WASTEWATER COLLECTION SYSTEM DESIGN CRITERIA TECHNICAL MANUAL

CITY OF SAN MARCOS, TEXAS

4/17/2015

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1.1 General

This technical manual presents criteria, standards and regulations related to the design of wastewater collection system facilities for general development within the City of San Marcos wastewater service area. The material is directed to the competent design professional and establishes minimum design criteria. Additional requirements for individual wastewater facilities may be imposed by the City of San Marcos as conditions warrant.

Designs for wastewater collection system construction and improvements shall conform to the most recent edition of 30 TAC Chapter 217 of the Texas Commission on Environmental Quality (TCEQ) and also Chapter 213 for development in the Edwards Aquifer Zone. Any unintended conflicts between the City of San Marcos and the TCEQ criteria will be resolved by the Engineering & Capital Improvements Director.

NOTE: If construction has not begun on the facility within one (1) year of the approval date, plans must be resubmitted for approval and must include all criteria in effect at the time resubmitted.

The following words and terms, when used in this manual, have the following meanings.

Private Wastewater Facilities – Privately owned and maintained wastewater infrastructure including piping and on site lift stations and associated equipment which conveys wastewater from private property to the public wastewater system. The break in jurisdiction between public and private facilities is at the edge of ROW or easement.

Public Wastewater Facilities – Publicly owned and maintained wastewater infrastructure which serves more than one parcel, residence, business or facility and is located in a public easement, right-of-way, or publicly owned property.

COSM – City of San Marcos representative as deemed appropriate by the Engineering & Capital Improvements Director

1.2 Submittal Requirements

1.2.1 Engineering Report

The Design Engineer shall submit the following information with all wastewater designs:

- Wastewater Design Report showing that the proposed improvements meet the flow requirements of this manual including, but not limited to the following items when applicable:
    - System capacity required (flow to system) and flow development including: calculations, flow measurement data, and future flow data for the project as well as estimates for future development within the sewer shed based on the best available information
    - Spreadsheet model or calculations of existing wastewater lines for a minimum of 0.25 miles from the start of improvements using Manning's formula showing flow capacity of existing lines (using recent field survey, As-Built drawings, COSM GIS numbers for manholes, existing pipe sizes, length between manholes, slope, flowline in and out of each manhole, manhole rim elevation, manning's N, at a minimum)
    - Spreadsheet model or calculations of proposed wastewater lines for a minimum of 0.25 miles from the start of improvements using Manning's formula showing design flow, flow capacity of proposed lines (using recent field survey; COSM GIS numbers for manholes; proposed: pipe sizes, length between manholes, slope, flowline in and out of each manhole, manhole rim elevation, manning's N, at a minimum)

- Summary tables of results
- Analyze scenarios and identify solutions for future flow capacity
- Provide a minimum of 2 alignments for the proposed improvements, as requested by COSM – including easement requirements for each; proximity to existing utilities, trees, power poles, mailboxes, and all other obstructions; location within a environmental or archaeological sensitive area; identification of TxDot, UPRR, or County ROW; at a minimum
- COSM Guidelines for Sulfide Generation
- Color coded exhibits for existing and proposed wastewater lines with all alignment information above included

- Copy of information provided to TCEQ in compliance with TCEQ submittal requirements (TAC 213, TAC 217, and any other applicable regulations) for City records purposes.
- Certification that plans meet all requirements and documentation of any proposed variances or alterations.
- Engineer's Opinion of Probable Construction Cost

1.2.2 Construction Plans

Construction plans shall be submitted in PDF format as well as two (2) hard copies. The following information should be provided on the construction plans:

(a) General: Sheet sizes shall be 24"x36" with minimum 10-point font
Show on all plans, as appropriate – North Arrow, Scale, Property Lines, Right of Way, Easements, 100-yr floodplain boundary, limits of construction
(b) Cover Sheet: Project Title, Index of all sheets, Vicinity Map (1"=2000' or larger)
(c) Names and Contact Information for: Owner/Developer, Engineer, Other professionals involved, City of San Marcos including: Director of Engineering & CIP Department, and Executive Director of Public Services, approval from TCEQ and TDLR with permit numbers.
(d) Contact Information for Coordination and Emergency: City of San Marcos Engineering & CIP Department, City of San Marcos Engineering Inspection Services, Electric Utility, Water Utility, Cable Utility, Telephone Utility, Natural Gas Utility, Railroad, Texas Commission on Environmental Quality (TCEQ), Texas Department of Transportation (if applicable)
(e) Plan and profile for Existing and Proposed Utilities: Water, Wastewater, Stormwater, Gas, Electric (overhead and buried), Communications (overhead and buried), etc.
(f) Survey of the project area indicating right-of-way lines, property lines, fences, pavement, signs, trees, power poles, utility markers, visible utilities, manhole flow lines, etc.
(g) Manhole and benchmark coordinates on the City's GIS coordinate system (NAD 1983)
(h) Slope, distance, direction of flow, size and material of each pipe segment, and alignment deflection angles at manholes
(i) Station numbers and pipe invert elevations at manholes, and at even n+00 station numbers
(j) Manhole rim elevation
(k) General Information:
- General Construction Notes and Sequence of Construction
- Erosion and Sedimentation Control Plan and Details see Storm Water Technical Manual
- Contour map of the property to be used (referenced to NAD83, Texas State Plane South Central Zone) – maximum two (2) foot interval
- Proposed lift station, including provisions for installation of future pumps, if applicable
- Existing lift station, if applicable
- Location within Edwards Aquifer Recharge, Transition or Contributing Zone, if applicable – if located within the Edwards Aquifer Recharge Zone, reference TAC 213.A.

- Location within San Marcos River Corridor, if applicable
- Detailed plans for all-weather access road, if applicable
- City of San Marcos standard details shall be included as applicable
- Test borings and groundwater elevations
- Wastewater bypass pumping plan during construction (if applicable)
- Soils Map

1.2.3 Special Designs

The City's Engineer may, upon written request, approve an alternate design or construction methodology that differs from the requirements in this manual if the City's Engineer determines that:

1) The alternative design or construction methodology is equivalent to, or superior to, the methodology required in this manual, and
2) The alternative design or construction methodology is sufficient to ensure public health and safety.

1.3 Wastewater Line Designations

Collection system wastewater line designations are as follows:

(a) Interceptors or trunk mains are gravity wastewater mains generally 18-inches and larger.
(b) Collector mains are gravity wastewater mains generally 12-inches and smaller.
(c) Service laterals are stubouts extending from a collector main to the right-of-way line or edge of easement to provide customer service. The City is responsible for the service laterals in right-of-way or easements.
(d) Private laterals are service lines on private property and are the responsibility of the customer.
(e) Force mains are pipes carrying lift station discharge under pressure and may be public or private depending on location.
(f) Inverted siphons are gravity mains flowing full under pressure due to a sag designed into the pipe profile between the inlet and outlet.

1.4 Wastewater Design Flows

The design flow for new wastewater lines shall be the peak wet weather flow (PWWF) which is obtained by adding the peak dry weather flow (PDWF) and an allowance for wet weather inflow/infiltration (I/I) due to storm events. In designing for an existing facility, flow measurement may be used in conjunction with calculations for the preexisting developed area.

Peak wet weather flow: PWWF (gal/day) = PDWF (gal/day) + I/I (gal/day)

The wastewater peaking factor (PF) shall be calculated as follows, where F is the average wastewater flow in gal/min based on 100 gal/day/capita for the service population:

Peaking factor: $PF = (18 + 0.139 * F^{½}) / (4 + 0.139 * F^{½})$

The peak dry weather flow is the average dry weather flow (ADWF) times a peaking factor (PF).

Peak dry weather flow: PDWF (gal/day) = ADWF (gal/day) * PF

Peak wet weather flow: PWWF (gal/day) = ADWF * PF + I/I.

The average dry weather flow (ADWF) shall be based on the following wastewater unit flow rates:

(a) Single-family residential land use – 225 gal/day/dwelling unit
(b) Multi-family residential land use – 112 gal/day/dwelling unit
(c) Retail land use (wastewater generation generally related to transient clientele) – 225 gal/day per 1000 square feet of building floor space.
(d) Office land use (wastewater generation generally related to stable daytime occupancy) – 65 gal/day per 1000 square feet of building floor space.
(e) Other land use (industrial, educational, medical, etc.) – Wastewater flows will be evaluated on a case-by-case basis where more specific development plans are available

Additional or alternative unit flow rates and supporting data may be submitted to the City for consideration.

Inflow/infiltration (I/I component of PWWF): Calculating extraneous wet weather flows for the purpose of sizing new wastewater lines shall be based on 750 gal per day per acre of contributing drainage area for new sewered development and any additional area deemed necessary by COSM. If the overall service area for new wastewater lines includes older collection system lines, the I/I unit flow rate should be determined in consultation with COSM. For wastewater systems in the Edwards Aquifer Zone refer to the Texas Commission on Environmental Quality (TCEQ) requirements.

Collection system design data should identify the potential wastewater service area that is beyond the limits of the proposed development that could generate additional flows for proposed wastewater improvements. The Wastewater Master Plan must also be included in the analysis of potential wastewater service area. If flows are accepted from existing upstream wastewater lines, the proposed wastewater improvements shall be designed to accommodate all flows generated by the upstream service area. If the existing upstream wastewater system experiences variable peak flows greater than the peaks utilized in the design of new wastewater line, the Owner/Developer must consult with the City's Engineer to confirm the proper peak flow rates to be used for the existing upstream wastewater collection system. COSM may include any additional area deemed necessary to be served by the potential wastewater service area. COSM will consider the need for oversizing in such cases.

The proposed wastewater collection system design shall include a review of all existing downstream sewers receiving flow from the proposed sewers to a location as determined by the City's Engineer, for verification that the flows do not adversely affect the performance of the downstream systems. COSM may require oversizing of certain downstream mains in accordance with City ordinances. Impacts of collection system extensions on existing downstream facilities shall be verified by COSM.

1.5 Determination of Pipe Size and Slope

The following nominal pipe sizes will be the only sizes allowed for use in the gravity system: 8", 12", 18", 24", 30", 36", 42". Larger sizes may be approved on a case-by-case basis.

The design capacity of new wastewater mains shall be determined as indicated below using Manning's "n" of 0.013, which takes into consideration fouling of the pipe over time. Use of an alternate Manning's "n" will require approval by COSM.

For wastewater mains 18-inch diameter or larger, the main shall be designed with size and slope so that the pipe capacity flowing full (where the hydraulic grade is at the inside top of the pipe) is at least 1.25 times the Peak Wet Weather Flow (i.e., the PWWF design flow will not exceed 80% of the capacity of the pipe flowing full).

For wastewater mains smaller than 18-inch diameter, two criteria apply:

1) the main shall be designed so that the pipe capacity flowing full is at least 1.54 times the Peak Dry Weather Flow (i.e., the PDWF design flow will not exceed 65% of the capacity of the pipe flowing full), and
2) the pipe capacity flowing full is at least 1.18 times the Peak Wet Weather Flow (i.e., the PWWF design flow will not exceed 85% of the capacity of the pipe flowing full). Whichever pipe size is larger shall govern.

The minimum design velocity calculated using the Peak Dry Weather Flow shall not be less than 2.0 ft/sec. The maximum design velocity calculated using the Peak Wet Weather Flow should not exceed 10 ft/sec. the table below shows the minimum and maximum slopes based on Manning's formula with an assumed "n" factor of 0.013.

Table 1.5 – 1. Minimum and Maximum Design Slopes Using n = 0.013

Size of Pipe *(inches)*	**Minimum Slope** *(%)*	**Maximum Slope** *(%)*
8	0.33	8.40
10	0.25	6.23
12	0.20	4.88
18	0.11	2.83
24	0.08	1.93
30	0.055	1.43

*taken from TCEQ Ch 217, Figure 30, Table C.1 217.53(I)(2)(A)

Under special conditions where no other options are available for limiting the maximum design velocity to 10 ft/sec, COSM may grant a waiver provided the design gives proper consideration to pipe material, turbulence, abrasion, and displacement. The construction plan and profiles sheets shall show the pipe size and slope, capacity and velocity flowing full, flow rate and velocity for Peak Wet Weather Flow, and, for pipes smaller than 18-inch diameter, flow rate and velocity for Peak Dry Weather Flow.

1.6 Main Alignment and Location

Wastewater mains shall be designed with straight alignment and uniform grade between manholes. The design of the wastewater collection mains should provide safe, full and economical access for maintenance and repair, reliability of location and minimum disruption to surrounding facilities during repair operations. Manholes should be located to facilitate access, inspection, and maintenance. In all cases, wastewater facilities shall comply with TCEQ requirements.

All Public Wastewater Facilities shall be located in dedicated public right-of-way or in a wastewater easement dedicated to the City or on public property. The typical assignment for wastewater mains in right-of-way is the center of the outer vehicular travel lane. In all cases, the separation distance between wastewater and water facilities shall comply with TCEQ §217.53. Wastewater mains shall be installed with a minimum clearance of 24 inches horizontally and vertically from other utility or drainage lines.

Easements shall be a minimum of 20 feet in width for a 12" or smaller line, with minimum cover defined in Section 1.8. The City will require greater easement width depending on pipe size, depth, and location. Installation of wastewater mains shall be 8' from one side of the easement. Utility or easement lots may be appropriate in some cases. New wastewater lines should not be installed underneath or along the side slope of a waterway or drainage system detention facility.

Selection of wastewater main alignments should be such as to avoid junction manholes with opposing flows from influent pipes. Such manholes shall be designed to avoid solids deposition and minimize turbulence.

The City may require the location of a proposed wastewater main within a site to be revised based upon proximity to any existing or proposed buildings. Where possible, wastewater lines should be located at least 20 feet away from structures, however size and depth of proposed wastewater line may increase distance.

1.7 Service Alignment and Location

All residential connections and service leads shall be installed according to the City's Standard Details on both sides to edge of right-or-way or easement at the time of main line installation.

Service connections shall only be tied into collector mains. Should the service tie into a manhole, the service or drop shall be installed in accordance with TCEQ Ch. 217. Services dropped at a manhole should be no deeper than what is required to service the lot.

The service line from the main to the property line shall be six (6) inch minimum size for a single residential customer and six (6) inch minimum size for dual service connections and commercial customers. The service line shall not be smaller than the diameter of the private service lateral. Standard service leads shall not be more than 150 feet in length.

Wastewater clean-outs are not allowed in sidewalks or driveways. A sampling port is required for commercial customers per the City's Wastewater Sample Port Standard Detail. The standard location for the service and cleanout is an offset of three (3) feet from the common property line between adjacent lots. All other Utility service is usually located at the other lot corner. Services to lots without a wastewater easement will terminate at the property line with a clean-out; service to lots having a five foot by five foot (5' x 5') water/wastewater easement will terminate within the easement. For details, see the City's Standard Details.

The minimum slope allowed for service lines is 2.0% (6/25-inch per linear foot). Grade breaks should be made with standard fittings and not exceed 45 degrees. Minimum service line depth of cover at the curb line is 36-inches.

Single-family and duplex service connections shall be made with sanitary tees at a 90 degree intersection with mains. Commercial, multi-family, and industrial services shall intersect the City system at a manhole.

Service connections are generally not allowed on wastewater mains 18-inches or larger in diameter and shall be considered on a case-by-case basis. Services into the top of mains, stack-type, are prohibited. Services shall be laid on straight grade from main to point of termination, without horizontal or vertical bends, unless otherwise approved by the City in writing according to the special designs section above.

1.8 Pipeline Design

Where the pipe grade exceeds 12%, concrete retards will be required at intervals of no more than 25 feet (preferably at mid pipe length joint locations).

All materials and appurtenances shall conform to the City standards. Acceptable pipe materials for new wastewater mains are as follows:

(a) Polyvinyl Chloride (PVC) Pipe – ASTM D2241. All PVC wastewater pipe must have a Standard Dimension Ratio (SDR) of 26 for sizes 6 through 12 inches and ASTM F679 for larger size pipe.
(b) Ductile Iron Pipe (DIP) – ASTM A746. DI pipe and fittings in wastewater applications shall have a corrosion resistant lining and polyethylene encasement.

(c) High Density Polyethylene (HDPE) Pipe. HDPE pipe may be used for rehabilitation of existing wastewater lines but not for new construction except with approval of the City.

Elevations must be shown on construction plans at 100-foot stations and at all manholes and match marks. Elevations are to be calculated to the nearest 0.01 foot. Minimum cover over top of pipe shall be 36-inches for wastewater mains installed in natural ground not within existing or planned streets or other traffic areas. Wastewater mains located in traffic areas shall have a minimum cover of 60-inches below finished grade. The maximum depth of wastewater mains shall be 13 feet unless otherwise approved by the City for the specific material, application and conditions.

Where the cover is three (3) feet or less, ductile iron pipe should be used and the pipe embedment zone shall follow the City's Utility Trench - Flowable Fill Detail. Flowable fill backfill shall be required where erosion may occur.

When necessary, wastewater mains shall be installed using trenchless boring and/or jacking techniques to avoid disturbance to surface features. All carrier pipes installed by boring or jacking shall be placed in an encasement pipe.

1.8.1 <u>Crossings</u>:

Wastewater collection mains that cross state highways must conform to the City's Technical Specifications and the requirements of the Texas Department of Transportation (TxDOT). Wastewater collection mains that cross railroads must conform to the City's Technical Specifications and the requirements of the railroad company whose right-of-way is being crossed. All crossings of existing streets must use dry bores, unless otherwise approved by COSM.

Above-grade crossing for wastewater collection mains at creeks or drainage channels, must use piers to support the elevated sections. Below grade crossings of creeks and drainage channels shall have a minimum cover of three (3) feet below the flowline at the time of construction. All below grade crossings will require encasement with steel encasement pipe and all ends shall be capped and sealed. The casing shall be carried into the bank a distance that should consider changes in the creek channel. This distance would usually be beyond the high bank such that if you measured a 1:1 slope from the high bank away from the channel, the casing would terminate at that location. If the pipe is less than three (3) feet in depth, steel encasement and concrete capping shall be required.

1.8.2 <u>Encasements</u>:

Steel cylinder pipe shall be used for all encasement pipe unless approved by COSM. Carrier pipes sized less than 30-inches shall use an encasement pipe with a wall thickness no less than 3/8-inch. For carrier pipes 30-inches and larger, a wall thickness of no less than ½-inch shall be used. The casing shall be steel pipe conforming to ASTM 134. Coating of encasement pipe may be required in special soil conditions. Ends of encasement pipes shall be sealed to prevent the intrusion and collection of ground water.

Casing spacers shall be provided on the carrier pipe for all boring/jacking operations. The size, length, number, and location of the spacers shall be per the manufacturer's recommendation. The annular space outside the carrier pipe shall be filled by pressure grouting for the entire bore length before the carrier pipe is set in place. Each end of the encasement shall be sealed with an approved boot and seal wrap or grouting to prevent migration of adjacent backfill and water into the encasement pipe.

Table 1.8.2 – 1. Carrier Pipe Diameter and Casing Pipe Diameters Minimum Thickness

Carrier Pipe Nominal Diameter	Casing Pipe Nominal Diameter	Casing Pipe Minimum Thickness
8”	16”	3/8”
12”	20”	3/8”
18”	30”	1/2”
24”	36”	1/2”

1. Casing pipe thickness for Railroad crossings shall be a minimum of ½-inch thick regardless of diameter.
2. Nominal diameter of casing pipe may be larger as needed for restrained joint pipe.

1.9 Manhole Design

Manholes are required at the following locations:

(a) a change in wastewater main alignment, slope, pipe size, or pipe material;
(b) wastewater main junctions, including the point of force main discharge to a gravity main; and
(c) The ends of wastewater lines that may be extended in the future; although a wastewater access device instead of a manhole may be used at ends of lines with no future extension. (see City’s Standard Detail)
(d) Intersection of service lines to main lines 18-inches and larger.
(e) A manhole is required at the point of connection of a building service line to the public wastewater service stub for multi-family projects exceeding 15 dwelling units and for commercial developments (containing more than 4,000 square feet) requiring a water meter greater than two (2) inches.
(f) Maximum manhole spacing shall be 500 feet for all pipe sizes

All manholes shall have watertight covers and may be required to be bolted if in the 100-year floodplain or as requested by COSM. The area around the manhole shall be built to drain and reduce the potential for I/I. Where new construction ties into an existing manhole, the existing manholes must be lined, coated, or replaced with a corrosion resistant material. If the existing manhole is in poor condition, the manhole must be repaired or replaced prior to lining or coating. Connections to existing manholes shall be made by coring and conform to the City’s Standard Details.

New manhole construction shall be pre-cast concrete or cast-in-place concrete with a corrosion resistant lining. Manholes shall have resilient watertight pipe connections, and the manhole base shall have a “U”-shaped channel to provide for a smooth flow of water and to carry the pipe slope through the manhole.

All lines into manholes, including drop connections, shall match crown-to-crown with a minimum of 0.1 ft drop across the middle of the manhole. Any deviation must be approved in advance. For connecting pipes of the same size, a minimum invert drop of 0.1-ft across the manhole is required. If lines entering a manhole are equal to or greater than 18” apart vertically, a drop manhole must be used. Exterior drop manholes will have a maximum of eight (8) foot of drop and require the approval of COSM where the main size exceeds 18-inches. Interior drop manholes will have a maximum of eighteen (18) inches of drop and require COSM approval. Reference the City’s Drop Manhole Standard Detail for additional requirements.

Manholes shall have the following minimum sizing:

(a) 48-inch diameter for pipe connections smaller than 18 inches;
(b) 60-inch diameter for 18 to 24-inch mains;
(c) 72-inch diameter for 30 to 36-inch mains; and
(d) 84-inch diameter for mains larger than 36-inch.

Wastewater lines entering a manhole shall be no closer than one (1) foot in the horizontal direction unless approved by COSM. Reference the City's Standard Manhole detail for additional requirements. To accommodate multiple pipe connections, manholes larger than the indicated minimum size or a cast-in-place junction structure may be required. Manholes larger than 60-inch diameter shall have eccentric cone sections.

Wherever adequate sewer ventilation is not provided within a 1500-ft reach of main, COSM will require sewer ventilation be provided by means of gooseneck vents at manholes. Vent discharge elevation shall be at least 18 inches above the estimated 100-year flood elevation at that point. Vent assemblies shall be 4-inch ductile iron pipe with two flanged 90 degree bends for the downturn with insect screen between flanges. The subsurface portion of the vent to the manhole cone connection shall be concrete encased.

Testing of wastewater manholes shall be in accordance with the requirements of the City's General Construction Notes and a project's technical specifications.

1.10 Odor and Corrosion Control

The Design Engineer shall evaluate the necessity for odor and corrosion control for collection system construction and improvements during average dry weather flow periods, using the City's Wastewater Collection System Odor Control Design Guidelines. These guidelines are intended to provide a step-by-step method for estimating pressurization at siphons and wet wells, off-site odor potential, and any vapor-phase control which may be necessary. The calculations shall be followed to establish the maximum off-site hydrogen sulfide concentration and to determine if treatment of gasses is necessary. Once the calculations are complete, they shall be submitted to the City of San Marcos Director of Engineering and Capital Improvements for review. Odor and corrosion control may be required by COSM even if the guidelines do not show a need.

All odor control methods shall be submitted for review and approval by the City. Alternative methods for odor control may be requested by the City. Design for alternative methods will be the responsibility of the Design Engineer.

1.11 Force Main Design

Design details for proposed force mains shall be included in a technical report for lift station design submitted to COSM. The technical report should include derivation of design flows based on criteria herein. The design report should include calculations of system head based on the force main size, length, and profile and for pumping head based on proposed pumps, with operating points indicated for both single and multiple pump operation where applicable. The design report should include a drawing of the complete force main pipe profile and the hydraulic grade line profile(s) at the design flow(s).

All force mains shall discharge into their own distinct manhole (i.e. multiple force mains shall not discharge into a single manhole). This pipe shall be ductile iron with non-corrosive lining, an approved HDPE with a minimum diameter of four (4) inches, or PVC meeting ASTM specifications with a minimum pressure rating of 150 psi unless otherwise approved. Force main pipe within the station shall be flanged. Flexible fittings shall be provided at the exit wall. Force mains shall be sized so that the flow velocity is between three (3) and six (6) feet per second at ultimate development. During initial development phases, flow velocities may be as low as two and one half (2.5) feet per second. The maximum time required to flush the force main shall be calculated on the basis of average dry weather flow. All thrust restraints, when required, shall be shown on the plan view. Odor and corrosion control shall be provided for the force main if the force main detention time exceeds 30 minutes and dual force mains are not feasible.

1.12 Lift Station Design

Lift stations are discouraged and will only be allowed where conventional gravity service is not feasible. The Owner/Developer shall provide COSM a detailed engineering study of alternative routes for sanitary sewer conveyance. The engineering study shall consider the City of San Marcos Wastewater Master Plan and the wastewater model when reviewing alternatives. Lift stations shall only be considered when the Owner/Developer has exhausted all other engineering studies for alternatives. The size and depth of the lift station shall be as required to service an area determined by COSM. Final acceptance of the lift station shall be subject to COSM approval.

The Owner/Developer of the proposed development shall bear the entire cost of the sewerage lift station and all appurtenances, unless an oversize agreement has been approved by COSM. The Developer/ Owner shall submit a certified cost statement outlining the cost of the lift station and appurtenances and certified documentation showing that bids were sought for construction of the lift station. The proposed lift station shall be sized to handle the service area designated in the City's Wastewater Master Plan or, at a minimum, to handle the proposed development. At the discretion of COSM, the capacity of a lift station can be increased or decreased.

A Public Improvements Construction Plan permit shall be obtained from the City, and all guidelines outlined by the permit shall be followed during construction. A one-year maintenance bond and warranty shall be posted by the Owner/Developer responsible for installation of the sewerage lift station and force main.

If a lift station serves more than one property, upon completion, it shall become the sole and exclusive property of the City and shall be operated and maintained as a part of the city sewerage system.

Two (2) copies and a PDF version of an engineering report and design plans shall be submitted for all lift stations. The following information shall be included:

1) **Engineering Report.**
   (a) **Flow Development.** The following calculations shall be included:
      (i) Peak Wet Weather Flow (PWWF) from Section 1.4. This flow is used to determine the lift station design capacity. All lift stations shall be designed to handle the peak wet weather flow for its service area.
      (ii) Peak Dry Weather Flow (PDWF) from Section 1.4. This flow is used to determine pipe size in the collection system.
      (iii) Average Dry Weather Flow (ADWF) from Section 1.4. This is the flow developed without the peaking factor. This flow is used to determine the average detention time in the wet well.
      (iv) Minimum Dry Weather Flow (using a peaking factor based on the minimum wastewater flow in gal/min, see Section 1.4 for formula) . This is used to determine the maximum detention time in the wet well.

   (b) **Wet Well Design**.
      (i) The wet well shall be a minimum of six (6) foot diameter.
      (ii) The wet well volume shall be sized to provide adequate storage volume at peak design flows and a pump cycle time of sufficient duration to prevent pump short cycling and consequential motor damage. Pump cycle time, defined as the sum of "pump off" time plus "pump on" time, shall be as follows:

Motor H.P.	Minimum Cycle Time in Minutes (tc)
2 to 50	10
51 to 75	15
76 to 250	30

Volume between "pump on" and "pump off" elevation (of the pump cycle) shall be determined by the following criteria:

(1) V = (tc/4) q; where q = pump capacity in gpm
(2) All "pump on" levels shall have a minimum separation of one (1) foot between levels.
(3) All "pump off" levels shall be at least six (6) inches above the top of the pump casing.
(4) For more than two (2) pumps, the "pump off" levels shall be staged with a minimum separation of one (1) foot between levels.

(c) Wet Well Detention Time.

(i) Calculate the detention time (Td) in the wet well for the maximum wet weather flow, maximum dry weather flow and average dry weather flow using the following equation:
Td = tf + te
Where: tf = (v) ÷ (i) = time to fill the wet well in minutes
te = (v) ÷ (q - i) = time to empty the wet well in minutes
v = volume of wet well between "pump on" and "pump off" elevations in gallons
q = Pump capacity in gpm
i = flow into the station corresponding to the maximum wet weather flow, maximum dry weather flow or average dry weather flow in gpm. Maximum detention time shall be calculated with i = minimum dry weather flow.

(ii) Odor control shall be provided for the wet well if the total detention time in the wet well and force main system exceeds 180 minutes or as requested. See City's Odor Control Design Guidelines.

(d) **Head Loss Curves**.

Data points for the system capacity curve shall be provided in tabular form and graphed with pump head capacity curve on the same graph. Two (2) system capacity curves shall be plotted using the Hazen Williams coefficient values of C = 100 and C = 140. Pump output in gpm at maximum and minimum head shall be clearly shown on the system curve for each pump and combination of pumps. For stations with two (2) or more pumps operating in parallel, multiple and single operation points shall be plotted on the system curve. Pumps with the highest efficiencies at all operating points shall be used.

The lift station design shall include a complete analysis of buoyant forces on the entire lift station structure.

2) Construction Plans and Specifications signed and sealed by a Professional Engineer licensed in the State of Texas including the City of San Marcos Division 1 Specifications.

(a) Specific Station Requirements

(i) Stations deeper than 30 feet, measured from the finished floor to the top of the entrance tube, shall require an electrically powered personnel lift.
(ii) Entrance hatches larger than 40 inches in diameter shall be spring loaded.
(iii) Valves higher than six (6) feet above the floor shall have chain operators.
(iv) Flow monitoring will be provided for all lift stations, as outlined under Instrumentation.
(v) Utility line markers are to be used on all wastewater lines within pervious areas outside the right-of-way, or on wastewater lines where development has not yet occurred, to locate the existing/proposed line. Locating tape is to be used on all wastewater lines per the City's standard detail.
(vi) Stations with motors that are 75 hp and larger shall have reduced voltage starters of the autotransformer or solid-state soft start type. Part winding starters and motors are not acceptable. Motors larger than 75 hp shall be designed with a maximum temperature

rise not to exceed 176°F (80°C) over a 104°F (40°C) ambient temperature. Motors larger than 300 hp may require a higher temperature rise and may be specifically approved with such.

(vii) Motors 75 hp and smaller shall be provided with high efficiency frames. Maximum temperature rise shall not exceed 194°F (90°C) over a 104°F (40°C) ambient temperature.

(viii) Any potable water supply below the overflow elevation of the wet well shall be protected by an air gap.

(ix) Stations shall include space, ports, etc. needed for chemical feed piping and equipment with tankage.

(b) Emergency Provisions

Back-up power or accessible connection for mobile generators is required unless otherwise approved by the City's Engineer or a designee.

(c) General Information:

- Maximum elevation of wastewater in the collection system and wet well in the event of a power failure for the estimated duration of power outage.
- Detailed electrical and control system plans
- Detailed plans for the force main (with profile, connecting to outfall location).
- Detailed plans for the lift station and all appurtenances

(d) Site Selection.

If an existing roadway easement with an existing asphalt or concrete road is not available for the lift station, one must be provided.

(e) Design.

Dry wells are not permitted. At least two pumps shall be provided. If only two pumps are provided, they shall have the same capacity. A phasing plan shall be required for review and approval by the City if the flow into the lift station will change significantly over the project duration or if the phasing will cause significant changes in flow. Phasing plans must include an odor control plan and maintenance requirements for each phase.

Level controllers shall be located as to not to be affected by flows entering the station. Small stations with duplicate units should make provisions to alternate pumps in use. Suitable and safe means of access shall be provided to wet wells. Lift stations shall be equipped with suitable devices for measuring, recording, and totalizing sewage flow and power consumption.

Alarm systems shall be provided for all lift stations. The alarm shall activate in cases of pump station malfunction.

Exceptions

Exceptions to these design criteria must be requested in writing. Written approval from the City's Engineer must be obtained before any exceptions will be allowed.

Approval

Once the design and plans are approved by TCEQ, submit two (2) copies and a PDF version of the engineering report and plans to the Department of Engineering for review and approval.

3) Construction

A permit is required for construction including lift station(s). Permit guidelines and the most recent City of San Marcos Construction Notes shall be followed.

(a) Miscellaneous Construction

The base slab and wet well shall be monolithic to prevent infiltration or leakage. SS bolts for pumps shall be cast-in-place in the base slab. All penetrations of the wet well walls shall be sealed with non-shrink grout or an approved wall seal. The top slab shall be provided with floor doors sized to allow for pump removal.

(b) Installation

Prior to beginning the installation of the wastewater lift station, the Engineering Department shall be given a minimum of five (5) working days advance notice. All erosion control measures are to be in place prior to and during installation. Follow the most recent COSM Construction Requirements.

(c) Materials

(i) Pre-Fabricated Lift Stations.

Prefabricated lift stations can be submitted for review and acceptance.

(ii) Valves.

(a) Iron-Body Gate Valves.

Unless otherwise indicated, Iron Body Gate Valves, 4" to 12" (102 mm to 305 mm), including Tapping Valves, shall conform to AWWA C509, "Resilient Seated Gate Valves for Water and Sewerage Systems".

Iron Body Gate Valves larger than 12" (305 mm), including Tapping Valves, shall be double disc, parallel seat valves meeting the requirements of AWWA C500.

16“ (406 mm) Iron Body Resilient Seated Gate valves may be used if called for in the design and if indicated in the Standard Product List WW-282.

(b) Ball Valves.

Ball valves shall be brass, bronze, stainless steel or PVC as indicated on the drawings or details or as approved by the City’s Engineer or designated representative.

(c) Air-Vacuum Release Valves.

Valves shall be combination air-release, air-vacuum units having small and large orifice units contained and operating within a single body or assembled unit. The small orifice system shall automatically release small volumes of air while the pipe is operating under normal conditions. The large air-vacuum orifice system shall automatically exhaust large volumes of air while the pipe is being filled and shall permit immediate re-entry of air while being drained.

Valves shall be rated for at least 150 psi (1 megapascal) {maximum} normal service pressure.

Unless otherwise indicated, these valves shall be ARI Combination Air Release for wastewater force mains.

4) Pumps

(a) Acceptable Manufacturer.

All equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this section. Submersible pumps shall have impellers of the multi-vane, recessed non-clogging design and have pump out vanes on the backside of the impeller to prevent grit and other materials from collecting in the volute and seal areas. Products that comply with this section by the following manufacturers will be acceptable.

(i) ABS XFP Series
(ii) Flygt N Impeller
(iii) Gorman-Rupp Vortex
(iv) Homa Vortex
(v) Hydromatic Vortex

(vi) Myers Vortex
(vii) Tsurumi C-Series

(b) **Data sheets** supplying the following information for the pumping units shall be submitted with the shop drawings.
(i) Make and type of pump
(ii) Speed _____ RPM
(iii) Horsepower at rated head _____ HP
(iv) Total weight (pump and motor) _____ Lbs.
(v) Rated capacity and head on pump curve
(vi) Maximum capacity and head on pump curve
(vii) Minimum capacity and head on pump curve
(viii) Minimum overall efficiency

(c) Motor.
(i) Make and type of motor
(ii) Brake horsepower of motor _____HP
(iii) Locked Rotor Current at full nameplate voltage _____ Amps
(iv) Full load current at full nameplate _____voltage
(v) Motor service factor
(vi) Insulation class and temperature rise at service factor load
(vii) Shaft Seal: Provide dry run/leakage test procedures and data for the specific pump shaft seal system.

5) Submersible Sewage Pumps

(a) Each pump, motor, and cable assembly shall be furnished in one integral unit, factory assembled by the Pump Manufacturer.

(b) The pump design shall be such that the pumping unit will be automatically and firmly connected to the discharge piping when lowered into place on its mating discharge connection. The discharge connection shall be permanently installed to the wet well using SS cast in place bolts. The pump shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be disconnected. Connection and disconnection of the pumping unit from the discharge piping shall not require personnel to enter the wet well.

(c) Each pump shall be fitted with an adequate length of stainless steel chain of adequate strength to permit raising and lowering the pump. The pump supplier shall provide a grip eye, which, when lowered into position over the stainless steel chain, will automatically attach to the chain for lifting and automatically release the chain after lowering the pump back into position. The grip eye, pump chain, and associated hardware shall have a minimum capacity of 1 1/2 times the pump weight.

(d) The pump assembly shall also be capable of running dry or partially submerged for extended periods without any damage to the pump, motor, seals, or accessories.

(e) Major parts, such as the stator casing, oil casing, sliding bracket, volute, impeller, and base coupling shall be constructed of cast iron. Surfaces coming into contact with the pumped liquid shall be protected by a factory-applied epoxy coating or shall be stainless steel. External bolts, nuts, and fastening hardware shall be a minimum of 316 stainless steel.

(f) Motor

(i) The motor shall be housed in an air filled, water tight enclosure. The motor shall

conform to NEMA design Class B, and incorporate Class H insulation material to withstand a continuous operating temperature of 356°F (180° C). The pump and motor shall be capable of handling liquids with a maximum temperature of 104°F (40°C). The motor shall be capable of sustaining up to 12 evenly spaced starts per hour. The motor shall be capable of operating in dry or partially submerged conditions for extended periods without damage. The nameplate motor service factor shall be at least 1.15. The motor shaft shall be 400 series stainless steel, or carbon steel 1035 if completely isolated from the pumped media. The motors shall be 460 volt, 3-phase, 60 cycle and rated for VFD duty (NEMA MG-1, inverter duty rated). The motors shall not be more than 1200 RPM at full load, and shall be completely isolated from the pump to media. Lead wires shall be suitable for operation in oil. The motor shall be provided with motor thermal switches embedded in the windings to protect the motor from burnout due to excessive heating. Inrush on starting shall be no more than allowed by NEC Code Letter G (5.6 KVA/HP).

1) The electrical cable entranceway to the motor shall be provided with positive strain relief to prevent leakage or pullout of the cable in the event that a force is accidentally placed on the cable during the raising or lowering of the pump.
2) The motor, cable, and electrical controls shall be sized, furnished, and installed so that the motor shall never exceed the nameplate rating at any point on the pumping curve.

(g) Sliding Coupling System

(i) A sliding guide bracket shall be an integral part of the pumping unit or securely attached thereto. The guide bracket shall be designed such that no strain is placed on the pump or guide rails. The volute casing shall have a machined discharge flange to automatically and firmly connect with the discharge connection, which when bolted to the floor of the sump and discharge line, will receive the pump discharge connecting flange without the need of adjustment, fasteners, clamps or similar devices. Discharge base elbow and base plate shall be supplied by the Pump Manufacturer.

(ii) The pump sliding coupling system shall be designed so that the downward force of the machined mating flanges shall shear away rags, hair, or other debris that would prevent a uniform watertight seal. No portion of the pump unit shall bear directly on the floor of the wet well. Nor shall the pump have any protrusions below the pump intake, such as legs that could cause debris and rags to hang up and cause coupling system misalignment. The pump body and slide coupling mating faces shall be non-sparking bronze.

(iii) The slide rails shall be continuous stainless steel designed to resist corrosion in sewage or sludge applications. Any joints in the rails shall be reinforced from within. If pipe is used, it shall be minimum Schedule 80 and shall be continuously full-depth welded, ground smooth, and treated to resist corrosion.

(iv) The rail support system shall be furnished by the Pump Manufacturer, of adequate length to extend from the lower guide holders on the pump discharge connection to 6" below the top of the wet well. The system shall be mounted with stainless steel hardware

6) Sump Pump

The sump pumps for the meter vaults and valve vaults shall be Hydromatic Model SP50A1, or approved equal.

7) Submersible Sump Pumps

The sump pumps shall have cast iron motor housing and volute, non-clog, cast iron impellers threaded to a stainless steel shaft and capable of handling 2-inch spherical solids. Each pump shall be equipped with a heavy-duty, wide-angle float switch. The backup pump float switch shall be set at 6 inches above the primary pump float switch. Each pump shall have a capacity of not less than 100 gpm at a total dynamic head of 10'. Each pump shall be equipped for automatic operation.

Motor. The motor shall be totally-encased, sealed, non-ventilating, and the motor windings shall contain automatic-reset, thermal overload protection for continuous duty.

8) Access Doors

Acceptable Manufacturers: Products that comply with the specifications by the following manufacturers will be acceptable:

(a) Bilco
(b) USF
(c) Halliday

Floor access door shall be Aluminum Leaf, Channel Frame, rated for 300 psf.

Fall through prevention systems shall be manufactured by and compatible with the installed aluminum access doors.

9) Swing Check Valves

(a) The check valves used shall be swing check valves unless otherwise specified and shall be constructed with a heavy cast iron body and bronze seat ring, non-corrosive shaft for attachment of weight and lever, and complete bronze air cushion chamber. Shaft, counter-weight, and cushion assembly shall be field reversible.

(b) The valve disc shall absolutely prevent the return of water or gas back through the valve when the inlet pressure decreases below the delivery pressure. The valve shall be tight-seating. The seat ring shall be renewable and shall be securely held in place by a threaded joint. The valve disc shall be of cast iron and shall be suspended from a non-corrosive shaft which passes through a stuffing box or O-rings and shall be connected to the weight and lever on the outside of the valve. The shaft shall be keyed into the disc and lever arm. Set screws shall not be acceptable.

(c) Swing check valves shall be furnished with ANSI 125 pound flanges. Swing check valves shall be Golden-Anderson 250-D Cushioned or Non-Cushioned, as appropriate.

10) Protective Coatings

Protective coatings will be required for the interior and exterior of the lift station. The lift station coating shall be Raven Chemicals Inc., unless otherwise approved by the City.

11) Electrical Control

(a) Electrical work shall be executed in accordance with local, State, and national codes, ordinances, and regulations. The applicable provisions of the following standards shall apply to all electrical installations and equipment:
  (i) National Electrical Manufacturing Association (NEMA)
  (ii) American Society for Testing and Materials (ASTM)
  (iii) National Fire Protection Association (NFPA)
  (iv) National Electrical Safety Code (NESC)
  (v) Institute of Electrical and Electronic Engineers (IEEE)
  (vi) National Electrical Code (NEC)
  (vii) Underwriters Laboratories (UL)
  (viii) American National Standards Institute (ANSI)

(b) Identification of electrical equipment shall be in accordance with the NEC, local authorities, and as specified.

(c) Conductors shall be soft-drawn, annealed copper with conductivity of not less than that of 98% pure copper bearing the UL label. Conductors shall be stranded THHN/THWN. Conductors shall be properly labeled and tagged with reference to “as built” blueprints for future troubleshooting.

(d) Disconnects and motor control centers shall comply with the specifications and shall be by the following manufacturers:
  (i) Cutler-Hammer

(ii) Siemens
(iii) Allen Bradley

(e) Variable Frequency Drives shall have harmonic filters, power factor correction, drive isolation transformers, and all appurtenances needed to meet the requirements of the application.
Acceptable manufacturers of VFDs:
(i) Robicon
(ii) Allen Bradley
(iii) Yaskawa

(f) All outdoor instrument and control enclosures shall be NEMA 4x.

12) Instrumentation

(a) On stations without generator backup, odor control, or flow meters, primary duplex and triplex pump control shall be by Tac Pack controller manufactured by:
Data Flow Systems
605 N John Rodes Blvd, Inc.
Melbourne, FL 32934
Phone: 321-259-5009
Fax: 321-259-4006
www.dataflowsys.com

Primary 4 pump control shall be by Data Flow Systems PLC with redundant pump control using SC2000 station controller manufactured by:
Motor Protection Electronics, Inc.
2464 Vulcan Rd.
Apopka, FL 32703
Phone: 407-299-3825
www.mpelectronics.com

(b) On stations with generator backup, and/or odor control, and/or flow meters primary control shall be as follows:
2 pump stations will use DFS PLC with redundant control using Mercoid MPC station controller manufactured by:
Mercoid Controls, Division of Dwyer Instruments
102 Indiana Highway 212
P.O. Box 373
Michigan City, IN 46361
Phone:(219)879-8000
Fax:(219)872-9057
www.mercoid.com .

(c) 3 & 4 pump stations will use DFS PLC with redundant control using SC2000 controller.

(d) Transit time ultrasonic flow meters shall be Thermo SX40 or approved equivalent.

(e) Level probe for pump control shall be Mercoid PBLT2-15-60-PU submersible level transducer or approved equivalent.

(f) Telemetry transmission will be by DFS Radio operating at City's licensed frequency. HMI inputs/outputs may include, but not be limited to, the following:
(i) Start/Stop for each pump
(ii) PLC failure alarm
(iii) Motor current
(iv) Motor speed
(v) Wet well level
(vi) Discharge flow

(vii) Discharge pressure
(viii) Pump status Auto/Manual
(ix) Run status On/Off
(x) VFD failure alarm
(xi) Wet well alarm Hi/Low
(xii) Generator status Auto/Fail/Running/HOA position
(xiii) Transfer Switch status
(xiv) Security contacts

(g) Contractor shall provide Owner with certificates of calibration for all instrumentation upon completion of installation.

13) Backup Generator

(a) Where backup generator is specified by the COSM, the gen-set shall be Caterpillar, sized to fit application.
(b) Acceptable automatic transfer switch manufacturers shall be:
  (i) ASCO
  (ii) Caterpillar

14) Odor Control Method

(a) Bio filter,
(b) Carbon filters,
(c) Or other methods approved by the City

All odor control methods shall be submitted for review and approval by the City.

15) Operations and Maintenance Manuals

(a) Prepare a complete and detailed Operation and Maintenance Manual in the form of an instruction manual for the Owner. The manual is to be suitable for use in providing operation and maintenance instruction for each type and model of equipment, product, or systems furnished and installed under this contract.
(b) Manuals are to be in addition to any information packed with or attached to the product when delivered. This information is to be taken from the product and provided as an attachment to the manual.
(c) Include updated "as built" prints for all structural, mechanical, and electrical components.
(d) Provide copies of the Manufacturer's warranties, guarantees, or service agreements.
(e) Provide affidavit stipulating start of warranty periods for all equipment at full acceptance by COSM, with copies to all equipment vendors.

16) Testing and Approval.

(a) Start up of the lift station shall be performed in the presence of the designated City Representative. Prior to start up, forty-eight (48) hours notice shall be given to the City.
(b) Alternate Power Supply Present. A two (2) hour continuous load bank test of the generator shall be performed prior to connection to the transfer switch. Loads from ten (10%) percent to one hundred (100%) percent of rated capacity shall be checked for voltage, frequency, and fuel. Correct phasing between the generator and the station shall be verified, and a simulation of generator alarms shall be performed. A signed test report shall be provided to the City. A total of two (2) power failures shall be simulated.
(c) All pump operations and alarm controls shall be demonstrated.
(d) Training. A minimum one (1) day training session for the City staff shall be provided covering the system operation and basic maintenance of all aspects of the lift station, one (1) week notice shall be provided to the City for scheduling the training session.
(e) As-Built Drawings. Upon completion of the project, as-built drawings shall be submitted to the City's inspector for review and approval. Once the as-builts are approved, two (2) hard copies, as well as one PDF and one DGN copy shall be submitted to the City. Each

sheet within the as-built set must be stamped RECORD DRAWING and initialed.

(f) Approval. Upon completion and acceptance of the start up operations and the one day training session and as-builts, a Certificate of Acceptance may be submitted for project approval.

(g) A one-year warranty and 100% maintenance bond shall be required.

1.13 Inverted Siphons

The use of inverted siphons is discouraged due to high maintenance requirements. A minimum of two (2) flow barrels is allowed for a new inverted siphon for substantial existing flows. A minimum of three (3) flow barrels is required when initial flows are substantially lower than future flows. Three-barrel siphons shall be designed to carry the capacity of the incoming gravity wastewater main(s) with one (1) barrel out of service. The inverted siphon shall have an air flow barrel between the siphon inlet and outlet structures with a minimum size of one-half (1/2) the diameter of the upstream pipe. The air jumper design shall provide for removal of condensation.

The smallest barrel should have a minimum velocity of 3.0 ft/sec at initial Peak Dry Weather Flow. The complete inverted siphon shall have capacity for future Peak Wet Weather Flow. Under all flow conditions the siphon should be designed so that head loss does not cause backwater or surcharging in the upstream wastewater system. Engineering calculations shall be submitted showing the head, flow, and velocity for each barrel at initial and future design flows.

The siphon inlet and outlet structures should be located with convenient access. An additional corrosion resistant pipe shall be designed to allow for the free flow of air between the inlet and outlet siphon boxes. Weirs at the siphon inlet to control flow splits between barrels shall have provisions for height adjustment. The siphon outlet structure should be designed to facilitate hydraulic and mechanical cleaning of the siphon barrels. The pipe profiles shall be designed with smooth curves to allow passage of cleaning equipment. Corrosion resistant materials and coatings shall be used for inverted siphon structures and pipes.

1.14 Abandonment of Facilities

If a new project will abandon existing facilities, the plans shall provide for the appropriate abandonment of these facilities. The plans shall include, at a minimum, the location, sequence, details, and methodology for abandoning the facility. Abandonment shall be considered permanent. Temporary abandonment must be approved on a case-by-case basis. Area shall be restored to a condition acceptable to COSM.

(a) Wastewater Mains and Services

Abandonment of wastewater mains in private easements shall consist of filling the main with a pumpable grout or slurry and meeting requirements of the current specifications. Plans, drawings and specifications shall include method of abandoning or removing services and all other mains.

(b) Manholes

Abandoned manholes shall be removed to a level not less than four (4) feet below grade, inlets and outlets securely plugged, inlet and outlet pipes cut and plugged outside the manhole, and the structure filled with low strength material according to the standard specifications.

(c) Lift Stations

Abandonment of lift stations shall consist of removing all pumps, motors, couplings, valves, and controls from the dry well and all appurtenances above finished grade. Both the wet well and dry well shall be cut down five (5) feet below grade, filled with flowable fill, and covered with top soil to grade. The associated force main shall be properly abandoned. This includes cutting and plugging both ends and/or grouting gravity mains as appropriate.

END OF SECTION