

## **FUD Water Design Criteria & Checklist**

### Design Criteria Checklist for Water Distribution Systems

	<b>Design Plans - General Information</b>
	Vicinity Map
	Key Map, for linear or large projects
	Clear depiction of future phases of Development
	Location of Water Lines relative to bridge, structures, and identifiable objects
	Location of proposed valves, hydrants, fittings, and appurtenances
	Location of existing and proposed utilities (water, sewer, gas, power, communication, etc.)
	Profile of proposed Water Main(s), including: existing and proposed Utility and Storm crossings, and existing and proposed ground surfaces.
	Stream Crossing details, including construction methods and materials used.
	Locations of permanent Utility Easement(s) and temporary Construction Easement(s).
	For projects requiring work in State or County Right-of-Ways, provide stamped Traffic Control Plans for FUD's use in making Utility ROW Permit Application.
	Sealed by a TN-Licensed Professional Engineer.
	<b>Design Report</b>
	Summarize population served, domestic demands, fire flow requirements, corresponding pressures and hydraulic grade lines, pumping requirements, etc.
	Identify future phases of development. Verify initial design is adequate to serve future growth.
	<p><u>Design Calculation Criteria:</u></p> <p>Per Capita Demands</p> <ul style="list-style-type: none"> <li>• 2.0 gpm/connection: 1 – 100 residential connections</li> <li>• 1.5 gpm/connection: 101 – 150 residential connections</li> <li>• 1.0 gpm/connection: 151 – 300 residential connections</li> <li>• 0.75 gpm/connection: 301 – 500 residential connections</li> <li>• 0.50 gpm/connection: 501 – 1,000 residential connections</li> </ul> <p>Min. Pressure Requirements</p> <ul style="list-style-type: none"> <li>• Domestic Flow: 20-psi across the property based upon a hydraulic grade line at mid-level elevation of the water storage tank.</li> <li>• Fire Flow: 20-psi at any meter during a fire flow at the most hydraulically remote hydrant. If providing fire protection, Engineer shall provide a stamped set of calculations for fire protection conditions.</li> </ul>
	Sealed by a TN-Licensed Professional Engineer.
	<b>Material &amp; Construction Requirements</b>
	<p>Main Line – Size and Material (Specification 33 11 13 and related sections)</p> <ul style="list-style-type: none"> <li>• 6" diameter is minimum size for fire hydrants</li> <li>• 2" minimum size; subject to FUD Approval. <i>2" Water lines will not be approved over 200-ft long or with more than five (5) single family residential homes.</i></li> <li>• 3" &amp; 4" not allowed</li> <li>• Minimum cover, bedding, and backfill per FUD Specifications and TDEC Criteria.</li> <li>• Clearance with other underground utilities: <ul style="list-style-type: none"> <li>• Sewer – 10-ft horizontal, 18-in vertical</li> <li>• Other underground – 3-ft horizontal, 12-in vertical</li> </ul> </li> </ul>

### Design Criteria Checklist for Water Distribution Systems

Material & Construction Requirements (continued...)	
	<p>Line Valves</p> <ul style="list-style-type: none"> <li>• Spacing at no greater than 1,500-ft apart, or as directed by FUD.</li> <li>• Placed on each main branching from a Tee.</li> <li>• Whenever possible, valves shall be placed outside of pavement.</li> <li>• &gt;2" Gate Valve. Refer to Specification Section 33 12 16.</li> <li>• ≤2" Ball Valve. Refer to Specification Section 33 12 16.</li> </ul>
	<p>Service Lines &amp; Meters</p> <ul style="list-style-type: none"> <li>• Specification Section 33 12 13 for product and execution requirements. All taps shall be made by FUD.</li> <li>• For single-family residential, each Lot shall be provided for by a service line and meter.</li> <li>• Water meters shall be set near the property corners. Where possible, meters shall be double set at a common property corner of two adjacent lots.</li> <li>• 1" and smaller service lines under sidewalks, driveways, or pavement shall be encased in 2" Sch40 PVC.</li> <li>• For multi-family residential, provide a separate meter for each building complex.</li> <li>• For commercial mixed use (ie, strip malls) with five or more tenants, provide a meter gang box per FUD Standard Detail. Vaults in pedestrian areas require an ADA-compliant hatch. Vault shall be furnished and installed by the Project and connected to the system by FUD. Contractor responsible for establishing finished grade.</li> <li>• Set top of meter boxes at four to six inches (4" – 6") above top of curb elevation.</li> <li>• Meter size shall be determined by property owner or Architect / Engineer of Record and subject to FUD Engineering Department approval. Refer to Guidelines for Service Line and Meter Capacities document in the FUD Development Packet.</li> </ul>
	<p>End of Line Flushing &amp; Hydrant Spacing</p> <ul style="list-style-type: none"> <li>• Fire Hydrants are required at the end of 6" or larger lines, min. pressure withstanding.</li> <li>• 2" Flush hydrant are required on the end of 2" lines.</li> <li>• End-of-line blow off (not allowed unless specifically approved by FUD) shall be sized to allow a minimum velocity of 2 ft/sec in the water main.</li> </ul>
Booster Stations	
	Public booster stations shall be owned by FUD and located on fee simple property under FUD ownership.
	Booster stations shall be designed and constructed per FUD's Standard Specifications and Drawings.
	FUD reserves right to provide input on booster station capacity.
Fire Protection	
	Provide Static Pressure, Residual Pressure, and Flow Rate for existing hydrant test on Design Plans and Design Report.
	<p>Provide proposed fire flow requirements for hydrant and fire protection systems on Design Plans and Design Report.</p> <ul style="list-style-type: none"> <li>• <u>NOTE:</u> Proposed System improvements as needed to meet fire flow conditions shall be subject to FUD's review and acceptance.</li> </ul>

### Design Criteria Checklist for Water Distribution Systems

	<p>Fire Hydrant Spacing &amp; Location</p> <ul style="list-style-type: none"> <li>Engineer shall design hydrant spacing starting from the downstream end and working toward the entrance based on allowable spacing.</li> <li>Additional hydrant spacing as required by local jurisdictional authority.</li> </ul>
	Minimum fire flow rate at hydrant shall be 500-gpm.
	Fire Protection Lines are not metered in FUD's distribution system. User will be billed annually in accordance with FUD's Rate Structure, latest version.
	Fire Protection (continued...)
	Fire Protection lines shall be constructed of ductile iron pipe.
	All fire line taps to existing mains shall be made by FUD.
	Fire Protection lines shall be disinfected, tested, and accepted in accordance with FUD Standard Specifications before being placed in service.
	Cross Connection Control
	Refer to Cross Connection Manual, Cross Connection Policy, and FUD Standard Specification 33 14 00.
	Irrigation systems are required to install an RPZ Backflow Preventer.
	Chemical Fire Protection systems require an RPZ Backflow Preventer. Non-Chemical Fire Protection systems will allow a DCDA Backflow Preventer.
	Multifamily residential, commercial, and any non-single family residence are required to install an RPZ Backflow Preventer on "domestic" water lines. These users are required to install two RPZ devices in parallel.
	For private fire protection lines, FUD reserves the right to require an RPZ backflow preventer installed in a heated enclosure at the property line.
	Easements & Property
	15-ft Utility Easement (o.c.) is required for all public water mains. Plans to reference Instrument #200908100011396 at Knox County Register of Deeds Office.
	Property for Water Booster Station shall be deeded to FUD. Depending on location, FUD may require a dedicated 20-ft wide access easement to booster station.
	Utility Easements or subdivision plats must be recorded before the system will be accepted by FUD.



*Where community comes first.*

## **FUD Gravity Sewer Design Criteria & Checklist**

## Design Criteria Checklist for Gravity Sewer Collection Systems

	Design Plans - General Information
	<u>DESIGN NOTE:</u> <i>Unless explicitly authorized by FUD, Gravity Sewer deeper than eight (8) feet will not be accepted, and Low Pressure Sewer will be required.</i>
	Vicinity Map
	Key Map, for linear or large projects
	Clear depiction of future phases of Development
	Location of Sewer Lines & manholes relative to bridge, structures, and identifiable objects
	Location of proposed force main lines, valves, air release valves, fittings, and appurtenances
	Location of existing and proposed utilities (water, sewer, gas, power, communication, etc.)
	Plan View shall include: <ul style="list-style-type: none"> <li>• Horizontal separation with other utilities, particularly Water</li> <li>• Manhole deflection angles for entering and exiting lines</li> <li>• Stub-out location(s) and elevation(s) for future phase(s)</li> </ul>
	Profile of proposed Sewer Main(s), including: existing and proposed Utility and Storm crossings, and existing and proposed ground surfaces.
	Profile shall include: <ul style="list-style-type: none"> <li>• Alignment stationing at manholes.</li> <li>• Invert elevations for incoming and outgoing lines.</li> <li>• Top elevation of manhole cover.</li> <li>• Existing and proposed ground surfaces.</li> <li>• Existing and proposed Utility and Storm crossings, including vertical clearance with Sewer line. (When vertical clearance is less than 18-inches, the lower utility line shall be installed with a stone envelope to the invert of the upper utility line.)</li> <li>• Identification of Stream Crossings, including “normal” and 100-yr Storm (FEMA FIRM or hydraulic modeling, as appropriate) water levels.</li> </ul>
	Service Line Information shall include: <ul style="list-style-type: none"> <li>• Depth of cover at property line</li> <li>• Verification, by Engineer, that the collection system is sufficiently deep to service each proposed lot.</li> </ul>
	Garbage Dumpster pads shall be covered to prevent intrusion of rainwater to sewer system.
	Stream Crossing details, including construction methods and materials used.
	Locations of permanent Utility Easement(s) and temporary Construction Easement(s).
	Include Grading Plan indicating existing and proposed contours (2’ max interval), including finished floor elevation(s) of structure(s) being served.
	For projects requiring work in State or County Right-of-Ways, provide stamped Traffic Control Plans for FUD’s use in making Utility ROW Permit Application.
	Sealed by a TN-Licensed Professional Engineer.
	Design Report
	Summarize population served, average flows, peak flows, corresponding velocities, etc.
	Identify future phases of development. Verify initial design is adequate to serve future growth.
	Design basis for wastewater flow and loadings shall be based on TDEC’s <i>Design Criteria for Sewage Works</i> – Appendix 2A, peer reviewed literature values, or from comparable regional data. Peaking flow shall be determined based on (1) the hours of operation and (2) peaking

### Design Criteria Checklist for Gravity Sewer Collection Systems

	factor based on the population served by the Development, as referenced in TDEC's <i>Design Criteria for Sewage Works</i> – Chapter 2.
	Sealed by a TN-Licensed Professional Engineer.
	<b>Environmental / Permitting</b>
	Stream crossings of Gravity or Force Main Sewer shall be permitted and approved by TDEC Division of Water Resources.
	<b>Material &amp; Construction Requirements</b>
	<p>Manholes – Specification 33 05 13</p> <ul style="list-style-type: none"> <li>Public sewer mains shall be terminated with a manhole meeting FUD Specifications.</li> <li>Max spacing not to exceed 400-ft</li> <li>Internal drop connections require a 5-ft diameter manhole</li> <li>Slope &gt;5% require ZLOK gasket and min drop of 0.2-ft.</li> <li>Manhole slope should generally be the average slope of the lines in and out.</li> </ul>
	<p>Gravity Main Line – Size and Material (Specification 33 05 01 and related sections)</p> <ul style="list-style-type: none"> <li>8" min. diameter.</li> <li>Bedding, and backfill per FUD Specifications and TDEC Criteria.</li> <li>Clearance with other underground utilities: <ul style="list-style-type: none"> <li>Water – 10-ft horizontal, 18-in vertical</li> <li>Other underground – 3-ft horizontal, 12-in vertical</li> </ul> </li> <li>Slope – minimum slope of 0.85%.</li> <li>Cover <ul style="list-style-type: none"> <li>Per TDEC <i>Design Criteria for Sewage Works</i>, latest version.</li> <li>Under pavement, lines with less than 4-ft of cover shall be ductile iron with ceramic epoxy coating. Minimum cover under pavement is 30-inches.</li> <li>Lines with greater than 12-Ft of cover (typically not allowed) shall be ductile iron with ceramic epoxy coating.</li> </ul> </li> <li>Aerial sewer crossings are not allowed unless no practical alternative exists. If an aerial crossing is approved by FUD for construction, the Engineer of Record will be responsible for coordinating with TDEC Division of Water Resources to obtain permits, provide hydrologic / hydraulic calculations, and comply with ancillary requirements.</li> </ul>
	<p>Service Lines &amp; Cleanouts</p> <ul style="list-style-type: none"> <li>Refer to Specification Section 33 05 01.12 for product and execution requirements.</li> <li>For single-family residential, each Lot shall be provided by a service line and cleanout.</li> <li>Cleanouts shall typically be set near the center of the front property line.</li> <li>Set top of cleanout at four to six inches (4" – 6") above top of curb elevation.</li> <li>For apartments, each building shall be connected to a manhole.</li> <li>Dumpster pads must be covered if connected to sewer.</li> <li>Easements are required on service lines that cross private property to service another lot. (This practice will typically not be accepted by FUD.)</li> <li>Consult with FUD about material requirements if services are made on a DIP main.</li> </ul>

### Design Criteria Checklist for Gravity Sewer Collection Systems

	Pump Stations
	Public Sewer Pump stations shall be owned by FUD and located on fee simple property under FUD ownership.
	Pump stations shall be designed and constructed per FUD's Standard Specifications and Drawings.
	FUD reserves right to provide input on pump station capacity.

	Easements & Property
	15-ft Utility Easement (o.c.) is required for all public sewer mains. Plans to reference Instrument #200908100011396 at Knox County Register of Deeds Office.
	Property for Sewer Pump Station shall be deeded to FUD. Depending on location, FUD may require a dedicated 20-ft wide access easement to pump station.
	Utility Easements or subdivision plats must be recorded before the system will be accepted by FUD.



## **FUD Low Pressure Sewer Design Criteria & Checklist**

### Design Criteria Checklist for Low Pressure Sewer (LPS) Collection Systems

	<b>Design Plans - General Information</b>
	<u>DESIGN NOTE:</u> <i>Unless explicitly authorized by FUD, Gravity Sewer deeper than eight (8) feet will not be accepted, and Low Pressure Sewer will be required.</i>
	Vicinity Map
	Key Map, for linear or large projects
	Clear depiction of future phases of Development
	Location of Sewer Lines & manholes relative to bridge, structures, and identifiable objects
	Location of proposed force main lines, valves, air release valves, fittings, and appurtenances
	Location of existing and proposed utilities (water, sewer, gas, power, communication, etc.)
	Profile of proposed Sewer Main(s), including: existing and proposed Utility and Storm crossings, and existing and proposed ground surfaces.
	Stream Crossing details, including construction methods and materials used.
	Locations of permanent Utility Easement(s) and temporary Construction Easement(s).
	For projects requiring work in State or County Right-of-Ways, provide stamped Traffic Control Plans for FUD's use in making Utility ROW Permit Application.
	Sealed by a TN-Licensed Professional Engineer.
	<b>Design Report</b>
	Summarize the population served, per capita flows, percentage of units contributing flow at instant in time, design flows, corresponding velocities, minimum and maximum elevations, minimum and maximum pressures, etc. Design calculations shall be prepared using Environment One's (E-One's) <i>LPS Design Assistant</i> , latest version. Note: <ul style="list-style-type: none"> <li>Clearly depict "zones" used in the E-One Software on the Design Plans.</li> <li>Verify the line sizes match between calculation and plans. Use HDPE DR11 for calcs.</li> <li>Use <math>C_{HW}</math> roughness coefficient not greater than 135.</li> <li>Main shall be sized to be the largest diameter that allows a velocity greater than 2-ft/s and a pump total dynamic head less than 180-ft at both initial and final phases of development. (For example, Engineer submits a design report depicting a zone with a 2-inch force main carrying a flow of 55-gpm, resulting in a velocity of 6.2-ft/s and pump TDH of 170-ft. FUD calculates the line could be a 3-inch, which would result in a velocity of 2.7-ft/s and significantly reduced pump head. FUD will require design change to provide increased pump life.)</li> <li>Submit all <i>LPS Design Assistant</i> worksheets with review package.</li> </ul>
	When connecting to an existing low pressure sewer system, Engineer shall provide hydraulic calculations that verify (1) both the existing and proposed grinder pumps will be operational and (2) allowable pressures are maintained in the system.
	Design basis for wastewater flow shall be based on E-One's <i>LPS Design Assistant</i> software, TDEC's <i>Design Criteria for Sewage Works</i> – Appendix 2A, peer reviewed literature values, and/or from comparable regional data.
	Identify future phases of development. Verify initial design is adequate to serve future growth.
	Sealed by a TN-Licensed Professional Engineer.

### Design Criteria Checklist for Low Pressure Sewer (LPS) Collection Systems

	<b>Environmental / Permitting</b>
	Stream crossings of Gravity or Force Main Sewer shall be permitted and approved by TDEC Division of Water Resources
	<b>Material &amp; Construction Requirements</b>
	<p>LPS Main Line – Size and Material (Specification 33 33 00 and related sections)</p> <ul style="list-style-type: none"> <li>• 2" min. diameter.</li> <li>• Bedding and backfill per FUD Specifications and TDEC Criteria.</li> <li>• Clearance with other underground utilities: <ul style="list-style-type: none"> <li>• Water – 10-ft horizontal, 18-in vertical</li> <li>• Other underground – 3-ft horizontal, 12-in vertical</li> </ul> </li> <li>• Cover - Per TDEC <i>Design Criteria for Sewage Works</i>, latest version.</li> </ul>
	<p>Connection to Existing Sewer</p> <ul style="list-style-type: none"> <li>• To Manhole – Construct “internal drop” tie-in per FUD Standard Drawings. Furnish and install isolation valve approximately 10-ft upstream of the manhole.</li> <li>• Connection to Gravity Sewer requires application of OBIC or Spectrashield coating to connecting manhole and next two downstream manholes.</li> <li>• To Force Main Sewer – Consult with FUD Engineering Dept. during the Design Phase.</li> </ul>
	<p>Line Valve Placement &amp; Spacing</p> <ul style="list-style-type: none"> <li>• Refer to Specification Section 33 33 00.</li> <li>• Spacing at no greater than 1,000-ft apart, or as directed by FUD.</li> <li>• Placed on each main branching from a Tee.</li> </ul>
	<p>Service Lines &amp; Cleanouts</p> <ul style="list-style-type: none"> <li>• Refer to Specification Section 33 33 00 for product requirements.</li> <li>• For single-family residential, each Lot shall be provided a service line and valve box.</li> <li>• Each lot’s valve box shall be set near the middle of the property frontage.</li> <li>• Set top of box at four to six inches (4" – 6") above top of curb elevation.</li> <li>• Easements are required on service lines that cross private property to service another lot. (This practice will typically not be accepted by FUD.)</li> </ul>
	<p>Grinder Pump for Multi-Family Residential</p> <ul style="list-style-type: none"> <li>• Simplex, duplex, or quadplex E-One grinder pump stations may be approved for individually metered buildings. Engineer shall be responsible for the basis of design inclusive of average flow, peak flow, emergency storage, and wet well design. Station shall be installed per FUD requirements and standard drawings. (<i>Other equipment may be allowed but shall not be serviced or maintained by FUD.</i>)</li> <li>• E-One grinder pump station shall be equipped with Simplex, Duplex, or Quadplex Protect Plus Panel with a manufacturer-supplied generator plug.</li> <li>• Pipe to wet well connection shall be by Link Seal caulking hub.</li> </ul>
	<b>Easements &amp; Property</b>
	15-ft Utility Easement (o.c.) is required for all public sewer mains. Plans to reference Instrument #200908100011396 at Knox County Register of Deeds Office.
	Property for Sewer Pump Station shall be deeded to FUD. Depending on location, FUD may require a dedicated 20-ft wide access easement to pump station.
	Utility Easements or subdivision plats must be recorded before the system will be accepted by FUD.