



City of Phoenix  
Water Services Department

# DESIGN STANDARDS MANUAL FOR WATER AND WASTEWATER SYSTEMS

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## Highlights and Revisions

Page Number	Revision Number	Date	Description of Change
All	1.0	6/12/2003	Complete revision and update
All	1.0	3/12/2003	Published document into electronic format.
All	1.0	2/01/2004	Incorporating changes to online document according to comments received.
All	1.0	8/01/2004	Incorporating changes to online document according to comments received.
All	2.0	2/29/2012	Complete revision and update

# CHAPTER 1 INTRODUCTION

## 1.1 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 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. The manual applies to existing systems being expanded, modified, upgraded, and rehabilitated as well as to the construction of new mains. The manual is not intended 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 has other design manuals available for the facilities (booster stations, lift stations, reservoirs, and pressure reducing valve stations) located on our website.

## 1.2 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.

## 1.3 REVISIONS AND PUBLIC COMMENTS

This manual may be revised periodically. Proposed revisions will be posted on the City of Phoenix Water Services Department (WSD) website for a period of 60 days prior to implementation unless the revision is required to comply with Federal, State, County, and City laws, regulations, ordinances or codes. In order to review proposed revisions, go to the following website:

<http://www.phoenix.gov/waterservices/design/index.html>

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 the WSD Design Standards Manual, you may send an email to the WSD through the link provided on the website. These comments will also be reviewed and responded to.

## 1.4 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 the WSD. The Director of the 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 the WSD Directors Representative. This appeal application is submitted to the Planning and Development Department (P&D) through the standard technical appeal process.



## 1.5 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:

1. Uniform Standard Specifications for Public Works Construction sponsored and distributed by the Maricopa Association of Governments (MAG). These specifications are herein referred to as MAG Specifications. These specifications are revised and updated periodically and are available electronically through the Maricopa Association of Governments office in Phoenix. To visit the website, go to <http://www.azmag.gov/>
2. Uniform Standard Details for Public Works Construction sponsored and distributed by the Maricopa Association of Governments (MAG). These details are herein referred to as MAG Standard Details. The details are revised and updated periodically and are available electronically through the Maricopa Association of Governments office in Phoenix. To visit the website go to <http://www.azmag.gov/>
3. 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). To visit the website go to <http://phoenix.gov/streets/reference/index.html>
4. Uniform Standard Details developed by the City of Phoenix Water Services Department are herein referred to as WSD Details.

## CHAPTER 2      DEVELOPMENT COORDINATION BY DEPARTMENTS

### 2.1 GENERAL

There are several City of Phoenix departments that may be involved in the processing of water and wastewater development projects. Among these departments are the Water Services Department (WSD), the Planning and Development Department (P&D), the Public Works Department (PWD), and the Street Transportation Department (STR). Each department has their own divisions assigned to process any portion of a project that falls within their jurisdiction.

**NOTE:** *If any portion of a project falls outside the Phoenix city limits, the developer must also include the prevailing jurisdictional agency and their processes.*

Water and wastewater development projects processed by the City of Phoenix fall into a variety of types with an array of variables regarding the following issues:

Joint venture agency projects through Intergovernmental Agreement, transmission mains, distribution mains, interceptor sewers, collection sewers, water and/or sewer related facilities, projects built inside the Phoenix city limits, projects built outside the Phoenix city limits, projects within the public right-of-way (ROW), projects outside the public right-of-way, public funded projects, private funded projects, private funded projects with public funding participation or reimbursement.

A project may be a straight forward and reviewed over the counter at one of several technical service counters or it may be a complex, multi-faceted development project lasting many years involving a regional master plan effort. The processing requirements and number of departments involved in a project depends entirely on the number of issues and jurisdictions included above.

The following department descriptions are intended to give an overview of these departments' jurisdictional areas and the services provided by each.

### 2.2 WATER SERVICES DEPARTMENT (WSD)

#### 2.2.1 General

The WSD is empowered by the Phoenix City Code to ensure the proper administration and operation of the water and wastewater works of the City. The WSD operates under one of five Deputy City Managers who report to the Assistant City Manager. The Water Services Director is the general executive officer of the Department. The Director is in charge of all personnel and the entire operation, equipment and facilities of the Department. He 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.

### 2.2.2 WSD, Divisions of Responsibility

The WSD is responsible for project review, approval and inspection coordination of all infrastructure projects, which are water and wastewater treatment facilities, wastewater collection, pumping facilities, transmission mains, well sites, water storage sites, and pressure reducing facilities, both inside and outside the Phoenix city limits. These projects include Capital Improvement Projects (CIP) and private development projects.

Only private development projects that involve these above infrastructure type projects are to be submitted to the P&D for review process evaluation. P&D will then collect all fees due and pass the appropriate projects on to the WSD for design review and processing.

**NOTE:** *The WSD has the responsibility for the review and approval of distribution size mains only when designed outside the city limits.*

All master plans that include infrastructure expansion, transmission mains and/or facilities, for developing new or expanded service areas shall be reviewed by the WSD.

Infrastructure facilities typically processed by the WSD include:

1. Booster pump stations
2. Pressure reducing facilities
3. Storage facilities.
4. Well sites
5. Water transmission mains (16-inch diameter and larger)
6. Wastewater interceptor mains (15-inch diameter and larger)
7. Wastewater lift stations, Public and Private (3,000 GPD or more)
8. Treatment plant process works
9. Any other major infrastructure facilities

**NOTE:** *Additionally, all private funded development and public CIP projects that are not in the public ROW must also be reviewed by P&D.*

### 2.2.3 WSD, Development Services Provided

The following is a representative list of the CIP and private development services provided by the WSD:

1. Develop, maintain, and prioritize the CIP Master Plan for project implementation through a 20 year schedule.
2. Administer the CIP Master Plan, developing prioritized work scopes for infrastructure development.
3. Provide system flow data and prepare system analysis reports as well as develop new programs as needed.
4. Provide project coordination throughout the selection process for consultants, contractors, and the selected alternative delivery system.
5. Perform and document a comprehensive review of developer master plans and planned community developments providing water and wastewater guidelines compatible with project development benefiting from the WSD CIP Master Plan.
6. Assist developers and consultants with fire flow test analysis assuring efficient project design.

7. Provide a project manager as a single contact person for consultants, facilitating coordination among other departments jurisdictionally involved as appropriate to meet project requirements.
8. Provide complete design review and processing of the project documents concluding with project approval for construction permits.
9. Coordinate and develop the goals and objectives for the project specifications process.
10. Provide coordination of environmental documentation, evaluation, and remediation.
11. Provide processing coordination for ROW dedications and other requisite legal instruments.
12. Provide mapping services in the latest Geographic Information System (GIS) land base, including historic records of all past WSD projects, as well as function as the depository for newly completed projects.
13. Provide a computerized project tracking process throughout the entire development effort.

For preparation of private development construction plans that will become a part of the Phoenix system, refer to the checklists and guidelines available in the P&D's Civil Section. Refer to the following website link:

<http://phoenix.gov/pdd/development/sitecivil/civil/index.html>

For preparation of CIP construction plans for water and sanitary sewer main extensions, an additional checklist is available to be used concurrently with P&D's water and sewer checklists. Refer to the **Checklist Requirements for Water and Sewer Plans** in the WSD website at the following link:

<http://phoenix.gov/waterservices/design/manuals/index.html>

## **2.3 PLANNING AND DEVELOPMENT DEPARTMENT (P&D)**

P&D is responsible for technical review, inspection, and approval of water mains smaller than 16-inches in diameter, and sanitary sewer main projects smaller than 15-inches in diameter, within the Phoenix city limits. This also includes other water and sewer plans such as fire lines, fire hydrants, and any 8 ½ x 11 standard detail plans.

Contact P&D for more detailed information describing the development review process. Information is also available online at the following link:

<http://www.phoenix.gov/development/index.html>

## **2.4 PUBLIC WORKS DEPARTMENT – PLANNING, DESIGN & CONSTRUCTION MANAGEMENT DIVISION**

Qualified private development projects will utilize services of PWD to establish and document the fair market value for work when public funds will ultimately participate in a project. All public water and sewer main extensions required for a CIP managed by PWD will be reviewed and approved by the WSD. All other minor water and sewer plans other than main extensions and construction inspection for these projects will be performed by P&D.

For preparation of CIP construction plans for water and sewer main extensions, an additional checklist is available to be used concurrently with P&D's water and sewer checklists. Refer to the **Checklist Requirements for Water and Sewer Plans** in the WSD website at the following link:

<http://phoenix.gov/waterservices/design/manuals/index.html>

## 2.5 *STREET TRANSPORTATION DEPARTMENT (STR) AND AVIATION DEPARTMENT*

All CIP projects constructing public water or sewer main extensions are to be reviewed and approved by the WSD. Construction inspection for these projects will be performed by the STR and/or Aviation Department.

For preparation of CIP construction plans for water and sewer main extensions, an additional checklist is available to be used concurrently with P&D's water and sewer checklists. Refer to the **Checklist Requirements for Water and Sewer Plans** in the WSD website at the following link:

<http://phoenix.gov/waterservices/design/manuals/index.html>

## CHAPTER 3      GENERAL WATER AND SEWER DESIGN CRITERIA

### 3.1    GENERAL DESIGN CRITERIA/CONSIDERATIONS

#### 3.1.1    Jurisdictional Agency Approvals

One of the most important early tasks is to develop a list of prevailing jurisdictional agencies that need to be consulted in order to obtain a notice to proceed for construction. 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.

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

#### 3.1.2    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 P&D Environmental Assessment form can be obtained from the following link:

<http://www.phoenix.gov/development/quickreference/index.html>

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 Pollution Discharge Elimination System (AZPDES) general permit for storm water discharges from construction sites. For more information, please use the following link:

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

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.

### **3.1.3 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.

### **3.1.4 Subsurface Investigations**

When requested by the 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 of not more than 1,000 feet and at railroad, highway and canal crossings.

## **3.2 ALIGNMENT AND EASEMENT REQUIREMENTS**

### **3.2.1 General**

A route study or alignment report shall be completed to assure a functional hydraulic gradient/grade as well as continuity of an accessible 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 in streets within the public ROW. Water and sewer mains not located within ROW create access problems and will not be permitted except as described in sections 3.2.2, 3.2.3, and 3.2.4.

### **3.2.2 Residential Development with Private Accessways**

For single family residential development with individual lots, public water and sewer mains may be constructed in 29.16 foot private accessways (measured from the back of the curb) per COP Supplement Detail P1020-2. There shall be a minimum 8 foot public utility easement on each side of the private accessway. The entire 29.16 foot private accessway shall be dedicated as an exclusive public water and sewer easement.

### **3.2.3 Residential Development located within the City's Infill Incentive Districts**

The WSD allows reduced easement standards for certain types of residential ownership projects that are located within the City of Phoenix Infill Development Incentive Districts as shown in the General Plan. WSD Policy P-104 describes the types of development that are applicable to this reduced easement standard and also provides the actual easement requirements. This policy is available on the WSD website at the following link:

<http://phoenix.gov/WATER/wsdengpl.html>

### **3.2.4 All other Easements**

Easements will only be considered in the following cases:

1. The project route falls in a future ROW alignment,
2. The project route falls in a major utility, canal or drainage channel corridor,

- For a short segment of water or sewer main that is not technically feasible to design the main in the ROW without violating City codes or ordinances and that, in the opinion of the WSD, the proposed alignment of the water or sewer main in an easement results in more efficient operation of the water or wastewater system.

Easements shall be located in tracts. Back lot or side lot easements will not be allowed.

Minimum Easement Widths:

- For water mains located in tracts; the minimum easement widths for water mains with 8 feet of cover or less shall be as follows:

**Table 3.1 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

The minimum easement widths for water mains with greater than 8 feet of cover may be increased on a case by case basis to reflect the required construction and maintenance activities.

In addition to the above, all appurtenances (blow-off, hydrants, etc.) shall be provided with an easement 6 feet by 6 feet centered on the appurtenances.

- For sewer mains located in tracts, the minimum easement widths for sewer mains shall be as follows:

**Table 3.2 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

- 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.

Location of water or sewer mains within the easement:

- Single water or sewer mains located within the easement shall be centered within the easement.
- For multiple mains allowed in an easement, maintain minimum separation requirements centered within the easement.



3. For water and sewer mains allowed in 29.16 foot private access ways, each main shall be 6 foot from centerline or as approved by the P&D.

The easements for water and sewer mains shall be dedicated and restricted for COP water and sewer mains only. Public utility easements (PUE's) are not acceptable.

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 nor permanent structures of any kind shall be constructed upon, over or under any water or sewer easements. Since water and sewer mains can be damaged by tree roots, trees shall not be planted within 10 feet of the outside diameter (OD) of the water or sewer main. A list of acceptable landscaping vegetation in easements is available on the WSD website at the following link:

<http://phoenix.gov/WATER/plantlistpue.pdf>

No landscaping shall be placed within an easement that will render the easement inaccessible by equipment. The WSD has the right to cause any obstruction to be removed 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 homeowners 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 homeowners association or other ownership group shall be submitted to the City of Phoenix, P&D for verification.

For water and sewer easements not located within a private access way, an all-weather access road is required if manholes, valves, fire hydrants or other appurtenance requiring City access are located within the easement. The access road shall have a minimum width of 10 feet and shall be paved or constructed of minimum 6 inch thick stabilized decomposed granite or as approved by the WSD. The road shall be located 3 feet to the side of the main(s) or other as approved by the WSD. Each end of the access road shall connect to a public street or private access way or a turn-around easement conforming to with COP Supplemental Detail P1022 shall be provided. The maintenance of access roads in the water easements is the responsibility of the property owner or homeowners association and shall be indicated as such in the CC&R's. A copy of the CC&R's providing evidence of this maintenance responsibility by the homeowners association or other ownership group shall be submitted to the P&D for verification.

Water or sewer mains shall not be placed in easements under retention basins. Water or sewer mains in easements at wash crossings shall not locate appurtenances such as manholes, fire hydrants or valves within the 100 year flood elevation of the wash.

For parcels that are being redeveloped and there are existing easements on the parcel that do not meet the requirements above, the City will review each on a case-by-case basis to consider construction options, for example, reinforced concrete retention walls.

### **3.2.5 Structures Adjacent to Existing Water & Sewer Easements**

No building 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 as shown in Table 3.1 & 3.2, 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 equal to the depth (invert) of the sewer main, shall be required to submit structural and soil calculations signed and sealed by an Arizona Registered Professional Engineer. This report shall verify integrity of the proposed structure under the condition of a sewer main failure.

Water

Buildings, building slabs or structures proposed outside of the easement but parallel to a water main within 12 feet, shall be required to submit structural and soil calculations signed and sealed by an Arizona Registered Professional Engineer. This report shall verify integrity of the proposed structure under the condition of a water main failure.

**NOTE:** *The horizontal distance is measured from the edge of the building foundation to the OD 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

### 3.3 SUBMITTALS

#### 3.3.1 Water and Sewer Master Plans and Reports

Planned Community Districts (PCD's) require the submittal of a 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's must be obtained from the P&D.

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

#### 3.3.2 Design Reports

Sewer

A design report shall be submitted for all proposed sewage collection systems. The design report shall include a description of the project, the basis of the design, calculations for project design flow, system capacity, capacity phasing and other information needed to gain a clear understanding of the project. The design report shall be signed and sealed by an Arizona Registered Professional Civil/Environmental Engineer. The following is a general guideline for information to include in the report:

1. **Project Description** - Describe the type of development including number of units. Provide a site map of the project showing major streets and physical features such as canals, floodplains, railroads, washes, etc. Describe the proposed collection system including lift stations and force mains. Describe the existing system adjacent to proposed development and specific locations where the proposed collection system will connect to the existing system. Show the service

- area that will be served by the proposed sewage collection system, including off-site areas. Show alignment of proposed offsite mains and onsite mains with diameter of 12 inches and greater.
2. **Design Flows** - 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. Flow projections shall be based on Table 3.3 in Section 3.4.2.
  3. **Basis of Design** - 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.
  4. **Conformance with Master Plans** - 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.
  5. **Environmental Issues** - The report shall address potential compliance issues with Clean Water Act Section 404, cultural resources, or any other environmental requirements.

#### Water

A design report shall be submitted for all proposed additions or extensions to a public water system. The report shall include a description of the project, the basis of design, calculations for project design, any modeling, and other information needed to gain a clear understanding of the project. The design report shall be signed and sealed by an Arizona registered Civil/Environmental Engineer. The following is a general guideline for information to include in the report:

1. Water main design must be based on peak day flow + fire flow. Calculating peak day flow is explained in Section 3.4.3 Water Peak Flow.
2. Water mains must be designed to maintain a pressure between 50 and 100 PSI during peak hour conditions at a flow velocity of less than or equal to 5 FPS. They must also be able 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. The pipe diameter shall be sized based on the largest diameter calculated from the two conditions above.

**Note:** *These design parameters supercede the minimum requirements in Section 4.3.4, Pipe Sizing 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.*

3. The engineer should provide flow calculations and any necessary computer models for the two scenarios described above to provide documentation for the basis of design. The engineer should provide a clear, understandable schematic of the system showing the junction nodes, pipes, etc. for any computer modeling. The engineer should 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.

### **3.3.3 Construction Plans and Technical Specifications – CIP Projects and Projects with City Financial Participation**

For CIP projects and private development projects where the City participates financially, signed and sealed design plans shall be submitted to WSD for approval. The plans shall also be submitted to Maricopa County Environmental Services Department (MCESD) for approval. For additional information, go to the MCESD website below:

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

Signed and sealed technical specifications shall accompany the plans submitted for the construction of water/sewer mains and all other appurtenances. The specifications accompanying construction drawings shall include, but not be limited to, specifications for the approved procedures for operation during construction, all construction information not shown on the drawings that is necessary to inform the builder in detail for the design requirements for the quality of materials, workmanship and fabrication of the project. Technical specifications shall conform to the MAG and COP Supplements and Specifications.

### **3.3.4 Construction Plans – Private Development Projects**

All technical and engineering plans relating to private developer projects subject to the Development Review process shall be submitted to the P&D for review and approval. This includes all 12 inch and smaller water and sewer mains. For water or sewer mains larger than 12 inches, the plans are submitted to the WSD for review and approval.

For preparation of private development water/sewer plans that will become a part of the Phoenix system, refer to the appropriate checklist available from the P&D website at the following link:

<http://www.phoenix.gov/development/siteandcivil/civil/index.html>

### **3.3.5 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/Environmental Engineer. The record drawings shall meet the requirements of WSD policies P-68 and P-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, P-69, and P-85 are available on the WSD website at:

<http://phoenix.gov/WATER/wsdengpl.html>

## **3.4 WATER DEMAND AND SEWER DESIGN FLOWS**

### **3.4.1 General**

Included in this section are basic water demands and sewer flow criteria established by the WSD. The minimum water main pipe sizes established in Section 4.3.4, Pipe Sizing for Distribution Mains 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.

### **3.4.2 Water and Sewer Design Flows**

Table 3.3 shall be used to calculate both water and sewer design flows utilized in the preparation of engineering design reports, plans, and specifications.

**Table 3.3 Water and Sewer Design Flows**

Land Use	Unit	WASTEWATER Avg Daily Flow/Unit (gal)	WATER Avg Daily Flow/Unit (gal)
Single Family Residential	dwelling	240	360
Multi-family <sup>1</sup>	dwelling	180	240
Commercial (retail/mall) <sup>1</sup>	1000sq-ft	75	125
Commercial (office) <sup>1</sup>	1000sq-ft	90	115
Warehousing/Big Box Retail <sup>1</sup>	1000sq-ft	25	30
Industrial <sup>1,2</sup>	1000sq-ft	50	65
Schools <sup>1</sup>	student	20	25
Hotel (no restaurant) <sup>1</sup>	room	100	140
Hotel (with restaurant) <sup>1</sup>	room	150	200
Resort <sup>1</sup>	room	210	300
Hospital (all flows) <sup>1</sup>	bed	300	500
<b>LANDSCAPE WATER REQUIREMENTS</b>			
General Landscaping	acre	NA	4,374
Public Right of Way or Streetscape	acre	NA	1,339
Surface Water	acre	NA	5,335

1) See landscape water requirements in section 4.6

2) Standard applies to domestic water demand and wastewater generation only. For additional water and wastewater requirements associated with industrial processing for semi-conductor, aerospace, commercial laundry, metal products mfg., food/dairy/bottling, environmental recycling, etc., the designer shall consult the WSD.

### 3.4.3 Water Peak Flow

Peak Day 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 Table 3.3, Water and Sewer 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

#### 3.4.4 Sewer Peak Flow

All gravity sewers, lift stations, and force 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

Design Flow = Peak Flow =  $Q_{Peak} = Q_{avg} [1 + \frac{14}{4 + P}]$ , Where P = Population/1,000

## **CHAPTER 4            WATER DISTRIBUTION AND TRANSMISSION SYSTEMS**

### **4.1    WATER SYSTEM OVERVIEW**

#### **4.1.1    Pressure Zones**

Approximately 90 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 40 to 100 PSI. 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 4.1, 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.

### **4.2    WATER MAIN DESIGN CRITERIA APPLICABLE TO BOTH DISTRIBUTION AND TRANSMISSION MAINS**

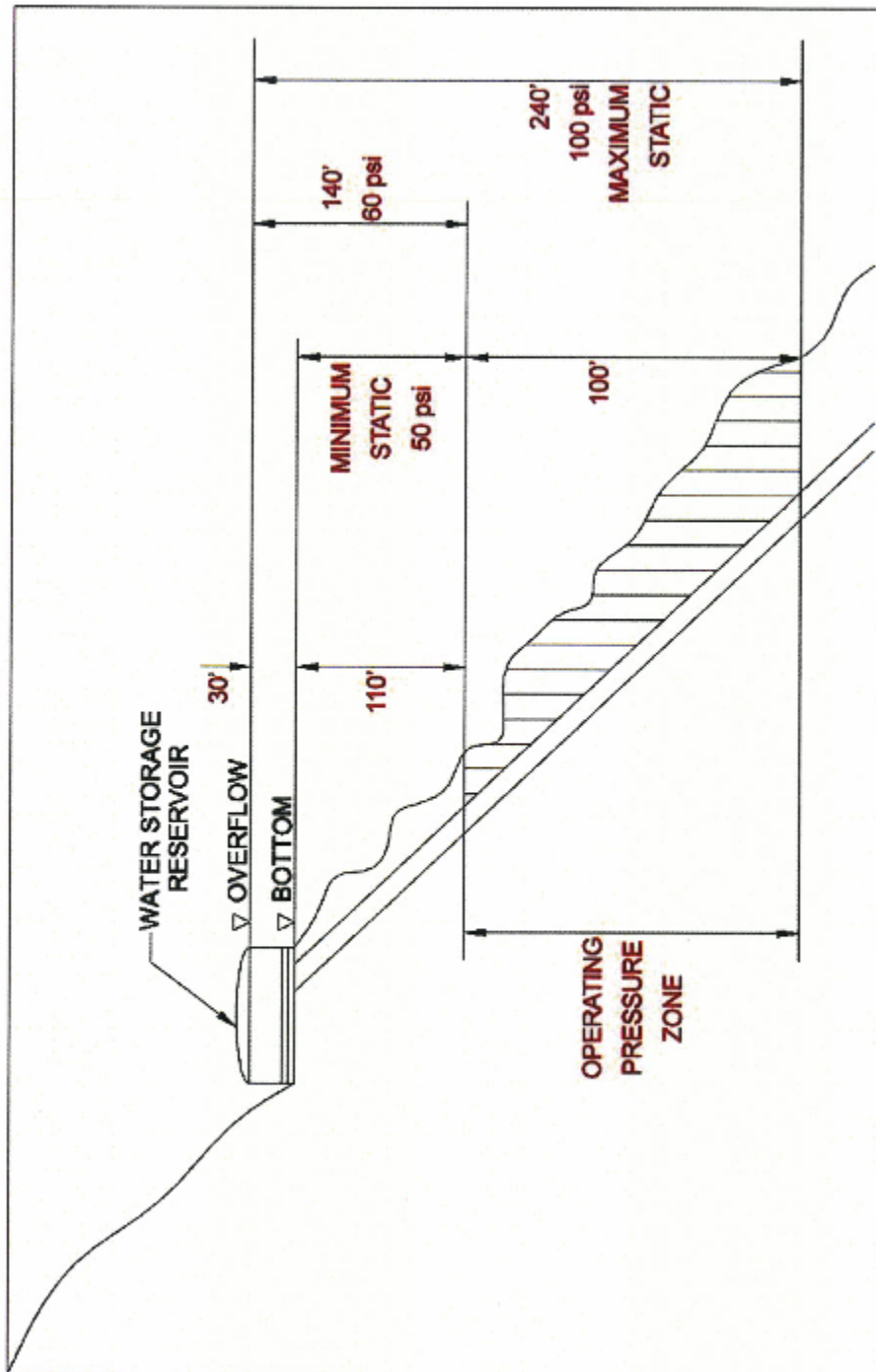
#### **4.2.1    Water Main Extensions**

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.

#### **4.2.2    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 will be stipulated and then configured as a distribution main. The WSD will make this determination.

**Figure 4.1 Typical Major Pressure Zone Configuration**  
(Pressures have been rounded to the nearest 10 PSI)





#### 4.2.3 Water Main Design

Generally, water main design shall be based on peak day flow plus fire flow demands up to a maximum of 3,000 GPM. In some circumstances, the 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 hour flow at a flow velocity of less than or equal to 5 FPS.

#### 4.2.4 Fire Flow Demand

For fire flow demands, please refer to the current adopted City of Phoenix Fire Code.

#### 4.2.5 Hydraulic Requirements

The 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. The WSD will make this determination.*

#### 4.2.6 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.

#### 4.2.7 Corrosion Protection/Ductile Iron Pipe

Where indicated by soil testing or as directed by the WSD, ductile iron pipe (DIP) mains shall be protected from exterior corrosion. This protection may consist of encasement in a polyethylene protective wrapping or other approved methods. Refer to the American Water Works Association corrosivity charts for more information.

#### 4.2.8 Separation from Sanitary Sewer Mains

To minimize the potential for cross contamination, water and sewer mains shall meet the separation requirements described in AAC R18-4-502 and illustrated in MAG Standard Detail No. 404-1.

#### 4.2.9 Separation from Sanitary Sewer Connections

Vertical clearance between water mains and sewer service connections: the water main shall not be less than 6 inches above the sewer service even if the sewer service connection is constructed with DIP.

#### 4.2.10 Separation from Storm Drains and Culverts

Water mains shall maintain 6 feet horizontal and 2 feet vertical exterior surface separation from storm drains and culverts. Water mains crossing less than 2 feet above a storm drain or culvert, but no closer than 12 inches, shall have additional protection. Examples of additional protection are restrained joints, pipe casing, alternative piping materials or as approved by the WSD.

#### **4.2.11 Separation from Other Utilities**

Water mains shall maintain a minimum 6 foot horizontal and 1 foot vertical separation to any underground dry utility. Any vertical separation between 1 foot and 2 feet shall be approved on a case-by-case basis by the plan reviewer or the construction inspector. Anything less than 1 foot vertical separation shall require approval through the technical appeal process.

#### **4.2.12 Cross Connections and Backflow Prevention**

No physical connection shall be allowed between potable and non-potable sources. Any connection is considered a cross connection. Specific provisions regarding cross connections and backflow prevention are available through the P&D, Backflow Prevention Program. Also refer to the City of Phoenix Uniform Plumbing Code.

#### **4.2.13 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.

### **4.3 *ADDITIONAL DESIGN CRITERIA ONLY APPLICABLE TO DISTRIBUTION MAINS***

#### **4.3.1 General**

Distribution mains are 6, 8 or 12 inches in diameter. As described in Section 4.2.2, 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.

#### **4.3.2 Water Plan Requirements - Check Lists**

For preparation of private development water system plans that will become a part of the Phoenix water system, refer to the P&D website at the following link:

<http://www.phoenix.gov/development/siteandcivil/civil/index.html>

#### **4.3.3 Acceptable Pipe Materials**

Distribution mains 6 inches through 16 inches in diameter shall be DIP. The pipe shall conform to the MAG and COP Supplements and Specifications.

#### **4.3.4 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 Table 4.1, Minimum Water Distribution Grid System. For all other types of development, water mains are sized to meet fire flow requirements or approved master plans, whichever is greater.

**Table 4.1 Minimum Water Distribution Grid System**

<b>LOCATION</b>	<b>PIPE SIZE (inches)</b>
Section line streets or grid arterials	12 (16 if stipulated by WSD)
Mid-section line streets or mid-grid feeders	8
All other streets (see exceptions below)	6

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 the WSD for acceptance of such a system.

This is a generalized pipe size guideline, which is subject to refinement in design analysis.

#### **4.3.5 Location/Alignment**

Distribution mains shall be located as set forth in the latest edition of Standard Utility Locations Manual for the City of Phoenix. Design engineers can obtain a copy through the Utilities Section of the Street Transportation Department. The standard utility locations are presented with the realization that every case will not be covered. There may be instances where the standards cannot be applied.

Project stationing shall be tied to established monumentation per WSD Policy P-68.

#### **4.3.6 Distribution Main Cover**

In accordance with MAG Specification 610.4, 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:

1. 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.
2. Four (4) feet for distribution mains 12 to 16 inches in diameter.
3. If finished grade cannot be identified, increased depth may be required.

#### **4.3.7 Line Valves**

Table 4.2, Valve Spacing, shows the maximum spacing for line valves on distribution mains.

**Table 4.2 Valve Spacing**

<b>LAND USE</b>	<b>MAXIMUM VALVE SPACING (feet)</b>
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.

1. A valve shall be located on each side of a canal, wash, railroad and freeway crossing.
2. Valves shall not be located in curbs, sidewalks, driveways, and valley gutters.
3. All valves shall conform to MAG Specification 610.6 and 630, including the COP Supplements thereto.
4. Valves shall be located at the point of curvature (PC) of the curb return at street intersections and aligned with a property or lot line in mid-block.
5. Valve boxes and covers shall be provided for all valves.

#### **4.3.8 Service Connections and Meters on Distribution Water Mains 6 inches and Larger**

Specific provisions for service connections and meters are contained in Article III and Article IV, Chapter 37 of the Phoenix City Code.

A brief summary of Code provisions for the design engineer follows:

1. Where new mains are being installed by a developer, service connections will be installed by the developer's contractor. With all service connections 3 inches and larger, the developer is responsible for providing the vault. The vault must be located in a Right of Way (ROW), water easement or PUE, as approved by the WSD. See vault detail W-500 on the WSD website at the following link:  
  
<http://phoenix.gov/waterservices/design/engdetails/index.html>
2. All new service connections on existing City water mains shall be installed by the WSD after all fees are paid. Contact P&D at 602-262-6551 for more information.
3. A water service line shall not be installed in a sewer trench with less than 6 feet of horizontal exterior surface clearance, however 3 feet with other water services and dry utilities is acceptable.
4. In accordance with Section 37-40 of the Code, every separate building supplied with City water must have its own separate service connection and meter. A single service line and a Master Meter can be used for two or more buildings located on the same lot or for apartment developments, trailer courts or similar projects covering one lot. In these Master Meter applications where an assured continuous supply must be maintained, the domestic development demand can be split and two meters may be used, each with its own service connection to the City main and then manifolded on the customer side of the meter. Beyond meeting the need to provide an uninterrupted supply to a development, the manifolded of more than 2 meters shall not be allowed.
5. The level of service impacts to existing customers and available resources shall be considered when selling new service connections and meters on existing mains. There is a limit to the level of service available, affected by competing adjacent property demands along a given water service main. New service connections shall be limited in size to 50% of the service main diameter. A new water main extension may be required when it has been determined by the WSD that existing main capacity has been exceeded.
6. When multiple distribution mains in the same pressure zone are adjacent to a development, all service connections must be taken from the largest diameter main or as approved by the WSD.

7. Where local static water pressure is in excess of 80 PSI a private pressure regulator valve shall be required on the customer side of the service meter.

#### **4.3.9 Service Connections and Meters on Substandard Distribution Water Mains (smaller than 6 inches in diameter)**

1. All development, excluding one single residence on a single lot as defined in 2 & 3 below, will not be allowed to purchase a new water service from a substandard waterline. In these cases, the developer shall comply with the requirements of City Code 37-33.
2. For a single residence on a single lot where there is a fire hydrant within 350 feet of the proposed construction, a service may be sold for the residence with the following stipulation:

“The waterline that you have purchased a service from is considered substandard by City Code 37-33. A tap may not be able to be placed successfully on the line. The City will attempt to place a new service tap onto the substandard waterline. If a new service tap cannot be placed on the substandard waterline, then the applicant will be required to extend a new waterline to the property from the nearest non-substandard waterline (6 to 12 inches in diameter) in order to provide service to the residence.”

3. For a single residence on a single lot where there is not a fire hydrant within 350 feet of the proposed construction, the applicant will be required to contact a Fire Protection Engineer with the Phoenix Fire Department to discuss options. Options may include a main extension to bring a hydrant closer to the property, installing a residential sprinkler system that allows for a hydrant to be located up to 500 feet from the proposed construction or obtaining a waiver. This is consistent with the Revised Fire Hydrant Location Requirements, April 2002, as adopted by the Development Advisory Board, and as written in this manual in section 4.8.

Once the fire protection issue is resolved, a service may be sold for the residence with the stipulation defined in 2 above.

All other requirements of Chapter 37 of the Phoenix City Code, and the Phoenix Plumbing Code shall apply.

#### **4.3.10 Water Meters and Sizing Guidelines**

**UPC Section 610.1:** The size of each water meter and each potable water supply pipe shall be based on the total demand and shall be determined according to the methods and procedures outlined in this section.

The type of meter selected should be compatible with these meter types, Positive Displacement (PD), Compound (Comp) or Turbine (Turbo) meter. The following guidelines should be used.

1. Positive Displacement and Compound meters are designed to accommodate the wide range of fluctuating demands associated with residential and commercial developments.
2. Turbine meters are designed to accommodate large demands within a narrow range of fluctuating flow as those associated with industrial type development. Also due to this characteristic, turbo meters have application for metered delivery of constant high flow rate demands associated with non pressure environments such as lake and pond fill lines during off peak hours.

Water meters will be sized in accordance with Table 4.3. The columns list the design allowable GPM or fixture units allowed for any given meter. Project designs which exceed the listed GPM unit values must be up-sized to the next larger meter.

**Table 4.3 Water Meter Sizing**

Column 1	Column 2	Column 3	Column 4
<b>METER SIZE AND DESCRIPTION</b>	<b>WSD &amp; P&amp;D DESIGN ALLOWABLE (GPM)</b>	<b>MAXIMUM FLUSH TANK FIXTURE UNITS</b>	<b>MAXIMUM FLASH VALVE FIXTURE UNITS</b>
5/8" x 3/4" PD	15	21	0
3/4" x 3/4" PD	25	42	8
1" PD	40	86	28
1-1/2" PD	65	200	92
2" PD	100	380	245
2" Compound	128	522	416
3" Compound	250	1335	1335
4" Compound	400	2670	2670
6" Compound	800	6280	6280
8" Compound	1280	10,048	10,048
Use of turbo meters is limited as described in paragraph 2 on previous page.			
2" Turbo	12	-	-
3" Turbo	280	-	-
4" Turbo	480	-	-
6" Turbo	1000	-	-
8" Turbo	2080	-	-

**Notes for Table Use:**

1. Use of water meters 6 inches and larger requires special advance consultation with the WSD to determine availability, actual flow capacity, meter cost, and delivery schedule.
2. Column 2 is the design meter flow rate as determined by the WSD and P&D.
3. Column 3 is the maximum number of fixture units permitted on a water distribution system when the plumbing fixtures are predominantly flush tank type water closets and urinals.
4. Column 4 is the maximum number of fixture units permitted on a water distribution system when the plumbing fixtures are predominantly flush valve type water fixture units.
5. Meter location must be out of traveled roadway/walk. Meter locations shall be easily accessible from a street.
6. Materials and installation for service lines 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.
7. Water meters servicing golf courses, lakes or any other continuous maximum flow uses terminating at atmospheric pressure require special approval from the WSD. These installations require a flow control valve and/or a flow restriction device and may be limited to the use of reclaimed water.
8. All new taps for buildings including all single family residential lots shall be a minimum of 1 inch in size. New 3/4 inch taps may be installed for landscape irrigation or other approved special uses only.

9. 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. (Phoenix City Code Section 37-53 (b) (1)).

**NOTE:** Refer to Section 4.6, *Irrigation Systems and Water Features*.

10. Combination Fire/Domestic/Landscape meters are prohibited. (Phoenix City Code Section 37-73 & UFC 1001.6.1). Each demand requires a separate service connection.

11. **Development Occupation Fees (DOF)** applies to all developments requiring water and/or sewer. Single family residential properties are charged a flat fee regardless of size of water meter. For multi-family uses, fees are charged per unit. For all other uses, fees are based on the water meter size, not the tap size. DOF fees are required per Phoenix City Code Sections 19 A-D.

12. **Water Resource Acquisition Fees (WRA)** applies to all developments requiring a water service. The fees vary by area and are based on the water meter size, not the tap size. WRA Fees are required per Phoenix City Code Section 30.

13. **Impact fees** vary by area and are based on the water meter size, not the tap size. Impact Fees are required per Phoenix City Code Section 19.

Questions about fixture unit calculations should be addressed to the following:

For single family residential: P&D Residential Permit Counter, (602) 262-7884.

For all other uses: P&D Regional Teams, (602)495-0258.

Questions about water meter sales, taps, service fees, and installation fees should be addressed to the P&D Engineering Counter (602) 262-6551.

## **4.4 ADDITIONAL DESIGN CRITERIA ONLY APPLICABLE TO TRANSMISSION MAINS**

### **4.4.1 General**

Transmission water mains are typically 16 inches in diameter and larger. Transmission mains must have a parallel distribution main, diameter to be determined by the WSD, in order to support the local water demand, including fire flow requirement. Refer to the WSD, "Standard Details for 16 inch and Larger Pipe" to supplement this design section. All ties, outlets and appurtenances shall be made by a flanged connection and shall include a valve with at least one flanged side at that point of connection for independent control.

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

### **4.4.2 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, pre-stressed concrete cylinder pipe (PCCP), or steel cylinder pipe. The pipe shall conform to the applicable MAG specifications and the COP Supplements thereto.

#### 4.4.3 Pipe Sizing for Transmission Mains

Transmission mains shall be sized to carry the designed peak flow required including fire flow without exceeding the velocities or headlosses shown below. Table 4.4, Allowable Velocity/Headloss, shows specific requirements for transmission mains.

**Table 4.4 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 the WSD.

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

#### 4.4.4 Location/Alignment

Transmission mains shall be located within rights-of-way as set forth in the latest edition of Standard Utility Locations for the City of Phoenix or as otherwise directed. A minimum 6 foot and 2 foot vertical exterior surface separation from any parallel underground utility is required. In all cases, a utility conflict review is required and requirements will be modified depending on the condition of the soils and any other factors that may adversely affect the project design.

Project stationing shall be tied to established monumentation per WSD Policy P-68.

Vertical alignment must be carefully considered in the design of transmission mains. A profile shall be provided for all transmission main designs.

1. To facilitate City review of a proposed main, a profile of the entire main shall be provided on a single sheet in condensed form.
2. Line segments shall be set at a constant slope.
3. Design of the main shall provide for a minimum number of high and low points consistent with economic feasibility.

#### 4.4.5 Cover

Minimum cover from finished grade to top of exterior surface of pipe shall begin at 6.5 feet for a 16 inch water line, and depending on design considerations, will generally range from 6.5 feet to 8 feet. If finished grade cannot be identified, increased depth may be required.

#### 4.4.6 Line Valves

Table 4.5, Line Valve Spacing, shows the maximum spacing for line valves on transmission mains.



**Table 4.5 Line Valve Spacing**

<b>PIPE SIZE (inches)</b>	<b>MAXIMUM SPACING (feet)</b>
16 to 30	2,640
greater than 30	5,280

All valves shall conform to MAG Specifications 610.7, COP Supplements 610 and 630. Also refer to COP Supplement Details P-1391 and P-1391-1

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 the WSD Large Pipe Details. For a copy of the typical valve installation details, contact the WSD Water Engineering Design and Construction Management Division at 602-495-3754.

If the WSD requires the installation of electronic monitoring and remote operation equipment, the line valve must 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 the WSD on acceptable equipment and the specific design requirements.

#### **4.4.7 Restraint Systems**

All bends, fittings, line valves, and bulkheads shall be restrained by using a joint restraint system compatible with the type of pipe. The WSD shall approve all restraint systems. 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 the WSD for review and approval. Concrete thrust blocks will not be accepted.

#### **4.4.8 Corrosion Protection**

Where indicated by soil testing or as directed by the WSD, mains shall be protected from exterior corrosion. This protection may consist of encasement in a polyethylene protective wrapping or other approved methods. Refer to the American Water Works Association Corrosivity charts for more information.

#### **4.4.9 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. The WSD must approve the location of outlets and tie-in connections to any existing or proposed facility including the bulkheads at the end of transmission mains.

#### **4.4.10 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 the WSD, Large Pipe Details. For a copy of the bypass assembly detail, contact the Water Engineering Design and Construction Management Division at 602-495-3754.

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.

#### **4.4.11 Air/Vacuum Valve Assemblies**

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

#### **4.4.12 Access Outlets for 42 inch Mains and Larger**

Access outlet with manhole as shown in WSD Large Pipe Details shall be installed on 42 inch diameter and larger transmission mains on each side of a line valves and shall not exceed 2,600 feet unless otherwise approved. For a copy of the access outlet detail, contact the Water Engineering Design and Construction Management Division at 602-495-3754.

#### **4.4.13 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 and de-watering when applicable.

#### **4.4.14 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 must 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.

#### **4.4.15 Transmission Main Plan Requirements - Check Lists**

For preparation of private development and CIP water system plans that will become a part of the Phoenix water system, refer to P&D's water checklist along with the additional checklist provided by WSD. Refer to the **Checklist Requirements for Water and Sewer Plans** in the WSD website at the following link:

<http://phoenix.gov/waterservices/design/manuals/index.html>

## **4.5 FIRE LINE SYSTEMS**

### **4.5.1 General**

A fire line is a private pipe system connected directly to the City water system. 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 Ordinance, 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. The WSD's review and approval interest is limited only to that portion to be constructed in the ROW or water easement.

#### **4.5.2 Acceptable Pipe Materials**

All fire line installations shall conform to the applicable MAG Specifications and Details and the COP Supplements thereto. The fire line shall be constructed of DIP from the control valve at the water main to the farther of the property line, backflow prevention device or detector check valve.

#### **4.5.3 Design Requirements**

All fire line installations shall conform to the City Fire Code and the following requirements of the WSD.

1. The minimum size fire line connection shall be 4 inches. Smaller fire line sizes are approved on a case-by-case basis.
2. Every fire line shall have a control valve at the connection to the City water main.
3. Backflow prevention devices are required per the City of Phoenix Adopted Plumbing Code, as well as City Code, Chapter 37, Article XII.

#### **4.5.4 Fire Line Plan Requirements - Check List**

For preparation of fire line plans that will become a part of the City water system, the design engineer is referred to the P&D website. A checklist for preparing the fire line plan is available at the following link:

<http://www.phoenix.gov/development/siteandcivil/civil/index.html>

#### **4.5.5 Plans Processing Guidelines**

All technical and engineering plans relating to projects subject to the Development Review process shall be submitted to the P&D for review evaluation and approval.

Other technical and engineering plans relating to City projects under the jurisdiction of the WSD shall be submitted to the P&D as directed for review evaluation and processing.

Plans for fire line systems outside of the city limits showing a fire line connected to the Phoenix water system shall be submitted to and approved by the WSD. The plans shall be prepared in accordance with applicable City Codes and procedures. The plans must have the approval of the appropriate jurisdictional fire agency prior to WSD approval. A plan review fee is charged by the City for review and processing.

The jurisdictional agency having authority over construction activity within their public rights of way will have additional plan approval requirements and shall be contacted for their plan processing procedures. Design approval and construction permits shall be obtained from all agencies involved.

## 4.6 IRRIGATION SYSTEMS AND WATER FEATURES

### 4.6.1 General

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.

### 4.6.2 Backflow Prevention

Backflow prevention assemblies will be required per City of Phoenix Adopted Plumbing Code.

### 4.6.3 Service Connections/Meters

In accordance with Section 37-53 of the Phoenix City Code, a separate irrigation meter is required for irrigation watering within landscaped areas over 10,000 square feet and/or for all water features (as defined in Section 37-111) having a maximum daily consumptive use of 1,000 gallons or more per day. Installation of irrigation meters requires a flow control valve and/or a flow restriction device. The WSD shall make that determination.

### 4.6.4 Landscape Water Permit

In accordance with Section 37-113 of the Phoenix City Code, 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 the 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 the WSD. A condition of the permit will be that non-potable water must be used for irrigation unless the cost of providing non-potable water would be prohibitively high to the developer or the WSD. The 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.

## 4.7 WATER ABANDONMENT

### 4.7.1 Plan Requirements Checklist

In order to prepare a water abandonment plan for removal or abandonment of an existing water main in the City of Phoenix system, the design engineer is directed to the WSD website under the title Water/Sewer Abandonment Plan.

<http://phoenix.gov/WATER/desstand.html>

### 4.7.2 Abandonment Methods

There are three approved methods of abandoning water and sewer lines in public ROW and easements:

1. Total removal of pipe.
2. Crush pipe in place by mechanical means. This cannot be applied to asbestos cement pipe.

3. Leave pipe in place and fill with low strength grout.

No other methods are acceptable.

## 4.8 FIRE HYDRANT REQUIREMENTS

### 4.8.1 General Location and Design Requirements

Fire hydrants must be located where they can be quickly found and easily used by fire engines arriving at an incident. Standardized location criteria are 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. Locate fire hydrants on the right hand (passenger) side of streets, intersections, driveways, 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.
2. Locate fire hydrants where they are readily visible by fire engines traveling along the street or approaching on intersecting streets. Never obscure or obstruct hydrants behind fences, gates, walls or landscaping.
3. Existing fire hydrants on major streets, collector streets or any other street having 4 or more lanes of traffic, that are not divided by raised median islands can be included in the coverage analysis. If those street classes are divided by raised median islands, then the existing hydrant can only be included in the coverage analysis if it is located on the same side as the new development.
4. 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 must then be spaced approximately evenly between these points at a distance not to exceed the maximum spacing between hydrants. Spacing is measured along the route of travel of a fire engine.
5. Fire hydrants separated from a subdivision, building or other development by 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 must 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.
6. A fire hydrant shall be placed within 30 feet of the end of all dead end water mains greater than 100 feet to facilitate flushing and maintenance of the water main (including cul-de-sacs).
7. Fire Hydrants shall not be placed within 3 feet of an above ground obstruction and must maintain 15 inches of clearance between the ground and the lowest hydrant outlet cap. If required by the WSD, hydrants shall be located within water easements providing at least 6 feet of clearance on all sides of the hydrant, including protective bollards as directed.

8. 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.
9. All fire hydrants shall be dry barrel type conforming to MAG Specifications 610.9, 756 and the COP Supplement 756.3.
10. Fire hydrants shall be located along streets in accordance with the COP Supplement Detail P-1362.

#### **4.8.2 Residential Subdivision Hydrant Location Standards**

Fire hydrant locations will be reviewed and approved as part of the subdivision approval process.

Follow the General Location and Design Requirements as stated in 4.8.1 and:

1. Start by locating a fire hydrant at the intersection of each public and/or private street entrance into the subdivision unless an existing fire hydrant meets spacing requirements.
2. Then space additional fire hydrants approximately 500 feet apart along all public and/or private streets within the subdivision and along all perimeter streets.
3. For cul-de-sacs:
  - a) No hydrant required on the cul-de-sac if all houses are within 350 feet of a hydrant on the street servicing the cul-de-sac and the dead end line within the cul-de-sac is less than 100 feet.
  - b) If all houses are NOT within 350 feet of the hydrant on the street serving the cul-de-sac and the dead end line within the cul-de-sac is less than 100 feet, then provide a hydrant at the intersection entrance into the cul-de-sac.
  - c) If dead end line length is such that additional hydrants are required, a hydrant shall be placed as close as possible to 30 feet from the end of the main.
4. For cluster home developments, locate fire hydrant locations per ordinance requirements.

#### **4.8.3 Commercial and Multi-Family Hydrant Location Standards**

Fire hydrant locations will be reviewed and approved as part of the site plan/building permit approval process. Provide a site plan showing all existing and proposed fire hydrant locations, all designated fire lanes, and all Fire Department Connections (FDC's) for building standpipe or sprinkler systems. Whenever possible hydrants shall be setback at least 40 feet from the building.

Follow the General Location and Design Requirements as stated in 4.8.1 and:

1. First, determine whether new fire hydrants are needed or not. New hydrants are not needed if existing hydrants are close enough to provide the required coverage:
  - a) Within 350 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 500 feet of the most remote corner of fire sprinkled buildings)
  - b) Within 200 feet of all FDC's for sprinkler and standpipe systems.

If existing fire hydrants do not provide the required coverage, new hydrants must be added as follows:

2. Start by locating a fire hydrant at the main entrance (driveway) into the development and at other entrances identified as fire apparatus access roads (fire lanes).
3. Next locate a fire hydrant within 200 feet of all FDC's and standpipe inlets on buildings, but not closer than 40 feet to the building.
4. Then space additional hydrants approximately 300 feet apart between the above hydrants along all public roads and along all designated fire lanes.

**4.8.4 Private Fire Hydrants**

Private hydrants are those hydrants located on private property and/or connected to any water line not owned and maintained by the 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 in working order at all times.

**4.8.5 Maximum fire Hydrant Spacing**

Table 4.6, 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.

**Table 4.6 Fire Hydrant Spacing**

LAND USE SPACING REQUIREMENTS	FIRE HYDRANT MAXIMUM SPACING (feet)
Single Family Residential	500
Two Story Townhouses and Apartments	300
Commercial and Industrial (including Shopping Centers)	300
Off-site main extensions adjacent to undeveloped property	1000 or as required by the WSD
Cul de Sacs	Same as above, to include hydrant within 30 feet of pipe end

**4.8.6 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 P1344, 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, the WSD will allow a 90 degree bend 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.

# CHAPTER 5      WASTEWATER COLLECTION SYSTEM

## 5.1 GENERAL REQUIREMENTS

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

### 5.1.1 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, Chapter 9. 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:

1. Engineer's Design Report.
2. Complete Construction-Ready Design Plans.
3. Specifications (CIP projects).
4. 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/Environmental 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:

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



### 5.1.2 Maricopa County Environmental Health Code Requirements

Sewage collection systems shall conform to the requirements of the Maricopa County Environmental Health Code. Sewage collection system projects to be installed as part of the City's CIP and projects to be constructed by private developers with City financial contribution shall be required to have plans approved and receive the certificates of approval and verifications of general permit conformance described above by the Maricopa County Environmental Services Department (MCESD).

### 5.1.3 City Code Requirements

Sewage collection systems shall comply with the requirements of Chapter 28 of the Phoenix City Code. The sewer line extension policy of the COP is contained in Article III of Chapter 28 of the Phoenix City Code. 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 Code repayment of the cost of "off-site" sewer lines may be available. 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.

## 5.2 GRAVITY SANITARY SEWER LINES

### 5.2.1 General

The design and construction of gravity sanitary sewers in the COP shall conform to the most current of the following publications:

1. Uniform Standard Specifications and Details for Public Works Construction sponsored and distributed by the Maricopa Association of Governments (MAG) and the COP Supplement thereto, available at the following link:

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

2. Arizona Department of Environmental Quality Aquifer Protection Permit Rules in Arizona Administrative Code, Title 18, Chapter 9, located at the following link:

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

3. Maricopa County Environmental Health Code available at the following link:

<http://www.maricopa.gov/EnvSvc/AboutUs/HealthCode.aspx>

4. The standard specifications and details of the WSD and design standards set forth in this manual, available at the following link:

<http://www.phoenix.gov/waterservices/design/index.html>

### 5.2.2 Acceptable Pipe Materials

Gravity sewer lines shall be either reinforced concrete pipe (RCP), ductile iron pipe (DIP) or vitrified clay pipe (VCP) as indicated below. Other materials may be approved on a case by case basis as approved by the WSD. The pipe shall conform to the applicable specifications as follows:

1. 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 lines 30 inches in diameter and larger.
2. DIP and fittings: MAG Specifications and the COP Supplement Section 750. DIP may be used for sewer lines 8 inches through 54 inches in diameter. When DIP is used, it shall be lined with Protecto 401 ceramic epoxy.
3. VCP and Fittings: MAG Specifications and the COP Supplement Section 743. VCP may be used for sewer lines 8 inches through 42 inches in diameter.

### 5.2.3 Pipe Sizing

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

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

### 5.2.4 Slope

Gravity sewers shall be designed and constructed to provide mean velocities of not less than the velocities shown in Table 5.1, 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 Table 5.1.

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

**Table 5.1 Design Velocity**

<b>PIPE SIZING (inches)</b>	<b>* MINIMUM DESIGN VELOCITY (ft/s)</b>	<b>MINIMUM DESIGN SLOPES (%)</b>	<b>MAXIMUM DESIGN SLOPES (%)</b>
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. Any slope outside the provided range will require a technical appeal to the Planning and Development Department (P&D) City Managers Representative. The Technical Appeals Procedure (P-107) can be found at the WSD's website shown below:

<http://phoenix.gov/WATER/desstand.html>

### **5.2.5 Alignment**

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

Sewers shall be located in street right-of-ways (ROW). Sewer alignments shall be parallel to property lines or street centerline or as close to parallel as possible. Gravity sewer alignments shall be located as set forth in the latest edition of Standard Utility Locations Manual for the City of Phoenix. The Standard Utility Locations Manual can be obtained through the Public Works Department – Planning, Design, and Programming Division.

### **5.2.6 Cover**

Generally, all sewer lines 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 lines installed with less than 4 feet of cover must be approved by the WSD.

Sewer lines 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 DIP. The DIP shall extend a minimum of 10 feet each side of the 100 year storm scouring, which would be manhole to manhole.

### 5.2.7 Sewer Main Connections at Manholes

There shall be no more than 4 connections at a manhole.

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

1. Sewer mains 15 inches and larger in diameter shall not change flow direction more than 45 degrees in 1 manhole. Two (2) manholes shall be constructed to change flow direction more than 45 degrees and up to 90 degrees.
2. 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 and shall not have its crown lower than the crown of the downstream pipe. Where local sewage collection systems connect to interceptor sewers, the invert of the intersecting pipe shall be at or above the crown elevation of the downstream pipe. Intersecting pipes shall be of equal or smaller diameter than the downstream pipe.

Typically, inverts through manholes and junction boxes shall be designed to maintain the energy gradient across the structure. Manholes and junction boxes having lines intersecting at 45 to 90 degrees shall have a minimum 0.10 foot drop across the structure.

### 5.2.8 Cross Connections Prohibited

There shall be no physical connections between a public or private potable water supply system and a sewer or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No water pipe shall pass through or come into contact with any part of a sewer manhole.

### 5.2.9 Separation from Water Mains

To minimize the potential for cross contamination, water and sewer lines shall meet the separation requirements described and illustrated in MAG Standard Detail No. 404-1 with the following COP supplemental requirements:

1. Vertical clearance between water mains and gravity sanitary sewer mains: the water main shall not be less than 12 inches above the sanitary sewer main, even if the sewer main is constructed with DIP in accordance with Note 3B in MAG Standard Detail No. 404-1.
2. Vertical clearance between water mains and sewer service connections: the water main shall not be less than 6 inches above the sewer service.
3. Horizontal clearance between sanitary sewers and water mains shall be 6 feet.

**Note:** All clearance measurements shall be from outside edge of pipe to outside edge of pipe.

#### **5.2.10 Separation from Water Supply System Structures**

While no general statement can be made to cover all conditions, it is generally 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.

#### **5.2.11 Separation from Storm Drains and Culverts**

For purposes of separation requirements, storm sewers are treated as sanitary sewers. Therefore, separation requirements are the same as sewer to sewer separation, which is 3 feet horizontal and 6 inch vertical or as approved by the WSD.

#### **5.2.12 Separation from Other Utilities**

Sewer mains shall maintain a minimum 6 feet horizontal separation and 2 feet vertical separation to any underground utility. Any vertical separation between 1 foot and 2 feet shall be approved on a case by case basis by the plan reviewer or the construction inspector. Anything less than 1 foot vertical separation shall require approval through the technical appeal process.

#### **5.2.13 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.

#### **5.2.14 Trenching, Bedding, and Backfill**

Trenching, bedding and backfill for wastewater construction shall conform to MAG Standard Specifications and Details and COP Supplements.

#### **5.2.15 Testing**

Perform leakage and uniform slope testing of sewers in accordance with MAG Specification 615 and COP Supplement Section 615.

#### **5.2.16 Depressed Sewers**

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

### **5.3 MANHOLES**

#### **5.3.1 General**

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

1. Aluminum manhole frames and covers are not permitted.
2. Steps are not permitted in manholes.

### 5.3.2 Manhole Locations

Manholes shall be installed at the following locations:

1. Changes of grade or slope.
2. Changes of pipe size.
3. Changes of horizontal or vertical alignment.
4. Changes in pipe material.
5. Service connections 8 inches in diameter and larger.
6. The end of each public sewer line.
7. At distances not to exceed the spacing shown in Table 5.2.

### 5.3.3 Manhole Spacing

The maximum spacing for manholes on sewer lines are shown in Table 5.2 Maximum Manhole Spacing. Manhole spacing greater than shown in the table shall be approved on a case by case basis by the WSD.

**Table 5.2 Maximum Manhole Spacing**

<b>PIPE SIZE (inches)</b>	<b>MAXIMUM MANHOLE SPACING (feet)</b>
less than 15	400
15 to 24	500
greater than 24	600

### 5.3.4 Manhole Diameter

The minimum manhole diameters and standard frame and cover sizes for various pipe sizes are shown in Table 5.3 Minimum Manhole Diameters.

**Table 5.3 Minimum Manhole Diameters**

<b>PIPE DIAMETER (inches)</b>	<b>MANHOLE DEPTH (feet)</b>	<b>MINIMUM MANHOLE DIAMETER (inches)</b>	<b>MINIMUM FRAME AND COVER DIAMETER (inches)</b>
12 and less	12 and less	48	24
12 and less	greater than 12	60	30
15 and greater	any	60	30

### 5.3.5 Metered Manholes

No connection of any kind (including service taps) will be allowed into a metered manhole. Furthermore, no service taps will be allowed into the sewer main 100 feet upstream and 25 feet downstream of the metered manhole.

### **5.3.6 Clean Outs**

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

### **5.3.7 Manhole Stub Outs and Knock Outs**

Manhole stub outs are not allowed. Knock outs shall be provided in manholes for future main extensions when requested by the WSD.

### **5.3.8 Drop Sewer Connections**

Drop sewer connections shall conform to MAG Standard Detail 426.

### **5.3.9 Flow Channel**

The flow channel straight through a manhole shall be made to conform as closely as possible in shape and slope to that of the connecting sewers. The channel walls shall be formed or shaped to the full height of the crown of the outlet sewer in such a manner to not obstruct maintenance, inspection or flow in the sewers.

### **5.3.10 Bench**

A bench shall be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench should be sloped to provide a minimum 3 inch fall from the top of the bench to the crown of the pipe or 0.5 inch per foot, whichever is greater.

### **5.3.11 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.

### **5.3.12 Testing**

Manholes shall be tested for leakage in accordance with MAG Specification and COP Supplement Section 615.

### **5.3.13 Corrosion Protection for Manholes**

All manholes for sewers 15 inches in diameter and larger or 12 feet or greater in depth, shall be coated in conformance with COP Supplement Section 626. Any disturbance of existing coatings shall be repaired in accordance with manufacturer's recommendations.

### **5.3.14 Junction Structures**

Junction structures shall be required on all sewer mains 30 inches and larger in diameter in lieu of manholes or as required by the WSD.

### **5.3.15 Insecticide Coating**

All new manholes or existing manholes that have been disturbed shall be sprayed on the interior with insecticide per COP Supplement Section 627.

## 5.4 SERVICE CONNECTIONS

### 5.4.1 General

Service connections to the City of Phoenix Wastewater system shall conform to Article IV of Chapter 28 of the Phoenix City Code, MAG Specification 615.14, COP Supplement Section 615.7, MAG Standard Details 440 and 441, and the WSD Standard Details S-511, S-512 and S-512D.

### 5.4.2 Service Connection Sizes

The following Table 5.4 Service Connection Sizes shows sizes based on the development type.

**Table 5.4 Service Connection**

DEVELOPMENT TYPE	SERVICES CONNECTION SIZE (inches)
Resident lots	4 or 6
Commercial lots	minimum 6
Multiple lots	minimum 6

The WSD may require justification of size prior to granting approval to construct

### 5.4.3 Service Connections in Manholes

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 the WSD website at the following link:

<http://www.phoenix.gov/waterservices/design/engdetails/index.html>

Service connections 8 inches in diameter and larger shall be installed directly into an existing or new manhole.

Service connections into sewer mains that are 15 through 30 inches in diameter must be installed into an existing or new manhole.

Service connections of any size shall not connect directly into sewer mains that are larger than 30 inches in diameter. Such connections shall require a minimum 8 inch public sewer main extension, which shall be constructed from the nearest downstream manhole to the point of service unless otherwise approved by the WSD.

No service connections are allowed in manholes equipped with a flow meter.

**Note:** A new manhole can only be constructed on sewer mains that are 30 inches or less in diameter.

### 5.4.4 Service Connection Installation Requirements

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.

The design engineer shall note that the WSD 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 main.



Generally taps extend perpendicular to the main. When a tap is made at a manhole, the tap may be installed at an angle less than 90 degrees to the main providing the installation does not restrict flow. The invert of the service connection shall be at or above the crown of the sewer main, but no more than 12 inches above.

The portion of the sewer tap located within the ROW shall be at no less than 1% slope.

## 5.5 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 from the WSD's website shown below:

<http://phoenix.gov/WATER/desstand.html>

## 5.6 ALLOWABLE DISCHARGES AND PRELIMINARY TREATMENT

In accordance with Chapter 28 of the Phoenix City Code, where necessary in the opinion of the Director, any user of the City of Phoenix sewage collection system shall provide, at their expense, such preliminary treatment as may be necessary to reduce objectionable characteristics or constituents to within the maximum limits provided for in Chapter 28 of the Phoenix City Code.

## 5.7 SEPTIC SYSTEMS WITHIN THE CITY OF PHOENIX

### 5.7.1 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.”

### 5.7.2 When Septic Systems May Be Allowed

The City of Phoenix does not allow private sewer systems when a public sanitary sewer is “available”. Therefore, the City will require that all owners of a property in the COP connect to the City’s public sewage system. However, if a property falls into one of the three exceptions listed below, the sewer main extension requirement will not be required. The owner may then contact the MCDES for approval of an on-site private sewage treatment system.

1. A single residence on a single lot whose closest lot line is more than 250 feet from an existing public sanitary sewer system.
2. A single residence on a single lot whose closest lot line is less than 250 feet from an existing public sanitary sewer system and has an existing septic system that the County has deemed as

adequate to continue serving the site without having to make any modifications or upgrades to the system.

3. A commercial development with an existing septic system that the County has deemed as adequate to continue serving the site without having to make any modifications or upgrades to the system.

**Note:** Any deviations from the exceptions above shall require a technical appeal to the P&D City Managers Representative. The "Technical Appeals Procedure" (P-107) can be found at the WSD's website shown below:

<http://phoenix.gov/WATER/desstand.html>

### 5.7.3 Existing Septic Systems

Existing commercial or residential septic systems that are properly permitted and operational are allowed to stay on existing septic until such time that the system either needs major repairs, upgrading or needs to be relocated, all of which would require compliance with the WSD septic policy as described in this section. When an existing commercial or residential property increase their calculated sewer flows (per plumbing code), it may stay on septic if the existing septic system is large enough to accept those flows with no modification. If the existing septic system is not large enough to accept the new calculated sewer flows or the septic system needs to be relocated, then the development will be required to comply with the septic policy as described in this section.

## **APPENDIX A      WSD POLICIES AND PROCEDURES**

All WSD Policies and Procedures are available on our website at the following link:

<http://phoenix.gov/WATER/wsdengpl.html>

## **APPENDIX B      MARICOPA ASSOCIATION OF GOVERNMENTS SPECIFICATIONS AND DETAILS**

The following is a link to Maricopa Association of Governments (MAG). MAG produces numerous publications that have proved beneficial to local agencies, business, industry, and other private sector interests. These publications range from Standard Specifications and Details for Public Works Construction to uniform code amendments to air quality plans.

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

The following is a link to the COP Supplement standards, specifications and details.

<http://phoenix.gov/STREETS/magsuppl.html>

## **APPENDIX C      ARIZONA ADMINISTRATIVE CODE**

The following is a link to Arizona Administrative Code, Arizona Department of Environmental Quality (ADEQ) - Water Pollution Control:

[http://www.azsos.gov/public\\_services/title\\_18/18-09.htm](http://www.azsos.gov/public_services/title_18/18-09.htm)

## APPENDIX D THE CODE OF THE CITY OF PHOENIX

The City Ordinances are available at the following link:

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

The following are Chapter Codes related to Water and Sewer:

- 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

## APPENDIX E 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.

**Agency**: The governmental agency for which the construction is being done, either by permit or contract. Also, the governmental or regulatory body with the authority to regulate the design and construction of water, wastewater and reclaimed water systems within the appropriate jurisdiction.

**Architect**: The individual or firm who has accomplished the architectural services for the project including their representatives.

**AZPDES Permit**: An Arizona Pollution 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 separation, 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 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 from one system to the other, the direction of flow depending on the pressure differential between the two systems.

**Department:** Unless otherwise designated, Department will be understood to mean the Water Services Department of the City of Phoenix.

**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.

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

**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

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

**Owner:** The City of Phoenix, acting through its legally constituted officials, officers or employees. Also, the developer of a project together with the City of Phoenix.

**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 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:** See Building Connection.

**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.

**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 lines, 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 F      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.

<b>AAC:</b>	Arizona Administrative Code
<b>ADEQ:</b>	Arizona Department of Environmental Quality
<b>APP:</b>	Aquifer Protection Permit ARS: Arizona Revised Statutes
<b>AWWA:</b>	American Water Works Association
<b>AZPDES:</b>	Arizona Pollution Discharge Elimination System
<b>CCP:</b>	Concrete Cylinder Pipe
<b>CC&amp;R's:</b>	Conditions, Covenants, and Restrictions
<b>CIP:</b>	Cast Iron Pipe or Capital Improvement Project or Program
<b>COP:</b>	City of Phoenix
<b>DOF:</b>	Development Occupation Fees
<b>DIP:</b>	Ductile Iron Pipe
<b>FPS:</b>	Feet Per Second
<b>FT:</b>	Foot
<b>GIS:</b>	Geographical Information System
<b>GPM:</b>	Gallons Per Minute
<b>GPD:</b>	Gallons Per Day
<b>MAG:</b>	Maricopa Association of Governments
<b>MCESD:</b>	Maricopa County Environmental Services Department
<b>OD:</b>	Outside Diameter
<b>PC:</b>	Point of Curvature
<b>P&amp;D</b>	Planning and Development Department
<b>POTW:</b>	Public Owned Treatment Works
<b>PRV:</b>	Pressure Regulating or Reducing Valve
<b>PSI:</b>	Pounds Per Square Inch
<b>PWD</b>	Public Works Department
<b>PVC:</b>	Polyvinyl Chloride Pipe
<b>Q:</b>	Rate of Flow
<b>RCP:</b>	Reinforced Concrete Pipe
<b>ROW:</b>	Right-of-Way
<b>STR:</b>	Street Transportation Department
<b>VCP:</b>	Vitrified Clay Pipe
<b>WSD:</b>	Water Services Department