipes of a potable supply of water, from any source or sources other than the City potable water system.

Backflow Prevention Device - Approved: An air-gap, double check valve assembly, reduced pressure principle backflow prevention device or other backflow prevention device or method approved by the Building Official of the City of Phoenix.

Bedding: The material placed in the area from the bottom of the trench to one (1) foot above the top of the pipe or conduit.

Building: Any structure built for the support, shelter or enclosure of persons, animals or movable property.

Building Code: A regulation adopted by the Phoenix City Council establishing minimum standards of construction for the protection of the public health, safety, and welfare in terms of measured performance rather than in terms of rigid specification of materials and methods.

Building Official: The Assistant Director of the Planning & Development Services Department in charge of the Building Service Branch, or their authorized representative.

Building Sewer: The extension from the building drain to the building connection or other place of disposal.

City: The City of Phoenix.

Council: The City of Phoenix City Council.

County: Maricopa County.

Cross Connection: Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other water of unknown or questionable safety or steam, gas or chemical whereby it is possible there may be a flow or molecular transfer from one system to the other, the direction of flow depending on the pressure differential between the two systems.

De Minimis General Permit: (DGMP): A general permit issued by ADEQ designed to cover discharges from potable or reclaimed water systems, subterranean dewatering, well development, aquifer testing, hydrostatic testing of pipelines and tanks, residential cooling water, charitable car washes, building and street washing, and dechlorinated freshwater swimming pool drainage.

Developer: Any person engaged in the organizing and financing of an improvement or addition to a water, reclaimed water or wastewater system forming a part of the City of Phoenix systems. A Developer may be a land owner, subdivider or legally constituted improvement district.

Director: The Director of the Water Services Department or their authorized deputy, agent or representative.

Discharge: The disposal of sewage, water or any other liquid or liquid/solids mixture by any sewer user into the sanitary sewer system.

Distribution Mains: Water mains 16-inches and smaller in diameter.

Distribution System: Water mains under 16-inches in diameter together with all appurtenant and necessary valves, fire hydrants, taps, meters, service pipes, and associated materials, property, and equipment receiving potable water from transmission mains and distributing it to individual consumers.

Engineer: The person appointed as City or County Engineer by the Council or the Board of Supervisors, acting directly or through their duly authorized representative. Also, the design engineer of the improvements, whether or not this person is the City or County Engineer.

Fire Line: A fire line is a private pipe system connected directly to the City water system. A fire line shall be utilized for fire protection only and shall serve only a single property.

Force Main: Wastewater main operating under pressure induced by mechanical pumping.

Irrigation System: An irrigation system is a private pipe system connected directly to the Phoenix water system through a metered service connection. An irrigation line is utilized for irrigation only.

Interceptor Sewer: Sanitary sewers 15-inches and larger usually at the lowest elevations in the wastewater system into which tributary sewers discharge. Interceptors usually transport the wastewater to the treatment facilities.

Maintenance: Keeping the water and wastewater works in a state of repair, including expenditures necessary to maintain the capacity and capability for which said works were designed and constructed.

MAG: The Maricopa Association of Governments

METRO: Valley Metro

Manhole: A means of access to utilities such as sewer mains for the main purpose of inspection and cleaning.

Permit: The license to do construction in public rights-of-way and/or easements issued by an Agency to a Contractor working for another party.

Person: Any individual, partnership, firm, company, corporation, association, joint stock company, trust, state, municipality, Indian tribe, political subdivision of the state or federal governmental agency or any other legal entity, including their legal representatives, agents or assigns.

Plans: All approved drawings or reproductions thereof pertaining to the work and details therefore.

Private Accessway: A private street within a development built to City standards with a homeowners' associate established for maintenance primarily for single family residential use.

Private Sewer and Lift Station: A privately owned piping system designed expressly for the purpose of collecting wastewater generated within a private development site and transporting it to the public sanitary sewer system.

Project: A specific coordinated construction or similar undertaking identified by a single project number and bid and awarded as one contract. On occasion two or more projects may be bid and awarded as a single contract.

Public Sewer: A sanitary sewer controlled and maintained by the City of Phoenix.

Reclaimed Water: Water that has been treated or processed by a wastewater treatment plant or an on-site wastewater treatment facility (A.R.S. 49-201). Reclaimed water is further defined in ADEQ Regulation R18-11 by Classes based upon the degree of treatment.

Relief Sewer: A sewer built to carry the excess flows of an existing sewer with inadequate capacity.

Right-of-way: A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to a street, highway or other public improvement.

Roadway: The portion of the right-of-way intended primarily for vehicular traffic and including all appurtenant structures and other features necessary for proper drainage and protection. Where curbs exist, it is that portion of roadway between the faces of the curbs.

Service Connection: A private connection to the public water or sewer system. For domestic/landscape water, the meter is the point of connection. For a fire line, the point of connection is the fire line valve nearest to the public water main. For sewer, the point of connection is at the public sewer main/manhole or appurtenance at the property line.

Sewage: Any liquid or water carried pollutant or waste including industrial discharge, which is introduced into the POTW from any dwelling, commercial building, industrial facility or institution together with such inflow as, may be present. Also known as sanitary sewage.

Sanitary Sewer: A pipe or other conduit that carries wastewater (sewage) Sewers are classified by function rather than size.

Sewer Tap: The wye, saddle or other device placed on a public sewer to receive a building connection.

Shop Drawings: Drawings or reproductions depicting detailing, fabrication and erection of structural elements, false work and forming for structures, fabrication of reinforcing steel, equipment and installation of such equipment or other supplementary plans or similar data for specified construction that the Contractor is required to submit for approval prior to fabrication, installation or construction.

Sidewalk: That portion of the roadway primarily constructed for the use of pedestrians.

Specifications: The descriptions, directions, provisions, and requirements for performing the work as contained in the Contract Documents.

Standard Details: Uniform detail drawings of structures or devices adopted as Standard Details by the Department.

Standard Specifications: Uniform general specifications adopted as Standard Specifications by the Department.

Storm Sewer: A sewer that carries storm runoff, other surface water, street wash, other wash waters or drainage but excludes domestic wastewater and industrial wastes. Also called storm drain.

Street: Streets, avenues, alleys, highways, crossings, lanes, intersections, courts, places, and grounds now open or dedicated or hereafter opened or dedicated to public use and public ways.

Structures: Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end walls, sewers, service pipes, under drains, foundation drains, fences, swimming pools, and other features, which may be encountered in the work and not otherwise classed.

System Design Capacity: The system capacity for normal operation as established by accepted engineering standards.

Transmission Main: A water main 16-inches and larger in diameter.

Transmission System: The system of water mains generally larger than 16 inches in diameter together with all necessary valves and other equipment required for delivering potable water to the Distribution System.

Utility: Pipe lines, conduits, ducts, transmission mains, overhead or underground wires, railroads, storm drains, sanitary sewers, irrigation facilities, street lighting, traffic signals, and fire alarm systems, and appurtenances of public utilities and those of private industry, businesses or individuals solely for their own use or use of their customers which are operated or maintained in, on, under, over or across public right-of-way or public or private easement.

Water System: Consumer's Potable: That portion of the privately owned potable water system lying between the service connection to the public potable water system and the point of use. This system includes all pipes, conduits, tanks, receptacles, fixtures, equipment and appurtenances used to produce, convey, store or use potable water.

Wastewater (Sewage): The combination of the liquid and water-carried wastes from residences, commercial buildings, industrial plants and institutions together with any inflow that may be present.

Waterworks System (Water Supply System): The reservoirs, pipelines, wells, pumping equipment, purification works, mains, service pipes, and all related appliances and appurtenances utilized in the procurement, transportation and delivery of an adequate, safe, and palatable water supply for the City.

Wastewater System: The pipelines, manholes, junction structures, lift stations, force mains, and appurtenances utilized in the collection, transport, and delivery of wastewater (sewage) to wastewater treatment facilities.

APPENDIX C – ACRONYMS

The following is a listing of primary acronyms used in this manual. All references to documents, manuals, standards or specifications of other agencies or organizations (i.e. AWWA C400) refer to the latest edition or revision thereof unless specifically annotated to the contrary.

AAC	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
APP	Aquifer Protection Permit ARS: Arizona Revised Statutes
AWWA	American Water Works Association
AZPDES	Arizona Pollutant Discharge Elimination System
CCP	Concrete Cylinder Pipe
CC&R's	Conditions, Covenants, and Restrictions
CCTV	Closed Circuit Television
CDRL	Contract Deliverable Requirements List
CIP	Cast Iron Pipe or Capital Improvement Project or Program
COP	City of Phoenix
DOF	Development Occupation Fees
DIP	Ductile Iron Pipe
FPS	Feet per Second
FT	Foot or Feet
GIS	Geographical Information System
GPM	Gallons per Minute
GPD	Gallons per Day
H₂S	Hydrogen Sulfide
HMW	High Molecular Weight
ICEA	Insulated Cable Engineers Association
IPC	International Plumbing Code
MAG	Maricopa Association of Governments
MCESD	Maricopa County Environmental Services Department
METRO	Valley Metro Transit System
MIL	Military Specifications
NACE	National Association of Corrosion Engineers
OD	Outside Diameter
PC	Point of Curvature
PCC	Phoenix City Code
PCCP	Pre-stressed Concrete Cylinder (Steel) Pipe
PDD	Planning and Development Department
POTW	Publicly Owned Treatment Works
PRV	Pressure Regulating or Reducing Valve
PSI	Pounds per Square Inch
PT	Point of Tangency
PVC	Polyvinyl Chloride Pipe
Q	Rate of Flow
RCP	Reinforced Concrete Pipe
ROW	Right-of-Way
RUA	Restricted Utility Area
STR	Street Transportation Department
UPC	Uniform Plumbing Code
VCP	Vitrified Clay Pipe
WRA	Water Resource Acquisition Fee
WRDP	Water Resources and Development Planning
WSD	Water Services Department

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I. INTRODUCTION

A. PURPOSE OF MANUAL

The purpose of this manual is to provide guidelines and minimum design criteria for the design of water and wastewater piping systems in the vicinity of METRO's light rail system for the City of Phoenix either as part of Capital Improvement Program (CIP) or as private development projects that will construct and dedicate the systems to the City or during the design and construction of METRO's light rail extension projects. This Light Rail Design Standards Manual for Water and Wastewater Systems is to be used in the design and execution of all light rail-related water and sanitary sewer relocations or new installations within the City of Phoenix. The manual applies to existing systems being expanded, modified, upgraded, and rehabilitated as well as to the construction of new systems. The manual is not to be used as a construction specification. All units of measurement used in this manual are United States standard measure unless otherwise noted. The Water Services Department (WSD) has other design manuals available for other facilities (booster stations, lift stations, reservoirs, and pressure reducing valve stations) located on our website.

METRO light rail projects and existing facilities will have design and construction features that are unique to utility relocation in the vicinity of the light rail tracks. Light rail systems have a zone in which the location of utilities is restricted due to safety clearances needed for future access to the utilities once the light rail system is in place. For the light rail project, the restricted utility area (RUA) extends horizontally 16 feet from the centerline of the tracks and vertically 6 feet below grade. All proposed water and sanitary sewer utilities shall be designed to be outside of the RUA. Refer to Detail No. LRT 2.

During the design of METRO light rail extension projects, all existing water and sanitary sewer utilities running parallel with tracks within the RUA will need to be relocated outside of the RUA. All existing water and sanitary sewer utilities crossing the RUA will need to be relocated below the restricted area and encased. New piping and appurtenances will be used for all relocations.

B. AUTHORITY

The design standards set forth in this manual are adopted pursuant to the authority granted in ARS 9-672 and Section 37-2, 37-3 and 28-3 of the Phoenix City Code (PCC).

C. ORGANIZATION AND INTERPRETATION OF MANUAL

This manual is composed of written engineering standards, references to established standards of other organizations and agencies, and standard details of WSD. The Director of WSD, whose interpretation shall be binding and controlling in its application, shall make the interpretation of any section or of differences between sections. NOTE: Any deviations from the standards in this manual shall require a technical appeal to WSD Director's Representative. This appeal application is submitted to the Planning and Development Department (PDD) through the standard technical appeal process. The Technical Appeals Procedure (P-107) can be found in WSD's website. For website link refer to Appendix A, pages ii and iii.

D. REVISIONS AND PUBLIC COMMENTS

This manual may be revised periodically. Proposed revisions will be posted in the City of Phoenix Water Services Department (WSD) website for a period of 30 days prior to implementation unless the revision is required to comply with Federal, State, County, and City laws, regulations, ordinances or codes. To review proposed revisions, go to WSD website.

All proposed revisions will be listed on this page. If proposed revisions are listed, all comments received during the public comment period will be considered and responded to.

At any time if you have a comment on WSD Design Standards Manual, you may send an email to WSD through the link provided on the website. These comments will also be reviewed and responded to.

E. HOW TO USE

The provisions of this design manual (Manual) are specific to their application and scope to light rail-related water and sanitary sewer relocations due to METRO light rail extension projects or new utility installation within the Light Rail corridor.

All applicable provisions of the Design Standards Manual for Water and Wastewater Systems not otherwise modified or replaced by this Manual will apply. If there is a conflict between the Design Standards Manual for Water and Wastewater Systems and this Manual, the applicable standards of this Manual will apply.

F. EFFECTIVE DATE

Light Rail Design Standards Manual for Water and Wastewater Systems (Manual) will become effective January 1, 2019.

All construction contracts advertised, and all permits issued within the Light Rail corridor on or after January 1, 2019 will be governed by this Manual.

II. DEVELOPMENT COORDINATION BY DEPARTMENTS

WSD and PDD are the two City Departments that review and approve public water and sewer infrastructure plans. The following department descriptions provide an overview of the jurisdictional areas and services provided by each department.

A. WATER SERVICES DEPARTMENT (WSD)

WSD is empowered by the Phoenix City Code to ensure the proper administration and operation of the water and wastewater works of the City. WSD operates under a Deputy City Manager who reports to the Assistant City Manager. The Water Services Director is the general executive officer of WSD. The Director is in charge of all personnel and the entire operation, equipment and facilities of WSD. The Director also has general supervision over all charges for water and wastewater services, departmental policies, agreements, new connections, repairs, other operational works and for all charges not explicitly provided for in the City Code, subject to approval of the City Manager.

1. Role and Functions

WSD is responsible for technical review, approval, inspection and coordination of all public infrastructure projects, which include the following:

- a. Booster pump stations¹.
- b. Pressure reducing facilities¹.
- c. Storage facilities¹.
- d. Well sites.
- e. Water transmission mains (16-inch diameter and larger).
- f. Wastewater interceptor mains (15-inch diameter and larger).
- g. Sewer Connection Details (S512, S512-D, S511) in sewer mains larger than 15-inch.
- h. Sewage lift stations¹.
- i. Water and sewer master plans.
- j. Water and wastewater treatment facilities¹.
- k. CIP projects for Aviation and Streets Department.
- l. Joint venture agency projects through Intergovernmental Agreement
- m. All plans outside city limits within the City's service area including:²
 1. All water mains
 2. All sewer mains
 3. Fire lines
 4. Fire hydrants
 5. Water and sewer main abandonments
 6. Water main vertical realignments
 7. S512, S512-D, S511 Details

¹ WSD and PDD will jointly review these type of plans. WSD will review a conceptual design plan prior to the review by PDD. PDD is responsible for the civil site review and the building code review. WSD is responsible for the review of the guide specifications and standards as per the Water Remote Facilities Design Guidance Manual and the Wastewater Lift Station Design Manual. These manuals can be found in WSD's website. For website link refer to Appendix A, pages ii and iii.

² If any portion of a project falls outside the Phoenix city limits, the developer must also include the approval and processes of the prevailing jurisdictional agency.

B. PLANNING AND DEVELOPMENT DEPARTMENT (PDD)

1. Roles and Functions

PDD is responsible for technical review, approval, inspection and coordination of all public infrastructure projects, which include the following:

- a. Water mains smaller than 16-inches in diameter.

- b. Sewer mains smaller than 15-inches in diameter.
- c. Fire lines.
- d. Fire hydrants.
- e. Water and Sewer main abandonments.
- f. Water main vertical realignments.
- g. Sewer Connection Details (S512, S512-D, S511) in sewer mains 15-inch and smaller.
- h. Any other 8 ½ x 11 standard detail plans.

Contact PDD for more detailed information describing the development review process. The general phone number is 602-262-7811 or refer to PDD's website. For website link refer to Appendix A, pages ii and iii.

III. GENERAL WATER AND SEWER DESIGN CRITERIA

A. GENERAL DESIGN CRITERIA/CONSIDERATIONS

1. Jurisdictional Agency Approvals

All appropriate agency levels affected within the Federal, State, County, and City involvement need to be contacted for their individual design requirements. These requirements will need to be addressed in a top down priority to avoid approval conflicts. This includes areas that are outside the city limits but served by the City of Phoenix water and sewer system.

NOTE: Any and all more stringent requirements by Federal, State, County or local codes or ordinances shall take precedence.

2. Standard Specifications and Details

The standard specifications and standard details relating to water and wastewater systems that are referenced in this manual include the following:

- a. Uniform Standard Details and Specifications for Public Works Construction sponsored and distributed by the Maricopa Association of Governments (MAG). These details and specifications are herein referred to as MAG Details and MAG Specifications. These details and specifications are revised and updated periodically and are available electronically through the Maricopa Association of Governments office in Phoenix. For website link refer to Appendix A, page ii, Specifications and Details, Maricopa Association of Governments Specifications and Details.
- b. City of Phoenix Supplements to the Maricopa Association of Governments Uniform Standard Specifications and Details for Public Works Construction. These specifications and details are herein referred to as COP Supplement Specifications or COP Supplement Details. These specifications and details are updated and revised periodically and are available electronically through the Street Transportation Department (STR). For website link refer to Appendix A, page iii, Specifications and Details, City of Phoenix Supplements.
- c. Uniform Standard Details developed by the City of Phoenix Water Services Department are herein referred to as WSD Details.
- d. Standard Details for 18" and Large Pipe developed by the City of Phoenix Water Services Department.

3. Environmental and Cultural Regulatory Requirements

This section is not intended to be all encompassing, but is provided as an overview of environmental and cultural requirements and typical agency involvement. A thorough consideration of the environmental and cultural impact of the project at the project location or along the project route shall be evaluated to identify environmental and cultural requirements. Private developers shall be responsible for regulatory compliance and for obtaining the required permits for their projects.

The Environmental Assessment Declaration form can be obtained from PDD's website link. Refer to Appendix A, page iii, Planning and Development Department, A to Z Topics, Environmental Assessment Declaration Form.

Whenever a project impacts Waters of the United States, a Clean Water Act Section 404 permit will be required by the U.S. Army Corps of Engineers (Corps). Compliance is also required with the Arizona Pollutant Discharge Elimination System (AZPDES) general permit for storm water discharges from construction sites, and with the De Minimis General Permit (DMGP) for certain types of non-stormwater discharges. For more information visit AZDEQ's website. Refer to Appendix A, page ii, Arizona Department of Environmental Quality, AZPDES.

Projects shall not adversely impact threatened or endangered species or their habitat and shall comply with the Federal Endangered Species Act. To address any biological requirements, an assessment report of the project may be required by the U.S. Fish and Wildlife Service and the Arizona Game and Fish Department.

No project shall adversely impact historic or prehistoric properties. Projects shall comply with the National Historic Preservation Act, the City's Archaeological policy, the Arizona Antiquities Act and the State Historic Preservation Act. As part of the cultural resources consideration, the City of Phoenix Archaeologist and the City of Phoenix Historical Preservation Office may be contacted for additional information and direction.

The Engineer should make the contractor aware of potential for encountering hazardous and contaminated substances within project boundaries. Health and safety shall be the sole responsibility of the contractor. The contractor shall provide for the safety of all contractor personnel, City of Phoenix personnel, and the public for the duration of the project. The contractor shall be required to have in place a hazardous and contaminated substance health and safety program conforming to applicable federal, state and local statutes, rules, regulations and ordinances.

4. Community Notification and Involvement

The City has made a commitment to early citizen notification and involvement. The goal of identifying neighborhood concerns has a high priority. Communication through printed notice, a public information phone number and public presentations could be a necessary element in construction plan approval.

5. Subsurface Investigations

When requested by WSD, a geotechnical engineer shall perform a soil investigation to determine the soil bearing capacity, soil backfill suitability, presence of groundwater or bedrock, corrosion potential and other conditions, which may affect the construction of the water or sewer main. Test holes shall be located at a maximum spacing if not more than 1,000-feet and at railroad, highway and canal crossings.

6. Design Life

All relocated or rehabilitated public utilities within the project work limits and planned right-of-way limits shall meet general design and construction requirements for a minimum fifty (50) year design life. Design life is defined as the period of time for which a facility is expected to perform its intended function.

7. Cathodic Protection System

A cathodic protection system shall be designed for metallic pipelines and casings per the Technical Specification and Details in Appendix D attached to this Manual and the City of Phoenix document, "Requirements for Corrosion Protection Design Standards Development Report for Large Diameter Ductile Iron, Steel, CCP and RCP Water Transmission Pipelines." The design documents shall include a cathodic protection design report and plans that will be submitted along with the utility relocation plans for City of Phoenix review.

It is not acceptable to have the cathodic protection system designed by the contractor or "field fit."

No conflict of interest shall exist between the cathodic protection system vendor/supplier, and the inspector. Each shall be an independent party.

B. LOCATION, ALIGNMENT, AND EASEMENT REQUIREMENTS FOR WATER AND SEWER MAINS

A route study or alignment report shall be completed to assure a functional hydraulic gradient/grade as well as continuity of an accessible right-of-way (ROW) and/or easement corridor.

The Water Services Department (WSD) requires safe and quick access to all City water and sewer mains at all times in order to repair main breaks, install taps, and perform preventive maintenance. For this reason, City of Phoenix water and sewer mains shall be constructed within the public ROW as discussed below. Water and sewer mains that are not installed in the ROW may only be permitted within a dedicated water or sewer easement. The water and sewer easements are discussed later in this chapter.

1. Public Water and Sewer in the Public Right-of-Way

The location and alignment of all water and sewer mains in the right of way shall be per the latest edition of Standard Utility Locations Manual for the City of Phoenix. Design engineers can obtain a copy through the Street Transportation Department. The standard utility locations are presented with the realization that every case will not be covered and there may be instances where the standards cannot be applied. Refer to the link in Appendix A, page iii, Street Transportation Department, Guide to the Standard Utility Locations.

When the developer is only required to dedicate ROW for half street improvements the WSD will allow water and sewer main extensions to be constructed in non-standard locations within the half street without a technical appeal. However, WSD will need to approve the location of the proposed main(s) on a case by case basis.

2. Public Water and Sewer within Private Accessways

The location and alignment of water and sewer mains in private accessways can only be used for single family residential developments with individual lots. A private accessway will only be permitted if it complies with options a. or b. as follows:

- a. Standard private accessway dedicated as shown in Figure 1, *Standard Private Access Way*.
- b. Infill Developments and Single Family Attached option (SFA) as shown in Figure 2, *Infill and SFA Option with Cutoff Wall*, and Figure 3, *Infill and SFA Option with Reinforced Slab*. The development must be within the Infill Development District Map or must be permitted to use the SFA option per the Phoenix Zoning Ordinance. To view the map, follow the web link in Appendix A, page iii, Planning and Development Department Website, Boundary map for City's Infill Development District.

The following additional requirements apply:

- a. Private accessways shall be constructed per COP Supplement Detail P-1020 and per Figures 1, 2, or 3, whichever applies per options a. or b. mentioned above.
- b. The entire private accessway shall be dedicated as an exclusive public water/sewer easement within a dedicated tract to be owned and maintained by the Homeowner's Association (HOA).
- c. Gated communities shall provide dedicated access codes or keys to the Water Services Department. This access would be similar to the access granted to the Fire Department.
- d. Where possible, the private streets under which the City water and sewer mains are located shall have a minimum of two ingress/egress points. If dead-end streets must be used, the homebuilder shall make full disclosure to buyers that access in or out of their property may be denied without prior notice in order to perform maintenance or repair of the City water mains, sewer mains, or water meters.
- e. If the subdivision requires a private storm drain within the development, it shall be approved during the preliminary site plan review process. The water and sewer mains shall be required to maintain a minimum of 6 feet of horizontal separation from the storm drain measured from outside of pipe to outside of pipe. The instance where private storm drains are required, the water and sewer mains shall be installed 9 feet from the monument line. This alignment shall be required for the entire length of the street that contains the storm drain; for all streets not containing storm drains, water and sewer mains shall be installed at the required standard 6 feet from the monument line.

Additional Items **f – h** apply to Infill and SFA Option **ONLY**:

- f. The minimum clear distance between any portion of the building face, including overhangs but excluding roof eaves, across the private street is 32 feet. Roof eaves that project into the 32 feet clear distance shall have a minimum of 18 feet vertical distance from finished floor elevation and each shall have a maximum of 18 inches horizontal projection into the 32 feet clear distance on each side.
- g. All water main joints, valves, fittings and bends in a reduced easement shall be restrained per MAG Standard Details 303-1 & 2 and City of Phoenix Supplement Specification Section

750.3.

- h. Building foundations shall be designed to prevent a building collapse or damage by limiting the deflection of the foundation due to loss of soil beneath the foundation in the event of a water main break. A certified statement from a structural engineer registered in Arizona is required. At a minimum, one of the following alternatives shall be met:
1. **Option 1 - Cutoff Wall:** As represented in Figure 2, *Infill and SFA Option with Cutoff Wall*, construct a cut-off wall around the perimeter foundation adjacent to the street. The cut-off wall shall be a minimum of two feet deep and one foot thick and shall be constructed of 500 psi (minimum) concrete. The cut-off wall is to be constructed along the front edge of the foundation and it must wrap at least 10 feet along the structure's sides. The cut-off wall is intended to provide a barrier between the building and the water main in the event of a water or force main break, and thus reducing the potential damage to the building. The cut-off wall shall be designed by the developer's structural engineer, based on the above requirements or soils report, whichever is more stringent.
 2. **Option 2 - Reinforced Slab:** As represented by Figure 3, *Infill and SFA Option with Reinforced Slab*, design the foundation strong enough to resist sagging in the event of ground loss beneath the foundation caused by scouring from a water or force main break. The foundation along the side of the home facing the street shall be designed with a 5-foot cantilever. The allowable deflection at the free edge of the cantilever shall be calculated as $L/360$ for slabs with stucco, $L/240$ for other brittle finishes and $L/480$ for brick veneer exteriors. The distance L used in the equation should be taken as twice the length of the cantilever. Therefore, for a slab supporting stucco exterior housing, the post tensioning and slab thickness shall be designed as required to limit the deflection at the free end of the overhang to be less than 0.33-inches of differential deflection between the edge of slab and 10 feet inward. The stresses in the slab and overhang shall be kept at or below the City's building code requirements. All other applicable design cases including center edge lift, etc., shall also be evaluated using the appropriate stress and deflection criteria.

Figure 1 – Standard Private Access Way

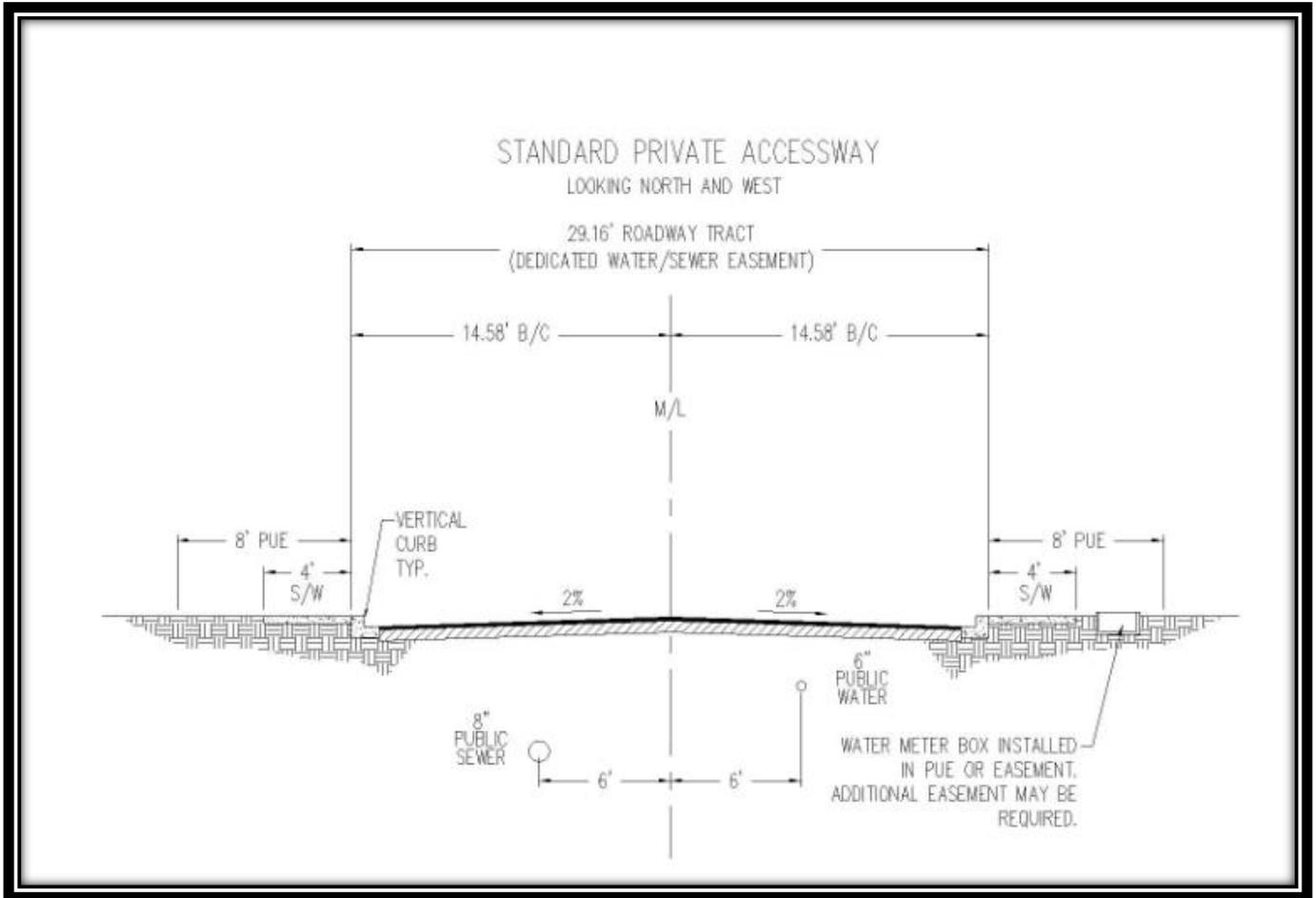


Figure 2 – Infill and SFA Option with Cutoff Wall

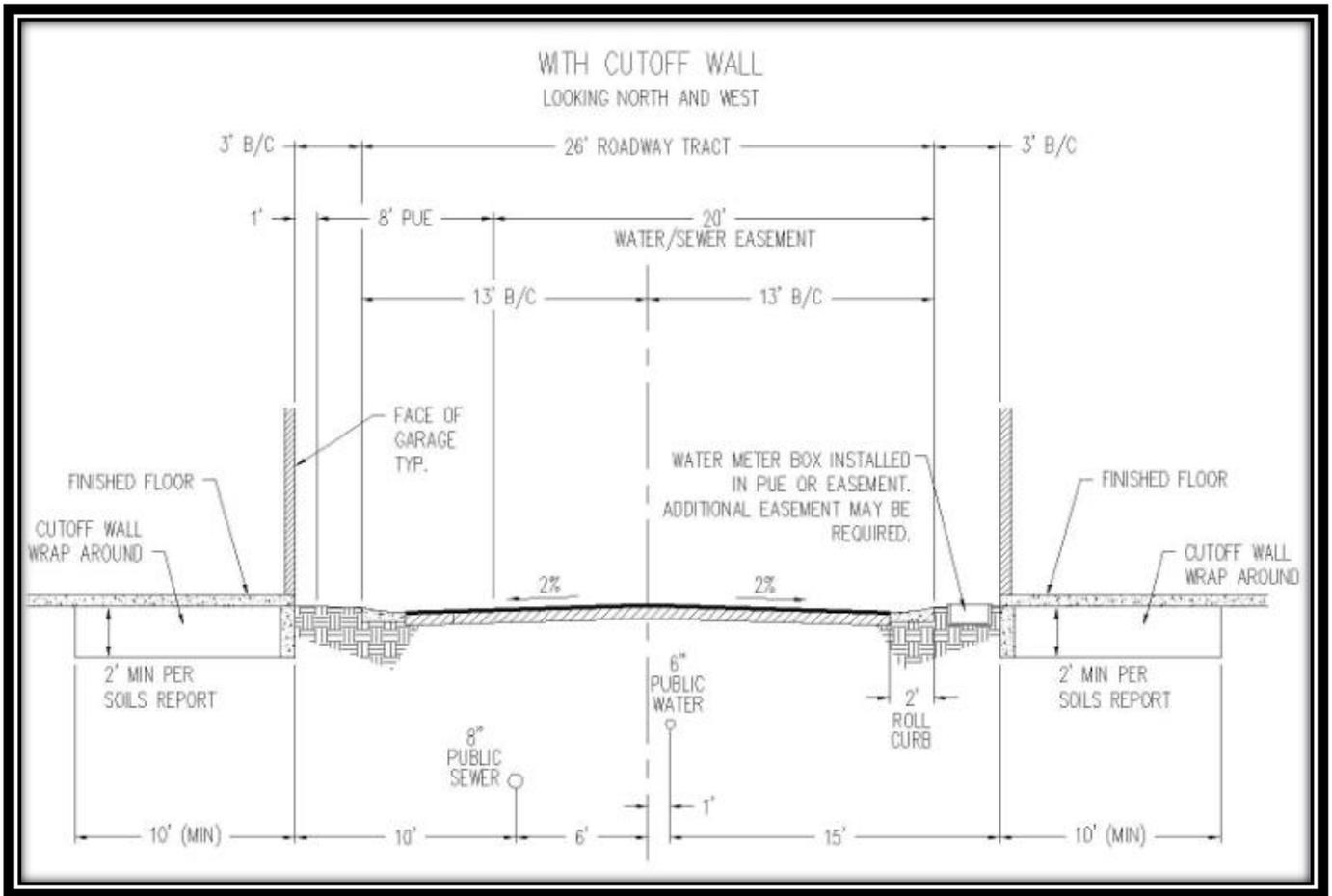
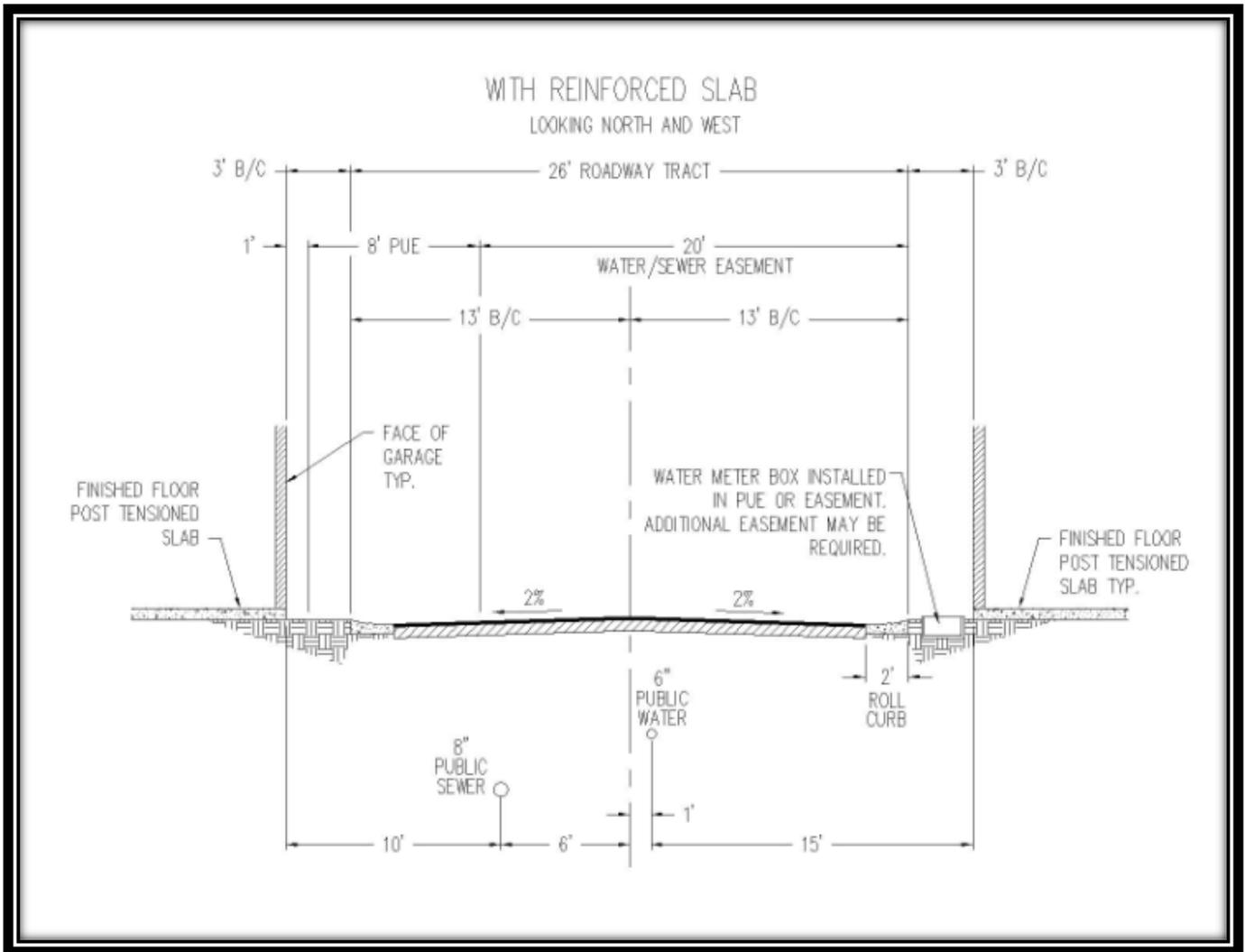


Figure 3 – Infill and SFA Option with Reinforced Slab



3. Public Water and Sewer within all other Easements

a. General - Easements will only be considered in the following cases:

1. The project route falls in a future ROW alignment.
2. A short segment of water or sewer main that is not technically feasible to design in the ROW and the proposed alignment results in a more efficient operation of the water or wastewater system.
3. Or as approved by WSD through the Technical Appeal process.

For projects requiring the installation of public water or sewer infrastructure within a property owned by the City of Phoenix, a temporary right-of-entry access agreement must be executed prior to construction. Contact WSD to initiate the process during the design review.

b. Minimum Easement Widths for Water Mains:

The minimum widths for water mains with 8-feet of cover or less shall be as follows:

Figure 4 – Minimum Easement Widths for Water Mains

Main Diameter (inches)	Minimum Easement Width (feet)
12 and Less	25
16 to 30	50
Greater than 30	80

- e. For water mains with greater than 8 feet of cover, easement width may be increased on a case by case basis to reflect the required construction and maintenance activities.
- f. All appurtenances shall have a contiguous easement/clearance as shown in Figure 5, *Minimum Easement/Clearance for Appurtenances*. Additional easement may be required.

Figure 5 – Minimum Easement/Clearance for Appurtenances

Appurtenances	Minimum Clearance/Easement
Air Relief	3 feet on all sides of the metal cage
Fire Hydrant	6 feet clear from outside of hydrant
Meters 2 inches and smaller	3 feet on all sides
Meters 3 inches and larger	3 feet on all sides of meter vault
Miscellaneous	6 feet on all sides

- g. Minimum Easement Widths for Sewer Mains:
The minimum widths for sewer mains shall be as follows:

Figure 6 - Minimum Easement Widths for Sewer Mains

Main Diameter (inches)	Cover Depth (feet)	Minimum Easement Width (feet)
15 and Less	≤ 10	35
15 and Less	10 - 15	40
15 and Less	≥ 16 - 20	45
15 and Less	≥ 20	50
16 to 30	≤ 10	40
16 to 30	10 - 20	50
16 to 30	≥ 20	60
Greater than 30	Any	80

f. Additional Easement and Main Requirements:

1. Easement Dedication - Easements shall be located in tracts. It shall be dedicated and restricted for COP water and sewer mains only. Public utility easements (PUE's) are not acceptable. Back lot or side lot easements will not be allowed. All other easements will be reviewed on a case-by-case basis by WSD.
2. Alignment for a single main - water or sewer main shall be centered within the easement. Alignment for multiple mains – water and/or sewer mains must maintain minimum separation requirements centered within the easement.
3. If parallel City water or sewer mains are to be located in the same easement, the adjusted minimum easement width for the overlapping easements shall be the sewer easement width plus an additional 7 feet.
4. Easements within retention/detention basins are not allowed.
5. At wash crossings, pipe appurtenances (e.g., manholes, fire hydrants or valves) are not allowed within the 100-year flood plain limits.
6. Re-developed parcels having existing easements that do not meet the current minimum easement width requirements, will be reviewed on a case-by case basis by WSD.
7. All Weather Access Road - water and sewer easements not in a private accessway require an all-weather access road. This allows the mains and all pipe appurtenances (e.g., valves, fire hydrants and manholes) to be accessible at all times. The following requirements shall apply:
 - The access road shall have a minimum width of 12 feet and shall be paved or constructed of a minimum of 6-inch-thick stabilized decomposed granite or as approved by WSD through the Technical Appeal process.
 - The road shall be located 3 feet to the side of the main(s) or as approved by WSD through the Technical Appeal process.
 - Each end of the access road shall connect to a public street, private accessway or a turn-around easement.
 - The maintenance of access roads in the water easements is the responsibility of the property owner or homeowner's association and shall be indicated as such in the Conditions, Covenants, and Restrictions (CC&R's). A copy of the CC&R's providing evidence of this maintenance responsibility by the homeowner's association or other ownership group shall be submitted to PDD for verification.

4. Encroachments within an Easement

Water and sewer easements shall be free of all obstructions and shall at all times be accessible to City service equipment. No buildings, sport courts, swimming pools, fences, shade structures, appurtenances, concrete pads, nor permanent structures of any kind shall be constructed upon, over or under any water or sewer easements.

No landscaping shall be placed within an easement that will render the easement inaccessible by equipment. WSD has the right to remove any obstruction without notice to the property owner and all related costs shall be the property owner's responsibility. The maintenance of all landscaping in easements is the responsibility of the property owner or homeowner's association thereof and shall be indicated as such in the Conditions, Covenants, and Restrictions (CC&R's). A copy of the CC&R's providing evidence of this maintenance responsibility by the homeowner's association or other ownership group shall be submitted to the City of Phoenix, PDD for verification.

5. Encroachments Adjacent to Existing Water and Sewer Easements

No buildings or permanent structures will be allowed to encroach on a water or sewer easement.

Regardless of the easement width, buildings shall have a sufficient setback from the water or sewer pipe such that buildings, building foundations or building slabs will not be undermined or damaged by a water or sewer main break or subsequent repair.

If the water or sewer easement does not meet the minimum width requirements as shown in Figure 4, *Minimum Easement Widths for Water Mains*, and Figure 6, *Minimum Easement Widths for Sewer Mains*, then clearances shall be as follows:

Sewer

Buildings, building slabs or structures proposed outside of the easement but parallel to a sewer main at a horizontal distance less than or equal to the depth (invert) of the sewer main, shall be required to submit structural analysis and a geotechnical soil survey report with each signed and sealed by an Arizona Registered Professional Engineer. These reports shall be submitted to the City for review and approval. The reports shall verify the integrity of the proposed structure under the condition of a sewer main failure, as well as verifying that the proposed structure and its foundations will not compromise the structural integrity of the sewer main.

Water or Force Main

Buildings, building slabs or structures proposed outside of the easement but parallel to a water main or sewer force main within 12 feet, shall be required to submit structural analysis and a geotechnical soil survey report with each signed and sealed by an Arizona Registered Professional Engineer. These reports shall be submitted to the City for review and approval. The reports shall verify the integrity of the proposed structure under the condition of a water/sewer force main failure, as well as verifying that the proposed structure and its foundations will not compromise the structural integrity of the water/sewer force main.

NOTE: *The horizontal distance is measured from the edge of the building foundation to the outside of the water or sewer pipe.*

Exceptions:

Pre-Built/Fabricated Wood Shed-type Structures

Pre-Built/Fabricated Aluminum Shed-type Structures

Pre-Built/Fabricated Shade Structures

Free Standing Barbecue Islands

Enclosures to Existing Garage/Carport/Patio where the existing concrete slab and roof will not be altered

6. Allowable Plants and Trees within an Easement

For WSD's list of acceptable plants that can be located within an easement, refer to Figure 9, *List of Acceptable Plants and Trees*. For a list of approved trees that can be placed within an easement,

refer to Section C, item 2, of this chapter. **NOTE:** If an allowable tree is placed in an easement, it shall also meet the minimum separation requirement from a water or sewer main.

7. Water and Sewer in Light Rail Corridor

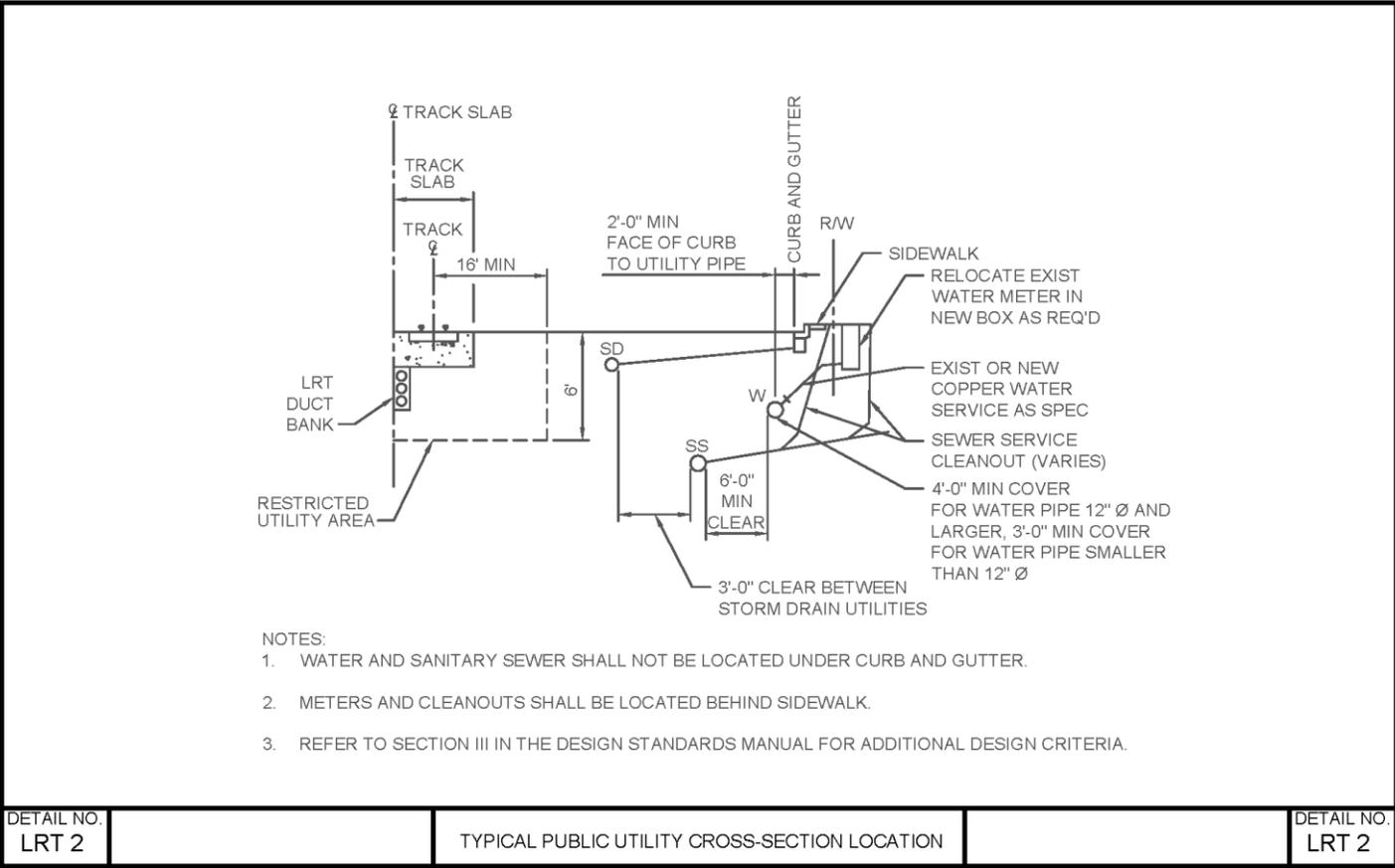
Within the Light Rail corridor, the preferred water main location is 2 feet from lip of gutter as shown in the drawings incorporated as Appendix E attached to this Manual. Public utility pipelines shall not be installed under curb and gutter, and existing water mains and valves under relocated curbs and gutters shall be relocated.

Except as provided herein, all water and sanitary sewer utilities within the RUA shall be designed or relocated outside the RUA as specified. See Drawing LRT 2 below for typical diagrams of the RUA and utility relocation locations.

- a. Pipelines Parallel to Light Rail Corridor Locations: Utility pipe design locations shall minimize length of service laterals and minimize traffic impacts for future operation, maintenance and service repairs. Where possible, utility pipelines shall be designed such that valve box covers and manholes are in the center of roadway shoulders, turn lanes or automobile traffic lanes for maintenance access, operation safety, and to minimize repetitive live wheel loads on the covers.

If a parallel pipeline has utility service connections, dual pipelines will be installed in lieu of having utility service connections cross ~~be~~ the tracks.

- b. Relocation of Existing Pipelines: The number and degree of deflections required for relocation of pipelines shall be limited to minimize system hydraulic head losses, bottlenecks, thrust restraint requirements or potential maintenance problems. Deflection at a pipe joint or fitting shall be limited to one half of the manufacture's maximum allowable deflection.
- c. Utility Track Crossings:
 1. All water and sanitary sewer piping that crosses the light rail track shall be encased in steel or high-density polyethylene (HDPE) casing. If the existing piping crosses within the RUA, it shall be lowered below the RUA and encased in steel or HDPE casing across the limits of the RUA. Provide casing detail.
 - Replacement limits of water piping shall be to the nearest intersecting main outside the RUA.
 - Replacement limits of sewer piping shall be to the nearest manhole outside the RUA or new manholes shall be installed outside the RUA.
 2. All water pipes or metallic casing materials crossing light rail shall have corrosion protection in accordance with the requirements of the Cathodic Protection System Requirements found in Appendix D attached to this Manual and in compliance with the stray current study.
 3. Water pipeline under light rail shall have isolation valves installed outside the RUA limits; unless on an existing system, there is an existing in-line valve located within 20 feet of the replacement limits. If there is an existing in-line valve located within 20 feet of the replacement limits specified above, then the contractor, consultant or private developer shall replace pipe to said valve.
 4. Limits of casings under the track bed shall extend across the limits of the RUA. The casing shall have the following characteristics:



- NOTES:
1. WATER AND SANITARY SEWER SHALL NOT BE LOCATED UNDER CURB AND GUTTER.
 2. METERS AND CLEANOUTS SHALL BE LOCATED BEHIND SIDEWALK.
 3. REFER TO SECTION III IN THE DESIGN STANDARDS MANUAL FOR ADDITIONAL DESIGN CRITERIA.

- Casing Materials:
 - ASTM A36 Steel with coating; or HDPE solid wall pipe manufactured by Chevron Phillips using PE 3408 material or equal; or HDPE smooth interior corrugated pipe casing, ADS Systems N12 WT 1B or equal for casing up to 24 inches in diameter.
 - Casing wall thickness shall be sufficient for dead and live load requirements, with a minimum 2.0 safety factor.
 - Steel casing shall have a factory applied tape wrap corrosion protection coating.
 - All casing joints shall be watertight to 10.8 psi in accordance with ASTM D3212.
 - Casing Size: Casing diameter shall be as follows:
 - Casing for Mains: Casing inside diameter shall be equal to or greater than the carrier pipe bell or coupling outside diameter plus a minimum of 6 inches.
 - Water Services: Water services 1 inch and smaller shall have a minimum 4-inch-diameter casing; 1-1/4-inch through 2-inch services require a minimum 6-inch casing. Services larger than 2-inch diameter require casings 6 inches larger than the bell O.D. or fitting as described above.
 - Sewer Services: Sewer services require casing 6 inches larger than the bell O.D. or fitting as described above.
5. Casing/Carrier Pipe Spacers and Insulators: The carrier pipe shall be installed with casing insulators banded to it for support and isolation. Refer to Appendix E.
 6. Casing End Seals: All casing shall be installed with pre-manufactured casing/carrier end seals intended for such use. Refer to Appendix E to this Manual (Detail LRT 9). No venting of the casings is required for water and sewer utility crossings.
 7. All gravity and pressure sewer mains that cross the light rail track shall be replaced with new City of Phoenix approved materials and encased in steel or HDPE casing.
 - a. For gravity sewers, manholes shall be located on each side of the track at the pipe material transition locations. Transition of pipe materials shall only be achieved inside of a manhole.
 - b. If the existing piping crosses within the RUA, it shall be lowered below the RUA and encased in steel or HDPE casing across the limits of the RUA.
 - c. Subject to written consent of the WSD, and on a case-by-case basis, existing perpendicular crossings of sanitary sewer pipelines under the light rail track and within the RUA which cannot be lowered may be left within the RUA if the following criteria are met:
 - Sewer pipeline depth is more than 3 feet from the top of pipe to the top of light rails.
 - Sewer pipeline is replaced with new piping to the limits specified above and is encased in steel or HDPE casing.
 8. All metallic pressure sewer mains crossing the light rail project shall have corrosion protection in accordance with the requirements of the Cathodic Protection System Requirements found in Appendix D. No corrosion protection is required for nonmetallic gravity sewers.
 9. Casing Annular Space: The annular space shall not be filled unless otherwise directed by other governing agencies and approved by the City.

C. HORIZONTAL AND VERTICAL SEPARATION REQUIREMENTS

To minimize the potential for cross contamination, water and sewer mains shall maintain a minimum horizontal and vertical separation. Horizontal separation is summarized in Figure 7, *Water/Sewer Horizontal*

Separation Requirement Table, and vertical separation is summarized in Figure 8, *Water/Sewer Vertical Separation Requirement Table*.

Figure 7 – Water/Sewer Horizontal Separation Requirement Table

Water / Sewer Horizontal Separation Requirement Table		TYPE OF PARALLEL UTILITY							
		Water Service Connection	Distribution Water Main	Transmission Water Main ¹	Sewer Main / Reclaimed Main	Sewer Service Connection	Dry Utilities	Private Fireline Service	Storm Drains / Culverts & Irrigation
TYPE OF WATER / SEWER UTILITY	Distribution Water Main	3-feet minimum	3-feet minimum	3-feet minimum	6-feet minimum	3-feet minimum	6-feet minimum	3-feet minimum	6-feet minimum
	Transmission Water Main	3-feet minimum	3-feet minimum	3-feet minimum	6-feet minimum	3-feet minimum	6-feet minimum	3-feet minimum	6-feet minimum
	Water Service Connection	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum
	Sewer Main / Reclaimed Main	3-feet minimum	6-feet minimum	6-feet minimum	3-feet minimum	3-feet minimum	6-feet minimum	6-feet minimum	3-feet minimum
	Sewer Service Connection	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum	3-feet minimum

¹ Clearances around pre-stressed concrete cylinder pipe (PCCP) will require 4 foot vertical clearance or as required by the WSD.

NOTE: This table applies to all above ground or underground utilities/structures.

Figure 8 – Water/Sewer Vertical Separation Requirement Table

Water / Sewer Vertical Separation Requirement Table		TYPE OF UTILITY CROSSING							
		Water Service Connection	Distribution Water Main	Transmission Water Main ¹	Sewer / Reclaimed Main	Sewer Service Connection	Dry Utilities	Private Fireline Service	Storm Drains / Culverts & Irrigation
TYPE OF WATER / SEWER UTILITY	Distribution Water Main Above Utility	6-inch minimum	1-foot minimum	2-foot minimum	1-foot minimum ²	6-inch minimum ³	1-foot minimum	1-foot minimum	1-foot minimum ⁴
	Distribution Water Main Below Utility	6-inch minimum	1-foot minimum	2-foot minimum	2-foot minimum ⁴	2-foot minimum ⁴	1-foot minimum	1-foot minimum	2-foot minimum ⁴
	Transmission Water Main Above Utility ¹	2-foot minimum	2-foot minimum	2-foot minimum	2-foot minimum	2-foot minimum	2-foot minimum	2-foot minimum	2-foot minimum
	Transmission Water Main Below Utility ¹	2-foot minimum	2-foot minimum	2-foot minimum	2-foot minimum ⁴	2-foot minimum ⁴	2-foot minimum	2-foot minimum	2-foot minimum ⁴
	Water Service Connection Above or Below Utility	6-inch minimum	6-inch minimum	2-foot minimum	6-inch minimum	6-inch minimum	6-inch minimum	6-inch minimum	6-inch minimum
	Sewer Main / Reclaimed Main Above Utility	6-inch minimum	2-foot minimum ⁴	2-foot minimum ⁴	1-foot minimum	6-inch minimum	1-foot minimum	2-foot minimum ⁴	1-foot minimum ⁴
	Sewer Main / Reclaimed Main Below Utility	6-inch minimum	1-foot minimum ²	2-foot minimum	1-foot minimum	6-inch minimum	1-foot minimum	1-foot minimum ²	1-foot minimum ⁴
	Sewer Service Connection Above	6-inch minimum	2-foot minimum ⁴	2-foot minimum ⁴	6-inch minimum	6-inch minimum	6-inch minimum	2-foot minimum ⁴	6-inch minimum
	Sewer Service Connection Below Utility	6-inch minimum	6-inch minimum ³	2-foot minimum ⁴	6-inch minimum	6-inch minimum	6-inch minimum	6-inch minimum ³	6-inch minimum

¹ Clearances around pre-stressed concrete cylinder pipe (PCCP) will require 4 foot vertical clearance or as required by the WSD.

² Extra protection is required for water mains and private fire line services that are between 1 and 2 feet above sewer. Refer to note below.

³ Extra protection is required for sewer service connections with less than one foot of vertical clearance. Refer to note below.

⁴ Extra protection is required. Refer to note below.

NOTE: Clearances are measured from outside of pipe to outside of pipe. Minimum separation and extra protection shall be in accordance with the requirements set forth in Arizona Administrative Code AAC R18-5-502, MAG Specification 610, and MAG Standard Detail No. 404-1; or as approved by WSD.

1. Separation Requirements from Water Supply System

While no general statement can be made to cover all conditions, it is recognized that sewers shall meet the requirements of the appropriate reviewing agency with respect to minimum distances from public water supply wells or other water supply sources and structures.

All existing waterworks units, such as basins, wells or other treatment units, within 200 feet of the proposed sewer shall be shown on the plans.

2. Tree Separation Requirements

To protect the public water and sewer infrastructure, all trees shall maintain 10 feet horizontal separation measured from outside of pipe to the tree trunk. WSD may allow less than 10 feet but not less than 6 feet, if it meets the following criteria:

The existing or proposed tree(s) MUST be on Figure 9, *List of Acceptable Plants and Trees*, or lists approved by the Walkable Urban Code or Downtown Code Zoning Districts.

Once an approved tree is selected, it shall be planted between 6 and 10 feet from a water/sewer main and the developer shall install a root barrier between the tree roots and the water/sewer main. Refer to Figure 10, *Tree Root Barrier Detail*, for the installation.

NOTE: Any COP approved trees are allowed if located more than 10 feet away from a water or sewer main.

Figure 9 – List of Acceptable Plants and Trees

ACCENTS/CACTI			
Botanical Name	Common Name	Botanical Name	Common Name
Agaves spp.	Century plant, agave	Ferrocactus cylindraceus	Barrel
Aizoaceae	Ice plant family	Fouquieria splendens	Ocotillo
Aloe spp.	Aloe	Hesperaloe parviflora	Hesperaloe
Bacillus cereus	Cereus	Manfreda maculosa	Manfreda
Cactaceae	Cactus Family	Opuntia	Prickly pear
Carnegiea gigantean	Saguaro	Pachycereus schottii	Senita
Cylindropuntia	Cholla	Pedilanthus macrocarpus	Lady slipper
Dasyliirion spp.	Desert spoon	Stenocereus thurberi	Organ pipe
Echinocereus triglochidiatus	Hedgehog	Xerophyllum tenax	Bear grass
Echinopsis pachanoi	Trichocereus	Yucca glauca spp.	Yucca

GROUNDCOVER			
Botanical Name	Common Name	Botanical Name	Common Name
Acacia redolens	Desert carpet trailing acacia	Gazania rigens "Sun Gold"	Gold gazania
Aloe barbadensis	Medicinal aloe	Lantana spp. "New Gold"	Yellow lantana "New Gold"
Aloe saponaria	Tiger aloe	Oenothera berlandieri	Mexican evening primrose
Ambrosia deltoidea	Triangle leaf bur-sage	Oenothera caespitosa	Tufted evening primrose
Ambrosia dumosa	White bur-sage	Oenothera stubbei	Saltito Primrose
Artemisia ludoviciana	White sage	Rosemarinus officinalis "Prostratus"	Trailing rosemary
Asparagus densiflorus 'Sprengeri'	Sprenger asparagus	Salvia chamaedryoides	Blue sage
Baccharis spp. "Twin Peaks"	Twin peaks coyote brush	Salvia coccinea	Sage
Bulbine frutescens	Bulbine	Santolina chamaecyparissus	Lavender cotton
Convolvulus mauritanicus	Ground morning glory	Santolina virens	Green santolina
Dalea Capitata "Sierra Gold"	Yellow flowered trailing dalea	Teucrium chamaedrys 'Prostrata'	Germander
Dalea greggii	Trailing indigo bush	Verbena peruviana	Peruvian verbena
Ericameria laricifolia	Turpentine bush	Verbena rigida	Sandpaper verbena
Eriogonum fasciculatum	California buckwheat	Zephyranthes candida	Rain lily
Eriogonum wrightii	Buckwheat	Zinnia grandiflora	Rocky mountain zinnia

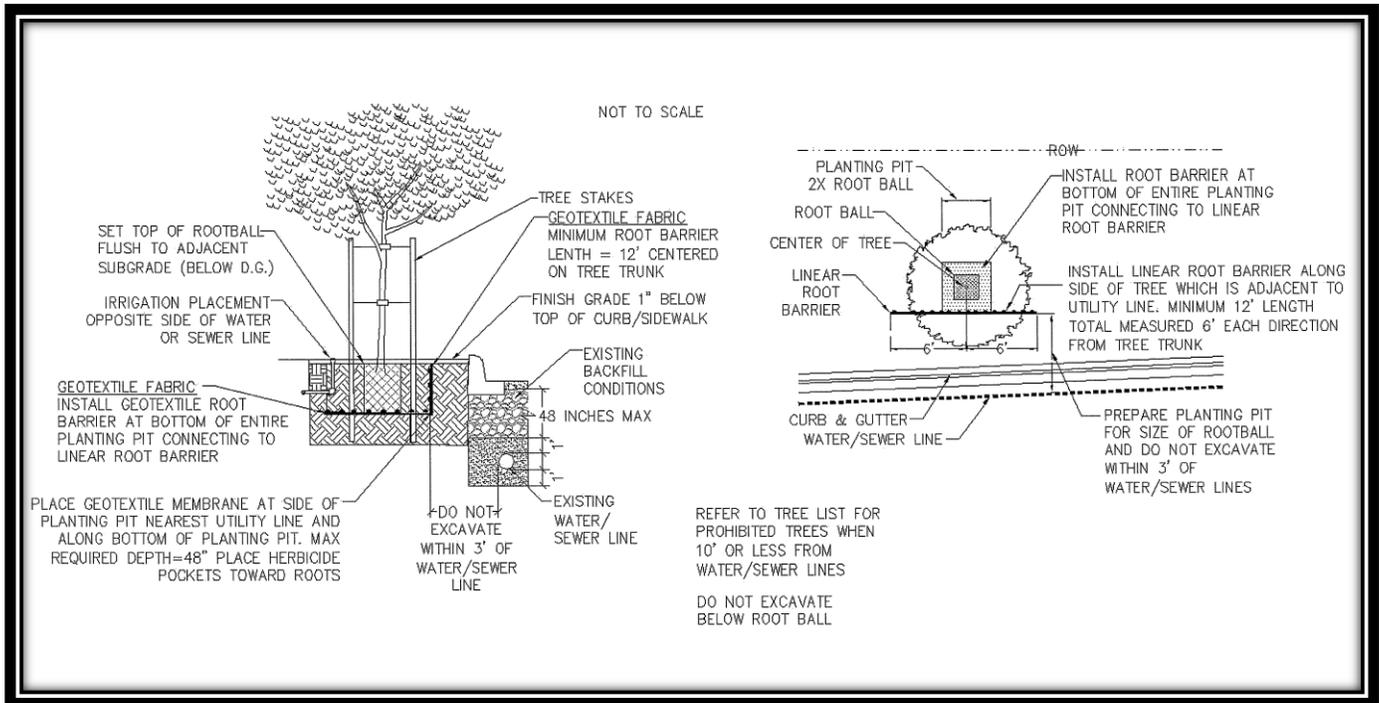
TREE TYPES ALLOWABLE – MINIMUM 6 FEET FROM WATER/SEWER MAIN			
Botanical Name	Common Name	Botanical Name	Common Name
Acacia aneura	Mulga	Ebenopsis ebano	Texas Ebony
Acacia coriacea	Desert Oak	Erythrina bidwillii	Bidwell's Coral Tree
Acacia brachybotrya	Grey Mulga	Eucalptus erythrocorys	Red-cap Gum
Acacia berlandieri	Guajillo	Eysenhardtia orthocarpa	Kidneywood
Acacia constricta	White Thorn Acacia	Fraxinus greggi	Little-leaf Ash
Acacia craspedocarpa	Leather-Leaf Acacia	Havardia pa/lens	Tenaza
Acaciajennearae	Coonavittra Wattle	Leucaena retusa	Golden Leadball Tree
Acacia notabilis	Notable Wattle	Ligustrum japonicum	Japanese Privet
Acacia rigidula	Blackbrush Acacia	Lysiloma watsonii v. thronberi	Feather Bush
Bauhinia lunarioides	Anacacho Orchid Tree	Mariosuouosa willardiana	Palo Blanco
Bauhinia mexicana	Orchid Tree	Phoenix canariensis	Canary Island Date Palm
Brahea armata	Mexican Blue Palm	Pistacialentiscus	Mastic Tree
Caesa/pinia caca/aco	Cascalote	Pittosporum angustifolium	Willow Pittosporum
Caesalpinia mexicana	Mexican Bird of Paradise	Punica granatum	Pomegranate
Calio secundif/ora	Texas Mountain Laurel	Ungnadia speciosa	Mexican Buckeye
Chamaerops humilis	Mediterranean Fan Palm	Vauquelinia ca/ifornica	Arizona Rosewood
Chi/apsis linearis 'Lucretia Hamilton'	Desert Willow	Washingtoniafilifera	California Fan Palm
Cordia boissieri	Texas Olive	Washintonia robusta	Mexican Fan Palm

Continued LIST OF ACCEPTABLE PLANTS AND TREES IN UTILITY EASEMENT

SHRUBS			
Botanical Name	Common Name	Botanical Name	Common Name
Abutilon palmeri	Superstition mallow	Krameria parvifolia	Ratany
Aloysia spp.	Bee brush	Lantana camera	Bush lantana
Ambrosia spp.	Bur-sage	Larrea tridentata	Creasote bush
Asclepias linaria	Pine leaf milkweed	Leucophyllum spp.	Texas sage
Asclepias subulata	Desert Milkweed	Lippia berlandieri	Mexican oregano
Atriplex spp.	Saltbush	Maytenus phyllanthoides	Mangle dulce
Berberis haematocarpa	Red barberry	Mimosa biuncifera	Catclaw mimosa
Berberis trifoliolata	Agarita	Mimosa dysocarpa	Velvet pod mimosa
Buddleia marrubifolia	Wooly butterfly bush	Myrtus communis	True myrtle
Caesalpinia spp.	Bird of paradise	Myrtus communis 'Boetica'	Twisted myrtle
Calliandra californica	Baja red fairy duster	Myrtus communis 'Compacta'	Dwarf myrtle
Calliandra eriophylla	Fairy duster	Nandina domestica	Heavenly bamboo
Calliandra peninsularis	Red fairy duster	Nerium oleander 'Dwarf'	Dwarf Oleander
Callistemon phoeniceus	Salt resistant bottlebrush	Perovskia atriplicifolia 'Heavenly Blue'	Russian sage
Callistemon viminalis "Captain Cook"	Dwarf bottlebush	Plumbago scandens	Plumbago
Calothamnus spp.	Net bush	Punica granatum 'Dwaft'	Dwarf pomegranate
Cassia (Senna) spp.	Cassia	Pyracantha spp.	Firethorn (susceptible to fireblight)
Chrysothamnus mexicana	Damianita	Rhus choriophylla	Mearns sumac
Chrysothamnus nauseosus	Rabbit bush	Rhus microphylla	Desert sumac
Cistus spp.	Rockrose	Rhus ovata	Sugarbush
Condalia globosa	Bitter condalia	Rhus trilobata	Skunk bush
Convolvulus cneorum	Bush morning glory	Rhus virens	Evergreen sumac
Cordia boissieri	Anacahuita	Rosmarinus officinalis	Rosemary
Cordia parvifolia	Little leaf Cordia	Ruellia californica	Ruellia
Dalea spp.	Indigo bush	Ruellia peninsularis	Ruellia
Encelia spp.	Brittle bush	Salvia spp.	Sage
Ephedra spp.	Mormon tea	Simmondsia chinensis	Jojoba
Eremophila spp.	Emu bush	Solanum xanti	Solanum
Ericameria linearifolia	Turpentine bush	Sophora arizonica	Arizona sophora
Erythrina flabelliformis	Southwest coralbean	Sophora formosa	Sophora
Euphorbia antisiphilitica	Wax plant, candelilla	Tecoma stans	Yellow bells
Euphorbia rigida	Euphorbia	Tecomaria capensis	Cape honeysuckle
Fraxinus greggii	Little leaf ash	Teucrium fruticans	Bush germander
Genista hispanica	Spanish broom (Self-propagating)	Thamnosma montana	Turpentine broom
Gutierrezia microcephala	Snakeweed	Trixis californica	Trixis
Hamela patens	Fire bush	Vauquelinia californica	Rosewood
Hyptis emoryi	Primrose jasmine	Viguiera deltoidea	Golden eye
Jatropha spp.	Limberbush	Vigueira tomentosa	Golden eye
Justicia spp.	Chuparosa	Westringia rosmarinaformis	Westringia

VINES			
Botanical Name	Common Name	Botanical Name	Common Name
Antigonon leptopus	Coral vine, queen's wreath	Mascagnia lilacina	Purple Mascagnia
Bougainvillea spp.	Bougainvillea	Maurandya antirrhinifolia	Snapdragon vine
Calleaum macropterum (Mascagnia macroptera)	Yellow orchid vine	Maurandya wislizeni	Snapdragon vine
Campsis radicans	Trumpet creeper	Merremia aurea	Yellow morning glory
Cissus trifoliata	Grape ivy	Podranea risasoliana	Pink trumpet vine
Clematis drummondii	Virgin's bower	Rhynchosia texana	Rosary bead vine
Hardenbergia comptoniana	Wild wisteria	Rosa banksiae	Lady bank's rose
Kennedia nigricans	Black yellow vine	Solanum jasminoides	Potato vine
Macfadyena unguis-cati	Cat's claw		

Figure 10 – Tree Root Barrier Detail



TREE ROOT BARRIER DETAIL NOTES for Figure 10:

Geotextile Fabric with Herbicide Nodules: Install per manufacturer's specifications. Length and depth per detail above. Root barriers to be installed from top of subgrade to a maximum depth 48-inches. Install at edge of trench with chemical pockets towards roots.

Geotextile fabric shall consist of long chain synthetic polyolefins (minimum 95% by weight) and contain a UV stabilizer. Herbicide nodules chemical composition that are attached to the geotextile fabric shall consist of time-released trifluralin (17.5% in total composite, minimum of 20% trifluralin in nodules).

DO NOT excavate below root ball depth in planting pit. If soil is disturbed below root ball depth in planting pit, then soil **SHALL** be tamped to 85% compaction.

3. Poles and Other Structures

Light rail poles and other structures shall be placed in locations that do not conflict or interfere with the maintenance, repair or replacement of existing or proposed water utilities. A minimum 6-foot clearance shall be provided from the closest outside edge of the light rail structure to the outside edge of any public utility.

4. Private Utility Relocations

Existing and proposed locations of WSD utilities shall take priority over private utility relocations as indicated. Private utilities shall not be relocated above the "pipe corridor" of sanitary sewer utilities. The "pipe corridor" shall be defined as the limits 6 feet from outside diameter of said utility, with additional reasonable offset to accommodate safe excavation of deeper utilities without undermining more shallow utilities (1 to 1 slope preferred).

D. SUBMITTALS

1. Water and Sewer Master Plans

Planned Community Districts (PCD) require the submittal of water/sewer master plans and design reports. Master plans are required to establish specific improvements and the sequence of improvements that must be completed prior to vesting of the PCD overlay zoning. All information regarding PCD must be obtained from PDD.

WSD may require the submittal of water/sewer master plans and design reports for large non-PCD developments where significant off-site infrastructure is required.

2. Design Reports

The objective of a water and sewer design report is to verify the design demands of the proposed development. All developments requiring public water and sewer main extensions must provide a design reports along with the design plan submittal. The design reports should include the following:

a. Project Description:

1. Type of land use – e.g., commercial, residential, mixed use
2. Provide the number of lots or units.
3. Provide a site map/location of the development showing major streets and physical features such as canals, floodplains, railroads, washes, existing water and sewer infrastructure and any information needed to gain a clear understanding of the project.
4. Phasing – identify the phase lines if applicable.

b. Design Flows/Modeling:

Flow projections for sewer and water shall be based on Figure 11, *Water and Wastewater Design Flows*.

Sewer

1. Provide the design average and design peak flows for the sewage collection system. The basis of the projection of initial and future flows shall be included and must be based upon the initial service area and the ultimate upstream service area that can be served by gravity even if it is outside a development's project area.
2. Provide the basis of design for the sewage collection system including pipe sizes and slopes. Include the sizing calculations and calculations showing that there is sufficient hydraulic capacity to transport the design flows at the proposed sizes and slopes.

Water

1. Peak flow + fire flow. See page 23 for calculating peak flow.
2. Must maintain a pressure between 50 and 100 PSI during peak day conditions and a velocity of less than or equal to 5 FPS.
3. Must maintain a pressure above 25 PSI during a fire flow event and a velocity not to exceed 10 FPS.
4. The engineer shall provide flow calculations and any necessary computer models for the items listed above in order to provide documentation for the basis of design. The engineer shall provide a clear, understandable schematic of the system showing the junction nodes, pipes, etc. for any computer modeling. The engineer shall also provide input data which shows the pipe diameter, pipe lengths, system demands, pipe flows AND output data that show pressures, velocities, head loss, and flow rates.

NOTE: *These design parameters supersede the minimum requirements in Chapter IV, Pipe Sizing for Distribution Mains that states the prescribed minimum requirement of 12-inch mains in major streets, 8-inch mains in collector streets, and 6-inch mains in local streets in case of conflict regarding design minimums.*

c. Conformance with Master Plan:

The engineering report shall show that the proposed collection system conforms to the City's master plan for the area and the development's specific master plan if applicable.

- d. Environmental Issues:
The report shall address potential compliance issues with Clean Water Act Section 404, cultural resources, or any other environmental requirements.
- e. Corrosion Protection Design:
A corrosion protection design shall be included. The design shall meet the requirements of the City of Phoenix Requirements for Corrosion Protection Design Standards Development Report for Large Diameter Ductile Iron, Steel, CCP and RCP Water Transmission Pipelines.
- f. Signed/Sealed:
The design report shall be signed and sealed by an Arizona Registered Professional Civil Engineer.

3. Checklists – Private Development and Capital Improvement Projects (CIP)

All technical and engineering plans relating to CIP and private developer projects subject to the development review process shall be submitted to PDD or WSD for review and approval. Refer to Chapter II to determine which department is responsible for the plan review.

For preparation of private development and CIP water/sewer main extensions that will become a part of the Phoenix system, refer to the checklists and guidelines available on PDD and WSD websites. For website links refer to Appendix A, pages ii and iii.

4. Construction Plans and Technical Specifications - CIP Projects/Projects with City Financial Participation

- a. Design Plans:
For CIP projects and private development projects where the City participates financially, signed and sealed design plans shall conform to the requirements of the Maricopa County Environmental Health Code. The design plans (water, sewer and reclaimed water) must be submitted to Maricopa County Environmental Services Department (MCESD) to receive the certificates of approval and verifications of general permit conformance. Approval from MCESD is required prior to City Approval.
- b. Technical Specifications:
Signed and sealed technical specifications shall accompany the design plans for the construction of water/sewer mains and all other appurtenances. The specifications shall include but not be limited to the following:
 1. Specifications for the approved procedures of operation during construction
 2. All construction information not shown on the drawings that is necessary to inform the builder in detail of design requirements for the quality of materials, workmanship and fabrication of the project.
 3. Technical specifications shall conform to the MAG and COP Supplements and Specifications.
- c. Identification Information:
The MCESD approval forms request the following identification information for the COP's Water and Sewer System:
 1. Potable water system # 0407-025.
 2. Sewage Collection System Name: City of Phoenix.
 3. Sewage Treatment Facility Name: 91st Ave Wastewater Treatment Plant.For additional information on MCESD go to the following link:
<http://www.maricopa.gov/ENV SVC/>

5. Record Drawings

Three sets of construction plans shall be submitted to the inspector as record drawings. The record drawings shall be sealed and signed by an Arizona Registered Professional Civil Engineer. The record drawings shall meet the requirements of WSD policies P-68/69 for private development projects and policy P-85 for CIP projects. For CIP projects, a CD of the sealed record drawings is also required to be submitted to the City. For private development projects, electronic copies are desired, but not required. WSD Policies P-68/69, and P-85 are available on WSD website. For website link refer to Appendix A, pages ii and iii.

Record drawings shall include the conduits and locations of items related to the corrosion protection system, such as but not limited to test station, location and number of anodes, isolation kits, pipe leads, reference cells, any applicable information or details to understand the system installation.

E. WATER DEMAND AND SEWER DESIGN FLOWS

Included in this section are basic water demands and sewer flow criteria established by WSD. The minimum water main pipe sizes established in Figure 14, *Minimum Water Main Sizing within COP Grid System* (found Chapter IV, Section C), are not always adequate to meet water demands. For some projects, a detailed analysis of domestic and fire flow demands may be required to properly define requirements for system design.

1. Water and Sewer Design Flows

The following Figure 11, *Water and Wastewater Design Flows*, shall be used to calculate both water and sewer design flows utilized in the preparation of engineering design reports, plans, and specifications.

Figure 11 – Water and Wastewater Design Flows

Land Use	Unit	Water Average Daily Flow/Unit (gal)	Wastewater Average Daily flow/Unit (gal)
Single Family Residential	Dwelling	360	240
Multi-family	Dwelling	240	180
Commercial (retail/mall)	1000 ft ²	125	75
Commercial (office)	1000 ft ²	115	90
Warehousing/Big Box Retail	1000 ft ²	30	25
Industrial	1000 ft ²	65	50
Schools	Student	25	20
Hotel (no restaurant)	Room	140	100
Hotel (with restaurant)	Room	200	150
Resort	Room	300	210
Hospital (all flows)	Bed	500	300
Landscape Water Requirements			
General Landscaping	Acre	4,374	N/A
Public Right of Way or Streetscape	Acre	1,339	N/A
Surface Water	Acre	5,335	N/A

NOTES: The following Italicized notes are for Figure 11, Water and Wastewater Design Flows

Complete design flows are not provided for **industrial and hospital facilities** because case-by-case evaluation is necessary due to varying water demands observed for these use types. Some industrial uses such as data warehouses, food processing, bottling plants, and semi-conductor manufacturing can use more than ten times as much water as compared to warehousing or dry assembly manufacturing with no cooling tower use. Water use in hospitals varies greatly depending upon cooling tower and boiler use, the extent to which the hospital is used as a research and teaching facility, the amount of out-patient versus in-patient services provided, and the types of equipment used. Estimates of anticipated water use and wastewater generation must be produced for each new development or major expansion using projections of demands taking into account the following types of categories:

- ***Water for cooling towers:*** Cooling towers use can make up more than fifty percent of water demand at industrial facilities having large refrigeration units or cooling of servers. In most cases, cooling towers use twenty to forty percent of the water requirements for industrial operations and hospitals.
- ***Water used as an input for production:*** In some manufacturing operations, water is used as an input in the manufacturing process and must be included in demand projections because of the large volumes used. Examples include ice-making, soft-drink or water bottling operations, and food manufacturing such as industrial bakeries.
- ***Water used in production/activities:*** In many manufacturing operations water is used for cooling, cleaning, or other operational activities and must be included in demand projections. Examples include metal forming and finishing, semi-conductor wafer production, and aerospace parts manufacturing. Processes employing newer technologies tend to use less water than older technologies, but estimates must be made on a location and process-specific basis. Some medical facilities are now using the newer medical imaging techniques and sterilization processes that use little or no water, while some medical equipment still requires significant amounts of water.
- ***Bed to space ratios and mix of services:*** Bed to space ratios and services provided in hospitals can vary greatly. These variations depend upon the proportion of space necessary to provide 24/7 nursing care, full linen service, and full food service to patients staying overnight. Furthermore, some hospitals are highly specialized and focus on particular types of treatment and/or research while others provide general and emergency services only. Water use on a per-square-foot or per-bed-basis can even vary significantly between different parts of hospitals, so large expansions will require an individual analysis.

2. Water Peak Flow

Peak Flow shall be calculated as 1.7 times the average daily flow.

NOTE: For clarification, the following example characterizes the calculations performed to determine the design flows and quantities involved in a hypothetical facility.

EXAMPLE: Hypothetical water demand/flow evaluation (not including fire flows).

ASSUME: A 1000 dwelling unit multi-family development.

CRITERIA: From Figure 11, *Water and Wastewater Design Flows*.
Average daily flow = 240 gallons per unit per day (gpupd)
Average total daily flow = 1,000 x 240 = 240,000 gallons per day (GPD)
Peak daily flow = 240,000 GPD x 1.7 (peaking factor)
Peak daily flow = 408,000 GPD

3. Sewer Peak Flow

All gravity sewer mains shall be designed for peak flow conditions. Peak flow is calculated as the product of the peaking factor and the average daily flow. The peaking factor should be calculated from Harmon's formula.

Design Flow Equation below:

Design Flow = Peak Flow = $Q_{Peak} = Q_{avg} [1 + 14 / (4 + P^{1/2})]$, Where P = Population/1,000

4. Water and Sewer Relocation Capacity

All relocated facilities shall meet or exceed the design capacity of the existing facilities being replaced. In instances where the existing facilities are undersized the new facilities will be designed to meet current design standards. All relocated gravity pipelines shall maintain existing grade and a minimum cleaning velocity. All gravity systems shall remain positive draining systems. Sewer siphons, "bubble-up" manholes, off-set manholes, and lift stations will not be allowed.

F. WATER AND SEWER MAIN ABANDONMENT

1. Abandonment Methods for Existing Water and Sewer Pipe

It is the intent of the Water Services Department that water mains be completely removed from the right-of-way at the time of abandonment. There may be instances where WSD allows abandoned water mains to remain due to special circumstances. There are three approved methods of abandoning water and sewer mains in public ROW and easements:

- a. Total removal of pipe.
- b. Crush pipe in place by mechanical means. This cannot be applied to asbestos cement pipe.
- c. Leave pipe in place and fill with low strength grout. All abandoned water mains left in place shall be completely filled with controlled low-strength material (CLSM). CLSM shall meet the slump and strength requirements for "1 sack CLSM" as specified in MAG Specification 728. The contractor shall dewater proposed water lines prior to filling them with CLSM.

No other methods are acceptable.

2. Abandonment Methods for Existing Water Tapping Saddle

All existing water service lines to be abandoned shall be completely removed from the corporation stop/valves to the existing water meter. The corporation stop or existing valve, as necessary, shall be closed at the main prior to removal of the piping.

The established procedure for abandoning tapping saddles within the City of Phoenix is as follows:

- a. WSD, or its designated representative, shall be notified whenever an existing tap to be abandoned is fully exposed. Such notification shall request inspection of the service saddle

and corporation stop by WSD (or its designated representative) to determine the condition of the assembly. At the time of inspection, WSD, or its designated representative, will determine whether the tapping saddle and corporation stop should be replaced with a repair sleeve, or the corporation stop capped and the tapping saddle and corporation stop left in place.

- b. The criteria for either abandonment in place or removal of the existing tapping saddle and corporation stop are based on the condition of the existing equipment and the type of material used in its composition and construction. If the service saddle and the corporation stop are in good condition and composed of the correct style and type of materials, as determined by WSD (or its designated representative), the corporation stop may be closed, the open end of the corporation stop capped, and the service saddle abandoned in place. The correct style for the service saddle is a double-strap saddle. Single-strap saddles and direct taps of corporation stops are not allowed.
- c. If the service saddle or corporation stop is deemed unacceptable by WSD (or its designated representative) because of type of style, material and condition, the saddle and stop shall be removed and a full-circle, stainless steel repair sleeve shall be installed at the tap location.
PowerSeal, Model 3122AS, Smith Blair 262 full-circle repair clamp or a Muller 550 Series full seal all-stainless repair clamp shall be used.
- d. The cost for the removal and replacement of the service saddle and corporation stop shall be paid by the contractor.

3. Abandonment Methods for Existing Fire Hydrants

Fire Hydrant Removal – After acceptance of the new waterline and new fire hydrants, the contractor shall remove, salvage, and deliver to the City of Phoenix Yard.

Valve and Service Connection Removal – After acceptance of the new waterlines, fire hydrant service connections and valves shall be abandoned.

Existing Main to Remain – At locations where the existing main will remain and a fire hydrant service is to be abandoned; the main connection shall be replaced with a straight section of pipe per City Detail P1344. Locations with mains greater than 12 inches shall be reviewed by WSD case by case.

4. Abandonment Methods for Existing Sanitary Sewer Manholes

Abandoned sanitary sewer manholes shall be completely removed, including the concrete base.

5. Abandonment Methods for Existing Sanitary Sewer Service Lines

All existing sewer service lines to be abandoned shall be removed from the property line or easement line back to the main. As part of abandonment, the service connection upstream of the last horizontal joint shall be saw-cut. Once cut, a stainless steel no-hub coupling and a cast-iron plug shall be installed to seal the remaining section of the sewer service connection. Abandonment in place will be approved by WSD on a case-by-case basis.

G. STUBS/TAPS AHEAD OF PAVING

1. Water/Sewer Stubs or Taps Ahead of Paving

City of Phoenix does not allow new stubs or taps ahead of paving unless the property owner can provide a conceptual design report and a site plan demonstrating the appropriate sizing and location of the mains or stubs. This applies to connections such as water/sewer stubs, water/sewer mains and service taps for fire lines and/or domestic use. The request for taps ahead of paving shall be submitted by the developer through a Water and Sewer Technical Appeal.

If the City approves the request for taps ahead of paving, and the size or location changes after the installation due to design changes, or for any other reason, it shall be the property owner's responsibility to abandon any unused infrastructure at the property owner's expense.

H. CROSS CONNECTIONS AND BACKFLOW PREVENTION

1. Cross Connection

No physical connection shall be allowed between a potable and a non-potable water supply system. Any connection is considered a cross connection. In addition, there shall be no physical connections between a potable water supply system and a wastewater system which would permit the passage of any wastewater or polluted water into the potable supply.

2. Backflow Prevention

To protect the public water system, a backflow preventer shall be installed and located on private property outside of the right-of-way or public utility easement. All maintenance of the backflow preventer is the responsibility of the property owner. Specific provisions regarding cross connections and backflow prevention are available through PDD, Backflow Prevention Program. Also refer to the City of Phoenix Adopted Plumbing Code as well as City Code, Chapter 37, Article XII.

IV. WATER DISTRIBUTION AND TRANSMISSION SYSTEMS

A. WATER SYSTEM OVERVIEW

1. Pressure Zones

Approximately 72 operating pressure zones serve the municipal water distribution system for the City of Phoenix (COP). These zones operate nominally within a static pressure range between 50 to 100 PSI and provides a minimum of 40 PSI at the customer's meter, which is in accordance with the City's Code. This 40 PSI minimum applies only if the property elevation is within the pressure zone elevation range, otherwise the developer/owner is required to install a private booster facility. With regards to typically high seasonal water demand variations among pressure zones with elevated storage, operating pressure fluctuations are normal. Information on pressure zones serving the various areas of the City can be obtained from the Water Services Department (WSD). Figure 12, *Typical Major Pressure Zone Configuration*, schematically shows a major pressure zone representing elevated storage. Not all pressure zones include elevated storage. Therefore, individual development design requirements may vary.

B. WATER MAIN DESIGN CRITERIA APPLICABLE TO BOTH DISTRIBUTION AND TRANSMISSION MAINS

1. Water Main Extensions

The water main extension policy of the COP is contained in Article II of Chapter 37 of the Phoenix City Code. As set forth in the Code, developers must pay all costs for constructing water mains necessary to afford adequate service during peak demands, including fire flow. Under certain circumstances, as described in Section 37-35 of the Code, repayment of the cost of "offsite" water mains (approach mains) may be available. For procedures on water repayments, refer to WSD Policy P-77, which is available on WSD's website. For website link refer to Appendix A, page ii.

2. Water Requirements for City Defined Areas (Master Plan)

Downtown Core Area: This area is defined as between 7th Street to 7th Avenue and Jackson Street to the I-10 Freeway. Refer to Figure 13, *Boundary Map for Downtown Core Area*, for the boundaries of the Downtown Master Plan. All new developments that occur within these boundaries require 12-inch water mains. Existing mains 6-inch in diameter and smaller are considered substandard within the Downtown Core Area and shall be replaced with 12-inch mains. All substandard mains shall be abandoned, left in place or as directed by WSD.

EXCEPTION: Adaptive Reuse Developments

Adaptive reuse projects that are within the Downtown Core Area may not be required to upsize 6-inch substandard mains. The developer or design engineer shall demonstrate the existing main is capable of meeting the project's total water needs as categorized below:

- a. Domestic water demand.
- b. Fire flow requirements.
- c. Fire sprinkler suppression system (if needed) demand.

NOTE: Water mains smaller than 4-inch shall be replaced regardless of the type of project being submitted with the exception of one new single family residence.

Figure 12 – Typical Major Pressure Zone Configuration

(Pressures have been rounded to the nearest 10 PSI)

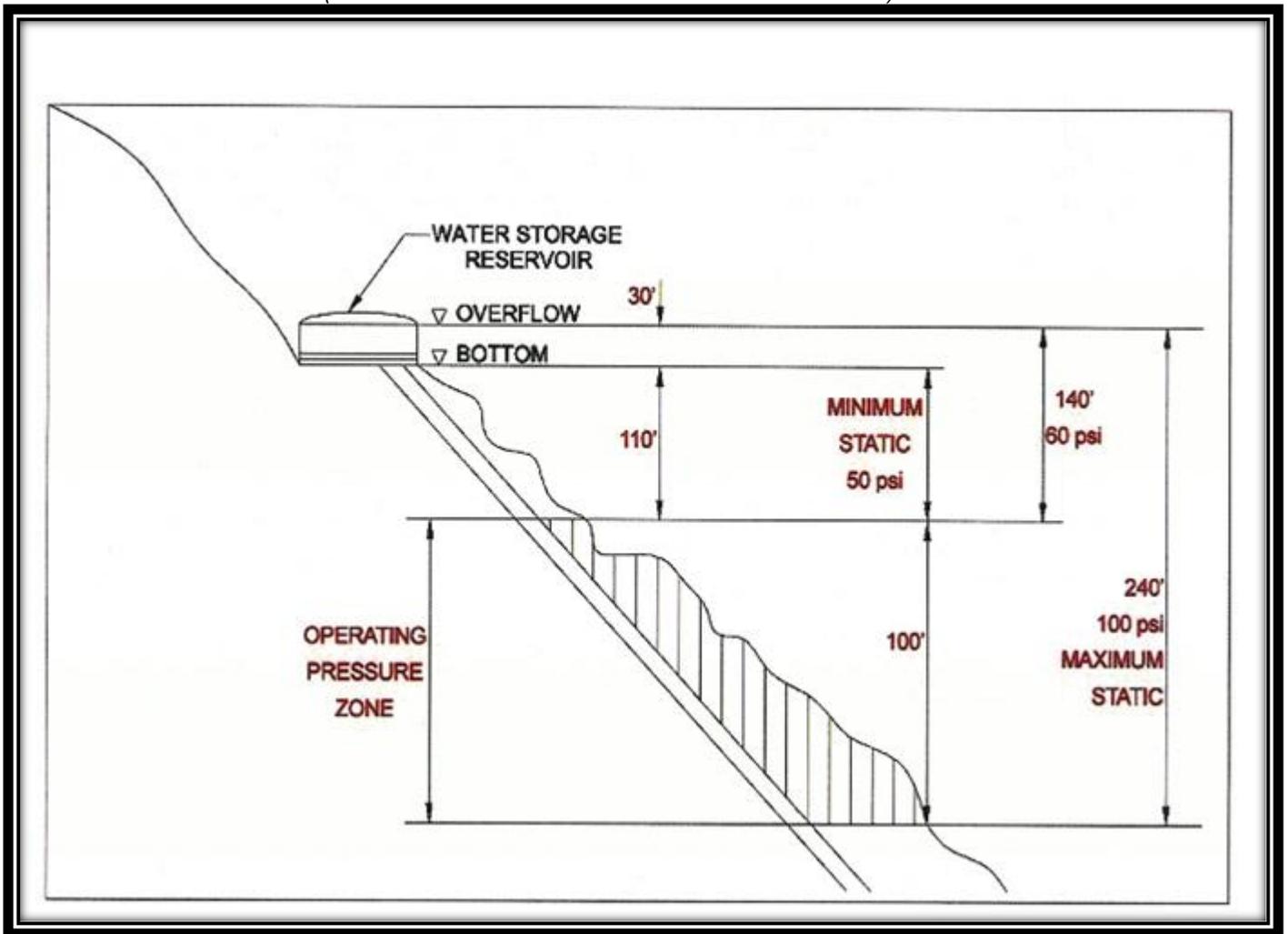
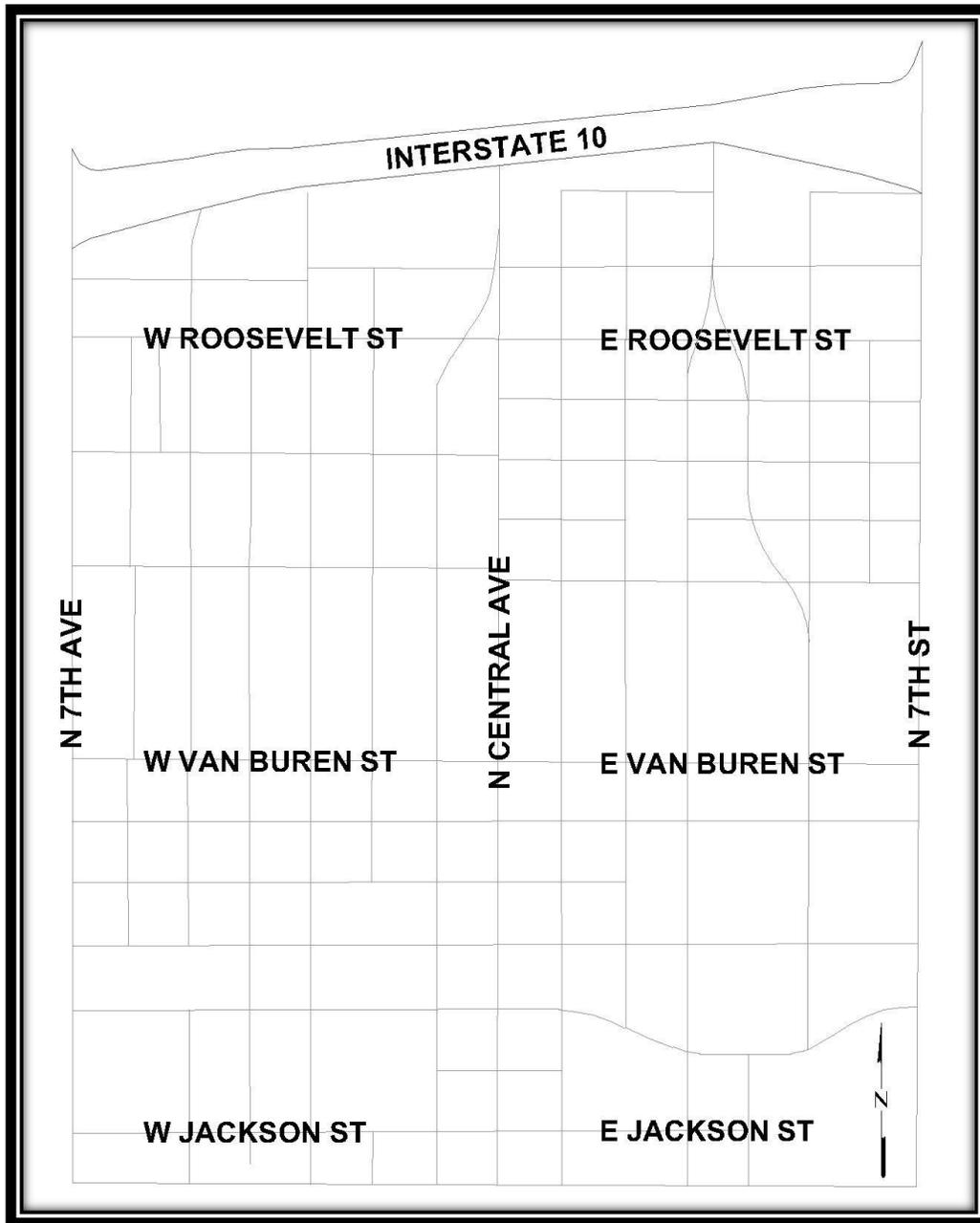


Figure 13 – Boundary Map for Downtown Core Area



3. Water Main Classifications

For the purposes of this manual, all water mains in the COP system that are 16-inches and larger in diameter, are classified as transmission mains. All water mains 12-inches and smaller in diameter are classified as distribution mains. **Exception:** occasionally water mains 16 inches in diameter can be either depending on the design application. In some cases, development water demands including fire flow may exceed the minimum pipe sized outlines in Chapter 37 of the Code. In the cases where the existing grid is not capable of providing adequate source water, a larger 16-inch main may be stipulated and then configured as a distribution main. WSD will make this determination.

4. Water Main Design

Generally, water main design shall be based on peak flow plus fire flow demands (not to exceed 3,000 GPM). In some circumstances, WSD may determine that larger or smaller water mains are required. Water mains shall be designed to maintain a pressure greater than or equal to 25 PSI at a point of maximum fire draft, at a velocity of less than or equal to 10 FPS. Furthermore, water mains shall be designed to maintain between 50 to 100 PSI during peak flow at a flow velocity of less than or equal to 5 FPS.

5. Fire Flow Demand

For fire flow demands, please refer to the current adopted City of Phoenix Fire Code. If the Fire Department requires more than 3,000 GPM, the engineer shall design the water system to minimize water age.

6. Hydraulic Requirements

WSD may require a hydraulic modeling analysis for a project in order to evaluate and properly develop the available water source.

NOTE: Modeling may identify a requirement for a booster station, pressure reducing facility, etc. WSD will make this determination.

7. Thrust Restraint for Distribution Mains

Joint restraint shall be used at all bends and fittings or where joint restraint devices are specified by the approved construction plan. Refer to MAG Standard Detail 303 and the COP Supplement Specifications 610 and 750.3.

All existing main's thrust restraint systems shall be protected, restored or replaced as required. Where existing thrust block-bearing soils are disturbed or when connecting to or modifying an existing system a new thrust restraint system shall be designed and installed for both the new and existing mains.

Thrust blocks are not allowed in place of approved restrained joint systems. Thrust blocks can be used in addition to the approved restrained joint systems where a specific COP Supplement Detail calls out for thrust blocking such as current COP Supplement Details P-1343, P-1351, and P-1360 or when otherwise approved by WSD through the Technical Appeal process.

The following MAG Details are **not** approved:
302-1 Joint Restraint with Tie Rods
302-2 Joint Restraint with Tie Rods- Anchor Blocks

8. Corrosion Protection/Ductile Iron Pipe

All ductile iron pipe (DIP) mains shall be protected from exterior corrosion per the City of Phoenix Requirements for Corrosion Protection Design Standards Development Report for Large Diameter Ductile Iron, Steel, CCP and RCP Water Transmission Pipelines. All DIP shall be encased in a polyethylene protective wrapping in addition to any other corrosion protection systems. Refer to COP Supplement Specification 750.2 and MAG Specifications Section 610.6.2 and 620.6.3 and the Technical Specification in Appendix A

For more information on corrosivity charts refer to the American Water Works Association.

9. Shop Drawings

For pipe and appurtenances larger than 12-inch, shop drawings and technical data are required for approval. After engineer's review and recommendation, shop drawings shall be submitted to WSD for review and approval. A minimum of three copies of each shop drawing and product data shall be provided.

10. Disinfection Testing

In accordance with MAG Specification 611, satisfactory water quality must be maintained for a 48-hour period during disinfection testing of potable water systems. The City of Phoenix does permit use

of the 24-hour coliform bacteria presence/absence test method for bacteria testing of water lines. Regardless of test method chosen, it must be approved by ADEQ.

Certification of ADEQ's approval of the test method used by the testing laboratory for each line section must be provided to the City of Phoenix.

Best management practices for protecting existing water mains opened for construction shall be implemented. Best management practices should include, but are not limited to, the following:

- Preventing debris from entering the opened pipe.
- Excavating a sump in the trench for pumping out the water and preventing water that has been in contact with the ground to enter the open pipe.
- Covering/sealing ends of existing lines removed from service to prevent intrusions of contaminants.
- Covering/sealing the ends of the pipe during storage and construction and after construction hours to prevent any intrusion of contaminants.

The entire portion of the existing water main which is removed from service must be disinfected if it has been exposed to the atmosphere for longer than 24 hours. This can be accomplished by the entire water main (both the new and existing lines) being disinfected between the closed line valves after the new main and the existing main have been tied in.

Applicable state regulations governing bacteria testing methods can be found at A.A.C. R18-4-106 (requiring use of approved analytical methods), R18-4-107 (requiring the use of a licensed laboratory) and R18-4-108 (requiring ADHS/EPA approval for sample collection, preservation and transportation procedures).

11. Existing Water Mains

During the design period, the break history of all water main in the vicinity of the Light Rail shall be obtained from the City, even if the pipelines are outside of the RUA. If a pipeline outside of the RUA is found to have a break history, the City may determine that the waterline will be replaced at the City's expense.

C. ADDITIONAL DESIGN CRITERIA ONLY APPLICABLE TO DISTRIBUTION MAINS

Distribution mains are 6, 8 or 12-inches in diameter. As described in Chapter IV, Section B, 16-inch mains are occasionally considered distribution mains. No other pipe sizes are allowed to be constructed within the Phoenix water distribution grid. Project designs shall make every effort to loop water mains throughout the development to limit dead ends.

1. Acceptable Pipe Materials

Distribution mains 6-inch through 16-inch in diameter shall be ductile iron pipe (DIP). The pipe shall conform to the MAG and COP Supplements and Specifications.

2. Pipe Sizing for Distribution Mains

The design engineer shall size all distribution system pipes and appurtenances in accordance with the provisions of this manual. Additionally, City Code 37-33(a) establishes a minimum water distribution master grid system for residential type development as indicated by Figure 14, *Minimum Water Main Sizing within COP Grid System*. For all other types of development, water mains are sized to meet fire flow requirements or approved master plans, whichever is greater.

Figure 14 – Minimum Water Main Sizing within COP Grid System

Location	Pipe Size (inches)
Section line streets or grid arterials	12
Mid-section line streets or mid-grid feeders	8
All other streets (see exceptions below)	6
Downtown Core Area **	12

The following four bullet points refer to Figure 14, Minimum Water Main Sizing within COP Grid System

- ** Refer to Figure 13 for the Boundary Map for Downtown Core area.
- Distribution mains that are single-feed (dead-end) systems and include fire hydrants shall be at least 8-inches in diameter.
- A 6-inch diameter distribution main configured as a system with 2 feeds (a looped system) can serve up to 6 fire hydrants. Additional hydrants can be served if the design provides for more feed points. A design analysis may be required by WSD for acceptance of such a system.
- This is a generalized pipe size guideline, which is subject to refinement in design analysis.

3. Distribution Main Cover

In accordance with MAG Specification 610, all distribution mains in major streets shall have a minimum cover of 4 feet over the top of the pipe from finished grade. Distribution mains in other locations shall have a minimum cover over the top of the pipe as follows:

- Three (3) feet for distribution mains smaller than 12-inches in diameter, unless located in an easement or major street, where 4 feet will be the minimum required.
- Four (4) feet for distribution mains 12 to 16-inches in diameter.
- If finished grade cannot be identified, increased depth may be required.

4. Line Valves

Figure 15, *Valve Spacing*, shows the maximum spacing for line valves on distribution mains.

Figure 15 – Valve Spacing

Land Use	Maximum Valve Spacing (feet)
Residential	800
Commercial and Industrial	600

In residential developments, valves shall be located so that a maximum of 30 single family dwelling units or a maximum of 5 valves are involved in a waterline shutdown. Additional valves may be required at tapping sleeves and valves and/or tee intersections.

- A valve shall be located on each side of a canal, wash, railroad, light rail, and freeway crossing.

- b. Valves shall not be located in curbs, sidewalks, driveways, and valley gutters.
- c. All valves shall conform to MAG Specification 610.6 and 630, including the COP Supplements thereto.
- d. Valves shall be located at the point of curvature (PC) or point of tangency (PT) of the curb return at street intersections and aligned with a property or lot line in mid-block. No valves shall be installed within major intersections.
- e. Valve boxes and covers shall be provided for all valves.
- f. An additional line valve shall be installed on dead-end lines, exclusive of mains that dead-end in a cul-de-sac, within 20 feet of the end of pipe to remove the necessity of shutting down residences and businesses should the main be extended in the future.

5. Service Connections (taps) and Meters on Distribution Water Mains

a. New Mains:

Where new mains are being installed by a developer, service connections and meter boxes/vaults will be installed by the developer's contractor.

b. Existing Mains:

All new service connections on an existing City water main shall be installed by WSD after all fees have been paid. Contact PDD at 602-262-6551 for more information.

1. When multiple distribution mains in the same pressure zone are adjacent to a development, all service connections shall be taken from the largest diameter main or as approved by WSD through the Technical Appeal process.
2. The service connections shall be limited in size to 50% of the service main diameter. On looped mains there shall be a limited number of service connections comparable to the equivalent existing main capacity. On a dead end main the service connection shall be limited to half that of the looped main. A new water main extension may be required when it has been determined that the existing main capacity has been exceeded.
3. Substandard Mains - (mains smaller than 6-inches in diameter) new service connections will only be allowed for a single family residence on a single lot where adequate fire protection has been verified. Contact a Fire Protection Engineer with the Planning and Development Department to determine fire protection requirements.

c. Service Connection Requirements:

1. **Meter Boxes/Vaults** – All meters shall be installed in a meter box/vault. The meter box/vault shall be located within the public ROW, water easement or PUE. In addition, each meter must be located out of a driveway, paved area or sidewalk. Meters may be located in a planter area, parking lot island, etc., and shall be sufficiently above finish grade to minimize flooding. Meter locations shall be easily accessible from a street. Meters 3-inches and larger require a meter vault. See vault detail W-500 on WSD's website. For the website link refer to Appendix A, page ii.
2. **Pipe Material** - Materials and installation for service lines from the main to the meter shall conform to MAG Specification 631 and the COP Supplement 610. All service lines for meters 3-inches and larger shall be DIP. Service lines for meters less than 3-inches shall be Type K Copper Tubing.
3. **Size** – All new domestic taps on existing or new mains for buildings including all single family residential lots shall be a minimum of 1-inch in size. New ¾-inch taps may be installed for landscape irrigation or other approved special uses only. Service connections can only be reduced down one size, e.g., a 2-inch tap can only be reduced to 1.5-inch, or 1.5-inch reduced to 1-inch or 1-inch to ¾-inch. Refer to WSD's fee schedule for allowable reducers to a service connection.
4. **Spacing** – A minimum 3-foot separation is required between water service connections.
5. **Static Water Pressure** – Where local static water pressure is in excess of 80 PSI or as per the COP Plumbing Code, a private pressure regulating or reducing valve shall be required on the customer side of the service meter.

6. **Separate Service for Each Demand** - A combination of fire, domestic and landscape meters is prohibited. Each demand requires a separate service connection. (PCC 37-73 & UFC 1001.6.1).
 7. **Backflow Preventer** - A backflow prevention assembly may be required. Refer to Chapter III for more backflow prevention information.
- d. Type of Uses:
1. **Master Meters** - A single service line and a master meter can be used as described below:
 - Two or more buildings located on the same lot (e.g., multi-family, trailer courts or similar projects covering one lot).
 - For single family residential attached (hybrid type developments) that do not comply with the City's private accessway and/or right-of-way requirements.
 - Developments using master meters must have a separate fire line connection and no more than two meters can be manifolded. If the property owner wants to use sub-meters beyond the city meter, it will remain as private and shall be the responsibility of the developer/property owner.
 2. **Mixed Use Developments** - (residential and commercial) require a separate meter and separate onsite plumbing for each type of use. Refer to WSD Procedure P-106 for additional information.
 3. **Landscape** - A separate landscape irrigation tap and meter is required for irrigated areas over 10,000 square feet, or 1,000 gallons or more per day (PCC Section 37-53(b) (1)).
 4. **Golf Courses/Lakes** - Water meters servicing golf courses, lakes or any other continuous maximum flow uses terminating at atmospheric pressure, require special approval from WSD. These installations require a flow control valve and/or a flow restriction device and may be limited to the use of reclaimed water.
 5. **Auto Court Cluster (Cluster)** – In a Cluster development, the meter boxes and service lines do not front a water main due to shared or common access drive between single-family detached lots. The meter boxes and service lines shall comply with the following:
 - a. Must be located in common tracts deeded to the homeowners association (HOA) for common purposes from the meter until such point as the service enters an individual lot. Water service lines shall not be permitted to cross adjacent lots even if a public utility easement exists on that lot.
 - b. The CC&R's shall require the HOA to be responsible for the maintenance and repair beyond the meter.
 - c. The service line shall have a minimum horizontal separation of 3 feet at the connection to the main and 6-inches at all other locations. Water service lines shall be installed insuring they do not cross each other.
 - d. Water service lines in common tracts shall have an identifier indicating which lot it serves. The identifier shall be located at the meter and every ten feet of pipe along the service alignment. The service line shall be constructed per the City of Phoenix Plumbing Code.
 - e. To minimize congestion, equal numbers of water meters should be placed on each side of a shared driveway.
 - f. Water Service Taps (Tapping Procedures)
The following procedure is to be followed for all tapping operations on existing water mains:
 - WSD shall be contacted to schedule the tap.
 - Per MAG Specification 610, all earth work, shoring access, fittings and materials for the tap shall be provided and installed by the contractor, consultant or private developer prior to scheduling the tap.

- The contractor, consultant or private developer shall be responsible for ensuring the excavation for the tapping equipment is large enough to accommodate the appropriate tapping machine.
- WSD inspectors shall be contacted 48 hours prior to the scheduled tapping date to arrange for the tap.
- The tapping saddle shall be disinfected prior to the actual tap.
- WSD personnel will perform the tap.
- Service installation and backfill are to be completed by the contractor, consultant or private developer.
- Size-on-size taps may be performed only on ductile iron pipe using full-circle stainless steel tapping saddles such as PowerSeal Model 3460AS or approved equal.

g. Vacant Land

Where vacant land is located in the vicinity of the Light Rail, the consultant or private developer shall work with the City to determine the potential future use of such land. The City will determine if a service connection will be made and extended to the vacant land.

NOTE: Additional provisions for service connections and meters are contained in Article III and Article IV, Chapter 37 of the PCC.

6. Water Meters and Sizing Guidelines

UPC Section 610.1: Water meters shall be sized in accordance with the table in Figure 16, *Water Meters and Sizing Guidelines*. The columns list the maximum allowable gallons per minute (GPM) and associated water supply fixture units allowed for any given meter size and type. Project designs which exceed the listed GPM unit values shall be upsized to the next larger meter. The Water Meter Sizing Table is also available on PDD's website. For website link refer to Appendix A, page iii.

Figure 16 – Water Meters and Sizing Guidelines

Column 1	Column 2	Column 3		Column 4	
Meter Size & Description	WSD & PDD Maximum Allowable G.P.M.	Maximum Flush Tank Fixture Tank Units		Maximum Flush Valve Fixture Units	
		UPC	IPC/IRC	UPC	IPC/IRC
5/8" X 3/4"	20	30	21	0	7
3/4" X 3/4"	30	54	53	13	14
1"	50	127	129	48	50
1-12"	100	380	375	245	245
2"	160	692	696	631	625
3" Compound	320	1,926	1,955	1,926	1,955
4" Compound	500	3,620	3,728	3,620	3,728
6" Compound	1,000	8,300	(1)	8,300	(1)
8" Compound	1,600	14,500	(1)	14,500	(1)

(1) The design method of the IPC is limited to 593 GPM maximum.

Column 1 identifies meter sizes and types available from the City of Phoenix. Use of water meter 6-inches and larger requires special advance consultation with WSD to determine availability, meter cost, and delivery schedule.

Column 2 is the design water meter flow rate as determined by WSD and PDD.

Column 3 is the maximum number of fixture units permitted on a water meter when the plumbing fixtures are predominantly flush valve type water closets and urinals. Values based on 2012 Uniform Plumbing Code (UPC), 2012 International Plumbing Code (IPC), or 2012 International Residential Code (IRC), whichever is applicable.

Column 4 is the maximum number of fixture units permitted on a water meter when the plumbing fixtures are predominantly flush type water closets and urinals, based on 2012 UPC, 2012 IPC, or 2012 IRC, whichever is applicable.

Turbine (Turbo) water meters are designed to accommodate large demands within a narrow range of fluctuating flow as those associated with industrial type development. These meters are not shown in the table above, but are still available on a case by case basis and their use will be determined by WSD WRDP Division in conjunction with PDD Plumbing Section staff.

D. TRANSMISSION MAINS

1. Acceptable Pipe Materials

Transmission mains 16-inches in diameter shall be ductile iron pipe (DIP). Transmission mains 16-inches through 42-inches in diameter, regardless of location, shall be DIP, concrete cylinder pipe (CCP), or steel cylinder pipe. Mains 48-inches in diameter and larger shall be DIP or steel cylinder pipe. The pipe shall conform to the applicable MAG Specifications and the COP Supplements thereto.

NOTE: Service connections will not be allowed on transmission mains.

2. Pipe Sizing

Transmission mains shall be sized to carry the designed peak flow required including fire flow without exceeding the velocities or headlosses shown on Figure 17, *Allowable Velocity/Headloss*, which shows specific requirements for transmission mains.

Figure 17 – Allowable Velocity/Headloss

Pipe Size (inches)	Maximum Allowable Velocity (fps)	Maximum Allowable Headloss (ft/1000 ft)
16	5	6.06
20	5	4.66
24 and larger	5	Varies*

**To be determined by WSD*

NOTE: The above table is based on a Hazen-Williams pipe roughness coefficient of $C = 120$.

3. Cover

Minimum cover from finished grade to the top of the exterior surface of the pipe shall be 6.5 feet for 16-inch water mains and larger. If finished grade cannot be identified, increased depth may be required.

4. Line Valves

Figure 18, *Line Valve Spacing*, shows the maximum spacing for line valves on transmission mains.

Figure 18 – Line Valve Spacing

Pipe Size (inches)	Maximum Spacing (feet)
16 to 30	2,640
Greater than 30	5,280

All valves shall conform to MAG Specifications 610, COP Supplements 610 and 630. Also refer to COP Supplement Detail P-1391.

An isolation valve shall be placed at the main between the water main and each fire hydrant and a second maintenance valve at the fire hydrant when installed on a transmission main.

Line valves on transmission mains up to 36-inch may be gate valves or butterfly valves. A typical valve installation is shown in WSD’s Large Pipe Details. For a copy of the typical valve installation details, contact WSD.

If WSD requires the installation of electronic monitoring and remote operation equipment, the line valve shall be a butterfly valve with a rectangular vault, housing the valve operator and telemetry equipment. Each installation will require individual details. The design engineer shall check with WSD on acceptable equipment and the specific design requirements.

A valve shall be located on each side a light rail crossing outside the RUA.

5. Restraint Systems

All bends, fittings, line valves, and bulkheads shall be restrained by using a joint restraint system compatible with the type of pipe. WSD will review all restraint systems prior to approval. The length of the restraint system shall be shown on the construction plans and complete supporting data on the restraint system design shall be submitted to WSD for review and approval. Concrete thrust blocks

will not be accepted in lieu of restrained joints, but may be used in conjunction with restrained joint systems as approved or required by WSD.

6. Corrosion Protection

Corrosion protection shall be provided per the City of Phoenix Requirements for Corrosion Protection Design Standards Development Report for Large Diameter Ductile Iron, Steel, CCP and RCP Water Transmission Pipelines.

7. Side Outlets

Flanged side outlets are provided to integrate parallel or crossing distribution lines. A minimum 12-inch flanged side outlet with a flanged side valve shall be provided at 1,320 foot intervals along the alignment. When connecting a transmission main to a distribution main, a maintenance valve at the connection to the distribution main shall be installed in addition to the flanged side valve from the transmission main. Prior to approval, WSD must review the location of outlets and tie-in connections to any existing or proposed facility including the bulkheads at the end of transmission mains.

8. Bypass Assemblies

Bypass assemblies shall be provided at valves on transmission mains 16-inches and larger in diameter. A typical assembly is shown schematically in WSD's Large Pipe Details. For a copy of the bypass assembly detail, contact WSD.

Bypass assemblies shall be installed a minimum of 150 feet away from any intersection to keep maintenance crews out of traffic.

Transmission mains between valves shall be treated as an independent unit with provisions for dewatering, filling, removing air, and adding air as appropriate for the transmission main construction and maintenance. A bottom tangent flanged outlet shall be provided at all profile low points and a top tangent flanged outlet shall be provided at all profile high points in all transmission mains.

9. Air/Vacuum Valve Assemblies

All air/vacuum valve assemblies for transmission mains require individual approval by WSD. Air/vacuum relief valve assemblies shall be installed at high points in the transmission main at locations approved by WSD. Air/Vacuum valve assemblies are to be used only when it is determined that a fire hydrant is not appropriate.

10. Access Outlets for 42-inch Mains and Larger

Access outlet with manhole as shown in WSD's Large Pipe Details shall be installed on 42-inch diameter and larger transmission mains on each side of a line valve and shall not exceed 2,600 feet unless otherwise approved by WSD through the Technical Appeal process. For a copy of the access outlet detail, contact WSD.

11. Use of Fire Hydrants and Placement

In water mains 16-inches and larger a fire hydrant shall be placed at the high point and/or low point of the profile to permit air release, de-watering and maintenance purposes when applicable. The bonnets on these hydrants are to be painted black.

12. Testing and Final Acceptance

The construction project is functional only after demonstrating the completion of pressure testing, bacteriological testing, and final inspections. Then an acceptable flushing schedule and chlorine residual monitoring plan shall be prepared by the design engineer to maintain and demonstrate an acceptable level of turnover during the early period of new project operation. Upon substantial completion, the start-up and commissioning period is ready to begin. The start-up details and duration of commissioning shall be identified early on and listed in the project scope of work by the design engineer.

E. FIRE LINE SYSTEMS

A fire line is a private pipe system connected directly to the City water system. All maintenance of the private fire line is the responsibility of the property owner and begins at the control valve located within the public right-of-way or water easement. A fire line, by the nature of its function and use, is susceptible to backflow. Consequently, it is subject to the requirements for backflow prevention. Above ground installation of backflow prevention devices shall conform to the requirements as written in City Code, Chapter 37, Article XII.

A fire line shall be utilized for fire protection only and shall serve only a single property. Typically, a fire line is a connection for on-site private hydrants or an interior fire sprinkler system for a building. WSD's review and approval interest is limited only to that portion to be constructed in the ROW or water easement.

1. Acceptable Pipe Materials

All fire line installations shall conform to the applicable MAG Specifications and Details and the COP Supplements thereto. A fire line sized 4-inch and larger shall be constructed of ductile iron pipe (DIP) from the control valve at the water main to the property line, backflow prevention device or detector check valve.

2. Design Requirements

All fire line installations shall be approved and permitted collectively by the Fire Department, PDD or WSD. Fire lines shall conform to the City Fire Code and the following WSD requirements:

- a. The standard size for fire line connections shall be 4-inches or larger. Fire lines smaller than 4-inches will require a meter. The meter will be installed by city forces after application and will be locked in the open position.
- b. Every fire line shall connect perpendicular to the public water main with a control valve. Fire lines cannot be installed at the end of a dead-end main.
- c. If the Fire Department determines that a fire pump system is needed requiring a redundant water source (i.e. two fire line connections), the water supply shall be provided from multiple water mains serving the same pressure zone. If two water mains are not available and the fire lines shall connect from a single source, WSD must review the proposed connections prior to PDD approval.
- d. Backflow prevention devices are required per the City of Phoenix Adopted Plumbing Code and the City Code, Chapter 37, Article XII. The backflow preventer shall be installed on private property and outside of the right-of-way or outside of the public utility easement. For additional requirements on backflow prevention refer to Chapter III.
- e. Properties may require a detector check assembly with a bypass meter assembly when one or more of the following conditions exists or may exist:
 - There are hose connections on the on-site water system other than hose cabinets or racks.
 - There are fire hydrants or yard hydrants on the on-site water system, which are not equipped with a locking device approved by WSD. The keys to such locks shall be delivered to the Fire Department.
 - The on-site water system includes outlets for future connections.
 - The on-site water system allows fire demand flow rates to occur without activating an alarm.
 - There will be an obvious means by which water from the on-site fire system might be used for purposes other than firefighting.

NOTE: *The design engineer shall check with PDD as to the need for a detector check device in these cases.*
- f. The public water system can fluctuate 20 PSI higher or lower than the average system pressure. The fire line shall be designed to accommodate the increase or decrease of pressure fluctuations.

F. IRRIGATION SYSTEMS

In accordance with Section 37-113 of the PCC, a Landscape Water Permit is required for irrigation of large turf-related facilities. A large turf-related facility is defined as a site that has 5 or more acres of turf or high-water-use landscaping. Schools, parks, cemeteries, and golf courses typically fall into this category.

A permit application may be obtained from WSD Water Resources Development Planning - Water Conservation Office. A permit may be issued after a Water Conservation and Non-Potable Water Use Plan is submitted and approved by WSD. A condition of the permit will be that non-potable water shall be used for irrigation unless the cost of providing non-potable water would be prohibitively high to the developer or WSD. WSD shall make that determination. The developer will need to enter into a contract for the sale and use of non-potable water before the service connection can be approved.

G. FIRE HYDRANT REQUIREMENTS

Public fire hydrants shall be located where they can be quickly found and easily used by fire engines arriving at an incident. Standardized location criteria is based on predictability, visibility, unobstructed accessibility, the type of development, Fire Department tactical needs, and the expected route fire engines will travel to the site.

Determining proper fire hydrant location requires the application of engineering judgment and common sense to the specific conditions found in each project. Minor variances in the locations or spacing of individual hydrants may be approved provided the functional intent of these design standards is achieved.

1. Location and Design Requirements

- a. Shall be installed in the public right-of-way or a dedicated water easement.
- b. Located on the right hand (passenger) side of streets, intersections, driveways, entrances to a development and fire lanes within 6 feet of the curb. This location matches the hose connections on fire pumpers and allows the hydrant to be connected in the quickest, most efficient manner.
- c. When designing a fire hydrant layout, the first hydrant is to be located at street intersections and at the main entrance into a subdivision, apartment complex or commercial development. Additional hydrants shall then be spaced approximately evenly between these points at a distance not to exceed the maximum spacing between hydrants as shown in Figure 19, *Fire Hydrant Spacing*. Spacing is measured along the route of travel of a fire engine.
- d. Located not less than 1 foot and not more than 6 feet from the back of curb along streets in accordance with the COP Supplement Detail P-1362.
- e. Place hydrant within 30 feet of a dead end water main greater than 100 feet in length to facilitate flushing and maintenance of the water main. However, a fire hydrant and valve may be placed directly at the end of a dead end main only if the hydrant is public and it's apparent that the water main cannot be extended any further, for example in cul-de-sacs or at the end of a water pressure zone.
- f. No hydrant will be required on a cul-de-sac if all houses are within 350 feet of a hydrant and the dead end water main is less than 100 feet. The water main shall end with a tapped cap and a corporation stop, with a valve box and lock as approved by WSD.
- g. Do not obscure or obstruct hydrants behind fences, gates, walls or landscaping.

2. Coverage Requirements

- a. Existing fire hydrants on major streets, collector streets or any other streets not divided by raised median islands or light rail tracks can be included in the coverage analysis. If those street classes are divided by raised median islands or light rail tracks, then the existing hydrant can only be included in the coverage analysis if it is located on the same side as the new development.

- b. Existing fire hydrants determined to be on a transmission main are intended for air relief, dewatering, and maintenance purposes and can be scheduled out of service periodically. Therefore, these fire hydrants shall not be included in the total count to meet a developer's fire hydrant coverage requirement. The bonnets on these hydrants are painted black.
- c. Fire hydrants separated from a subdivision, building or other development by a continuous fence, wall or other obstruction cannot be counted as providing protection to that subdivision or development. For example, where a residential subdivision is separated from its perimeter street by a continuous fence, fire hydrants shall be installed along the perimeter street (City Code Section 37-33) and internally along the streets within the subdivision, with hydrant spacing measured along the route of travel of the fire engine, not over the fence.

3. Clearance Requirements

All fire hydrants shall maintain a 6-foot horizontal clearance from any utility and above ground structures.

4. Specification Requirements

All fire hydrants shall be dry barrel type conforming to MAG Specifications 610, 756, COP Supplement 756 and COP Supplement Details P-1359, P-1360, P-1361 and P-1362.

5. Maximum Fire Hydrant Spacing

Figure 19, *Fire Hydrant Spacing*, shows the maximum spacing for fire hydrants. Spacing distance shall be measured along the centerline of the street or route, which the fire truck will most likely travel.

Fire hydrant spacing requirements apply to all new developments, including those that do not need to install new public water mains. New developments adjacent to existing water infrastructure shall install the necessary hydrants to meet the spacing requirements.

Figure 19 – Fire Hydrant Spacing

Development Type	Maximum Spacing (feet)
Single Family Residential	500
Townhouses and Apartments	300
Commercial and Industrial (including Shopping Centers) ¹	300

¹ A fire hydrant is required within 400 feet of the most remote building corner or the most remote hazard on site, measured as the hose lays along designated fire lanes or other clear access routes (within 600 feet of the most remote corner of fire sprinkled buildings).

6. Fire Hydrant Relocations

In the design phase of projects, every attempt should be made to locate driveways outside of existing fire hydrant locations. In the event that a hydrant must be relocated, the relocation shall be in accordance with COP Supplement Detail P-1344, which requires the existing service line and valve be cut and removed from the existing water main and a new section of pipe installed with a flexible coupling. A new fire hydrant service line shall be installed perpendicular to the new hydrant location.

In circumstances where the relocation of the existing hydrant would be 5 feet or less in either side-to-side direction, WSD will allow a 90-degree bend to be placed on the existing hydrant service line and the hydrant to be relocated. Hydrant relocations with a 90 degree bend will only be allowed up to a maximum distance of 5 feet.

7. Private Fire Hydrants

Private hydrants are those hydrants located on private property and/or connected to any water line not owned and maintained by WSD. Private fire hydrants shall have their bonnets painted reflective white to identify them as privately owned and maintained. The property owner is responsible for maintaining all private fire lines and private fire hydrants.

H. Water Main Shutdown Accommodation Guidelines

NOTE: *These guidelines do not address situations involving fire service connections.*

For the purposes of this subsection, the term “contractor” can mean any party (contractors, engineers or City forces) requiring a planned shutdown.

These are intended to be guidelines only and allow a degree of flexibility in working with the affected water customer.

It is to be understood that the existing water transmission and distribution systems are operating systems and that equipment such as valves, air release valves and fire hydrants may at times fail to operate as expected due to the age of the equipment. In the event that any such equipment fails to operate properly during a shutdown, the contractor, consultant or private developer shall not be entitled to any additional cost or time extension due to the failure. The WSD will make every effort to minimize equipment failures and, in the event of a failure, the shutdown may be re-scheduled as soon as the affected customers can be re-notified, and the valve closure can be re-scheduled.

1. Initial Contact with Water Customers

The City has made a commitment to early citizen notification and involvement. All water customers impacted by a planned shutdown shall be notified at least one week in advance of the shutdown date. Face-to-face communication at the residence or place of business is the preferred method of contact. As directed by the City, the contractor, consultant, private developer or his representative shall provide the water customer the following information:

- Date of the shutdown.

- Time and duration.
- Known customer service connections impacted (including fire lines).
- Contractor, consultant or private developer contact telephone numbers (prior to the shutdown and contractor emergency number during the shutdown).
- Any other notification requirements required under METRO contract specifications.

2. Recognition and Consideration of Customer Issues

During contact with water customers, the contractor, consultant or private developer shall solicit any particular concerns or circumstances impacting customers during the proposed shutdown. Water customers should be allowed to offer and suggest alternate timelines for the shutdown.

Heightened efforts for clear and interactive communications shall be undertaken for the following customers. Absent any alternate arrangements or agreements between the contractor, consultant or private developer and a water customer impacted by a temporary water service disruption, *these customers will be provided with continuous water service* that meets the minimum needs of the customer:

(These have previously been identified as Light Rail “Critical Customers”)

- 24-hour health care facility.
- Beauty shop/day spa.
- Day care facility.
- Dialysis center.
- Elderly housing.
- Facilities with fire protection systems.
- Hospital.
- Hotel/motel.
- Individual with mobility limitations.
- Individual with serious medical concerns.
- Major employer (50+ employees).
- Major food preparation facility/restaurant.
- Nursing home.

3. Accommodations during Shutdown Events

To the extent practical, and in consideration of the varying needs of multiple customers involved in a single shutdown event, the contractor, consultant or private developer is expected to review the requirements of each impacted water customer and to provide adequate services, including the following, for any and all impacted customers:

- Adjustment to the shutdown date.
- Adjustments to the shutdown window (start and finish time of scheduled shutdown).
- Consideration of multiple, shorter-duration shutdown periods (should that appear more practicable for customers).

4. Water Shutdown Requirements for distribution mains 12-inch and smaller

- a. The maximum allowable shutdown time shall typically be no longer than 8 hours. The maximum allowable time shall be defined as the time that any of the affected customers are without functional water service. No shutdown will be allowed without the notification of the affected customers. The contractor, consultant or private developer is responsible to coordinate shutdown time and duration with the affected customers to minimize disruption of service.
- b. Temporary piping, valve and fitting requirements for continuous water service shall be the responsibility of the contractor, consultant or private developer. The contractor, consultant or private developer shall determine the need for temporary services through the

information gathered during interviews with each affected customer. It is the contractor's, consultant's or private developer's responsibility to minimize impact to the affected customer during the service outage. All cost for temporary piping, coordination, affected customer interviews, planning, engineering and implementation of temporary piping will be considered subsidiary to the applicable bid item.

- c. In cases during extended shutdown, where a portion of the existing main is taken out of service creating a dead-end condition, which, in the opinion of the WSD or its designated representative, creates a potential for water-quality degradation, the contractor, consultant or private developer (at its own expense) shall install a flushing connection and shall flush the line as necessary to maintain chlorine residual indicative of normal operation.
- d. The contractor, consultant or private developer shall prepare and submit a shutdown request to WSD for each relocation, tap or tie-in activity requiring a distribution main shutdown. The Contractor shall contact the inspector to make the necessary arrangements to have the City forces perform the required work. With the exception of permit work, there will be no charge for valve cut-ins, waterline shutdowns, and wet taps that are necessary for construction. Water distribution main shutdown request form is provided in Appendix F, attached to this manual.
- e. Shutdown requests shall be submitted to the WSD a minimum of two weeks prior to the proposed shutdown date.
- f. The engineer shall investigate and provide valve numbers on the plans that are required to be operated to complete the work.

5. Water Shutdown Requirements for transmission mains 16-inch and larger

- a. When shutdowns are required on transmission mains 16-inches and larger, the engineer shall coordinate with WSD during the design phase of a project to develop an initial construction schedule and scope of work. Shutdown of critical infrastructure such as transmission mains requires up to two years advanced notice. The shutdown duration shall be restricted to the minimum period of time required to complete the work. All shutdowns of transmission main constraints shall be dictated by WSD. The WSD, or its designated representative, will determine these constraints and the contractor, consultant or private developer shall update its construction schedule and sequence to take the constraints into account. Under no circumstances shall the contractor be entitled to additional compensation or time extension due to WSD requirements for shutdown.
- b. Typically, transmission mains cannot be shut down between May 15 and October 1 during peak water demand.
- c. The engineer, contractor, consultant or private developer shall prepare and submit a Shutdown Project Information Form for each required transmission shutdown as soon as the plans are finalized. A detailed construction shutdown plan for each relocation, tap or tie-in activity requiring a transmission main shutdown shall be developed using the Shutdown and Disinfection MOPO form. The MOPO shall be submitted for review a minimum of 45 working days prior to the proposed shutdown date. The MOPO shall be approved by WSD at least two weeks prior to the start of the event. Shutdown Project Information and MOPO forms are provided in Appendix F, attached to this manual.
- e. The engineer shall investigate and provide valve numbers on the plans that are required to be operated to complete the work.

6. Shutdown Notification Plan

The contractor shall prepare and submit a Shutdown Notification Plan to WSD, or its representative, for approval. The contractor shall not be permitted to proceed with the work until WSD has approved the Shutdown Notification Plan.

At a minimum, the Shutdown Notification Plan shall include the following:

- a. A sample of the means and methods for notifying customers affected by the construction and shutdown. The means and method of notification of residential customers can be a

flyer that can be delivered to those affected. Commercial customer notification will require direct contact with the customer. At a minimum, the notification shall state the following:

- Purpose of the shutdown.
 - Anticipated impact on the customer
 - Expected shutdown start time and duration.
 - Contractor's 24-hour project hotline number that is staffed during the daytime, is bi-lingual (English/Spanish) and plays a recorded message with emergency numbers for night time use.
 - Contractor's mailing address and field location.
 - Instruction to the affected customers to call in or send written notification that they received the notification, and whether the customer has any special requirements for the temporary discontinuation of water service.
 - A sample notification flyer is provided in Appendix F, Form SD-8.
- b. Once the WSD and its representative have approved the contractor's Shutdown Notification Plan, the contractor shall adhere to the following requirements:
- Notify the WSD and its representatives of the shutdown 14 days prior to the start of construction.
 - Notify the City of Phoenix Fire Department of any hydrants or fire services out of service as a result of the shutdown 14 days prior to the start of construction. Use Form SD-9 (Appendix F) for Fire Department notification.
 - Complete the general customer notification 7 days prior to the planned shutdown date.
 - Collect signatures/initials or letters of acknowledgement from customers who received the shutdown notification. This information shall be reflected in Form SD-4 (Appendix F).
 - Re-notify affected customers 24 hours before the planned shutdown.

The contractor shall make every effort to notify and collect the proper signature/acknowledgement from affected customers. The contractor shall also have the sole responsibility of documenting the construction and shutdown notification process.

The WSD will not operate any water main valves for shutdown or perform the tie-ins until the construction and shutdown notification list has been verified, or until all construction and shutdown notification requirements have been met by the contractor.

In the event the duration of the shutdown exceeds the planned and notified shutdown duration and schedule, the contractor will immediately notify affected customers of the extended duration of the shutdown and the expected time of return of service. The contractor shall immediately make available bottled water to affected customers and have available bulk water supplies such as potable water tanks or trucks.

V. WASTEWATER COLLECTION SYSTEM

A. GENERAL REQUIREMENTS

NOTE: Any and all more stringent requirements by Federal, State, County or local codes or ordinances shall take precedence.

1. Arizona Aquifer Protection Permit Requirements

The design of sewage collection systems shall conform to the requirements of the Aquifer Protection Permit General Permit rules in Arizona Administrative Code, Title 18, and Chapter 5-505. An Application for *Approval to Construct* and/or *Notice of Intent to Discharge* shall be submitted in accordance with AAC R18-9-A301(B) and E301(C). An *Approval to Construct* and/or *Provisional Verification of General Permit Conformance* shall be issued prior to commencing construction. *Approval to Construct* and/or *Provisional Verification of General Permit Conformance* include, but are not limited to, the following requirements:

- Engineer's Design Report.
- Complete Construction-Ready Design Plans.
- Specifications (CIP projects).
- All other relevant information to verify that the facility conforms to the terms of the 4.01 General Permit.

The design report, plans and specifications shall be signed and sealed by an Arizona Registered Professional Civil Engineer.

The sewage collection system shall not be placed in service until an *Approval of Construction* and/or *Verification of General Permit Conformance* has been issued. *Approval of Construction* and/or *Verification of General Permit Conformance* includes, but is not limited to, the following requirements:

- An Engineer's Certificate of Completion sealed and signed by an Arizona Registered Professional Civil Engineer, attesting that the sewers have been constructed to the requirements of AAC R18-9-A301.
- As-built drawings, with each changed sheet sealed and signed by an Arizona Registered Professional Civil Engineer, are submitted to the Water Services Department (WSD).
- Satisfactory test results from deflection, leakage, and uniform slope testing are confirmed by the City of Phoenix (COP).
- All other relevant information to verify that the facility conforms to the terms of the 4.01 General Permit.

2. Sewer Main Extension

Sewage collection systems shall comply with the requirements of Chapter 28 of the PCC. The sewer main extension policy of the COP is contained in Article III of Chapter 28 of the PCC. Developers shall pay all costs for constructing all elements of the public wastewater system authorized by the City. Under certain circumstances as described in Section 28-23 of the PCC, repayment of the cost of "off-site" sewer mains may be available. For procedures related to sewer repayment, refer to WSD Policy P-77, which is available on WSD's website. For website link refer to Appendix A, page ii.

For developments that are located outside the City of Phoenix limits and are seeking to connect to the City's sewer system, refer to WSD's Policy P-105. For website link refer to Appendix A, page ii.

Sewer extensions shall be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension at a manhole with special consideration of an appropriate flow channel to minimize turbulence when there is a change in sewer size. A relief sewer may be planned in the future. All new sewer mains shall be extended to the point of need.

Sewers shall be laid with straight alignments between manholes. Curvilinear sewers are not permitted. Sewer alignment shall not meander across the street centerline.

B. GRAVITY SANITARY SEWER MAINS

1. Acceptable Pipe Materials

Gravity sewer mains shall be vitrified clay pipe (VCP), reinforced concrete pipe (RCP) or ductile iron pipe (DIP) as indicated below. For pipes 15-inches and smaller, WSD prefers VCP to be used unless DIP is necessary for extra protection per MAG Specification 610.5.5, MAG Detail 404, and A.A.C. R18-5-502(c). Other materials may be used as approved by WSD through the Technical Appeal process. The pipe shall conform to the applicable specifications as follows:

- a. VCP and Fittings: MAG Specifications and the COP Supplement Section 743. VCP may be used for sewer mains 8-inches through 42-inches in diameter.
- b. RCP and Fittings: MAG Specifications and the COP Supplement Sections 735 and 741. RCP shall be Polyvinyl Chloride Pipe (PVC) lined. RCP may be used for sewer mains 30-inches in diameter and larger.
- c. DIP and Fittings: MAG Specifications and the COP Supplement Section 750. DIP may be used for sewer mains 8-inches through 54-inches in diameter. When DIP is used, it shall be lined with Protecto 401 ceramic epoxy. All DIP shall be protected from exterior corrosion per the City of Phoenix Requirements for Corrosion Protection Design Standards Development Report for Large Diameter Ductile Iron, Steel, CCP and RCP Water Transmission Pipelines. This protection shall consist of encasement a polyethylene protective wrapping in addition to any other corrosion protection systems. Refer to COP Supplement Specification 750.2 and MAG Specifications Section 610.6.2 and 620.6.3 and the Technical Specification in Appendix D.

2. Pipe Sizing

Gravity sewer mains shall be sized to accommodate the peak design flow subject to the following limitations:

- a. The d/D ratio for gravity sewer pipes shall be no greater than 0.75 at the peak flow condition.
- b. Minimum pipe size shall be 8-inches.

3. Slope

Gravity sewers shall be designed and constructed to provide mean velocities of not less than the velocities shown in Figure 20, *Design Slopes*, based on Manning's formula, flowing full, and using an "n" value of 0.013. The minimum slopes required to maintain the minimum mean velocity are shown in Figure 17, *Allowable Velocity/Headloss*.

Designers shall minimize grade changes to be uniform throughout the entire pipeline project as well as from manhole to manhole. WSD will not permit the use of larger pipe diameters than required to carry the peak flow in order to reduce the slope.

Figure 20 – Design Slopes

Pipe Sizing (inches)	*Minimum Design Velocity (feet/second)	Minimum Design Slopes (%)	Maximum Design Slopes (%)
8	2.1	0.380	6.980
10	2.2	0.306	5.121
12	2.3	0.256	3.919
15	2.4	0.205	2.880
18	2.4	0.140	2.390
21	2.5	0.146	1.890
24	2.6	0.127	1.520
27	2.6	0.115	1.378
30	2.7	0.102	1.113
36	2.7	0.085	0.945
42	2.8	0.073	0.754
48	2.9	0.064	0.616
54	3.0	0.058	0.522
60	3.0	0.051	0.430
66	3.1	0.047	0.396
72	3.1	0.043	0.362
78	3.2	0.040	0.316
84	3.2	0.037	0.293
96	3.3	0.032	0.238
108	3.3	0.028	0.208
120	3.4	0.026	0.182

** The velocities are based on the minimum required design shear stress recommendations provided in the American Society of Civil Engineers Manual of Practice No. 69 (MOP 69). These velocities will provide the design shear stress required to transport fine sand and grit particles less than 0.2 mm in diameter.*

4. Cover

Generally, all sewer mains shall have a minimum 7 foot of cover or a sufficient depth to serve the ultimate drainage area to include serviceable areas outside of the development project.

Sewer mains installed with less than 4 feet of cover require approval by WSD through the Technical Appeals process. Sewer mains constructed in washes and floodways shall have their crowns at least 2 feet below the 100 year storm scour depth and shall be constructed with ductile iron pipe (DIP). The DIP shall extend a minimum of 10 feet on each side of the 100-year storm scouring, which would be manhole to manhole.

5. Sewer Main Connections at Manholes

There shall be no more than 4 connections at a manhole or structure, including the outlet sewer.

At manhole connections, the angle between the upstream pipe and the downstream pipe shall conform to the following guidelines:

- Sewer mains 15-inches and larger in diameter shall not change flow direction more than 45 degrees in one manhole. Two manholes shall be constructed to change flow direction more than 45 degrees and up to 90 degrees.
- Sewer mains smaller than 15-inches in diameter shall intersect with manholes maintaining a minimum of 90 degrees to the downstream pipe.
- The upstream pipe shall be the same or smaller diameter than the downstream pipe. Inverts through manholes and junction boxes shall be designed to maintain the energy gradient across the structure. Manholes and junction boxes having sewer mains intersecting at 45 to 90 degrees shall have a minimum 0.10 foot drop across the structure.

Figure 21 – Connections to Existing Sewer System

(Applies only for new sewer main connections to existing sewer systems.)

CONNECTIONS TO EXISTING SEWER SYSTEM			
Existing Pipe Diameter	Proposed Pipe Connection Size	CONNECTION REQUIREMENT	
		Connecting to END manhole	Connecting to THROUGH manhole
Less than 15-inches	Same	Crown to Crown	Invert to Springline ¹
	Same	Crown to Crown	Invert to Springline ¹
15-inches and larger	Same	Crown to Crown	Invert to Springline ¹
	Smaller than existing pipe and less than 15-inches	Invert to Crown	Invert to Crown
	Smaller than existing pipe and > or = 15-inches	Crown to Crown	Crown to Crown

¹ For new systems

6. Buoyancy

Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where high groundwater conditions are anticipated and within the 100-year floodplain where trenches could become saturated due to flooding.

7. Depressed Sewers

Depressed sewers, inverted siphons or sag pipes are not permitted.

8. CCTV Inspections

All newly constructed sewer lines shall be closed-circuit television (CCTV) inspected by the City of Phoenix prior to final acceptance. CCTV procedure is as follows:

- A request for CCTV inspection shall be submitted to the City of Phoenix using the City of Phoenix TV Sanitary Sewer Main CCTV Inspection Request Form, a copy of the line section drawing with highlighted area to be inspected, and a quarter-section sketch. Submit request two weeks prior to the inspection date.
- CCTV section shall schedule a supervisor to inspect the site prior to inspection. The supervisor will set the date and time for the CCTV crew to perform the inspection directly with the contractor.
- The contractor shall provide traffic control, clean the sewer main prior to inspection, and provide sewer plugs as requested by CCTV section personnel.

- d. CCTV crew shall perform the inspection as scheduled.
- e. CCTV crew shall prepare a written report and a DVD, which will be delivered to the contractor.
- f. The contractor shall be responsible for reviewing the written report and DVD, making any corrections, and the rescheduling of a follow-up CCTV inspection, if applicable.
- g. A follow-up inspection will require the contractor to submit a request with all appropriate documentation as outlined in the first step above (full package is required).
- h. All additional inspections required due to failure of the initial inspection will be paid for by the contractor.

NOTE: See Appendix G attached to this Manual for the TV Inspection Request form.

9. Sewer Bypass Pumping

Whenever it becomes necessary to construct temporary bypass of sewer lines around a construction area, the contractor, consultant or private developer shall provide all labor, materials and supervision to temporarily bypass flow around the contractor's, consultant's or private developer's work. The actual design of the bypass arrangement shall be prepared by the contractor, consultant or private developer and shall be submitted for approval to WSD.

The contractor, consultant or private developer shall adhere to the guidelines defined in the Sewer Bypass Specifications. See Appendix H attached to this Manual.

It is the contractor's, consultant's or private developer's responsibility to arrange the necessary access and temporary construction agreements with all affected parties for the location of the bypass pumping system. It is also the contractor's, consultant's or private developer's responsibility to prepare and conduct the sewer bypass to allow safe traffic flow and comply with a traffic control plan approved by STD.

The bypass pumping system shall be designed to keep the flow in the sewer system from surging (at or below the crown of the pipe). The contractor, consultant or private developer shall perform sewer flow measurements to determine the peak flow rate or use the full flow capacity of the pipe, whichever is greater. The use of the pipe's full flow capacity in designing the bypass pumping system shall not relieve the contractor from its responsibility to provide an adequate and properly functioning bypass system. Any additional monitoring or flow data gathering shall be the responsibility of the contractor. The City of Phoenix is not responsible for any deviations in quantity of sewage flow at any time during the construction period. Higher flows may be encountered, depending on weather and other upstream conditions.

The contractor, consultant or private developer shall provide noise reduction measures necessary to prevent noise complaints by residents and businesses and otherwise comply with City of Phoenix noise ordinances and requirements.

The contractor, consultant or private developer shall test the entire bypass pumping system in place before bypassing any sewage. Bypass pumping shall be continuously monitored by personnel qualified to operate the pumping equipment.

10. Sewer Odor Control

A high priority is placed on minimizing the public's exposure to foul odors while work is being carried out in the wastewater collection system. The design and construction of gravity sanitary sewers in the City of Phoenix shall conform to the following:

- a. An odor control program for sewer relocation, rehabilitation, bypass pumping and other activities related to wastewater collection sewers shall be designed.
- b. Successful odor control mitigation shall be based on receiving no public odor complaints.
- c. Prior to the beginning of work, the section of sewer main affected by construction shall be cleaned by jetting or other means to remove any deposited solids and reduce the potential for odor complaints. The length of the sewer to be cleaned shall be determined by the City, or its representative, but shall measure, at a minimum, the entire pipeline length between existing manholes.
- d. The appropriate odor control mitigation practices shall be chosen to meet the odor control criteria listed in Item b above. Possible odor mitigation practices include:
 - Addition of ferrous or ferric chloride and/or hydrogen peroxide into the wastewater.
 - Addition of sodium hypochlorite (12 percent bleach) into the wastewater.
 - Covering, containing and treating foul air using activated charcoal canisters.
- e. The following actions shall be followed when performing odor mitigation procedures:
 - If chemical injection is used, prior approval by WSD in writing and a minimum of 24 hours' advance notification to the downstream wastewater treatment plant shall be provided.
 - If ferric chloride is used, 24 hours per day/7 days per week containment must be secured.
- f. The contractor shall be responsible for preventing any public complaints regarding foul odor and maintaining the level of H₂S concentration in the affected construction area at or below the odor nuisance limit at all times.
- g. Immediate action shall be taken to remedy public complaints regarding foul air emanating from the sewer construction. A fine of \$1,000 for each day odor complaints are received after the first notification for a particular construction site or location shall be levied.
- h. All necessary precautions shall be taken, including personnel training in the proper handling, storage and use of the chemicals for odor control. Required materials safety data sheets, personal protective equipment, spill prevention controls and warning signs for each chemical used for odor control shall be maintained.

C. MANHOLES

All manhole construction shall conform to MAG Specifications and Details and the COP Supplements to the MAG Specifications and Details except as detailed below:

- a. Aluminum manhole frames and covers are not permitted.
- b. Steps are not permitted in manholes.

1. Manhole Locations

Manholes shall be installed at the following locations:

- a. Changes of grade or slope.
- b. Changes of pipe size.
- c. Changes of horizontal or vertical alignment.
- d. Changes in pipe material.
- e. Service connections 8-inches in diameter and larger.
- f. The end of each public sewer main.
- g. At distances not to exceed the spacing shown in Figure 22, *Maximum Manhole Spacing*.

2. Manhole Spacing

The maximum spacing for manholes on sewer mains are shown in Figure 22, *Maximum Manhole Spacing*. Manhole spacing greater than shown in the table may be approved by WSD through the Technical Appeal process.

Figure 22 – Maximum Manhole Spacing

Pipe Size (inches)	Maximum Manhole Spacing (feet)
Less than 15	400
15 to 24	500
Greater than 24	600

3. Manhole Diameter

The minimum manhole diameters and standard frame and cover sizes for various pipe sizes are shown in Figure 23, *Minimum Manhole Diameters*.

Figure 23 – Minimum Manhole Diameters

Pipe Diameter (inches)	Manhole Depth (feet)	Minimum Manhole Diameter (inches)	Minimum Frame and Cover Diameter (inches)
12 and Less	12 and Less	48	24
12 and Less	Greater than 12	60	30
15 and Greater	Any	60	30

4. Metering Manholes

Sewer main extensions or sewer taps will not be allowed into a metered manhole. Furthermore, no service connections will be allowed into the sewer main 100 feet upstream and 25 feet downstream of the metering manhole.

5. Clean Outs

Clean outs are not permitted. If the property owner/developer chooses to connect to an existing clean out at the end of a sewer main, the clean out shall be removed and replaced with a manhole.

6. Manhole Stub Outs and Knock Outs

Manhole stub outs and knockouts are not allowed. However, knock outs shall be provided in manholes for future main extensions when requested by WSD.

7. Drop Sewer Connections

Drop sewer connections for public sewer mains into a manhole shall conform to MAG Standard Detail 426.

8. Water Tightness

Manhole lift holes and grade adjustment rings shall be sealed with non-shrinking mortar.

Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be required in isolated easement locations or where vandalism may be a problem.

9. Corrosion Protection for Manholes

All manholes for sewers 15-inches in diameter and larger, shall be coated in conformance with COP Supplement Section 626. Any disturbance of existing coatings shall be repaired in accordance with manufacturer’s recommendations.

10. Junction Structures

Junction structures shall be required on all sewer mains 33-inches and larger unless otherwise approved by WSD through the Technical Appeal process.

D. SERVICE CONNECTIONS

Service connections to the City of Phoenix Wastewater system shall conform to Article IV of Chapter 28 of the PCC, MAG Specification 615, COP Supplement Section 615.7, COP Supplement Details P-1431 and P-1440, and WSD Standard Details S-511, S-512 and S-512D.

Service connections are privately owned and maintained unless it’s a single family residential lot within a public right-of-way. Refer to WSD’s Policy P-51, Service Lateral Maintenance Policy. The policy can be found in WSD’s website. Refer to Appendix A, page ii for WSD’s website link.

1. Service Connection Installation Requirements

- a. Service connections to the sewer main shall be watertight and not protrude into the sewer. Saddle type connections shall not be used. 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.
- b. The design engineer shall note that WSD's procedures do not permit a contractor to set a service saddle connection on an existing sewer main. The contractor shall not connect to a city public main.
- c. The portion of the sewer tap located within the ROW shall be designed in accordance with the slopes set forth in the City's currently adopted plumbing code (IPC/UPC).
- d. Service connections shall extend perpendicular to the main. The invert of the service connection shall be at or above the crown of the sewer main, but no more than 12-inches above.

2. Type of Developments Allowed to Share a Sewer Service Connection

WSD allows sharing a sewer service connection for different type of uses after written approval from WSD through the Technical Appeal process. For residential developments, the service connection must be located within a common tract deeded to the homeowners association (HOA). A commercial development may require a Developer Maintenance Agreement and a Building Code Modification, as approved by PDD.

- a. Two or more buildings located on the same lot (i.e., multi-family, trailer courts or similar projects covering one lot).
- b. Single family residential attached (hybrid type developments) that do not comply with the City's private accessway and/or right-of-way requirements.
- c. Mixed Use Developments (residential and commercial) - this type of use has the option to share or separate the sewer service connection for each use.
- d. Auto Court Cluster Developments (Cluster).
- e. Any development that cannot be served through a gravity sewer system and requires a lift station with a capacity less than 1 million gallons per day (MGD).

3. Service Connection Sizes

Figure 24, *Service Connection*, determines the connection size required based on the development type:

Figure 24 – Service Connection

Development Type	Services Connection Size (inches)
Residential Lots	4 or 6
Commercial Lots	Minimum 6
Multiple Lots	Minimum 6

4. Service Connections

Service connections shall connect to existing/new sewer mains or manholes and require a plan submittal of an S-511, S-512 or S-512D detail. The details are available on WSD's website. For website link refer to Appendix A, page ii.

- a. Service connections 4 to 6-inches in diameter do not require a manhole connection unless the main size is 15 to 30-inches in diameter.
- b. Service connections 8-inches in diameter and larger connecting into 8-inch to 30-inches in diameter shall be installed directly into an existing or new manhole.

- c. Service connections of any size shall not connect directly into sewer mains that are 33-inch and larger. Such connections shall require a minimum 8-inch public sewer main extension, which shall be constructed from the nearest existing downstream manhole to the point of service unless otherwise approved by WSD through the Technical Appeal process.

5. Vacant Land

Where vacant land is located in the vicinity of the Light Rail, the consultant or private developer shall work with the City to determine the potential future use of such land. The City will determine if a service connection will be made and extended to the vacant land.

E. WASTEWATER LIFT STATIONS AND FORCE MAINS

Wastewater pumping stations and force mains shall conform to the City of Phoenix Lift Station Design Manual. This manual is available on WSD's website. For website link refer to Appendix A, page ii.

Force mains connecting to an existing sewer main, shall submit an S-511 Sewer Detail and follow the S-511 (Manhole – Pressure Tap) Checklist. For website link refer to Appendix A, page ii.

Force mains crossing the Light Rail shall be handled the same as water line crossings detailed in Section 7 of this Manual. When DIP is used, it shall be lined with Protecto 401 ceramic epoxy.

All DIP shall be protected from exterior corrosion per the City of Phoenix Requirements for Corrosion Protection Design Standards Development Report for Large Diameter Ductile Iron, Steel, CCP and RCP Water Transmission Pipelines. This protection shall consist of encasement a polyethylene protective wrapping in addition to any other corrosion protection systems. Refer to COP Supplement Specification 750.2 and MAG Specifications Section 610.6.2 and 620.6.3 and the Technical Specification in Appendix D.

F. ALLOWABLE DISCHARGES AND PRELIMINARY TREATMENT

In accordance with the PCC Chapter 28, sewer pretreatment devices are required for industrial and commercial developments where treatment may be necessary to reduce objectionable characteristics or wastes and *Wastewater Discharge Permits* and sampling devices are required for specific industries as identified in federal codes.

PDD staff will pre-screen the building plans during the plan review to determine if the development will require pretreatment, discharge permits and/or wastewater monitoring.

G. SEPTIC SYSTEMS WITHIN THE CITY OF PHOENIX

1. City Ordinances Which Apply to Septic Systems

City Code 28-25, Private Sewage Systems - Construction and maintenance within the City prohibited generally, states the following: *“Except as provided in this chapter, it shall be unlawful to construct or maintain within the City a privy, privy vault, septic tank, cesspool or other facility intended or used for the disposal of sewage.”*

City Code 28-26, Private Sewage Systems - When permitted to be constructed and maintained in sanitary manner, states the following: *“Where a public sanitary sewer is not available within the City, or in any area under the jurisdiction of the City, the building sewer shall be connected to a private sewage disposal system, complying with the provisions and recommendations of the Arizona Department of Health Services and the Sanitary Code of the County Health Department. Such private sewage disposal system shall be constructed, maintained, and operated at all times in a sanitary manner.”*

2. When NEW Septic Systems May Be Allowed

COP does not allow private sewer systems when a public sanitary sewer is “available”. Therefore, COP will require that all properties within the service area connect to the public sewage system. However, if a property falls into one of the following exceptions, the sewer main extension will not be required:

- a. A new single residence on a single lot whose closest lot line is more than 250 feet from an existing public sanitary sewer main.
- b. A new commercial or residential development that is provided COP water but is outside COP limits. Septic requirements for properties outside of COP limits are ultimately determined by the property's jurisdiction (i.e., County, Town of Cave Creek, or Paradise Valley).

If one of these exceptions is met, the property owner may then contact the MCDES for approval of an on-site private sewage treatment system.

3. When Existing Septic Systems May Remain in Use

Existing residential or commercial septic systems that are properly permitted, operational, and have been deemed adequate by the County to continue serving the site, are allowed to remain. In addition, if a single residence or commercial development increases the calculated sewer flows to the system (per approved plumbing code), and the existing septic system has capacity to accept the increase in flows, the developments may remain on the existing septic system.

Any development on an existing septic system shall be required to connect to COP's public sewer system if one of the following occurs:

- a. The existing septic system needs major repairs.
- b. The existing septic system needs to be upgraded/increased in size in order to accept an increase in calculated sewer flows (per approved plumbing code).
- c. The existing septic system needs to be relocated on the property.

VI. APPEAL PROCESS FOR WATER/SEWER REQUIREMENTS

A. PURPOSE OF APPEALS

The purpose of a technical appeal is to provide customers with a description of the City of Phoenix's Water Services Department (WSD) and Planning and Development Department (PDD) appeal processes relating to all water and wastewater requirements.

WSD, in coordination with PDD, both stipulate water and wastewater infrastructure requirements for all developments within the City of Phoenix.

- If the customer does not agree or cannot meet the stipulations or design standards, they may file a Technical Appeal to the Water and Sewer Technical Appeals Committee (Committee) through PDD (see below for the process). However, if the customer is a residential homeowner (meaning a single dwelling, such as single family home, condominium, town home, or same), the appeal application fee is reduced, and the appeal application is routed to WSD for review rather than routing it to the Committee.
- In any appeal where the Applicant believes that a "takings" has occurred, the Applicant has the option to pursue the City's Proportionality Appeal Process. This type of appeal is submitted through PDD.
- For appeal fees, refer to PDD's current fee schedule.

B. DEVELOPER TECHNICAL APPEALS

Developer Technical Appeals to the Water and Sewer Technical Appeals Committee (Committee): A technical appeal application is submitted to PDD where an appeal fee is charged. The appeal is reviewed by the Committee, which is comprised of a minimum of two (2) WSD engineers and two (2) PDD engineers. The Committee reviews the appeal to determine the type of appeal.

- If the applicant is appealing WSD design standards, the appeal will be approved as is; approved with stipulations or changes; or denied. For these types of appeals denied by the Committee, the applicant may request a meeting with the WSD Director's Representative, in which the applicant appears in person to justify the appeal. Refer to that section at the end of this chapter.
- If the applicant is appealing a requirement from City Code chapters 28 or 37 (water and sewer), then the Committee must deny the appeal, as these City Codes cannot be waived. The applicant may then request a meeting with the WSD Director's Representative in which the applicant appears in person to justify the request. Refer to that section at the end of this chapter.

C. RESIDENTIAL HOMEOWNER APPEALS

Residential Homeowner Appeals to the Water Services Department: An appeal application is submitted to the PDD where a reduced appeal fee is charged. The appeal is routed directly to WSD, which will be reviewed by WSD staff.

- If the applicant is appealing WSD design standards, the appeal will be approved as is; approved with stipulations or changes; or denied. For appeals that are denied, the homeowner has the option to pursue the appeal further by requesting a hearing with the WSD Director's Representative to appear in person to justify the appeal. Refer to that section at the end of this chapter.
- If the homeowner is requesting to not comply with a requirement from the City Code chapters 28 or 37 (water and sewer), then the WSD staff will inform the applicant they must appear in person with the WSD Director's Representative to justify the appeal. Please refer to that section below.

D. WSD DIRECTOR'S REPRESENTATIVE APPEAL PROCESS

The applicant schedules a meeting with the Director's representative to justify their appeal. At the end of the meeting, the representative may render a decision, or take up to two weeks to make a final decision if additional research is necessary. This will result in the representative approving the appeal as is; approving with stipulations or changes; or denying the appeal. If the appeal is denied, the applicant has the option to

request an appeal to the Development Advisory Board (DAB). This appeal request is made through PDD. If the appeal is denied by the DAB, the applicant may pursue legal recourse with the Maricopa County Superior Court.

E. WSD DIRECTOR'S REPRESENTATIVE INTERPRETATION OF CITY CODE PROCESS

As stated above, City Code chapters 28 and 37 (water and sewer) cannot be waived and only WSD Director's Representative has the authority to interpret the Code. It is the responsibility of the applicant to propose to the representative what can be done differently to still meet the intent of the Code. The representative will then discuss the Code requirements with the applicant and determine if what is being proposed still complies with the intent of the Code. At the end of the meeting, the representative will either render a decision, or inform the applicant that it may take up to two weeks to render a decision. If the appeal is denied, the applicant may pursue legal recourse with the Maricopa County Superior Court.

Appendix D: Corrosion Protection System Requirements

SECTION 13110

CATHODIC PROTECTION (GALVANIC ANODE TYPE)

PART 1 – GENERAL

The Contractor shall furnish all labor, materials, tools, and equipment and perform all work necessary for a complete and operational sacrificial anode cathodic protection system for the water line piping as shown on the Drawings and specified herein.

1.1 QUALIFICATIONS

- A. Submit resume and qualification of the NACE certified specialist, including NACE International certification number whose services shall be used on the project.
1. A NACE International-certified Cathodic Protection Specialist, Corrosion Specialist, Senior Corrosion Technologist, or Corrosion Technician shall be required for corrosion-related activity guidance and review of testing.
 2. Testing shall be performed by a NACE-certified experienced personnel with a minimum certification of CP Level 2 or CP Level 1 with 5 years of experience.
 3. Data analysis and reports shall be reviewed and signed by the NACE-certified Cathodic Protection Specialist, Corrosion Specialist, or Senior Corrosion Technologist.
 4. Certified personnel shall have a minimum of 5 years' experience with installing and testing cathodic protection systems of pipe lines.
 5. All work and tests performed under this section shall be installed in accordance with the Plans and Specifications and shall be consistent with sound corrosion engineering practice.
- B. In lieu of NACE certification, the testing personnel must be able to provide documented recent experience in the installation and/or design of cathodic protection systems for buried metal pipe lines and structures similar in size and scope as detailed in these Specifications and shall also have a valid Professional Engineering License to perform such testing or design.

1.2 SUBMITTALS

All submittals shall be per the requirements as specified in the Special and General Conditions.

- A. Prior to the installation of any cathodic protection materials, the Contractor shall submit for approval, data on the following items:

1. Magnesium anodes.
2. Test stations, terminal boards, and shunts.
3. Exothermic weld equipment and materials.
4. Conductors, test-station wires, and joint-bond wires.
5. Joint-bonding clips.
6. Wire-splice kits.
7. Wire terminal connectors.
8. Wire and cable marker tags or terminal-board labels.
9. Insulating flange kits and insulating mechanical couplings.
10. Contractor NACE cathodic protection qualifications.
11. Testing procedures.

B. After completion of the cathodic protection installation, the Contractor shall submit a Test Report and Operation and Maintenance Manual for the cathodic protection system.

PART 2 – PRODUCTS

2.1 SACRIFICIAL ANODES

A. Dimensions of the magnesium anodes shall conform to the dimensions for standard sizes of anodes and of the weights specified. All magnesium anodes shall be cast around a galvanized steel core (flat strap or spring) and be made of high-potential magnesium alloy conforming to the following compositions by weight:

- | | |
|---------------------|--------------------------|
| 1. Aluminum | 0.01% Max. |
| 2. Manganese | 0.50% Min. to 1.30% Max. |
| 3. Copper | 0.02% Max. |
| 4. Silicon | 0.05% Max. |
| 5. Iron | 0.03% Max. |
| 6. Nickel | 0.001% Max. |
| 7. Other Impurities | 0.05% Each Max. |
| 8. Magnesium | Balance. |

B. Sacrificial anodes shall be a minimum size of 32 pounds (bare weight) and High Potential Prepackaged Magnesium Anodes such as MAXMAG or approved equal. Acceptable suppliers are Mesa Products or Farwest Corrosion Control or equal.

C. Sacrificial anodes shall be packaged in a permeable cloth bag with a prepared backfill mixture of 75-percent gypsum, 20-percent bentonite, 5-percent sodium sulfate, and shall be of the quick-wetting type. Anodes shall be centered in the backfill material before installed.

D. All anodes shall be shipped and stored out of inclement weather and in waterproof bags which shall be removed prior to installation.

- E. Anode lead wires shall be black #8 AWG Type HMWPE (high molecular weight polyethylene) single-conductor, stranded-copper wire. Lead wires shall be a minimum of 25 feet in length. The lead wires shall be connected to the galvanized steel core of the anode by silver soldering and this connection shall be sealed with a waterproof epoxy or electrical potting compound.

2.2 WIRE CONDUCTORS

- A. Test station wires shall be black #10 AWG and #6 AWG Type HMWPE single-conductor, stranded-copper wires.
- B. Joint-bond wires, except where stated otherwise, shall consist of a minimum of two wire bonds, 18-inches long minimum, and installed on all non-isolated connections with size as follows:
 - 1. For 16-inch diameter pipe or larger shall be sized #2 AWG Type black HMWPE single-conductor, stranded-copper.
 - 2. For pipe smaller than 16-inch diameter shall be sized #6 AWG Type black HMWPE single-conductor, stranded-copper.
- C. Joint-bond wires for mechanical coupling follower rings shall be black #8 AWG Type HMWPE single-conductor, stranded-copper wire. A minimum of two wire bonds, 18-inches long minimum, shall be installed on all non-isolated connections.

2.3 WIRE-SPLICE CONNECTIONS

- A. All splices of buried test station or anode wires shall be made using a mechanical connector and soldered then sealed with an epoxy-type material. Splice kits shall be Royston "MINI SPLICE- RIGHT" with Burndy KS-90 split bolt or approved equal.

2.4 EXOTHERMIC WELDS

- A. All electrical cable connections to the buried piping shall be made by an exothermic weld. Exothermic-type weld materials, including the proper size and type of weld cartridges and welder molds for use on steel pipe, shall be by Erico Products Inc. "CADWELD" or Continental "THERMOWELD" or approved equal.
- B. Copper sleeves specifically designed for the purpose shall be crimped on all bare wire ends of all stranded cables, #8 or smaller, prior to exothermic welding to improve mechanical strength and thermal capacity.

2.5 EXOTHERMIC WELD COATING AND BACKFILL SHIELD

- A. Exothermic welds shall be primered with Continental's ThermOprimer spray, Royston's Roybond 747 primer spray, or equal. The primered weld shall be covered with a plastic weld cap, prefilled with mastic, specifically made for the

- purpose and installed in accordance with the manufacturer's directions. Approved manufacturers are Continental's ThermOcap, Royston's Handy Cap, or equal.
- B. As an alternative for steel pipe, the exothermic weld and surrounding bare steel may be coated with a primer and layers totaling a minimum of 60 mils of tape wrap compatible with the pipeline tape wrap coating, as shown on the Drawings.
 - C. All exposed surfaces of copper cables shall be coated with suitable repair coating or primer pipe spray.

2.6 TEST STATIONS

- A. Cathodic protection test stations shall consist of a concrete test station enclosure, cast-iron lid, terminal block with studs, and anode shunt.
- B. Test station boxes located in unpaved areas shall be Brooks Products Inc. Model "No. 1-RT", Christy Mfg. Model "G3" or "G5," or approved equal with the lid inscribed with the words "CP TEST." Test station boxes located in paved areas shall be 6" Tyler Series #6850 valve boxes (top and middle sections only) with "CP TEST" cast on the cover. Both sections shall be screw-type, adjustable cast iron. No slip-type boxes will be allowed. Top section shall be Model 69, 16-1/2-inch length. Boxes shall be placed on flat blocking.
- C. Test station terminal boards shall be 5-inch x 5-inch x 1/40-inch micarta or phenolic or approved equal. Terminal-board hardware shall be nickel-plated brass and consist of either five or seven, as appropriate, 1/4-inch diameter by 1-1/4-inch long bolts with double nuts, flat washers, and lock washers.
- D. Test station boards shall be furnished with a Cott Mfg. Co. calibrated 0.01 ohm - 8 ampere (color coded yellow) anode shunt, Holloway RS wire shunt or approved equal. Exception: the shunt is not required at test stations designated as insulating fitting type test stations with no anodes or pipe casing type test stations with no anodes.

2.7 INSULATING FLANGE KITS

- A. Dielectric-flange kit (flange-insulating kit [FIK]) materials shall consist of full-faced gaskets, bolt sleeves, nonmetallic washers, and steel-backing washers.
- B. Gaskets shall be "Type E" (full face) phenolic with either a Buna-N O-ring type sealing element or a full neoprene facing on both sides of the gasket.
- C. Insulating bolt sleeves shall be the single one-piece sleeve and washer-type made of Minlon or acetyl resin plastic, shall fit within the bolt facing of the flange, and shall allow the standard size bolt or stud for the flange to be inserted. In the event

the diameter of the flange bolts or studs is larger than 1-1/2 inches, a two-piece sleeve and washer set consisting of a Mylar bolt sleeve with phenolic washer may be utilized.

- D. The steel backing washers shall be 1/8-inch thick; cadmium-plated, hot-rolled steel and shall fit within the bolt facing on the flange.

2.8 INSULATING MECHANICAL COUPLINGS

- A. Insulating mechanical couplings (IMC) shall be Dresser "Style 39," Rockwell "416" or Romac "IC501," or Baker "Series 216" without pipe stop.

2.9 WIRE AND CABLE MARKER TAGS

- A. Marker tags shall be permanent and shall be made of weather resistant/UV light resistant nylon and shall be attached to a plastic non-releasing holding device and cable fastening tail, similar to Panduit Corporation Part No. PLF1MA. The marker tag writing surface shall have minimum dimensions of 0.75-inch L x 1.0-inch W.
- B. Marker tag identification shall be completed by using a waterproof ink nylon marker pen designed specifically for this purpose, similar to Panduit PFX-0 or 3M ScotchCode SMP marking pen.

2.10 JOINT-BONDING CLIPS

- A. Joint-bonding clips for steel pipe shall consist of 10-gauge thick ASTM A36 carbon steel with a nominal cut length of 2-1/2 inches and a nominal width of 1-1/4 inches. The clip shall be bent and formed as shown on the Drawings.
- B. Bonding clips shall be supplied with cut-to-fit Lytherm filler strips.

2.11 PERMANENT REFERENCE ELECTRODE

- A. Permanent reference electrode or cell shall be bare solid-state copper-copper sulfate for underground service with a minimum service life of 20 years.
- B. The electrode lead shall be #14 RHH-RHW yellow wire long enough with plenty of slack to terminate inside the test station (minimum of 25 feet) on the terminal board.
- C. Permanent reference electrode shall be bare GMC "STAPERM" Model CU-1-UGPC. Manufacturer shall be Mesa Products or equal.

PART 3 – EXECUTION

3.1 GENERAL

- A. The cathodic protection system shall be installed in compliance with the applicable portions of NACE Standard RP-01-69 latest revision.

3.2 WORKMANSHIP

- A. All materials and equipment shall be in accordance with the directions of the manufacturer to conform to the specification documents.

3.3 SACRIFICIAL ANODE INSTALLATION

- A. Contractor shall procure, store and install high-potential magnesium anodes as indicated herein.
- B. Anodes shall have approved waterproofing protection at all times prior to installation. Damaged anodes or anode wires shall not be used and replacement anodes installed instead. Anode waterproofing protection shall be removed before installing the anode.
- C. The specified high-potential magnesium anodes shall be installed at the locations indicated herein. Anode locations or spacing may be adjusted slightly to clear other buried or topographical obstructions with prior approval of the Engineer.
- D. The specified magnesium anodes shall be installed completely dry and shall be laid horizontally in the pipe trench without touching the pipe and as shown on the cathodic protection details. Anodes shall be installed horizontally in the pipe trench 18 inches to 24 inches from the pipe. Lay anodes end to end, a minimum of 5 feet apart. The anode lead wire shall not be used in handling the anodes. The anode shall be backfilled with fine native excavated soil (imported sand or other select backfill shall not be allowed) in 6-inch layers and each layer shall be hand-tamped around the anode. Care must be exercised not to strike the anode or lead wire with the tamper. After the anode has been backfilled approximately 1 foot, a minimum of 10 gallons of fresh water shall be added and allowed to soak into and around the anode. After water absorption by the anode and surrounding soil, continue backfilling with pipe backfill.

3.4 TEST STATION INSTALLATION

- A. The Contractor shall install cathodic protection test stations as shown on the Drawings and specified herein. Corrosion test stations shall be:

1. Located no more than 1,000 feet apart between test stations.
 2. Located at each end of the pipeline (beginning and end to test electrical continuity of the entire pipe line).
 3. Located at each end of a steel casing (to test for casing isolation).
 4. Located at every FIK (to test for FIK isolation).
 5. Located at existing foreign line crossings with cathodic protection.
 6. Have at least two (2) magnesium anodes unless cathodic protection design does not require cathodic protection anodes.
- B. Test stations shall be installed directly over the pipe unless the pipe is laid under pavement in which case the test station shall be offset behind existing curb or proposed future curb line, as indicated on the Drawings.
- C. Test station wiring shall be arranged and completed as shown on the Drawings. Test station wiring shall extend 2 feet above the top of the test station box.
- D. Wire connections to the test-station terminal boards for conductor sizes of #8 AWG and larger shall be made with single-hole terminal lugs of corrosion-resistant bronze-, copper-, or nickel-plated brass similar to Blackburn Type L (socket), Square D Company Type LU, Burndy SCRULUG Type KPA or other approved equal.
- E. Wire connections to the test-station terminal boards for conductor sizes of #14 through #10 AWG shall be terminated with a properly sized non-insulated support ring tongue compression connector similar to Panduit P10-14R-L or Burndy Hylug Type YAV Box Ring Tongue connectors, or other approved equal.
- F. Test station wires shall be color-coded with electrical vinyl tape at the ends as shown herein and each wire shall be permanently identified using nylon marker tags and plastic cable ties or labeled on the test station board as shown on the Drawings and specified herein. Marker tag identification shall be completed by using block-type lettering with the letter size to be a minimum of 1/8-inch high and shall specify test station number, pipe diameter, and pipe material. Test station numbering shall be as indicated herein or shown on the Drawings.

3.5 WIRE CONNECTIONS TO BURIED PIPING

- A. Anode wire, test-station wire, and joint-bond wire connections to specified buried piping shall be accomplished by exothermic welding. The surface of the pipe shall be cleaned with a grinder or metal file to a bright, shiny condition. The exothermic weld shall be completed using the appropriate weld charge and welder as per the manufacturer's recommendations. A properly sized copper wire sleeve shall be installed around the bare wire end prior to welding to improve weld strength and thermal capacity. Completed welds shall be capable of withstanding moderate hammer blows.

- B. After cooling, the weld and surrounding metal surface shall be cleaned, primed, and covered an exothermic weld cap. Any exposed metal not covered by the weld cap shall be primed and tape-wrapped with approved pipeline-coating materials. The weld cap shall also be secured to the pipe with pipeline tape wrap.
- C. For steel pipe, in lieu of manufactured exothermic weld caps, cap welds may be covered with approved primer followed by three rotated layers of minimum 20-mil thick pipeline tape wrap partially slotted to allow the wire to exit from beneath preceded by primer as shown on the Drawings.

3.6 WIRE SPLICE CONNECTIONS

- A. Buried splice connections of anode and/or test station wires shall be completed with a splice-connection kit.
- B. Installation of the splice-connection kit shall be completed per the manufacturer's instructions, with the exception that the wires shall also be soldered to the split bolt or crimp connector after tightening.

3.7 ELECTRICAL ISOLATION

- A. Electrical isolation of the buried waterline piping shall be accomplished by the use of insulating-flange kits, insulating mechanical couplings, or a piece of non-metallic piping and fittings where specified herein or shown on the Drawings. In the event an insulating coupling is restrained using harness rods, each rod shall be insulated using a properly sized one-piece insulating sleeve and washer with steel backing washer.
- B. Insulating-flange kits shall be ordered according to pipe size and pressure rating of the flange and shall be installed per the manufacturer's instructions. Care shall be exercised so as not to damage the insulating bolt sleeves.
- C. All bare or non-coated pipes that are exposed during the excavation on the non-cathodically protected side of insulated flanges or insulated mechanical couplings shall be coated and wrapped if the pipe is steel or reprimed and encased in a double-polyethylene wrap if it is ductile iron.

3.8 JOINT BONDING

- A. All non-welded pipe joint connections, including mechanical couplings, tees, elbows, valves, etc., except those specified to be insulating joints or those used with PVC pipe, shall be electrically bonded, coated, and wrapped or reprimed and encased with a double-polyethylene wrap to ensure electrical continuity. Blow-off and hydrant piping must also be bonded.

- B. For steel pipe, steel bonding clips shall be utilized for push-on pipe joints. Clips shall be welded at three locations on each joint as shown on the Drawings.
- C. Where bonding clips are not utilized, bond wires shall be stranded #2 AWG Type HMWPE for 16-inch diameter pipe or larger and #6 AWG Type HMWPE for pipe smaller than 16-inch diameter and installed as shown on the Drawings.
- D. Joint bond wires for mechanical coupling follower rings shall be stranded #8 AWG Type HMWPE and installed as shown on the Drawings.

3.9 PERMANENT REFERENCE ELECTRODE

- A. Install permanent reference electrode/cell per manufacturer recommendations. Install as indicated on the Plans, permanent reference electrode or cell at least 6 inches from the pipe or as shown on the cathodic protection details.
- B. Run direct-burial electrode lead with slack (minimum of 25 feet) and terminate on one of the test station board terminals.

3.10 TESTS AND MEASUREMENTS

- A. All cathodic protection system tests shall be conducted by NACE-Certified CP Level 2 or higher or CP Level 1 with 5 years' experience and reviewed by the Contractor's Corrosion Specialist, Cathodic Protection Specialist, or Corrosion Engineer. Unless otherwise authorized, no testing shall be conducted without the presence of a representative of the Owner.
- B. All structure-to-soil (pipe-to-soil) potential measurements shall be conducted using a calibrated saturated copper/copper sulfate reference electrode and a voltmeter with a minimum input impedance of 10 meg-ohms.
- C. Preliminary testing shall be performed prior to backfill on casing isolation and FIK isolation. Isolation measurements shall be 1-ohm or greater for acceptance.
 - 1. Effectiveness of FIK: FIK shall be considered isolated if the resistance (measured with Terrameter) across the FIK is 1-ohm or greater. Alternatively, the FIK shall be considered effective if, during a current applied test, the potential of the isolated side of the FIK remains unchanged or changes in a positive direction during the test. If test leads are not available, testing shall be conducted with Radio Frequency Isolation Tester (RFIT) with a PASS/FAIL measurement or Terrameter resistance meter with 1-ohm or greater measurement or equal isolation test equipment.
 - 2. Effectiveness of steel casing from metallic carrier pipe: Casing shall be considered isolated if the resistance (measured with Terrameter) between the casing and carrier pipe is 1-ohm or greater. Alternatively, the casing isolation shall be considered effective if during a current applied test, the potential of the casing remains unchanged or changes in a positive direction

when current is applied to the carrier pipe. If test leads are not available off of the casing and carrier pipe, testing shall be conducted with Terrameter resistance meter with 1-ohm or greater measurement or equal isolation test equipment.

- D. Final testing shall be performed upon completion of the cathodic protection system installation work and backfill. The Contractor shall perform testing to ensure proper operation of the system. The portable reference electrode shall be calibrated copper-copper sulfate and positioned in the soil directly over the pipe or structure where possible.
- E. Final tests shall be conducted as follows and as applicable:
1. Native or static (before anode connection) pipe-to-soil potentials at each test station off of each wire.
 2. Pipeline span resistance between adjacent test stations for electrical continuity of joint bonds with resistance meter such as a Terrameter measuring milliohms. Alternately, electrical continuity can be conducted with the current applied method utilizing portable rectifier/power source and measuring potentials in millivolts.
 3. Effectiveness of FIK. FIK shall be considered isolated if the resistance (measured with Terrameter) across the FIK is 1-ohm or greater. Alternatively, the FIK shall be considered effective if, during a current applied test, the potential of the isolated side of the FIK remains unchanged or changes in a positive direction during the test.
 4. Sacrificial anode-to-soil potential before anode termination. High-potential magnesium anodes should read around -1700 millivolts. If reads are around -1500 millivolts, then the anodes are most likely “standard” magnesium anodes and not high-potential magnesium anodes. High-potential magnesium anodes are acceptable, while standards are not acceptable. The cathodic protection specialist will determine this as well as what action is to be taken to correct the situation (replace standard anodes or add high-potential anodes).
 5. Anode current output measurement of each anode or anode header cable as measured across a 0.01-ohm shunt.
 6. Pipe-to-soil potentials on all leads after connection of anodes.
 7. Soil resistivities at each test station at 5-, 10- and 15-foot depths using the “Wenner” four -in method to assess soil corrosivity.
 8. Stray-current interference tests, if applicable, where cathodically protected foreign pipelines cross or parallel pipe line. Coordinate with foreign utility as applicable. Provide evaluation and corrections as needed.
- F. All anode current output and pipe-to-soil and anode-to-soil potential measurements shall be recorded including the test date in tabular form in an 8-1/2-inch x 11-inch format. The test data shall be included in the Operation and Maintenance Manual to be submitted at the completion of the project.

3.11 CATHODIC PROTECTION CRITERIA

- A. Cathodic protection level shall be considered satisfactory when all pipe-to-soil potential measurements at all locations are -0.85 volts (-850 millivolts) or more negative and all anode-to-soil potential measurements are -1.7 volts (-1700 millivolts) or more negative when referenced to a copper/copper sulfate electrode. IR drops in the soil shall be compensated for in the measurements.

3.12 INADEQUATE PROTECTION

- A. Inadequate pipe-joint continuity and/or cathodic protection levels due to defective or incorrect installation work shall be corrected by and at the sole expense of the Contractor.

3.13 OPERATION AND MAINTENANCE (O&M) MANUAL

- A. The Contractor's Corrosion Specialist, Cathodic Protection Specialist, or Corrosion Engineer shall prepare and furnish a written O&M Manual upon completion of the cathodic protection system testing.
 - 1. Submit complete installation, operation and maintenance manuals, including test reports, maintenance data and schedules, description of operation and spare parts information.
 - 2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781 Operation and Maintenance Data.
- B. The O&M Manual shall be organized into the following sections to facilitate future review:

<u>Section No.</u>	<u>Title</u>
1.	Cathodic Protection System Description
2.	Test Measurements and Field Data
3.	Preventative Maintenance and Troubleshooting Procedures

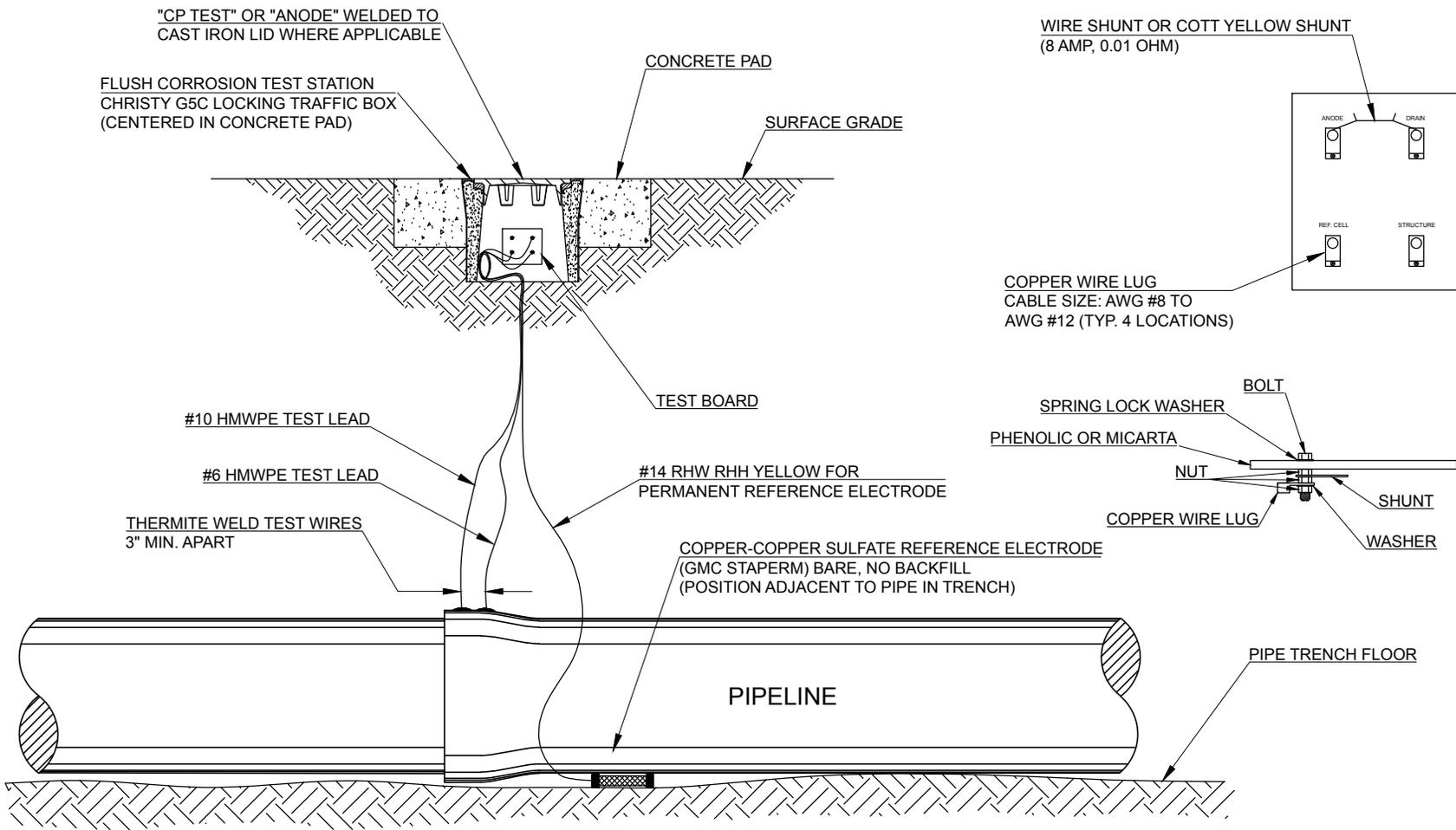
- C. Section Organization
 - 1. Section 1 should contain a written description of the structures to be protected and their cathodic protection systems, including details of the pipe sizes, pipe materials, including locations of any change in pipe material, and coating; type and location of anodes, test stations, and insulating fittings; and the number of separate CP areas (electrically isolated pipe sections). The extent of each CP area should be defined by the location of piping end points and/or insulating fittings, and the number of anodes and test stations installed in each CP area under this project should be indicated.

2. Section 2 should contain a written report of the tests conducted at the completion the system installation under this project, with the test data obtained listed in the previously specified tabular form.
3. Section 3 should contain any manufacturer's equipment maintenance information as well as a written description of basic sacrificial anode cathodic protection system preventative maintenance and troubleshooting procedures, including equipment necessary, the frequency and extent of pipe-to-soil surveys, interpretation of the pipe-to-soil potential data, proper documentation of survey data, how to locate defective insulating fittings, and what are underground "shorts" and how should they be located.

3.14 AS-BUILT DRAWINGS

- A. The Contractor shall maintain at the job site one full set of full-size Contract Drawings marked to show any deviations which have been made from the Contract Drawings as well as any appropriate field construction notations. Approved dimensioning and scale of all anode and test station locations shall be included. Upon completion of the work, the marked sets of prints shall be submitted to the Engineer.

END OF SECTION



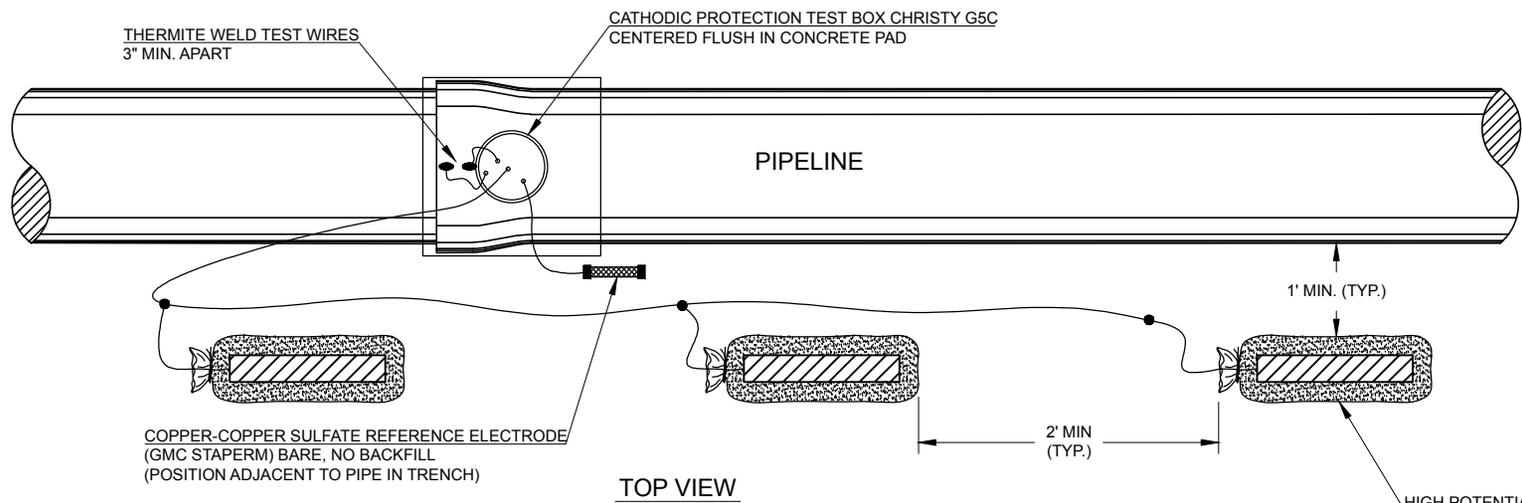
NOTES:

1. LOCATE REFERENCE ELECTRODE 6 INCHES FROM WALL OF PIPE AT BOTTOM OF PIPE TRENCH
2. FOR CONCRETE PIPES THE CABLE TO PIPE CONNECTION SHALL BE AT PIPE JOINTS
3. TRIM WIRES TO FACILITATE PULLING TEST WIRES AND TERMINAL BOARD 18 INCHES ABOVE TOP OF TEST BOX (18 INCHES OF SLACK IN TEST BOX)
4. FASTEN WIRES TO TERMINALS ON TEST BOARD
5. FOR UNPAVED AREAS THE CONCRETE PAD SHALL BE 36 INCHES SQUARE AND 6 INCHES THICK WITH CHAMFERED EDGES
6. FOR PAVED AREAS THE THE CONCRETE PAD SHALL BE 24 INCHES SQUARE AND 12 INCHES THICK
7. LOCATE TEST BOX DIRECTLY ABOVE PIPE. FOR TRAFFIC AREAS LOCATE THE TEST BOX BEHIND CURB OR PROPOSED CURB
8. IN REMOTE AREAS INSTALL TWO 6-INCH DIAMETER CONCRETE FILLED BOLLARDS TO MARK THE LOCATION

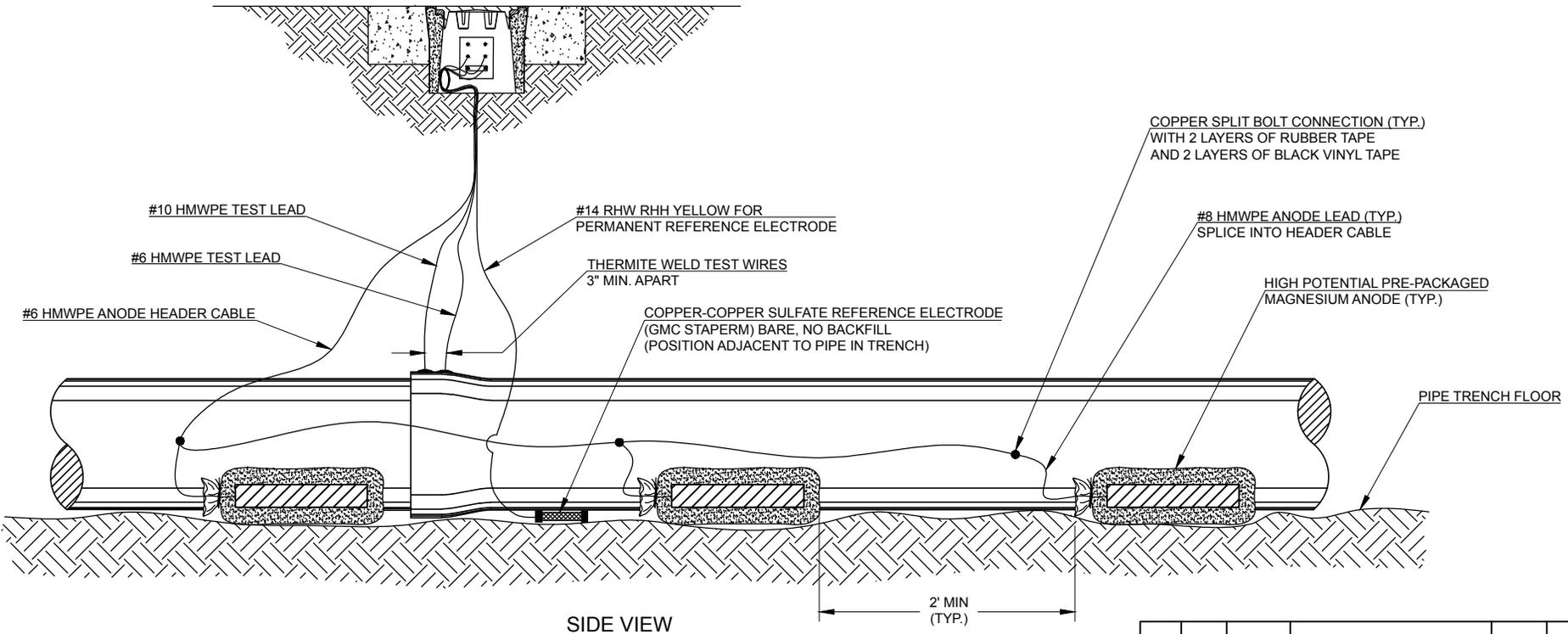
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ISSUED:	SIDE VIEW -- TEST STATION WITH REFERENCE ELECTRODE	01	SEB		1/23	INITIAL RELEASE		
1/23/17								
REVISED:	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION							
--/--/--								


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DETAIL NO.
CP-1
SHEET 1 OF 8



TOP VIEW

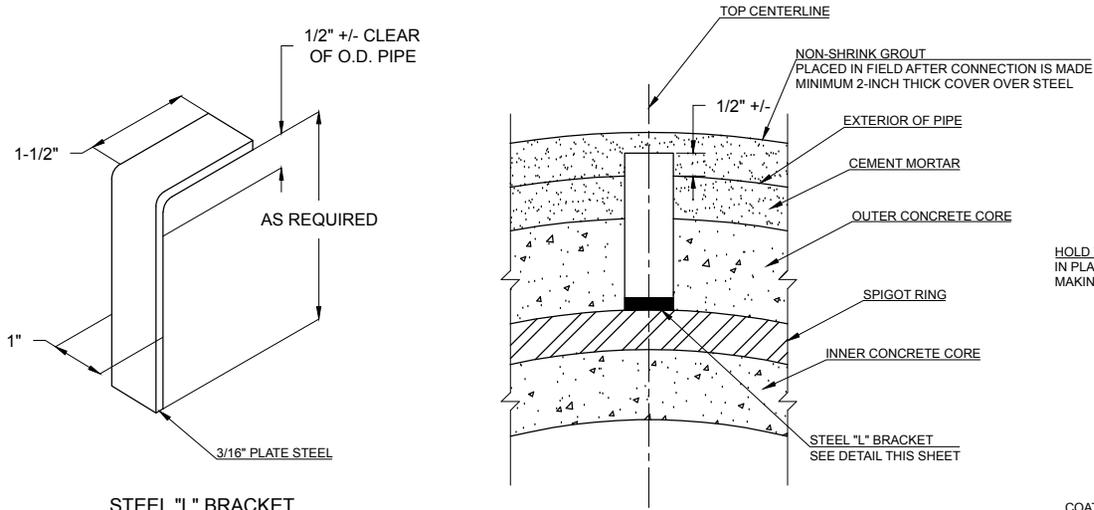


SIDE VIEW

		NO.		BY	DATE	REVISION HISTORY	APPD	DATE
ISSUED:	3-ANODE TEST STATION WITH REFERENCE ELECTRODE	01	SEB	1/23	INITIAL RELEASE			
1/23/17								
REVISED:	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION							
--/--/--								

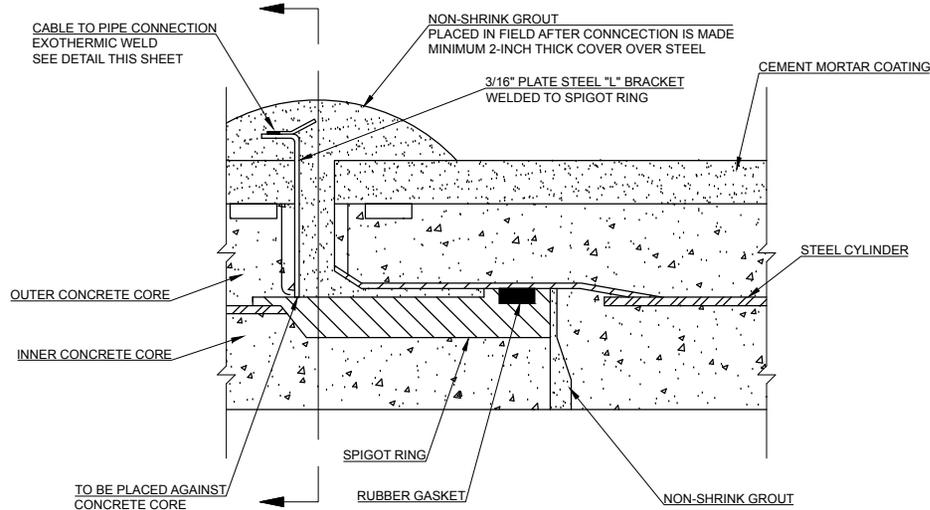

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DETAIL NO.
CP-2
SHEET 2 OF 8

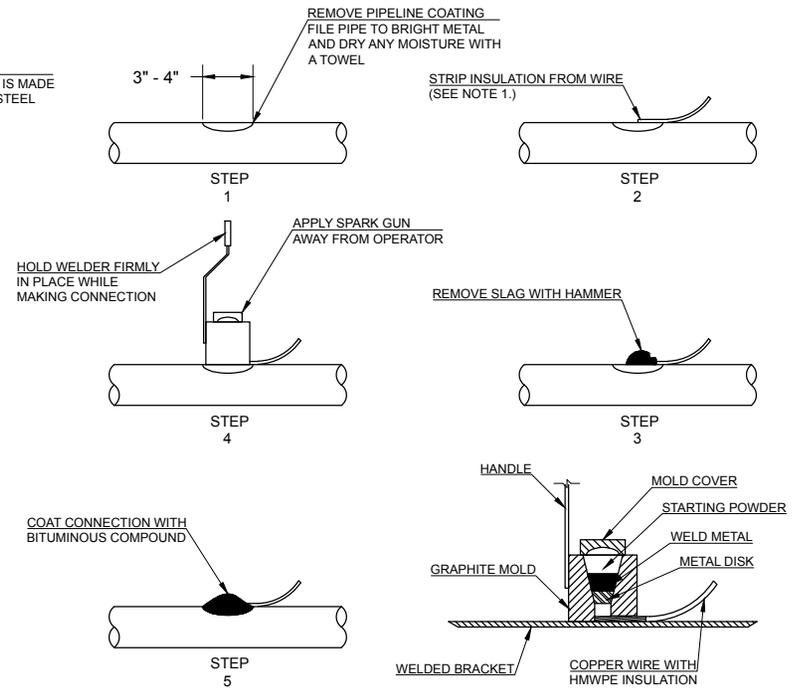


STEEL "L" BRACKET

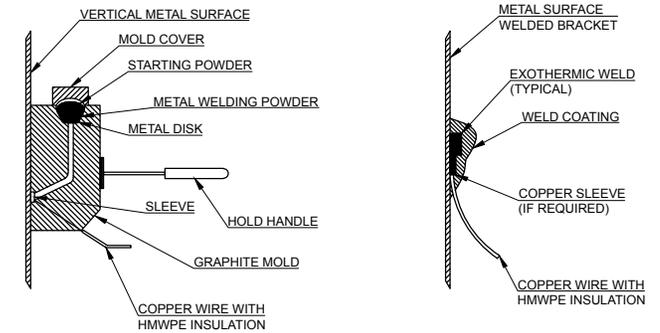
CONCRETE PIPE CONNECTION SECTION VIEW A-A



CONCRETE PIPE CONNECTION SIDE VIEW



EXOTHERMIC WELD HORIZONTAL SURFACE



EXOTHERMIC WELD VERTICAL SURFACE

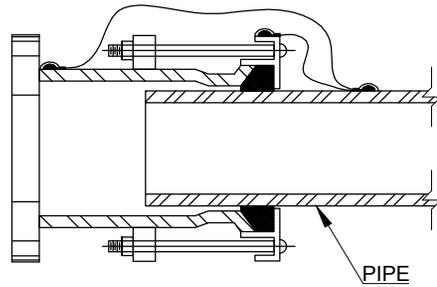
CABLE TO PIPE CONNECTIONS

EXOTHERMIC WELD NOTES:

1. REVIEW AND FOLLOW ALL MANUFACTURER INSTRUCTIONS, INCLUDING SAFETY PRECAUTIONS, CONSUMABLE MATERIAL SELECTION, STRUCTURE TYPE, PIPE DIAMETER, STRUCTURE SHAPE, CONNECTION ORIENTATION, SURFACE PENETRATION, AND CABLE SIZE
2. ALL CONSUMABLES MUST BE COMPATIBLE WITH AND WHERE SUITABLE, MANUFACTURED BY THE SAME MANUFACTURER AS THE CONNECTION SYSTEM.
3. CHECK ADHERENCE OF BOND FOR MECHANICAL INTEGRITY BY PULLING AND APPLYING STEADY TENSION ON THE CABLE WHILE STRIKING THE SIDE OF THE WELD ONCE WITH A 2-POUND HAMMER WITH A SHEARING BLOW. DO NOT STRIKE COPPER CONDUCTOR.
4. ANY CONNECTIONS THAT BREAK LOOSE OR SHOW SIGNS OF POOR QUALITY SHALL BE REMOVED AND REPLACED WITH A SOUND CABLE-TO-STRUCTURE CONNECTION.
5. COAT ALL EXPOSED WIRTE, COPPER, AND WELD METAL, AND EXPOSED PIPE SURFACE.

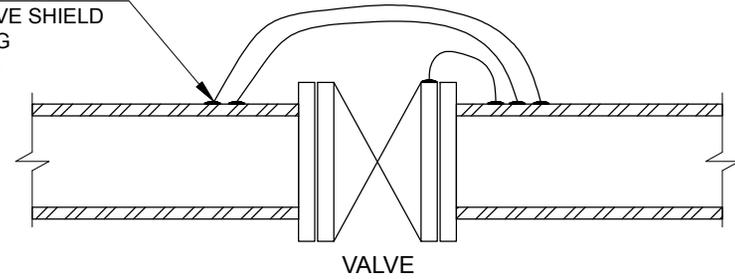
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ISSUED:		01	SEB	1/23	INITIAL	RELEASE							
1/23/17	CATHODIC PROTECTION CABLE-TO-PIPE CONNECTIONS												
REVISED:													
--/--/--	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION												
		DETAIL NO.		CP-3		SHEET 3 OF 8							


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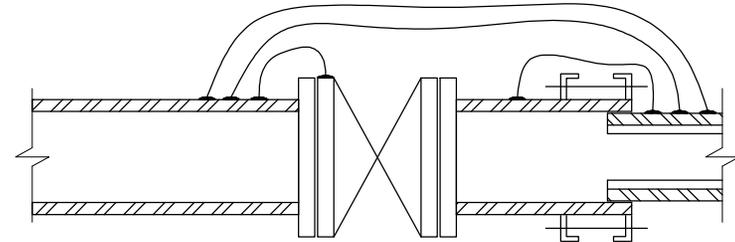


FLANGE COUPLING ADAPTER

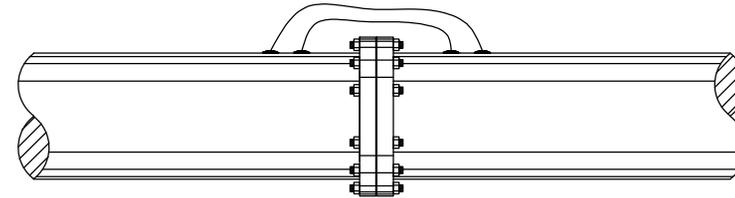
CABLE TO PIPE CONNECTION
WITH PROTECTIVE SHIELD
AND/OR COATING
SEE DETAIL CP-3



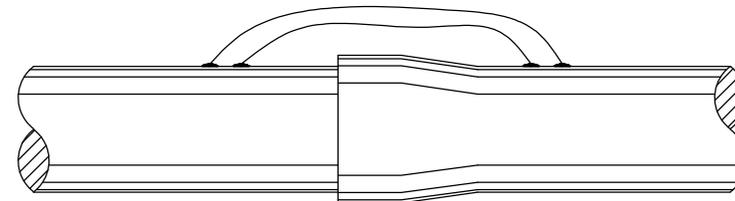
VALVE



VALVE & FLANGE
ADAPTER



FLANGE



DUCTILE IRON PIPE
SLIP-ON JOINT

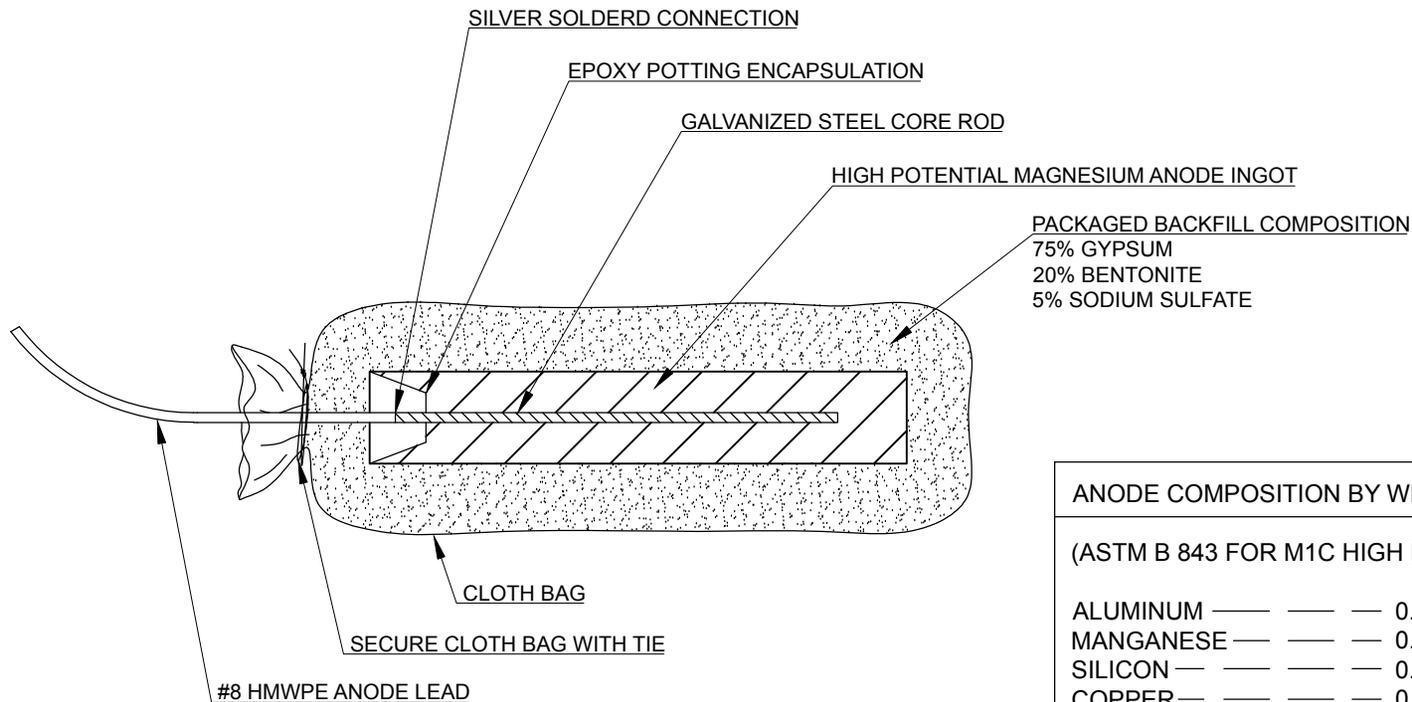
BOND NOTES:

1. BOND WIRES FOR FOLLOWING RINGS SHALL BE AWG #8 WITH HMWPE INSULATION
2. DETAIL SHOWN FOR 24-INCH OR SMALLER DIAMETER PIPE
3. USE TWO #4 HMWPE WIRES PER JOINT FOR 16" PIPE AND LARGER
4. USE TWO #6 HMWPE WIRES PER JOINT FOR PIPE SMALLER THAN 16" DIAMETER
5. BOND WIRES SHALL BE KEPT TO MINIMUM LENGTH WITH NO TENSION
6. FIELD COAT ALL EXPOSED METAL AND CONDUCTOR
7. DO NOT BOND ACROSS INSULATING FLANGE

ELECTRICAL CONTINUITY BONDING

		NO.		BY	DATE	REVISION HISTORY	APPD	DATE
ISSUED:	CATHODIC PROTECTION ELECTRICAL CONTINUITY BONDING	DETAIL NO.		01	SEB	1/23	INITIAL RELEASE	
1/23/17		CP-4						
REVISED:	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION	SHEET 4 OF 8						
--/--/--								

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PACKAGED BACKFILL COMPOSITION
 75% GYPSUM
 20% BENTONITE
 5% SODIUM SULFATE

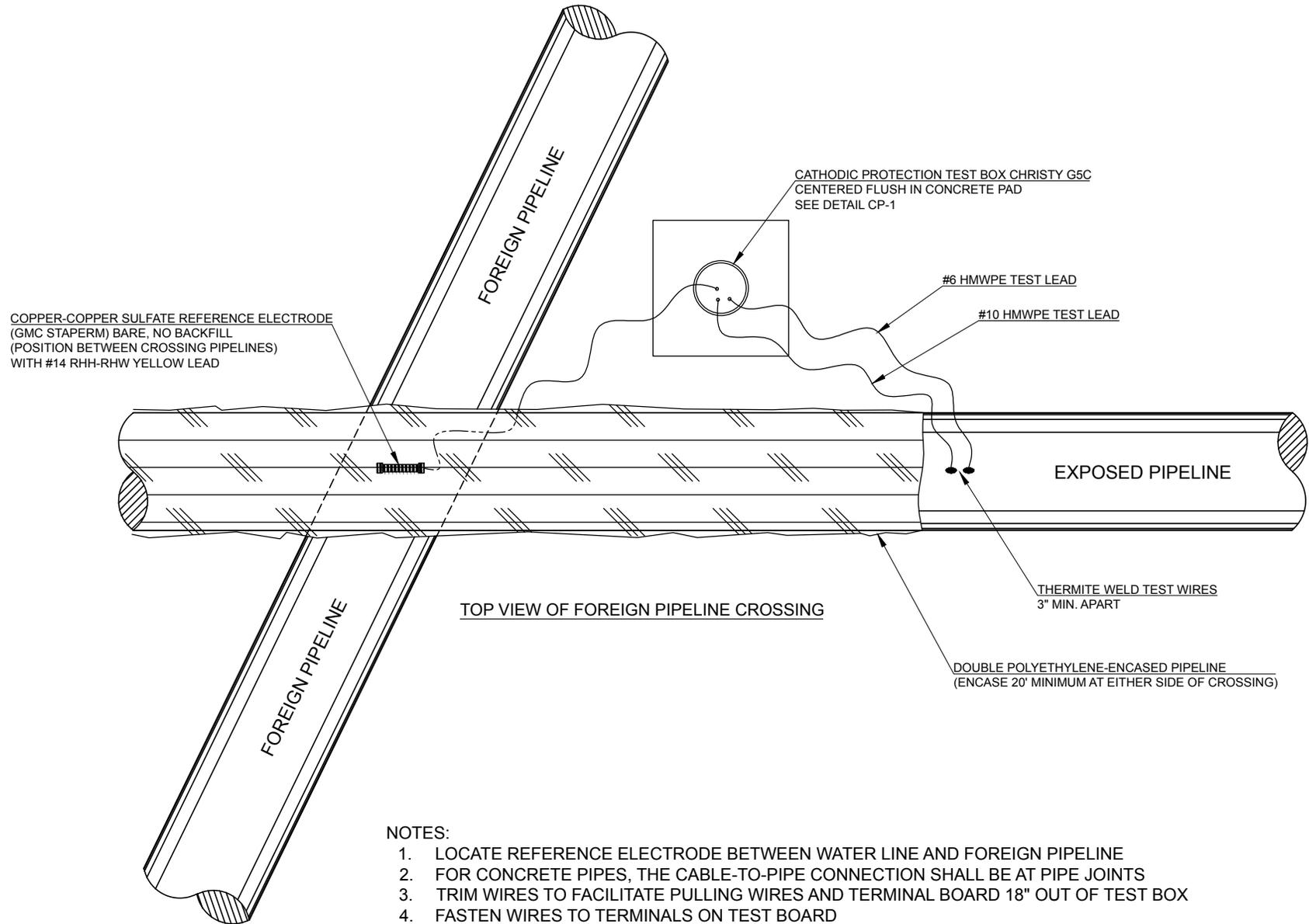
ANODE COMPOSITION BY WEIGHT :			
(ASTM B 843 FOR M1C HIGH POTENTIAL MAGNESIUM ANODE)			
ALUMINUM	—	—	0.01 % MAXIMUM
MANGANESE	—	—	0.5 - 1.3 %
SILICON	—	—	0.05 % MAXIMUM
COPPER	—	—	0.02 % MAXIMUM
NICKEL	—	—	0.001 % MAXIMUM
IRON	—	—	0.03 % MAXIMUM
OTHER IMPURITIES	—	—	0.05 % EACH, 0.30 % MAX TOTAL
MAGNESIUM	—	—	REMAINDER

HIGH POTENTIAL PRE-PACKAGED MAGNESIUM ANODE

ANODE INSTALLATION NOTES:

1. UNTIL INSTALLATION, ANODES SHALL BE PROTECTED FROM INCLEMENT WEATHER. DO NOT HOLD OR CARRY THE ANODES BY THE ANODE LEAD.
2. TO INSTALL THE ANODES, REMOVE THE PLASTIC OR PAPER COVER LEAVING THE FABRIC INTACT AROUND THE ANODE TO HOLD THE PREPACKAGE BACKFILL.
3. ANODES SHALL BE INSTALLED HORIZONTALLY IN THE PIPE TRENCH APPROXIMATELY 12-INCHES FROM THE PIPE. LAY ANODES END TO END, A MINIMUM OF 2 FEET APART. SOAK EACH ANODE WITH A MINIMUM OF 10 GALLONS OF WATER TO ACTIVATE, THEN BACKFILL WITH 12" OF NATIVE, DEBRIS-FREE BACKFILL. AFTER THE SURROUNDING SOIL AND ANODE IS THOROUGHLY SATURATED WITH WATER, BACKFILL WITH CLEAN FILL.
4. ANODE HEADER CABLE SHALL BE DIRECT BURIED AND RUN UP TO THE TEST STATION WITH SLACK. TERMINATE THE ANODE HEADER CABLE TO THE #6 TEST LEAD THROUGH THE 0.01 OHM SHUNT INSIDE THE CORROSION TEST STATION. THE #6 PIPE LEAD BOLT SHALL BE LONG ENOUGH TO TERMINATE THE #6 PIPE LEAD AND ANODE SHUNT.

		NO.	BY	DATE	REVISION HISTORY	APPD	DATE
ISSUED:	CATHODIC PROTECTION HIGH POTENTIAL MAGNESIUM ANODE	01	SEB	1/23	INITIAL RELEASE		
1/23/17							
REVISED:	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION						
--/--/--							
 PEAK CORROSION CONTROL, INC. 805 North Camino Cordon • Tucson, AZ 85748-2001 (520) 722-7484 • Fax (520) 722-0293		DETAIL NO.					
		CP-5					
		SHEET 5 OF 8					

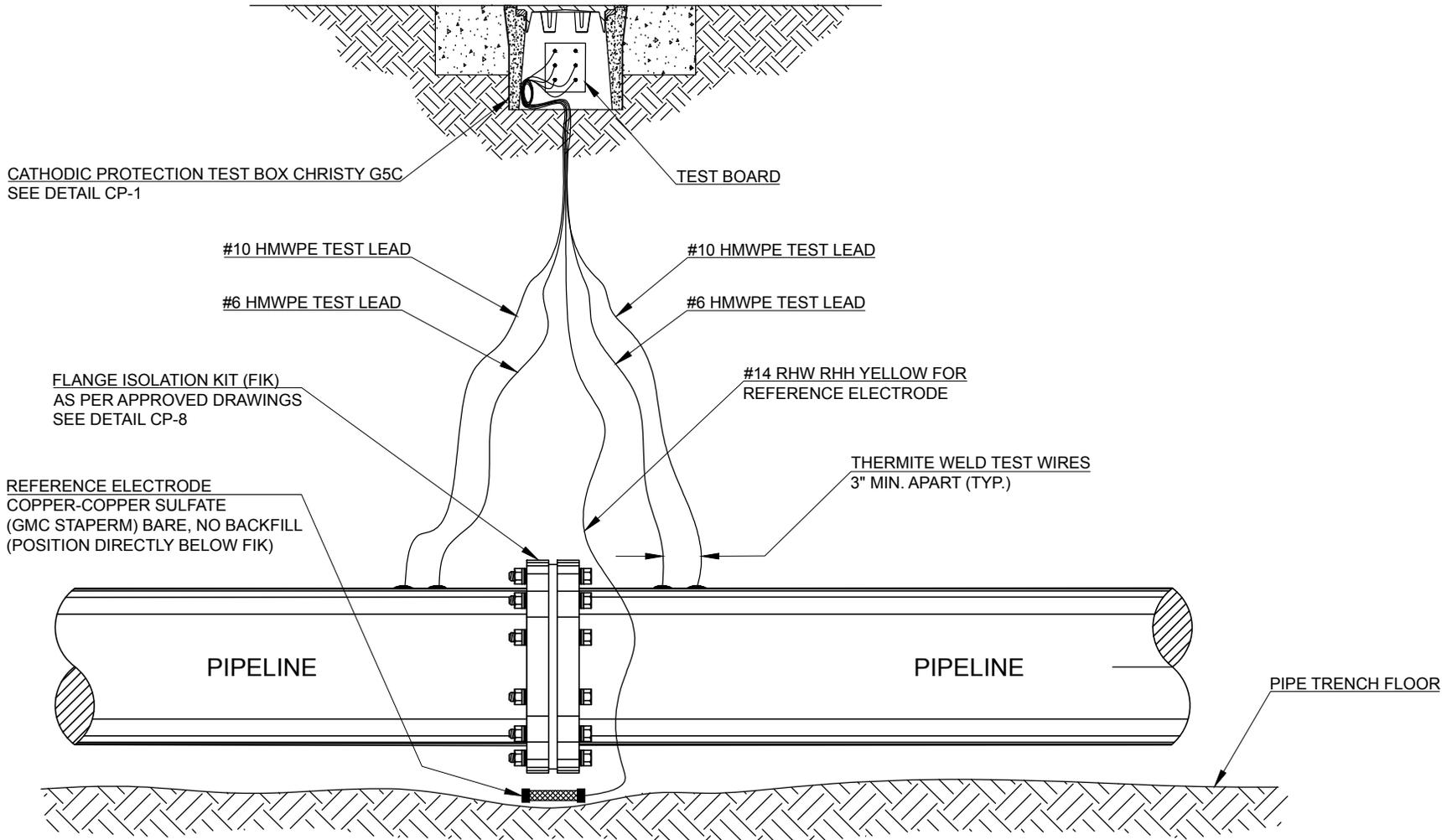


- NOTES:
1. LOCATE REFERENCE ELECTRODE BETWEEN WATER LINE AND FOREIGN PIPELINE
 2. FOR CONCRETE PIPES, THE CABLE-TO-PIPE CONNECTION SHALL BE AT PIPE JOINTS
 3. TRIM WIRES TO FACILITATE PULLING WIRES AND TERMINAL BOARD 18" OUT OF TEST BOX
 4. FASTEN WIRES TO TERMINALS ON TEST BOARD
 5. NOTIFY AND COORDINATE WITH FOREIGN PIPELINE OPERATOR WHEN EXCAVATING AND FASTENING WIRES
 6. WHERE DISTANCE BETWEEN PIPE SURFACES IS LESS THAN DIAMETER OF THE LARGER PIPE AT CROSSING, CP DESIGNER SHALL ISSUE REPORT TO ENGINEER WITH DESIGN FOR CURRENT EXCHANGE MITIGATION

		NO.		BY	DATE	REVISION HISTORY	APPD	DATE
ISSUED:	CATHODIC PROTECTION FOREIGN PIPELINE CROSSING	01	SEB		1/23	INITIAL RELEASE		
1/23/17								
REVISED:	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION							
---/--/--								


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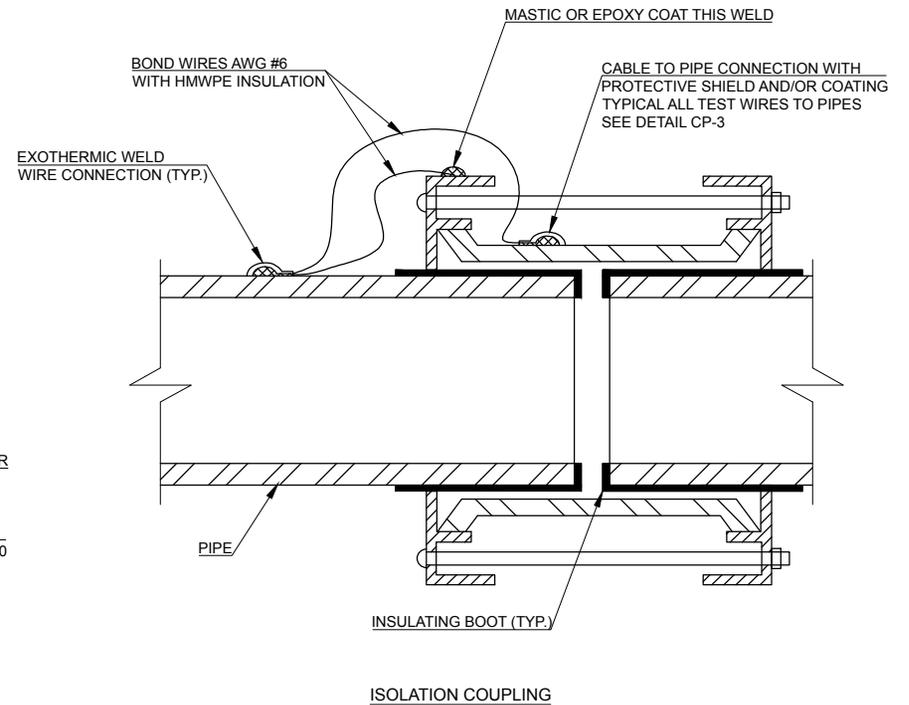
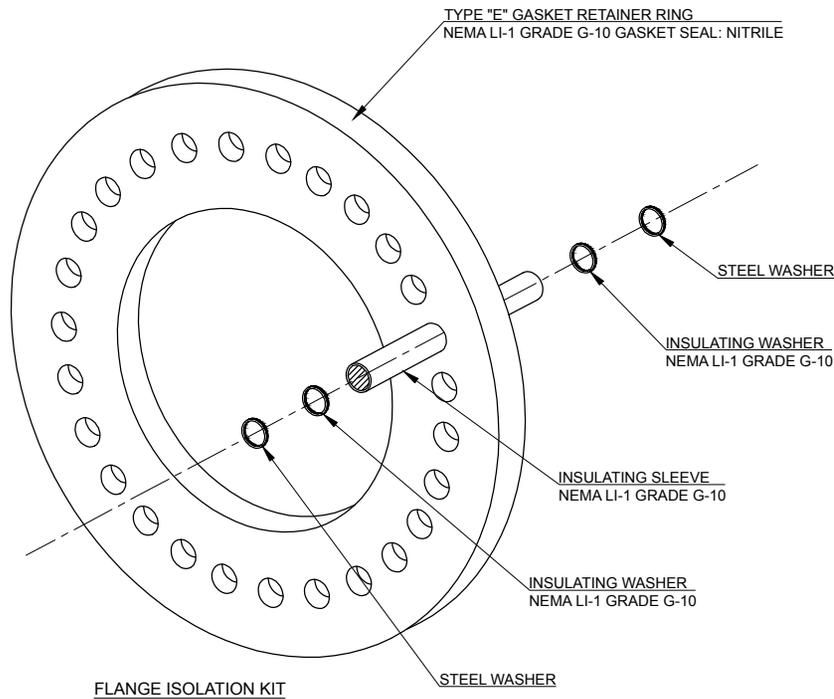
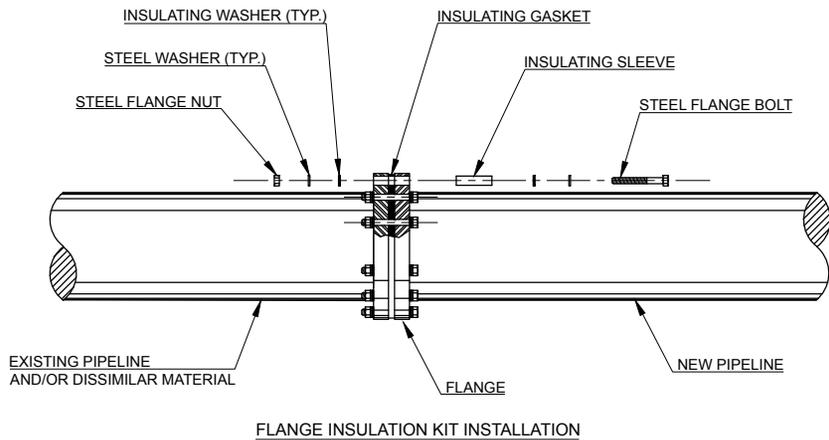
DETAIL NO.
CP-6
SHEET 6 OF 8



NOTES:

1. LOCATE REFERENCE ELECTRODE BELOW FLANGE ISOLATION KIT
2. FOR CONCRETE PIPES, THE CABLE-TO-PIPE CONNECTION SHALL BE AT PIPE JOINTS
3. TRIM WIRES TO FACILITATE PULLING TEST WIRES AND TERMINAL BOARD 18 INCHES ABOVE TOP OF TEST BOX
4. FASTEN WIRES TO TERMINALS ON TEST BOARD
5. CABLE IDENTIFICATION SHALL IDENTIFY WHICH SIDE OF FLANGE ISOLATION KIT ISOLATION EACH CABLE IS CONNECTED TO.

		NO.		BY	DATE	REVISION HISTORY	APPD	DATE	
ISSUED:	CATHODIC PROTECTION TEST STATION AT FLANGE ISOLATION KIT	01	SEB	1/23	INITIAL RELEASE				
1/23/17									
REVISED:	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION								
---/--/--									
 PEAK CORROSION CONTROL, INC. 805 North Camino Cordon • Tucson, AZ 85748-2001 (520) 722-7484 • Fax (520) 722-0293		DETAIL NO.							
		CP-7							
		SHEET 7 OF 8							

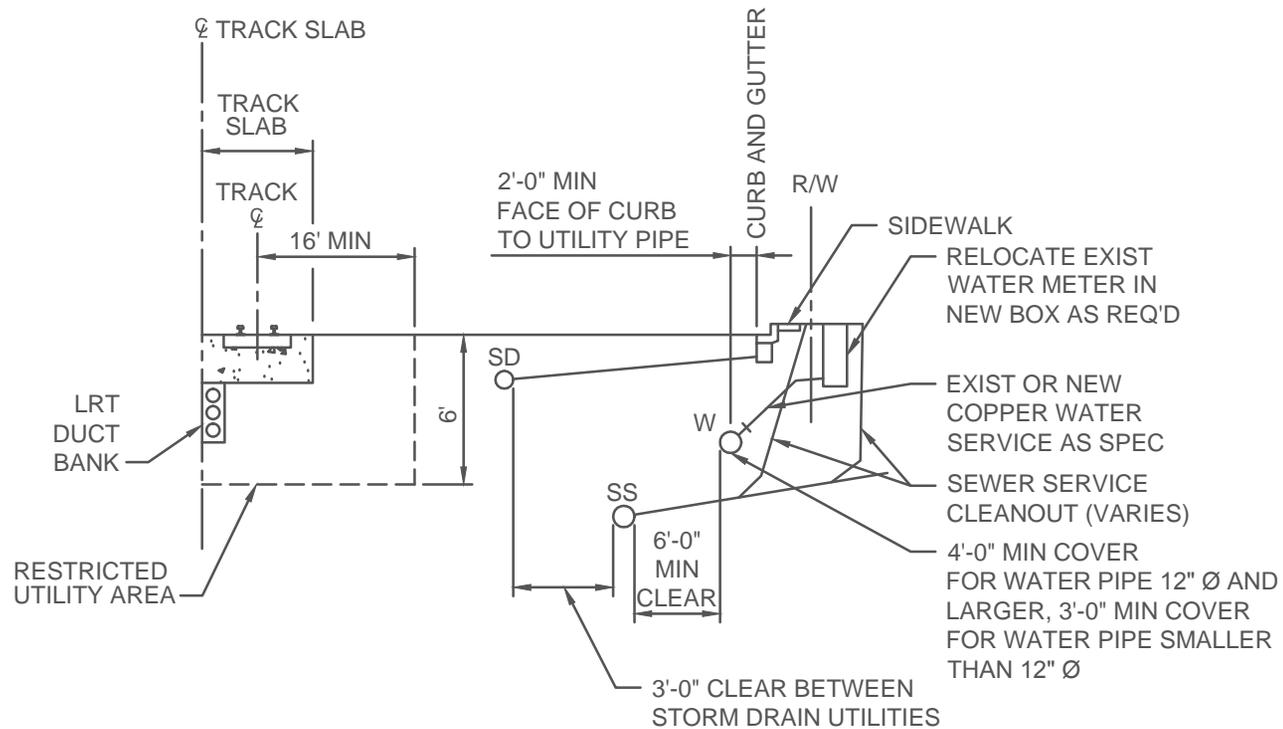


ELECTRICAL ISOLATION

		NO.		BY	DATE	REVISION HISTORY	APPD	DATE
ISSUED:	CATHODIC PROTECTION ELECTRICAL ISOLATION	DETAIL NO.		01	SEB	1/23	INITIAL RELEASE	
1/23/17		CP-8						
REVISED:	BROWN AND CALDWELL -- PHOENIX LIGHT RAIL CATHODIC PROTECTION	SHEET 8 OF 8						
---/---/---								


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Appendix E: Light Rail Water and Sanitary Sewer Details



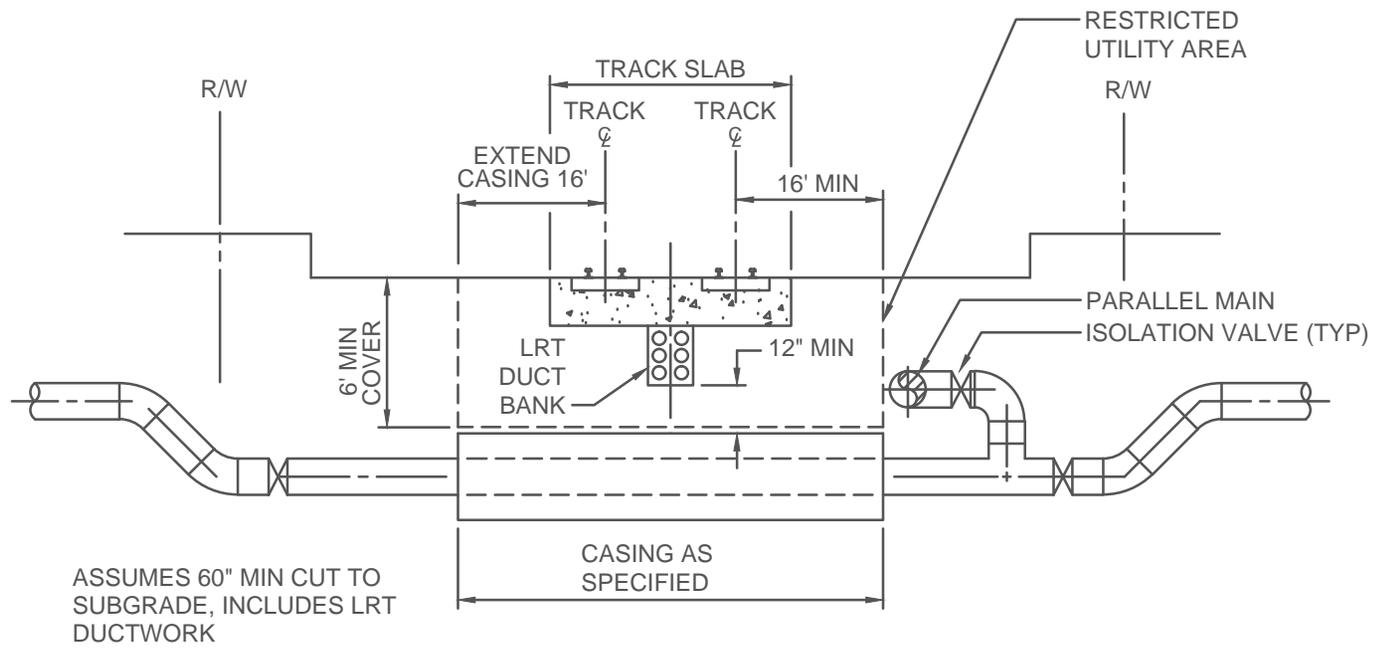
NOTES:

1. WATER AND SANITARY SEWER SHALL NOT BE LOCATED UNDER CURB AND GUTTER.
2. METERS AND CLEANOUTS SHALL BE LOCATED BEHIND SIDEWALK.
3. REFER TO SECTION III IN THE DESIGN STANDARDS MANUAL FOR ADDITIONAL DESIGN CRITERIA.

DETAIL NO.
LRT 2

TYPICAL PUBLIC UTILITY CROSS-SECTION LOCATION

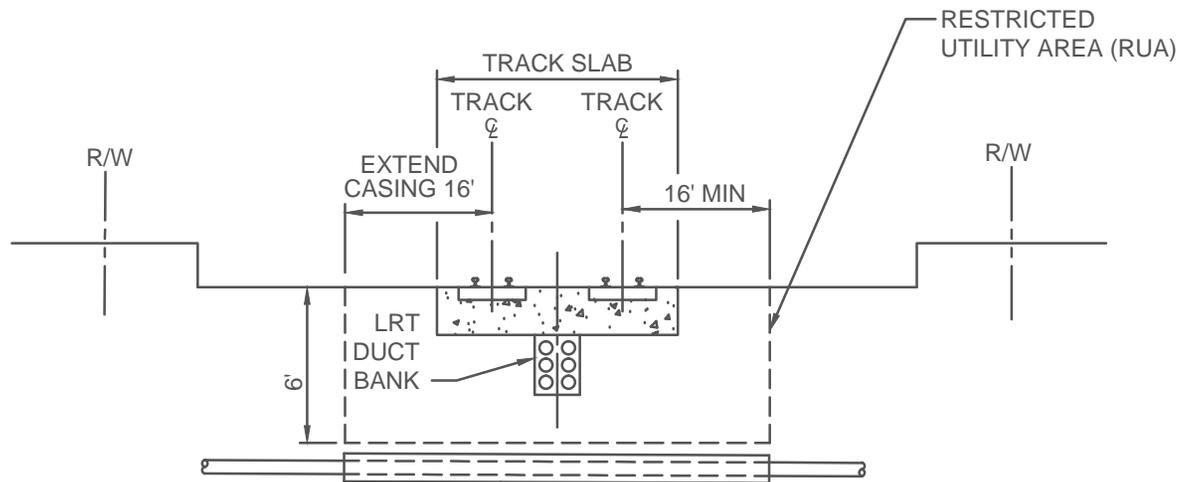
DETAIL NO.
LRT 2



DETAIL NO.
 LRT 3

COMBINATION MAIN CROSSING DETAIL

DETAIL NO.
 LRT 3

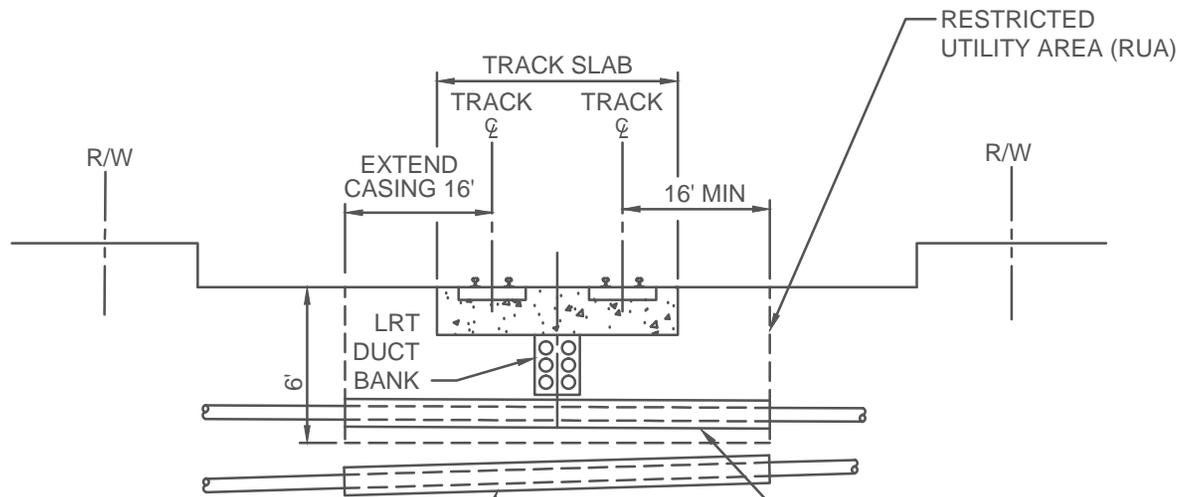


EXISTING WATER SERVICE PIPING SHALL BE RELOCATED BELOW THE RUA. FOR EXISTING AND NEW WATER SERVICE INSTALLATIONS, NEW PIPING AND CASING SHALL BE PROVIDED AS SPECIFIED.

DETAIL NO.
LRT 4

WATER SERVICE CROSSING DETAIL

DETAIL NO.
LRT 4



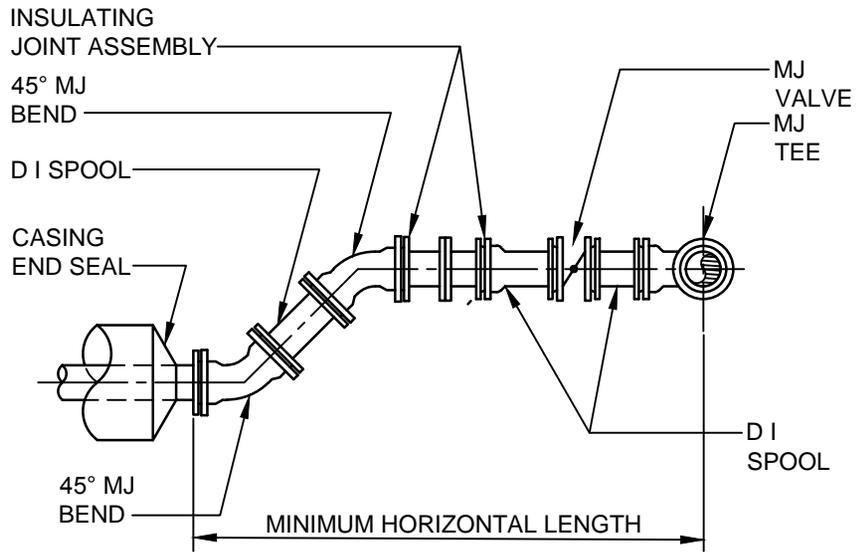
EXISTING SANITARY SEWER PIPING SHALL BE RELOCATED BELOW THE RUA. FOR EXISTING AND NEW SEWER SERVICE INSTALLATIONS, NEW PIPING AND CASING SHALL BE PROVIDED AS SPECIFIED.

IF APPROVED BY WSD, EXISTING SANITARY SEWER PIPING WITHIN THE RUA WHICH CANNOT BE RELOCATED LOWER SHALL BE REPLACED WITH NEW PIPING AND CASING AS SPECIFIED

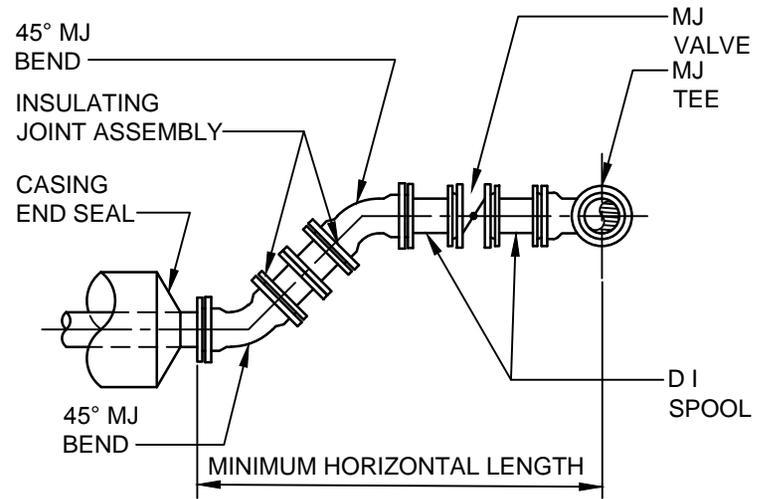
DETAIL NO.
LRT 5

SANITARY SEWER CROSSING DETAIL

DETAIL NO.
LRT 5



CASE 1

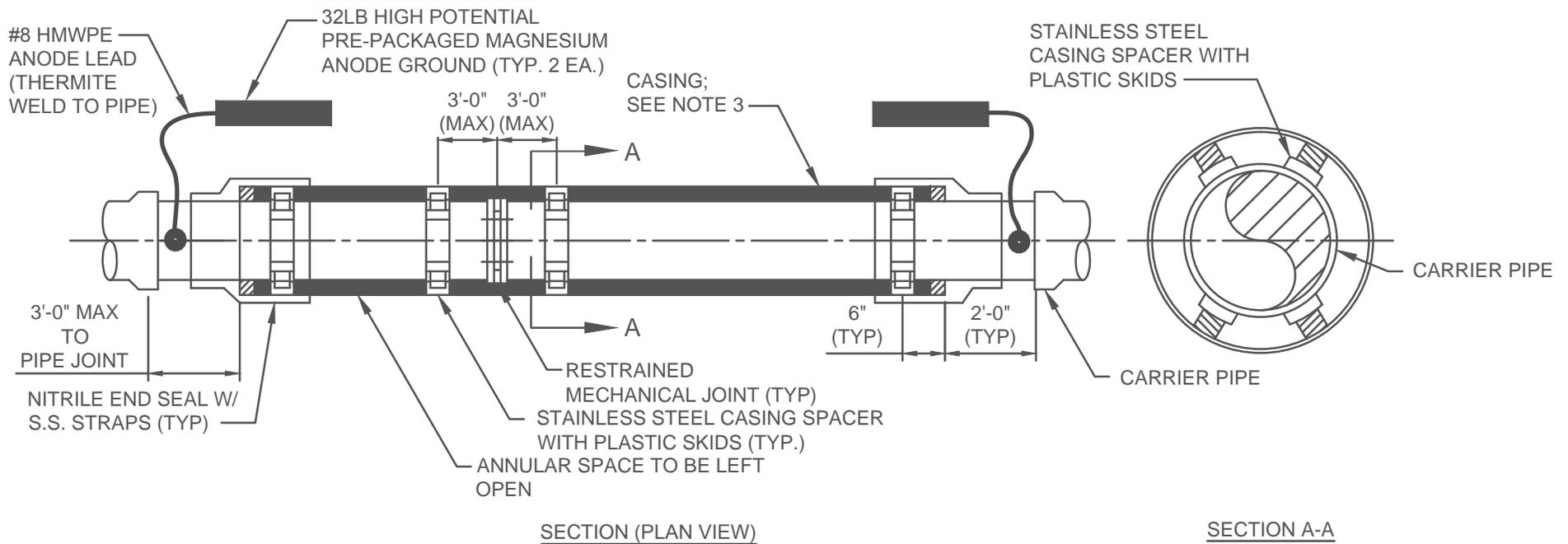


CASE 2

DETAIL NO.
LRT 6

WATER MAIN CONNECTION DETAILS

DETAIL NO.
LRT 6



NOTES:

1. ALL JOINTS INSIDE OF CASING PIPE SHALL BE RESTRAINED MECHANICAL JOINTS OR AS APPROVED BY THE ENGINEER.
2. INSTALL CASING PIPE AS SHOWN ON DRAWINGS OR MINIMUM 16 FT. BEYOND THE CENTER LINE OF THE TRACK.
3. SEE SPECIFICATIONS FOR CASING MATERIAL, JOINTS, DIMENSIONS AND COUNTY REQUIREMENTS.
4. MINIMUM 2 CASING SPACERS PER PIPE SEGMENT. INSTALL CASING SPACERS 3 FT. FROM THE END OF EACH PIPE SEGMENT. CASING SPACERS SHALL BE SPACED THROUGH THE MIDDLE SECTION OF THE PIPE SEGMENT ACCORDING TO CASING SPACER MANUFACTURER RECOMMENDATION OR AS APPROVED BY ENGINEER.
5. THERMITE WELD #8 HMWPE ANODE LEAD TO PIPE IN TRENCH AT EACH END OF CASING. GROUNDING ANODES SHALL BE HORIZONTAL IN TRENCH 12 INCHES MINIMUM FROM PIPE. EACH ANODE SHALL BE SOAKED WITH 10 GALLONS MINIMUM OF WATER AND THEN BACKFILLED WITH DEBRIS-FREE NATIVE SOIL.

DETAIL NO.
LRT 9

WATER AND SANITARY SEWER PIPE CASING DETAIL
(REVISED TO SHOW GROUNDING ANODES)

DETAIL NO.
LRT 9

Appendix F: Water Shutdown Documentation

Date submitted: _____



Water Distribution Main Shutdown Request Form

(*Email completed form to: WSDshutdown@phoenix.gov)

CITY PROJECT/PERMIT NO.: _____

PROJECT DESCRIPTION: _____

LOCATION OF SHUTDOWN: _____

PURPOSE OF SHUTDOWN:

QUARTER SECTION(s): ____ - ____ - ____ - ____

VALVE NO.(s): _____

INSPECTOR: _____ PHONE NO.: _____

CONTRACTOR: _____

FIELD CONTACT: _____ PHONE NO.: _____

PROPOSED SHUTDOWN DATE: _____

SPECIAL CIRCUMSTANCES (Night, Weekend, Holiday): _____

IT WILL TAKE UP TO 14 DAYS, ONCE WE RECEIVED EMAIL, TO SCHEDULE AND COMPLETE TEST SHUT DOWNS. ONCE TEST(S) HAVE BEEN COMPLETED WE WILL CONTACT YOU TO SCHEDULE ACTUAL SHUTDOWN.
PLEASE PLAN ACCORDINGLY.

Attach picture(s) of maps clearly identifying locations of the water main needed to be shutdown.

Shutdown Project Information Form

(Please use this form is to be used to initialize a shutdown request or reschedule a planned shutdown)

<input checked="" type="checkbox"/> Request NEW Shutdown.		
Project Name:	XXXXXXXXXXXXXXXXXX	
Project No.:	STXXXXXXXXXXXX	
Project Location:	XXXXXXXXXXXXXXXXXX	
Shutdown Description:	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
Project Contact:	Project Manager Name	
Contact Phone & Email:	(602) 555-5555	
Planned window of shutdown/ Reschedule:	From: XXXXXXXX	To: XXXXXXXX
Expected duration of Shutdown	XXXXXXXXXXXX	X Days <input type="checkbox"/> Hours <input type="checkbox"/> Months
Reason for Shutdown/ Reschedule:	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
Water facilities expected to be impacted (include as many as needed):	Facility Name: Unknown Type of impact: Unknown	
	Facility Name: Type of impact:	
Expected pressure zones to be impacted:	Zone #X	Alternative Supply: Unsure
Does shutdown impact WS capacity?	<input type="checkbox"/> YES: provide impact on production &/or delivery capacity: Unsure. Please verify	
Consequences of not performing the shutdown as requested:	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
Flexibility in modifying schedule:	<input type="checkbox"/> NO <input checked="" type="checkbox"/> YES, How flexible? XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
Additional comments:		
Date project added/ Rescheduled to shutdown schedule:		
Date project last re-scheduled:		

1. Shutdown Project Information Form (SPIF) must be used for any NEW or REVISED shutdown request. This includes change in duration and/or schedule.
2. All updates of changes need to be conveyed to PRPM contact as soon as they become available.
3. Email to be sent to all project contacts/ managers whose shutdown requests start or finish dates are within 6 weeks of the following shutdown meeting, requesting updates if any by completing SPIF and emailing changes to PRPM contact prior to shutdown meeting day.
4. Changes and updates will be included in shutdown schedule by the day of meeting.



**Project Name
Shutdown & Disinfection MOPO**

Date MOPO submitted:	-	1/1/2019
Project Start Date	-	5/1/2019
Approximate Duration	-	160 Days

Draft/or Revision 1

City of Phoenix - LARGE MAINS

MOPO written by: Project Manager

Pipe length/volume: 3.0 miles of 48 inch
1.5M gallons (example) Cell Phone: (602) 555-5555

Site/Location: 3rd Avenue & Washington City Project Manager: Name

PROJECT # WS55500555 Cell Phone: (602) 555-5555

Pre-work Items

	Activity	Start Time	Date	Departments / Section / Contractor
a				
b				
c				

Shutdown & Disinfection Plan

Item	Activity	Start Time	Date	Departments / Section / Contractor
1				
2				
3				
4				
5				
6				
7				
8				
9				

Additional items that will need to be addressed

1				
2				
3				

EMERGENCY / 24-HR CONTACT LIST

Appendix G: CCTV Request Form

SANITARY SEWER MAIN CCTV INSPECTION REQUEST

DATE: _____ CONTRACTOR: _____

PROJECT NAME: _____ PHONE #: _____

PROJECT NUMBER: _____

LOCATION: _____

REASON FOR INSPECTION: _____

Q.S.: _____ *(Please provide copy of Contract Drawing with the section to be inspected highlighted)*

LINEAL FT. TO INSPECT: _____ C/O MH#: _____ TO C/O MH#: _____

PIPE DIAM.: _____ IN.

PIPE MATERIAL: _____

DEPTH OF FLOW: _____ IN.

MH DEPTH: _____ FT.

DATE WHEN LAST CLEANED: MH'S: _____ MAIN: _____

FOR NEW INSTALLATIONS, DATE PRESSURE TEST WAS COMPLETED: _____
(Please provide copy of pressure test report)

COMMENTS: _____

SECTION FOR CITY OF PHOENIX USE

DATE RECEIVED: _____ ASSIGNED TO: _____

COMPLETED BY: _____ DATE COMPLETED: _____

RESULTS: PASS: _____ REINSPECTION REQUIRED: _____

COMMENTS: _____

Appendix H: Sanitary Sewer Bypass Pumping Specification

SECTION 02145

SEWER BYPASSING

PART 1 – GENERAL

1.1 DESCRIPTION

A. SCOPE:

This section describes the existing conditions for temporary bypassing and dewatering of sewers during internal television inspection (CCTV), cleaning operations, new construction, realignment, or rehabilitation of the project pipelines and service laterals prior to placing the pipeline or lateral service into service.

B. REQUIREMENTS:

1. Contractor shall provide labor, materials, and supervision to temporarily bypass flow around the Contractor's work in accordance with the specific needs of the rehabilitation method being utilized and dewater the manhole structures in preparation for cleaning and rehabilitation of the channel. All references to the bypass pumping and/or bypass pumping system include, but are not limited to, all pumps, piping, valves and other equipment needed to move the intended flow from one location to another.
2. The actual design of the bypass arrangement and alignment shall be prepared by the Contractor, and shall be submitted to the Engineer to determine conformance to project objectives. Means and methods of accomplishing the bypassing shall be the responsibility of the Contractor.
3. Sanitary sewer mains shall remain in service at all times throughout the duration of the project. Contractor shall be responsible for diverting flow away from the limits of construction through the use of bypass pumping with prior written approval by the Engineer.
4. Service to laterals shall be disrupted for a period of no more than 8 hours. Laterals within residential areas shall only be out of service between the hours of 8:00 am to 5:00 pm, Monday through Friday. Laterals within business areas shall be addressed on a case-by-case basis. If Contractor feels that it is necessary to disrupt lateral services for a period longer than 8 hours, Contractor shall provide alternate means of service without disrupting use of the service by the owner/resident.

5. Contractor shall maintain pedestrian and vehicular traffic and comply with Americans with Disabilities Act regulations for access to all residential and commercial property unless written approval is otherwise obtained from the property owner allowing for reduced access.
6. It is the Contractor's responsibility to arrange all necessary access and temporary construction agreements with all affected parties for the location of the bypass pumping system.
7. The bypass pumping system shall be designed to normally maintain the wastewater flow below the top of the pipe, without surcharging.
8. The Contractor shall have the complete bypassing system in place and successfully pressure tested at 1.5 times the maximum operating pressure of the system before bypassing any sewage.
9. The Contractor shall notify the Engineer 48 hours prior to bypassing, plugging or shutting down bypassing of pipelines.
10. The bypassed flow shall be continuously monitored.
11. Contractor is responsible for immediate and proper cleanup should any spill occur, regardless of amount. Additionally, regardless of the amount, the Contractor shall pay for all damages and fines incurred as a result of the spill.

C. EXPERIENCE:

Contractor shall utilize staff and/or a subcontractor that has been directly responsible for completion of other projects that required the bypass pumping of sewage flows in excess of the peak flows defined in section 3.01.

1.2 SUBMITTALS

At the Preconstruction Conference, the Contractor shall submit drawings and complete design data showing methods and equipment proposed to utilize in sewer bypassing for approval by the Engineer. The submittal shall include the following information:

1. Drawings indicating the scheme and location of temporary sewer plugs and bypass discharge lines. The drawings shall also show the method and location for discharging the bypass lines.
2. Capacities of pumps, prime movers, flow-through plug configuration, and standby equipment.
3. Design calculations proving adequacy of the system and selected equipment.

4. Standby power source.
5. Staffing plan.
6. Show suction and discharge points with elevations and stationing on the design plans.
7. Provide pump performance curves.
8. Submit calculations to verify suction lift of pumps has not been exceeded.
9. Contractor shall submit proposed noise control and exhaust control plans for pumping equipment.
10. Contractor shall submit a proposed plan for disruption of sewer service laterals.
11. Contractor shall submit bypass piping inspection, emergency flow reinstatement, and emergency response plans.
12. Contractor shall submit qualifications as specified in Section 1.01 C. A minimum of three projects in the last 8 years shall be referenced.

The actual design of the bypass arrangement shall be prepared by the Contractor or Subcontractor performing the work, and shall be submitted to the Engineer to determine conformance to project objectives. The Contractor shall be responsible for any subcontractor's design (if used) on this project. Means and methods of accomplishing the bypassing shall be the responsibility of the Contractor.

Approval of submitted plans for sewer connection and temporary rerouting shall in no way relieve the Contractor of its responsibility for the protection of adjacent properties, downstream drainage systems and water tributaries against sewage spill. Any litigation, claims, fines, etc. associated with any sewage spill shall be the responsibility of the Contractor.

1.3 JOB CONDITIONS

A. AVAILABLE FLOW DATA:

Available flow data for the sewers to be rehabilitated at the project site is located in 3.01 of this section. Flow data for the service laterals are not available. The Contractor shall determine the flow in the service laterals.

B. PROTECTION:

In areas where flows are bypassed, all bypass flows shall be discharged as approved by the Engineer. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.

All sewer plugs 24 inches and larger shall have a minimum 3/8-inch, stainless steel, braided safety cable affixed to the plug. The safety cable should be anchored in such a way to restrain the plug from passing downstream, in the event the plug lost internal pressure.

C. SCHEDULING:

The bypassing system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer. The bypass system will have an attendant around the clock, 24 hours per day, 7 days per week, whose only duty is to maintain the bypass pumping system until the bypassing of that specific pipeline is no longer required.

PART 2 – PRODUCTS

2.1 PUMPING SYSTEMS

Two different bypass pumping system criteria have been identified for this project. These criteria are identified below. Projects that are in environmentally sensitive areas or that have high sewage flows will require one or more of these criteria as specified herein.

A. CRITERION 1 - BYPASS PUMPING SYSTEM WITH FLOWS EQUAL TO OR LESS THAN 2.5 MGD

Contractor shall maintain on site the following minimum requirements for all bypass pumping systems:

1. Sufficient equipment and materials to ensure continuous and successful operation of the bypass systems. The COMPLETE bypass system, including all piping, shall be continuously monitored by Contractor personnel.
2. A system of pumps and piping operating on site to maintain a minimum 50% over capacity of the anticipated maximum flow (as determined by the Contractor). In addition, the Contractor shall have a standby pump, equal in capacity to the largest pump in the system, piped, plumbed and ready for operation. Standby pumps shall be fueled and operational at all times.

3. The Contractor shall maintain on site a sufficient number of valves, tees, elbows, connections, tools, sewer plugs, piping, hoses and other parts of system hardware to ensure immediate repair or modification of any part of the system as necessary.
4. Sound-attenuated pumps and/or power generators shall be provided for bypass pumping system. The sound-attenuated pumps and/or power generators shall be capable of achieving an operating noise level of 70 decibels or less, measured at a distance of 50 feet. The Contractor shall be responsible to provide and install sound-attenuation devices, methods and/or system to maintain noise levels below stated decibels. Sound measurements shall be made and recorded by the Contractor in accordance with American National Standards S 13-1971.
5. All liquid fuel powered pumps, generators, and other equipment shall be placed in a containment barrier to protect against gasoline, oil, and hydraulic fluid spills.

B. CRITERION 2 - BYPASS PUMPING SYSTEM WITH FLOWS GREATER THAN 2.5 MGD

In addition to the requirements identified under Criterion 1, Contractor shall design construct, operate and maintain the bypass system specified herein:

1. All bypass piping shall be fused high-density polyethylene piping.
2. The bypass piping system shall include multiple pipelines to convey 150% of the maximum anticipated flow (as determined by the Contractor). A minimum of one additional (spare) pipeline will be constructed and plumbed for immediate operation that is equal in diameter to the largest pipe size in use for the bypass setup. All other requirements shall be the same as identified under Criterion 1 of these specifications.

PART 3 – EXECUTION

3.1 ESTIMATED FLOWS AND SEWER CAPACITY PROJECT PIPELINE

A. DAILY FLOW DATA:

The following paragraph provides calculated daily flow information for the project pipelines. The information was obtained from the data provided by the City of [_____]. For additional information contact the City of [_____], during normal business hours. Use of this flow data in no way relieves the Contractor from his responsibilities for design, construction and operation of an adequate and properly functioning bypass system. Any additional monitoring or gathering of flow data is the responsibility of the Contractor.

CITY OF PHOENIX: Water Services Department
PROJECT NAME: (INSERT PROJECT NAME)
PROJECT NUMBER: (INSERT PROJECT NUMBER)

The average daily and peak flows for each of the projects are presented below. The average daily flows are based on daily reported averages for the period [Add Dates]. The peak hour flows are based on the highest hourly reported flow for the month of [Add Date].

Metered Average Day and Peak Hour Sewage Flows		
Location	Average Daily Flow (mgd)	Peak Hour Flow (mgd)
[]

Abbreviations: mgd – million gallons per day

B. FLOW CONDITIONS:

The Contractor is responsible for obtaining current flow condition information at the time of construction. The Owner is not responsible for any deviations in quantity of sewage flow at any time during the construction period. Higher flows may be encountered depending on weather and other upstream conditions.

3.2 INSPECTION

The Contractor shall inspect the entire bypass pumping and piping system for leaks for spills on an hourly basis. The Contractor shall also create an inspection log and shall enter the time of the inspections and the condition of the piping and the name of the inspector into the log for review by the Engineer.

3.3 DAMAGES

The Contractor shall repair, without cost to the Owner, any damage that may result from its negligence, inadequate or improper installation, and maintenance and operation of bypassing system, including mechanical or electrical failures.

****END OF SECTION****