

Minimum Design Standards for Sanitary Sewers

Unified Government of Wyandotte County and Kansas City, Kansas

June 22, 2007

This page intentionally left blank.

Table of Contents

I	MINIMUM DESIGN STANDARDS FOR SANITARY SEWERS.....	1
A	General.....	1
II	PRELIMINARY DESIGN PLAN- DESIGN MEMORANDUM.....	4
A	Preliminary Design Plan	4
B	Design Memorandum.....	5
III	SANITARY SEWER DESIGN CRITERIA.....	9
A	Reference Documents	9
B	Sanitary Sewer	9
C	Geotechnical Investigation.....	9
D	Design Period.....	10
E	Design Flows	10
F	Sanitary Gravity Sewer Size	11
G	Sanitary Sewer Locations, Alignments and Easements.....	12
H	Sanitary Gravity Sewer Depth	13
I	Sanitary Gravity Sewer Slope and Velocity	14
J	Energy Grade Design.....	16
K	Sewer Pipe Materials	16
L	Sanitary Sewer Structural Design Requirements.....	17
M	Building Sewer Connections to Sanitary Gravity Sewers	19
N	Manholes.....	20
O	Aerial Crossings.....	21
P	Stream Crossings	22
Q	Inverted Siphons	22
R	Force Main	23
S	Pipe Installation Methods	24
IV	PLAN PRESENTATION	36
A	Contents of Plans	36
B	Record Drawings	40
C	Right-of-Way and/or Easement Legal Descriptions.....	40
D	Contract Documents.....	40
E	Right-of-Way/Easement Maps.....	41
V	PIPE REHABILITATION METHODS	43
A	Cured in Place	43
B	Sliplining.....	44
C	Pipe Bursting.....	48
VI	PUMP STATION DESIGN	50
A	Applicability and Approval.....	50
B	General.....	50
C	Station Type	53
D	Station Capacity	56
E	Wet Well Design.....	57
F	Layout and Siting.....	58
G	Power Supply/Electrical.....	59
H	Monitoring and Control	61

I	Ventilation.....	63
J	Appurtenances.....	64
K	Plans and Specifications	65
L	Pump Station Acceptance Testing	67
M	Pump Station Design Review Checklist	68
VII	LOW PRESSURE SEWER	69
A	Use and Applicability	69
B	Preliminary Plan Submittal	70
C	Technical Considerations.....	76
D	Contract Documents/As-built Drawings.....	79
E	Ownership and Maintenance.....	79
F	Low Pressure Sewer Plan Review Checklist	80
G	Low Pressure Sewer Lighting Panel Checklist.....	80
	APPENDIX.....	1
A	Sanitary Sewer Design and Plan Review Checklist.....	1
B	Wet Well Top with a Formed Cable Tray	1
C	Pump Station Acceptance Testing Guidelines	1
D	Pump Station Review Checklist.....	1
E	Branch Analysis Example.....	1
F	End Flushing Assembly Detail	1
G	Grinder Pump Station Sample Specification	1
H	Electrical Wiring and Connection Sample Specification.....	1
I	Low Pressure Sewer Preliminary Plan Submittal Review Checklist.....	1
J	Lighting Panel Checklist.....	1

I MINIMUM DESIGN STANDARDS FOR SANITARY SEWERS

A General

The reader should note that references in this document to the Owner, the Unified Government of Wyandotte County, the Unified Government, and the UG refer to the City of Kansas City, Kansas. References in this document to a UG designee refer to persons in the Engineering or Water Pollution Control Divisions.

Persons who wish to design either public sanitary sewerage facilities, or private sanitary sewerage facilities which will connect to public sewerage facilities, for proposed construction in the sewerage service area of the Unified Government, must be professional engineers licensed in the State of Kansas; or the designs of such facilities supervised, signed and sealed by a professional engineer licensed in the State of Kansas. In addition, the owner, developer, and/or designer shall provide for a full-time, qualified construction observer to be present onsite during the construction of any sanitary sewerage facilities within the sewerage service area of the Unified Government.

Further, the City reserves the right, through its Water Pollution Control Department, to require submittal of any or all information relating to the design of sanitary sewers, such as: results of soil studies and/or other reasonable investigations; field survey data; design calculations; and/or other reasonable information which was used or which should have been used in the design of the proposed sewerage facilities. The City also reserves the right to inspect the sewerage facilities before they are placed in service.

Finally, upon completion of construction of a sanitary sewerage facility, the owner, developer, contractor, and/or designer of the facility shall request a final inspection and acceptance of the facility, by submitting a signed and attested certification from the design engineer that the project was completed in relatively close conformance with the approved plans and specifications. The certification must be accompanied by submittal of two full size hardcopy sets of record drawings and a set in electronic format compatible with UG GIS database (AutoCAD format).

For projects involving sanitary sewerage facilities other than sewers, such as pumping stations, special valves or structures for bypass or overflow control, or other similar facility, two (2) copies of an operation and maintenance manual must accompany the record drawings. Also, submit the operation and maintenance manual in electronic format.

1. Applicability

These minimum design standards for sanitary sewers shall serve as a guide in the design and preparation of plans and specifications for

construction of sanitary facilities in the Kansas City, Kansas area. The Water Pollution Control Department shall not accept any sanitary sewer designs which are not in compliance with these design criteria.

2. Pre-design conference

The Water Pollution Control Department strongly recommends a conference between personnel of said department, the developer, and the designer during the pre-design, exploratory phase of the project. Conferences are mandatory for projects that include pump stations, low pressure sewer systems, or any sanitary sewer development in areas with no existing sanitary system. Ignorance of activity-controlled ordinances, guides, master plans, and written policies of the Water Pollution Control Department shall not excuse the designer from meeting those requirements.

3. City ordinances which pertain to the design, construction and acceptance of public sanitary sewers

Copies of applicable ordinances may be obtained from the Office of the City Clerk, 3rd Floor, Municipal Office Building, Kansas City, Kansas 66101.

4. Compliance with sanitary sewer master plan

The design of sanitary sewers in the Kansas City, Kansas area shall comply with the applicable portion of the City's Sanitary Sewer Master Plan, which is a current compilation of Facility Plans the Water Pollution Control Department maintains. For sewer design in areas where the Master Plan is not complete, the Pre-design conference, as described in Section 2 of this chapter, is mandatory.

5. Compliance with standard sanitary sewer specifications and contract documents

Construction of all sanitary sewers within the City limits of Kansas City, Kansas shall comply with the latest edition of the *UG Technical Provisions*.

6. Variation from the design criteria

The Director of the Water Pollution Control Department or a designee of the Director, on an individual review basis, may grant variation from this Design Criteria. Approval may be granted if the requested variations represent equivalent or better design methodology than that required by this document. Approval for variation should be requested during the early project design phase.

7. Compliance with the Kansas State Department of Health and Environment, Division of Environment, Minimum Standards for Designing Sewerage Facilities

This design guide shall not be used to replace the Kansas State Department of Health and Environment, Division of Environment, *Minimum Standards for Designing Sanitary Sewerage Facilities*, but shall be used in conjunction with that document, to provide the finest possible design project.

8. Amendment to design criteria

Revision of these design criteria will occur from time to time, as everyday use and more advanced technology may require. The Director of the Water Pollution Control Department must approve appropriate design criteria amendments.

II PRELIMINARY DESIGN PLAN- DESIGN MEMORANDUM

A Preliminary Design Plan

1. All sewerage projects require a preliminary design plan.
2. The preliminary design plan shall conform to applicable master plans for the area.
3. The UG will evaluate the preliminary design plan to determine whether the project requires a more detailed design memorandum.
4. The preliminary design plan shall briefly cover the following as required by the UG:
 - a. Describe proposed sanitary sewerage improvements. Discuss all system components including elements other than gravity sewers such as low pressure sewer systems, pump stations, and on site treatment;
 - b. Provide maps and exhibits to describe the project area including:
 - 1.) Report the size of the project area;
 - 2.) Report the zoning within the project area;
 - 3.) Provide a topographic map identifying the drainage basin containing the project area;
 - a.) Show the location of the project area within the drainage basin; and
 - b.) Show the location of the proposed improvements in the project area.
 - 4.) Identify the acreage and zoning of the drainage basin that could potentially gravity drain through the project area; and
 - 5.) Describe the existing public sewer system within the drainage basin including:
 - a.) The system components;
 - b.) The proposed tie in point and invert elevation of the connection point;

- c.) Capacity analysis for the collection/treatment systems located in the drainage basin downstream of the project area, as required by the UG; and
 - d.) Identify the elevation of the public sewer in the proximate area.
- c. Provide the projected project design flow rate and the projected ultimate build out flow rate for the potential upstream service area, and provide the basis of the flow rate calculation;
 - d. Identify all proposed crossings of roadways, railroads, streams, minor drainages, flood plains, and other route constraints;
 - e. Identify all proposed inverted siphons;
 - f. Identify power sources for all proposed pump stations;
 - g. Identify areas of the alignment where the anticipated trench depth is twenty (20) feet or greater;
 - h. Describe the wastewater flow path from the project area to the ultimate destination at the treatment plant. Identify all pump stations on the flow path and force main diameters;
 - i. Identify permit requirements for stream crossings, wetlands, flood plain, historical, cultural and archeological resources;
 - j. Identify unusual characteristics such as brownfield sites and potential or known areas of soil contamination; and
 - k. Identify permanent and temporary easement requirements.

B Design Memorandum

1. Upon request following review of the Preliminary Design Plan, the designer shall prepare a design memorandum and submit to the Director of Water Pollution Control for review and approval prior to the beginning of final design work for the sanitary sewerage improvements.
2. The Design Memorandum shall include the following minimum information.
 - a. Provide a statement of the project purpose and a list of the project scope items;
 - b. Provide a description and exhibits for the proposed sanitary sewer

project including:

- 1.) Location (exhibit required) and general background information concerning the project area including:
 - a.) Identify the drainage basin that contains the project area;
 - b.) Show the location of the project area within drainage basin;
 - c.) Show the location of the proposed improvements in the project area;
 - d.) Describe the relationship of the project area to the surrounding area within the drainage basin;
 - e.) Report the present state of development and proposed land use within the project area; and
 - f.) Describe and show the existing and proposed sanitary sewerage facilities within the drainage basin. Base the existing facilities on information from a UG sewer map. Identify areas in the drainage basin that are not currently sewered.
- 2.) Describe the relationship of the proposed improvements to existing sanitary sewerage facilities outside of the project area;
- 3.) Capacity analysis for the collection/treatment systems located in the drainage basin downstream of the project area, as required by the UG;
- 4.) Describe all pump stations/force mains, septic service areas, low pressure sewer systems, on-site treatment facilities and potential connection points (provide connection point elevations);
- 5.) Identify pump station type and firm capacity, location within the watershed, number of pumps, pump horsepower, pump design points, power supply and backup power source, controls, and site grade and elevations of incoming lines;
- 6.) Identify planned improvements located within the flood plain delineated in a FEMA flood plain map. Describe the affect of locating in a flood plain on the sanitary sewer layout and design (materials specified, high water table considerations, ect.);
- 7.) Describe the anticipated water quality (pH, temperature, volume, BOD, ect.) from industrial users;

- 8.) Provide the projected wastewater flow rates;
 - a.) Submit two copies of sanitary flow calculations with the design memorandum. The calculations shall conform to the guidelines found in the Sanitary Sewer Design Criteria section of this document.
 - b.) The calculations shall indicate:
 - 1 Design population or population equivalent;
 - 2 The design flow; and
 - 3 The depth, velocity, and flow in each reach of sewer.
 - c. Provide pipe design calculations highlighting anticipated worst-case scenarios. The pipe design calculations shall clearly state all assumptions and reference all material used for the design. Refer to the Sanitary Sewer Structural Design Requirements section for design guidelines.
 - d. Where corrosive conditions due to septicity or other causes are anticipated, such as at manholes receiving flow originating from pump stations or manholes where turbulence is a factor consideration shall be given to providing corrosion protection on the interior of the manholes. Where high flow velocities are anticipated, the manholes shall be protected against internal corrosive erosion and displacement from impact.
 - e. Provide a schedule of development phasing, where applicable, and discuss the affect the planned phasing has on this project;
 - f. Discuss the unusual construction conditions anticipated including, but not limited to, stream, railroad, highway and aerial crossings and trenching conditions other than open cut excavation less than twenty (20) feet deep;
 - g. Identify permit requirements for stream crossings, wetlands, flood plain, historical, cultural and archeological resources.
 - h. Provide a material, installation, and testing specification for the intended pipe material and written certification from the pipe manufacture detailing the materials suitability for use under local conditions, when required by the UG.
 - i. Provide an estimated project cost;
 - j. Describe anticipated exceptions to materials and methods specified in

the UG *Technical Provisions*;

- k. Include a statement concerning compliance with applicable sanitary sewer facility plan; and
- l. Include a statement that the design will be in compliance with applicable Kansas Department of Health and Environment requirements.
- m. Discuss the construction materials selected and the justification for each.

III SANITARY SEWER DESIGN CRITERIA

A Reference Documents

The following list contains sanitary sewer design references that form the foundation of the design criteria presented in this chapter. Designers shall refer to these references for further design guidance.

1. The Unified Government of Wyandotte County/Kansas City, Kansas – *Technical Provisions and Standard Drawings for Roads and Sewers*;
2. Water Environment Federation Manual of Practice No. 9 – *Design and Construction of Sanitary and Storm Sewers*;
3. Kansas Department of Health and Environment – *Minimum Standards of Design for Water Pollution Control Facilities*;
4. UG plumbing code found in Chapter 8, Building and Building Regulations, of the Code of Ordinances City of Kansas City, Kansas;
5. UG *Sewers and Sewage Disposal* code found in Chapter 30, Building and Building Regulations, of the Code of Ordinances City of Kansas City, Kansas;
6. 2003 *International Plumbing Code*;
7. Kansas Department of Transportation *Utility Accommodation Policy*;
8. American Railway Engineering and Maintenance-of-Way Association *Manual for Railway Engineering*; and
9. AASHTO Standard Specifications for Highway Bridges.

B Sanitary Sewer

Provide separate collection systems to convey wastewater and storm water runoff. All sanitary sewer improvements shall conform to provisions found in Article V of Chapter 30.

C Geotechnical Investigation

A geotechnical investigation is generally required. Typically, the minimum investigation includes one (1) soil boring for each sixteen hundred (1600) linear feet of line and soil borings at significant structures such as pump stations and at stream crossings. Additional borings may be required at the discretion of the designer. Show the soil boring locations on the general layout sheet. Include copies of the boring logs with the contract document submittal;

D Design Period

1. Design flows shall be based on the ultimate development using existing and/or projected land use for collector sewer of the size up to and including a nominal diameter of twenty four (24) inches.
2. Design flows shall be based on a minimum design period of twenty five (25) years, using existing and/or projected land use unless phased development is cited from an approved facility plan covering the project area for sewers with a nominal diameter of larger than twenty four (24) inches. A longer design period shall be justified by a cost-effectiveness calculation using the "present worth" method.

E Design Flows

1. Design sanitary sewers to provide capacity for the anticipated peak hourly flow with an appropriate allowance for infiltration and inflow.
2. Use actual measured flows as the basis for the design peak hourly flow rate whenever reliable wet and dry weather flow measurements are available.
3. In absence of actual measured flows, use average water use rates from comparable developments with an appropriate peaking factor and an allowance for infiltration and inflow as the basis for the design peak hourly flow rate.

- a. Base the peaking factor on the following relationship:

$$PF = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

Where:

PF is the peaking factor (ratio of peak hourly flow rate to average daily flow rate)

P is the population in thousands

- b. Base the infiltration/inflow allowance on the contribution rate of 0.0015 cfs/acre.
 4. In the absence of applicable water use rate data, use the following minimum design peak hourly flows for watersheds of three hundred (300) acres or less (infiltration-inflow allowance is included):

Sanitary Sewer Design Criteria

- a. Single and two (2) family dwellings 0.02 cfs/acre
- b. Apartments (actual density shall be considered):
 - 1.) One through three story 0.02 cfs/acre
 - 2.) Four story and greater As directed by the UG
- c. Commercial (actual density and tenant types to be considered):
 - 1.) Small stores, offices and miscellaneous businesses 0.010 cfs/acre
 - 2.) Strip and regional shopping centers 0.015 cfs/acre
 - 3.) High rise As directed by the UG
- d. Industrial (actual density to be considered):
 - 1.) Light 0.015 cfs/acre
 - 2.) Heavy As directed by the UG

The following minimum design peak hourly flow allowances apply to watersheds greater than three hundred (300) acres (infiltration-inflow allowance is included):

301-500 acres	0.017 cfs/acre
501-1,000 acres	0.015 cfs/acre
1,001-3,000 acres	0.015-0.010 cfs/acre with a linear decrease based on area

- 5. Depth of flow
 - a. Sanitary sewers up to and including a diameter of eighteen (18) inches should carry the design flow at two-thirds ($2/3$) depth or seventy eight (78) percent of the full flow capacity.
 - b. Sanitary sewers larger than eighteen (18) inches in diameter should carry the design flow at three-quarters ($3/4$) depth or ninety two (92) percent of the full flow capacity.

F Sanitary Gravity Sewer Size

- 1. No gravity sanitary sewer shall be less than eight (8) inches in diameter.

2. Downstream gravity sewer diameters shall not be less than upstream diameters.
3. Gravity building sewer service lines shall not be less than four (4) inches in diameter. Building sewer service lines shall comply with the standards contained in Chapter 8, Building and Building Regulations, of the Code of Ordinances, Kansas City, Kansas.

G Sanitary Sewer Locations, Alignments and Easements

1. Locate sanitary sewers within street or alley right-of-way whenever possible and economically feasible.
2. Locate sanitary sewers not within a street or alley right-of-way in a dedicated utility easement.
3. When the easement is for the exclusive sanitary sewer use and where sanitary gravity sewers are located outside of existing right-of-way, the minimum permanent easement width shall be the greater of either the depth to invert or fifteen (15) feet. Center the gravity sewer in the easement.
4. When the easement is for the exclusive sanitary sewer use and where sanitary force mains are located outside of existing right-of-way, provide a minimum permanent easement width of ten (10) feet. Center the force main in the easement.
5. Regrading, resurfacing, and landscape alterations shall not be permitted on utility easements.
6. Provide permanent access easement to each manhole and/or structure.
7. Easements for new development shall include a utility corridor that provides easement for water, gas, and sanitary.
8. Provide the necessary temporary construction easement. The following are the typical widths for temporary construction easement, and include the permanent easements:

Trench Depth In Feet	Width in Feet	
	Populated	Non-populated
0-12	40	50
12-16	40	60
16-20	40	70

9. Layout sanitary gravity sewers with straight alignment between manholes or structures.
10. Locate manholes at the beginning and end of each line; at every change of grade, pipe size or alignment; at each street or alley intersection; and at distances of not greater than five hundred (500) feet for sewers eighteen (18) inches or less in diameter, and not more than six hundred (600) feet for larger sewers.
11. Water line protection

The protection of water lines shall comply with all design guidelines found in the Kansas Department of Health and Environment *Minimum Standards of Design for Water Pollution Control Facilities* including, but not limited to the following:

 - a. Maintain a minimum horizontal distance of ten (10) feet between parallel water and sanitary sewer lines.
 - b. At points where sanitary sewers cross water mains, the sanitary sewer shall cross beneath the water line at an angle within forty five (45) degrees of perpendicular with the water line. If the distance between crossing pipes is greater than two (2) feet then no special requirements exist. If the distance between crossing pipes is less than two (2) feet then use ductile iron pipe (DIP) for the sanitary sewer line conforming to ASTM A536 or ANSI/AWWA C151/A21.51 with a minimum thickness class 50 for a minimum distance of ten (10) feet in each direction from the crossing with the sewer pipe joints arranged as far as possible from the water main joints. Alternatively, utilize any pipe material when the crossings distance is less than two (2) feet if the sanitary sewer line is concrete encased for a minimum distance of ten (10) feet in each direction of the crossing.
12. Protection of gas, electric, telephone, storm sewer and other utility lines
 - a. Maintain a minimum clear horizontal distance of five (5) feet between parallel sanitary sewer lines, and utility lines other than water lines.
 - b. Maintain an angle within forty five (45) degrees of perpendicular between crossing sanitary sewer and utility lines.
 - c. Maintain a minimum of two (2) feet vertical clear separation between sanitary and storm sewers.

H Sanitary Gravity Sewer Depth

1. Place gravity sewers at an adequate depth to accept sewerage by gravity flow from the lowest floor of all contributing buildings.

2. Provide a minimum earth cover of six (6) feet for all gravity sewers.
3. When the six (6) feet depth of cover is not available, provide additional protection by earth fill, relocation, encasement in concrete, or construction with approved pipe material.
4. Refer to Utility Protection section for sewer depth guidelines at utility crossings.
5. Avoid sewer alignments in areas where the depth of cover over the top of pipe is fill material. Where unavoidable, refer to the *UG Technical Provisions* for installation guidelines.

I Sanitary Gravity Sewer Slope and Velocity

1. Place gravity sanitary sewers with uniform slope between manholes.
2. Base all velocity and flow calculations on the Manning equation:

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where:

- Q is the discharge (cfs);
- A is the cross sectional area of flow (ft²);
- n is the roughness coefficient which is assume to be 0.013 for all pipe material;
- R is the hydraulic radius which is the area of flow over the wetted perimeter. In the case of full pipe flow R is D/4 where D is the pipe diameter in feet;
- S is the slope (ft/ft).

And:

$$V = \frac{1.486}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where:

- V is the velocity (fps).

3. Design and construct gravity sanitary sewers to provide mean velocities, when flowing full, of not less than two and seven-tenths (2.7) feet per second and not more than ten (10) feet per second as estimated using Manning's equation.

4. Designs providing for sewers with full pipe mean velocities greater than ten (10) feet per second shall include special provision to protect the sewer system against displacement by erosion and/or shock.
5. The following table lists the minimum and maximum slope for the appropriate class of PVC gravity sewer pipe as detailed in the Technical Provisions. These slopes are based on full pipe flow at the recommended minimum (2.7 fps) and maximum (10 fps) mean velocity. The table serves as a guide only. Establish the minimum and maximum slopes for sewers larger than forty two (42)-inches using Manning's velocity equation assuming an appropriate full pipe velocity.

Nominal Sewer Size	Min. Slope n=0.013 (ft./100 ft.)	Max. Slope n=0.013 (ft./100 ft.)
8-inch		
less than 10 homes	1.00	8.46
10 to 35 homes	0.76	8.46
35+ homes	0.62	8.46
10-inch	0.46	6.30
12-inch	0.36	4.98
15-inch	0.28	3.80
18-inch	0.21	2.91
21-inch	0.17	2.34
24-inch	0.15	2.00
27-inch	0.12	1.70
30-inch	0.10	1.42
36-inch	0.08	1.12
42-inch	0.07	0.92

6. Secure sewers sloped twenty (20) percent or greater with the appropriate anchors spaced as follows:

Slope (ft./ 100 ft.)	Anchor spacing Center-to-center (ft.)
20-35	36-24
35-50	24-16
50-over	16-less

- a. Slope anchors shall be a minimum of twelve (12) inches thick and

- shall extend a minimum of two (2) feet from the exterior of the pipe on all sides;
- b. Cast slope anchors against undisturbed earth in the trench walls and bottom;
- c. In rock, key anchors a minimum of six (6) inches into undisturbed rock; and
- d. Anchors shall be cast against pipe bells or a capped cross on bell-less pipe.

J Energy Grade Design

1. Where a sanitary sewer joins a larger sewer at a manhole, lower the invert of the larger sewer to maintain a continuous energy gradient.
2. The rule of thumb that may be used to maintain a continuous energy gradient is to adjust the pipe depths so the $y/D = 0.8$ depth of both pipes are at the same elevation.
3. Where sanitary sewers change direction at manholes, the maximum allowable change in direction shall be ninety (90) degrees.
4. The difference in elevation at manholes between the invert of the incoming sewers and the invert of the outgoing sewers generally should not exceed twelve (12) inches, except where it is necessary to provide for a smooth hydraulic gradient.
5. The minimum drop in manholes between the incoming sewers and the outgoing sewers shall be 0.2 foot for pipelines up to eighteen (18) inches, and whatever is necessary for a smooth hydraulic gradient in larger pipes.
6. The minimum drop in manholes between the incoming sewers and the outgoing sewers shall be 0.4 foot when the deflection angle between the incoming and outgoing sewers exceeds forty five (45) degrees.

K Sewer Pipe Materials

1. The materials selected shall conform to the specifications found in the latest edition of the *UG Technical Provisions*.
2. All eight (8) and ten (10) inch diameter gravity sewers shall be PVC SDR 26 material, where applicable.

3. A number of generally acceptable pipe materials are commercially available for use. Generally approved materials for gravity sewers include:
 - a. Polyvinyl Chloride Pipe (PVC);
 - b. Ductile Iron Pipe (DIP);
 - c. Lined Reinforced Concrete; and
 - d. Composite Pipe.
4. Generally approved materials for pressure sewers include:
 - a. Polyvinyl Chloride Pipe (PVC);
 - b. High Density Polyethylene (HDPE); and
 - c. Ductile Iron Pipe (DIP).
5. The materials selected shall be suitable for local conditions, such as: septic conditions, soil characteristics, flow characteristics, and anticipated superimposed live and dead loads.
6. Designers must obtain approval from the Director of Water Pollution Control to use materials not listed.
7. Designs including a change in pipe material must transition between pipe materials at a manhole.

L Sanitary Sewer Structural Design Requirements

1. General

The structural design of sanitary sewers and sanitary sewer appurtenances, other than those included in the latest edition of the *UG Technical Provisions*, must follow the general structural design concept for loads on pipe and pipe supporting strength found in the "Water Pollution Control Federation Manual of Practices, No. 9," supplemented by appropriate ASTM Standards, manufacturer's design recommendations, and generally accepted sound engineering design practices. In addition, the following general structural design guide shall apply:

- a. Pipe embedment material and placement
Pipe embedment material and placement shall conform to specifications found in the latest edition of the *UG Technical Provisions*.

b. Trench width

Trench widths shall conform to specifications found in the latest edition of the UG *Technical Provisions*.

c. Backfill weight

The unit weight for backfill material varies for different soils, from a minimum of about 100 lb/cu. ft. In the absence of actual measured value, use a value not less than 120 lb/cu. ft. For granular backfill, use the actual weight value.

d. Estimate loads due to gravity earth forces using Marston's equation with the appropriate load coefficients (C_d , C_e , C_μ)

1.) Select the dimensionless load coefficients using the following K_μ' values.

	K_μ'
a. Non-cohesive backfill materials	0.165
b. Cohesive backfill materials	0.130

e. Superimposed loading

Structurally design sanitary sewers to withstand the actual superimposed loading conditions (concentrated loads, dynamic loads, distributed loads).

f. Safety factor

Safety factor is the ratio between the field supporting strength and the safe supporting strength of the sewer pipes. Apply factors of safety as follows:

1.) Rigid pipes

Reinforced Concrete Pipe (RCP); a minimum safety factor shall be applied of not less than 1.0 against D load, producing a 0.01-inch crack.

2.) Flexible pipes other than plastic

Apply a safety factor of not less than 1.25.

3.) Flexible plastic pipes

Apply a safety factor of not less than 2.5.

g. Maximum deflection for flexible pipes

The allowable deflection for flexible pipes shall not exceed eighty percent (80%) of the manufacturer's allowable maximum deflection. In no case shall the maximum allowable deflection exceed five percent (5%) of the inside pipe diameter.

h. Highway and railroad crossings

1.) Highway crossings

Refer to the Kansas Department of Transportation *Utility Accommodation Policy*.

2.) Railroad crossings

Refer to the American Railway Engineering and Maintenance-of-way Association *Manual for Railway Engineering*, Chapter 1 Part 5, Chapter 6 Part 16, and Chapter 8 Part 10.

M Building Sewer Connections to Sanitary Gravity Sewers

1. Place new connections to a new receiving pipe using a wye.
2. Place new connections to an existing receiving pipe using a saddle.
3. Design wyes, tees, saddles and stubs to provide a vertical angle of not less than thirty (30) and no more than forty-five (45) degrees to the horizontal centerline plane of the sanitary sewer.
4. Manufactured couplings are required to mate the main fittings with the service line.
5. Provide a capped stub for each building site.
6. Provide a separate service line for each user.
 - a. The design and layout of building service lines shall comply with provisions published in Article III of Chapter 30 *Sewers and Sewage Disposal*.
 - b. Duplexes must have a separate sewer service connection for each unit. Attached houses, other than duplexes, must have a common sewer service connection. Individual house services must be ganged outside of the foundations. Covenants or plat restrictions must provide for common maintenance of the ganged sewer service. Submit covenants with sewer service maintenance section highlighted.
 - c. Service lines shall not cross property lines and shall not run longitudinally in a street or alley.

7. Building services shall also comply with applicable plumbing code.
8. Extend service lines to the property line of the building site.
9. Do not connect building sewers to interceptor sewers, force mains, or manholes.

N Manholes

1. In general, manholes should provide convenient access to the sewer for observation and maintenance operation; should cause a minimum interface with the hydraulics of the sewer, and should be durable structures.
2. Refer to the UG *Technical Provisions* for specifications for:
 - a. Manhole construction, materials, and installation;
 - b. Manhole channel and bench;
 - c. Manhole grade rings;
 - d. Manhole sealant; and
 - e. Concrete encasements.
3. Provide a capped stub at the most upstream manholes for future extension to upstream service area.
4. Where applicable, extend sewer lines to locate terminal manholes directly adjacent to property lines.
5. The flow channel through manholes shall be a smooth continuation of the pipe.
6. Base the required manhole diameter upon the size, number, and location of manhole wall penetrations. The minimum allowable circumference clearance measured along the manhole inside between wall openings shall be twelve (12) inches.
7. The minimum manhole inside diameter for sewers up to thirty (30) inches is four (4) feet, for sewers between thirty (30) inches and forty eight (48) inches is five (5) feet, for sewers between forty eight (48) inches and sixty (60) inches is six (6) feet, and for sewers greater than sixty (60) inches is seven (7) feet.
8. Provide a drop pipe for a sewer which enters a manhole at an elevation of twenty-four (24) inches or more above the manhole

invert. An outside drop pipe shall be standard. Protect the outside drop pipe against breaking or settling by the use of a concrete encasement placed on a continuous slab located beneath the manhole. The drop pipe shall have the same nominal diameter as that of the incoming sewer. Provide an inside drop pipe with UG approval only. The minimum diameter of an inside drop pipe manhole must be increased to five (5) feet or greater.

9. Provide a bolted frame, cover, and appropriate gasket for manholes either located in the one hundred (100) year flood plain, located wherever the manhole may be flooded, located on interceptor sewers, or as required by the UG. Anchor the manhole cover frame to the manhole.
10. Protect manholes from corrosion where corrosive conditions are anticipated by providing an approved protective coating.
11. Do not use cleanouts or lampholes in sanitary sewers other than building sewers.

O Aerial Crossings

1. Avoid aerial crossings where possible.
2. Do not include aerial crossings for sewers which serve fewer than one hundred (100) persons.
3. Design aerial crossings to avoid obstruction of one hundred (100) year channel flows.
4. Design sanitary sewer aerial crossing to provide a minimum flow velocity of not less than two and seven tenths (2.7) feet per second.
5. Use ductile iron pipe (DIP) material for all aerial crossings. Refer to structural design guidelines.
6. Design pipe supports to prevent downward, upward, and horizontal movement. Provide supports designed in accordance with guidelines found in AASHTO *Standard Specifications for Highway Bridges*.
7. The design shall include precautions against freezing such as increasing the pipe slope or providing a cellular glass insulation sized to provide protection against freezing to -30°F.
8. Provide expansion joints between above ground and below ground sewers. Due consideration shall be given in sanitary

sewer pipe structural design to the appropriate thermal expansion coefficient (0.62×10^{-5} per degree Fahrenheit for DIP).

P Stream Crossings

The following design criteria apply to both gravity sewers and force mains.

1. Refer to the American Public Works Association specification section 5600, Storm Drainage Systems & Facilities for stream crossing guidelines for:
 - a. Crossing location;
 - b. Stream analysis; and
 - c. Stabilization of stream bank and stream bed.
2. Sanitary sewer layouts shall minimize the number of stream crossings.
3. Align sewers crossing streams as nearly perpendicular to the stream flow as possible and at a constant grade.
4. Install impervious trench checks upstream and downstream of the stream crossing.
5. Concrete encase sewers crossing streams that are not utilizing ductile iron pipe and sewers crossing streams with less than three (3) feet of cover. In no case shall the top of the encasement be above the streambed.
6. Locate manholes that are adjacent to streams so they do not interfere with stream flood flows. Place manholes located on flood plains in area outside the likely meander of the stream.

Q Inverted Siphons

1. Avoid inverted siphons when possible and include only with UG approval.
2. Inverted siphons shall have a minimum of two (2) barrels.
3. The minimum acceptable siphon barrel diameter is six (6) inches.
4. Design siphons with the necessary features for convenient maintenance, flushing, and inspection including adequately sized inlet and discharge structures. The design shall enable complete removal of one (1) barrel from service by diverting all flow to the remaining barrel(s).

5. Size and locate barrels to provide a minimum of three (3) feet per second flow velocities at design average flow rates.
6. The maximum deflections above horizontal for the rising leg shall be 11.25 degrees for six (6) inch pipe, 22.5 degrees for eight (8) to twelve (12) inch pipe and 45 degrees for pipe with a diameter greater than twelve (12) inches.

R Force Main

1. Refer to the Pump Station Design section in this document for pump station design guidelines when applicable.
2. Refer to the Low Pressure Sewer section in this document for system design guidelines when applicable.
3. The minimum allowable diameter for sanitary pressure sewers is four (4) inches. The only exception is with low pressure sewer systems complete with grinder pumps which may have smaller force main diameters.
4. Size force mains to have a minimum operating velocity of two (2) feet per second at average design flow.
5. Select force main wall thickness to withstand anticipated external loads and internal operating and surge pressures.
 - a. Evaluate superimposed loads based on guidelines found in sanitary sewer structural design requirements.
 - b. Estimate the static earth load based on Marston's prism load theory.
 - c. Estimate other static loads based on the Boussinesq theory.
 - d. Estimate the live load assuming a minimum HS-20 loading.
 - e. Estimate pipe deflection using Spangler's Iowa Deflection Formula.
 - f. Evaluate internal pressures while accounting for both transient and cyclic surge pressures.
 - g. The minimum acceptable force main wall thickness shall be suitable for handling a sustained test pressure that is twice the maximum operating pressure.
6. Limit joint deflection to eighty (80) percent of the manufacturer's allowed maximum.

7. Locate force mains beneath public streets, within an alley right-of-way, or in permanent easement on private property. Limit flat sections with zero slope to less than one hundred (100) feet in length.
8. Refer to the Sanitary Sewer Locations and Easements section for guidelines for utility line protection.
9. Generally, force main vertical alignment shall follow the topography of the terrain. The minimum depth of cover over the top of pipe shall be forty two (42) inches.
10. Place air relief valves at high points in the force main to prevent air locking. Vacuum relief valves may be necessary to relieve negative pressures in the force main. Evaluate the force main layout and head conditions to determine the need for and placement of vacuum valves. Provide A.R.I. valves, or an approved equal.
11. Provide odor control measures either at the pump station or at the air relief valve vault when these valves are located where odor could be a public nuisance.
12. Equip force mains with a minimum of one (1) flushing assembly. Place flushing assemblies at a maximum interval of one thousand (1000) feet.
13. Force main installation and thrust restraint design shall conform to specifications found in the latest edition of the UG *Technical Provisions*. Thrust restraint design shall include thrust block sizing and detailing where applicable.
14. Terminate force mains in a manner to facilitate a smooth flow transition to gravity flow by providing a tenth (0.1) of a foot drop between the invert elevation of the contributing force main and the receiving gravity sewer.
15. Provide corrosion protection, as required, for the receiving manhole or structure including but not limited to coating systems and corrosion resistant materials for all hardware and accessories.

S Pipe Installation Methods

A variety of acceptable pipe installation methods exist. Base the pipe installation method utilized on a number of factors including site, engineering, and economic considerations. The pipe installation method used shall be consistent with pipe manufacturer guidelines. Install all pipe in a manner

consistent with guidelines found in the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standards.

1. Open cut trenching

Open cut trenching methods shall comply with the specifications in the latest edition of the *UG Technical Provisions*.

a. Trench width

Generally, minimize trench widths to limit the load on the pipe. Use the following general guidelines to establish a minimum trench width:

- 1.) The trench must be wide enough to enable proper placement of the embedment material.
- 2.) Maximum sidewall clearance shall be $\frac{3}{4} D$, where D is the pipe diameter.

b. Trench depth

Trench depth should be limited to the depth required to position pipe at the required elevation on a minimum bedding layer thickness as specified in the latest edition of the *UG Technical Provisions*.

c. Bedding

Pipe embedment material and placement shall be as specified in the latest edition of the *UG Technical Provisions*. Place bedding in a manner that assures full contact between embedment and pipe.

d. Dewatering

Continuously dewater open trenches as required. The dewatering method should reflect considerations for the soil and site condition and the height of the water table relative to the elevation of the trench bottom.

e. Rock

When open cut trenching in rock material the trench bottom shall be overexcavated to provide room for placement of a layer of granular bedding material which will support the pipe. Remove loose rock from the trench bottom prior to placement of bedding.

f. Pavement cuts and repair including permits and fees

Pavement cuts and repair methods shall comply with the provisions found in latest edition of the *UG Technical Provisions*.

2. Microtunneling

Use of microtunneling to install pipe is typically applicable to placing gravity sewer pipe because the technology utilizes a remote controlled, steerable, guided machine that is capable of accurately aligning pipe.

- a. Subsurface investigation
 - 1.) Soil conditions are a major factor affecting the feasibility and cost of using microtunneling for a particular application.
 - 2.) The subsurface investigation should be fashioned with consideration for the complexity of the project and the complexity of the ground conditions.
 - 3.) The minimum level of investigation should include borings at each reception and jacking shaft locations and along the alignment at a maximum spacing of three hundred (300) feet.
- b. Alignment accuracy

Specify a minimum acceptable variance from the design alignment. Alignment accuracy for microtunneling installations is typically limited to \pm one (1) inch in the vertical and horizontal directions.
- c. Jacking and receptions shafts
 - 1.) Location
 - a.) In general, for gravity sewer installation, situate shafts manhole locations.
 - b.) Pressure sewer installations should have jacking shafts at each change in horizontal or vertical alignment.
 - c.) Minimize the number of jacking shafts by jacking in both directions from a jacking shaft.
 - d.) Shafts should be located to minimize the impact of construction on the public and to avoid features that would cause construction inefficiencies such as existing overhead and underground utilities.
 - 2.) Design
 - a.) Generally, detailed shaft design responsibility is given to the Contractor.
 - b.) The design should include consideration for dewatering the shafts, stabilizing the shaft walls with entry or exit seals, and

sizing and placing thrust blocks between the shaft wall and the jacking frame to distribute loads evenly to the ground.

- c.) The design should provide the Contractor with general guidelines for shaft design that include:
 - 1 Adherence to applicable codes and standards;
 - 2 Establish groundwater control and disposal constraints;
 - 3 Allowable ground surface settlement (typical maximum of \pm one (1) inch except where existing development warrants less allowable movement); and
 - 4 Constraints and requirements for relocating existing utilities within the footprint of the shaft.

d.) Space requirement:

- 1 Provide adequate space at reception and jacking shaft locations; and
- 2 The area requirement will depend upon the diameter of the pipe installed and the pipe stick lengths.

d. Power supply

- 1.) Microtunneling design should address available power sources. Often portable generators serve as the power source.
- 2.) Establish constraints on power draw if using local sources of power.

e. Pipe design and selection

1.) Depth of cover

- a.) Applicability of the microtunneling pipe installation method is typically not limited by excessive depth of bury.
- b.) The minimum depth of bury should be established due to concerns for heave or settlement.
- c.) The minimum depth of bury should not be less than five (5) feet while maintaining a depth of cover to pipe outside diameter ratio of three (3).

2.) Pipe size

- a.) Pipe installation by the microtunneling method is suitable for pipe diameters ranging from ten (10) to one hundred thirty six (136) inches.

3.) Pipe material

- a.) Acceptable pipe material for microtunneling gravity sewer applications includes:
 - 1 Polymer concrete;
 - 2 Reinforced concrete;
 - 3 Fiberglass-reinforced polymer mortar; and
 - 4 Vitrified clay pipe.
- b.) Acceptable pipe material for microtunneling pressure sewer applications includes:
 - 1 Ductile iron;
 - 2 Reinforced concrete;
 - 3 Fiberglass-reinforced polymer mortar; and
 - 4 Reinforced concrete cylinder pipe.

4.) Pipe design

Design pipe installed by microtunneling for both the in-use loads and the installation loads.

a.) In-use load

Design procedures for in-use loading may vary depending upon the pipe material, but should include the following minimum considerations:

- 1 Internal operating, transient, and test pressures;
- 2 Overburden soil loading;
- 3 Live loading; and
- 4 External static water head and vacuum.

b.) Installation load

- 1 The ultimate axial compressive strength of the pipe should be a minimum of two and a half (2.5) times the design jacking load on the pipe.
- 2 Evaluate external pressures from groundwater, soil and surface loads, and annular space lubrication.

5.) Post installation inspection

- a.) Pipe inspection following installation is required to determine if damage occurred to the pipe during installation.
- b.) Specify pipe inspection methods which may include video or visual inspection.
- c.) Perform pressure testing, where appropriate, to confirm water tightness of the pipe and joints.

6.) Damage repair

- a.) A range of acceptable methods for repairing damaged pipe exist. Specify acceptable repair methods.
- b.) Suitable methods vary depending upon the depth of bury and pipe diameter.
- c.) Repair methods may include any one (1) or a combination of the following:
 - 1 Pull back
Pull the affected sections back to the jacking shaft and remove and reinstall.
 - 2 Push through
Push affected sections to the reception shaft and remove. Jack replacement pipe into place from the jacking shaft.
 - 3 In-place repair
Repairs may be made in-place internally when pipe diameters are large enough to enable safe entry.
 - 4 Point excavation
Repair damaged pipe that is not excessively deep using a point excavation to expose the affected area for repair.
 - 5 Lining

Repair the damaged pipe using pipe lining methods or sliplining.

7.) Technical specifications

Technical specifications for microtunneling should establish performance based guidelines rather than specify construction means and methods. The minimum guidelines should:

- a.) Establish a minimum level of experience for microtunneling contractor;
- b.) Establish a minimum acceptable level of performance and capabilities for tunneling equipment;
- c.) Establish necessary constraints, when warranted, for construction sequence, work hours and noise;
- d.) Establish limits for settlement and heave;
- e.) Establish requirements for contaminated soil and groundwater disposal;
- f.) Establish shaft requirements;
- g.) Identify acceptable pipe materials, pipe joint type, and pipe coating system;
- h.) Establish alignment tolerance;
- i.) Identify contractual and technical means to handle obstructions; and
- j.) List required submittals which may include:
 - 1 Description of similar projects;
 - 2 Description of equipment;
 - 3 Method of line and grade verification and adjustment;
 - 4 Description of guidance system;
 - 5 Description of method to remove and dispose of spoil;
 - 6 Description of lubrication and grouting system;
 - 7 Description of settlement monitoring program;
 - 8 Estimate of anticipated jacking loads;

- 9 Equipment layout at shafts;
- 10 Sequence and schedule of construction;
- 11 Calculations for shafts, shoring and thrust walls;
- 12 Dewatering plan; and
- 13 Contingency plans for:
 - a Obstructions;
 - b Steering corrections;
 - c Loss of ground;
 - d Damage to pipe;
 - e Inflows at the shafts;
 - f Slurry migration to the ground surface;
 - g Excessive settlement or heave;
 - h Excessive thrust wall deflections; and
 - i Contaminated ground.

3. Directional drilling

- a. Work space requirements
 - 1.) The design shall consider the area requirements at the bore entry side and the bore exit side and provide the drilling contractor adequate room to conduct unhindered operations.
 - 2.) Factors such as the length of the bore and the diameter of the pipe shall determine area requirements.
 - 3.) Provide sufficient space at the bore exit side to accommodate staging of a continuous length of joined pipe with a length that will accommodate a single step pull back operation.
 - 4.) The equipment size, which generally reflects the size of pipe installed, typically determines the space requirement at the bore entry side.

- b. Water supply
 - 1.) Consider a source of water the contractor can use to mix the drilling fluid.
- c. Drilling fluid disposal
 - 1.) Provide the contractor a disposal means for the drilling fluid.
- d. Subsurface investigation
 - 1.) Soil conditions are a major factor affecting the feasibility and cost of directional drilling methods.
 - 2.) Extensive subsurface explorations are generally the first step necessary to establish applicability of directional drilling.
 - 3.) Conduct a subsurface investigation that is fashioned after the guidelines contained in ASTM F 1962.
- e. Bore path layout
 - 1.) The locations of the bore entry and exit pits as well as the bore entry and exit angles and the depth of path and path curvature characteristics such as the radii of curvature and approximation location of points of tangency between curved and straight sections define the bore path layout.
 - a.) Bore entry angles should range between eight (8) to twenty (20) degrees from the ground surface.
 - b.) Bore exit angles should be less than ten (10) degrees from the ground surface.
 - 2.) The maximum depth for direction drill installations is generally two hundred (200) feet.
 - 3.) The maximum drive length for directional drill installations is generally a function of soil and site conditions and may be several thousand feet.
 - 4.) The pipe bore path determines the stresses placed on the pipe during the pull back operation and during the service life.
 - 5.) Contract documents shall clearly define the bore path layout.
- f. Pipe design and selection
 - 1.) Pipe material.

The pipe material most suited for horizontal directional drill installations should be smooth, flexible, and capable of resisting the tension, bending, and external pressure loads generated during installation. Typical pipe materials used include steel and HDPE.

2.) Pipe design

Pipe design and selection shall be based upon pipe manufacturer guidelines with attention given to a number of pipe design parameters listed in ASTM F 1962, including but not limited to:

- a.) Operational and installation loads;
- b.) Internal pressure loads;
- c.) External hydraulic and earth loads;
- d.) Pipe deflection;
- e.) Unconstrained collapse;
- f.) Axial bending stress;
- g.) Axial tension stress;
- h.) Combined loads during installation; and
- i.) Combined loads during operation.

g. Pipe installation

Precautions are required to protect against pipe damage during the pull back operation. Necessary considerations include the following:

1.) Reaming

Size pilot holes up to fifty (50) percent larger than the carrier pipe diameter. The required size depends upon a number of factors including but not limited to the soil type, soil stability, depth, drilling mud, bore hole hydrostatic pressures.

2.) Pulling loads

The maximum pull (axial tension force) exerted on the pipeline shall be measured continuously and limited to the maximum allowed by the pipe manufacturer so that the pipe or pipe joints are not overstressed. Breakaway links should be required between the swivel and pipe grip to limit the tension in the pipe to a level below the maximum allowable for the pipe.

3.) Torsion and stresses

Require use of a swivel connecting the pipeline to the drill pipe to prevent torsional stresses from occurring in the pipe.

4.) Pipeline support

The pipeline requires adequate support during installations to prevent overstressing or buckling.

h. Testing

1.) Conduct hydrostatic tests both before and after pipe installation in conformity to AWWA C600.

2.) The ovality of the installed pipe may be tested using a sizing pig.

i. Technical specifications

Technical specifications for directional drilling should provide the following minimum guidelines:

1.) Establish a minimum level of experience for the drilling contractor and require references from similar projects;

2.) List required permits;

3.) Identify party responsible for making fresh water available;

4.) Establish the party responsible for locating underground utilities which is generally the contractor;

5.) Establish time and level limits for noise levels;

6.) Establish the minimum requirements for the equipment;

7.) Establish a minimum radius of curvature;

8.) Establish horizontal and vertical alignment tolerances;

9.) Establish provisions for directional drill failures;

10.) Establish testing procedures which may include checking for buckling or out of roundness and pre and post installation hydrostatic testing conforming to AWWA guidelines; and

11.) List required submittals which may include:

a.) Description of similar projects;

b.) List of subcontractors;

- c.) Construction plan;
- d.) Site layout plan;
- e.) Project schedule;
- f.) Communication plan;
- g.) Safety plan;
- h.) Description of equipment;
- i.) Type and capacity of the mud mixing system; and
- j.) Drilling fluid management plan including:
 - 1 Method of slurry containment;
 - 2 Source of fresh water;
 - 3 Method of recycling drilling fluids;
 - 4 Method of transporting drilling fluid off site; and
 - 5 Approved disposal site for drilling fluid and spoils.
- j. As-built drawings
A record of the actual bore path is required to assure future work does not conflict with the installation.

IV PLAN PRESENTATION

The plans are graphic aids to be used with the project manual and illustrate to bidders (and later, to construction observers and contractors) the work to be done. Sanitary sewer plans shall:

1. Clearly and precisely present the sanitary sewerage improvements in a legible manner;
2. Be prepared and sealed by a licensed professional engineer registered in the State of Kansas;
3. Clearly identify the party responsible for the development of a stormwater pollution prevention plan (SWPPP), should a plan be required (required when the total disturbed area is one (1) acre or larger);
4. Indicate locations that will require erosion control measures which conform to the specifications found in the *UG Technical Provisions*;
5. Be submitted separately from road and storm sewer plans; and
6. Be modified after completion of the project to reflect the actual locations, elevations, types of materials used, and other pertinent field information, and they shall be utilized as the record drawings.

A Contents of Plans

1. Each sheet shall contain a title including the individual sheet number and the total number of sheets, the engineer's seal, proper project identification, and date. Revised sheets shall contain a revision block with the identifying notations, date, and marks for the revisions.
2. Include a plat map for the development area bound with each set of construction drawings. The plat map may be included as an unnumbered reference drawing in the construction drawing set.
3. The standard cover sheet and/or supplemental sheet to the cover sheet shall include the following:
 - a. Project name;
 - b. General location showing the drainage basin boundary and name, highways, street, rivers and other significant features within the project area;
 - c. General comments;

- d. Name, addresses, signatures and seal of the design engineer;
 - e. An approval block for the County Engineer's signature and date; and
 - f. Legend, index, date, and other notes such as "revised", "preliminary", etc.
4. The general layout sheet shall include:
- a. A legend of symbols which will apply to all sheets;
 - b. A map of the entire proposed sewerage improvement system presented on a background showing the existing and proposed site topography. If the project area can not be adequately illustrated on a single sheet, then provide an overall sheet with no street names and additional breakout sheets. Where more than one sheet is necessary, provide an identified match line showing an overlap of each drawing. The map shall identify the sheet numbers locating details of the proposed improvements in the drawing set;
 - c. North arrow and scale;
 - d. Drawing orientation with north toward the top or left side of the sheet;
 - e. Names of subdivision, block designation (if any), lot designation or proposed block and lots, all street names, and an accurate tie to at one quarter-section corner. An unplatted tract shall have an accurate tie to at least one quarter-section corner;
 - f. Location of all existing and proposed sewers, properly designated, within or adjacent to the project area;
 - g. Connection point or points to existing facilities tied to a known point on existing facility (manhole identified by UG manhole number, etc.);
 - h. Provisions for service extension to upstream service area (typically provide a capped stub);
 - i. Boundary line of project area;
 - j. Name, address, and telephone number of the utility companies, railroads and highway agencies which are involved during construction of the project; and
 - k. List all datum plane and survey reference points. The project control benchmark should be an established benchmark and identified as to location, description, and elevation. Vertical control shall be tied to NGVD29, National Geodetic Vertical Datum 1929. The horizontal

control shall be tied to NAD83, the Kansas State Plane Coordinate System.

1. Include the following note:

“Sanitary sewerage improvements shall conform to the requirements of the Technical Provisions and Standard Drawings for Roads and Sewers, prepared by the Unified Government of Wyandotte County/Kansas City, Kansas”.

m. A statement identifying the minimum floor elevation served by the proposed sewer system.

5. Sewer plans shall:

- a. Have a scale not smaller than 50 feet to one inch;
- b. Show a north arrow on each sheet;
- c. Be continuous strip maps having a preferred overall size not larger than 22" × 34" (aerial photo may be used);
- d. Be drawn directly above the profile to indicate detailed locations of all work, surface topography, existing and proposed improvements such as paved streets, curbs and gutters, driveways, culverts, fire hydrants, utility poles, trees, shrubs, fences, walls, and houses, existing and proposed street names, natural drainage lines with the channel centerline and top of bank of existing and proposed waterways, and underground and overhead utilities which are along, across or near the proposed construction route;
- e. Show all temporary and permanent easement and right-of-way;
- f. Show the property lines and ownership information for all private property within easement and right-of-way boundaries;
- g. Indicate the depth and location of existing or proposed underground structures, utilities, and creek flowlines; and
- h. Preferably drawn with an orientation placing the north direction at the top or to the left, as governed by the alignment;
- i. Preferably drawn with the flow direction in a right to left orientation;
- j. Matching line must be shown on each drawing to indicate the transition from drawing to drawing;
- k. Indicate stationing at increments of one hundred (100 feet). Station numbering shall normally increase from the left to right side of the

sheet;

- l. Show clearly marked manholes, structures and wye, tee, or saddle locations. Provide stationing, appropriate numbers, and northing and easting;
 - m. Show manhole number (UG six (6) digit number for existing manholes and any labeling system other than a six (6) digit number for new manholes), station, deflection angle, and the northing and easting coordinates locating the manhole;
 - n. Show the elevation, description, and location of at least one applicable benchmark on each sheet;
 - o. Show soil boring locations with labels consistent with the labels used in the soil boring report; and
 - p. Show elevations of the first-floor surface for all building sites served by the proposed sewer system. Establish the minimum floor elevation served by the system.
6. Sewer profile drawings shall:
 - a. Include a continuous profile of all sewer runs;
 - b. Show existing and proposed ground surface and sewer and grade elevations at each manhole and/or other structure;
 - c. Clearly identify anticipated fill areas where the existing grade is below the top of pipe and reference installation guidelines found in the *Technical Provisions*.
 - d. Show existing grade above center line as a solid line, proposed finish grades or proposed street grades by dashed lines, and show the flow line of any drainage channel, either improved or unimproved and either crossed or paralleled;
 - e. Indicate pipe size, length between manholes, slope and limits of each pipe size, strengths or types of pipes, pipe material, and the exact location of each structure;
 - f. Have a scale not less than:

Vertical – 10 feet to one inch.
Horizontal – 50 feet to one inch.
 - g. Indicate stationing at increments of one hundred (100) feet;
 - h. Show all manholes with manhole designation, station, and top of

manhole and incoming and outgoing flow line elevations. Designate drop manholes as such;

- i. Indicate the depth and location of existing or proposed underground structures, utilities, and creek flowlines; and
- j. Properly identify each existing and proposed utility line.

7. Sewer detail drawings shall:

- a. Be clearly and neatly drawn with proper identification, dimensions, materials, and other information necessary to insure the desired construction;
- b. Special details shall be prepared only when the Standard Drawings contained in the UG *Technical Provisions* are not appropriate; and
- c. Fully detail special structures not covered by standard details.

B Record Drawings

During construction, the contractor shall measure and record the locations of all wyes, tees, saddles, and other buried facilities, such as utility lines, which may have to be located in the future, in addition to all construction changes from the original plans. Record rock profiles, groundwater elevations and other noteworthy soil information. The "record drawings" shall indicate all above recordings accurately. In addition, the record drawings shall indicate construction which varied from contract requirements. Submit all contract drawings and record drawings to the UG in AutoCAD .dwg format.

C Right-of-Way and/or Easement Legal Descriptions

Note that this section is only applicable to public capital improvement contracts.

- 1. All right-of-ways and easements shall be described by a surveyor licensed to practice in the State of Kansas; and
- 2. All right-of-way and/or easement legal descriptions for all permanent and temporary access easement shall follow the general requirements for right-of-way plans, exhibits, and descriptions found in the latest edition of the UG *Standardized Legal Descriptions and Exhibits*. This document is available from the UG web site.

D Contract Documents

Note that this section is only applicable to public capital improvement contracts.

- 1. Contract documents include project plan sets and specifications.

2. The latest edition of the *UG Technical Provisions* may be so modified to apply to the appropriate contracting needs (private, public – bid, negotiated). This document is available at the UG web site.
3. The UG Engineering Division shall determine the number of required contract document copies.
 - a. Specifications
 - 1.) Use the latest edition of the *UG Technical Provisions* for all sanitary sewer construction, and extension or connection thereto.
 - 2.) A special consideration shall be included in each sanitary sewer contract document to relate and/or modify standard specifications which are suitable for the specific project.
 - 3.) Specify only currently available materials.

E Right-of-Way/Easement Maps

Note that this section is only applicable to public capital improvement contracts.

1. All right-of-way and easements must be shown on a map prepared by a surveyor licensed to practice in the State of Kansas;
2. Provide dedicated right-of-way and/or easement maps for larger projects and certain smaller projects, as required by the UG.
3. Right-of-way and/or easement maps shall be comprehensive layouts, preferably prepared on aerial photographs.
4. Right-of-way/easement map sheet size shall match the sewer plan profile sheet size.
5. The information on the right-of-way/easement maps may be presented directly on the sewer plan and profile sheets for smaller projects.
6. The right-of-way/easement maps shall show the following minimum information:
 - a. Scale: Not smaller than 50 feet to one inch. A bar scale shall be shown on each sheet;
 - b. North arrow pointing toward the top or left side of the sheet;
 - c. Match lines properly referenced to sheet numbers;

- d. All existing property lines and corners and associated property owner names, addresses and tract or lot numbers;
- e. Locations for all boundary monuments;
- f. All proposed right-of-way requirements numerically referenced to legal descriptions:
 - 1.) Property acquisitions;
 - 2.) Permanent easements; and
 - 3.) Temporary construction easements.
- g. Contour lines at a minimum of 10 feet contour intervals; and
- h. Street names.

V PIPE REHABILITATION METHODS

A Cured in Place

Cured in place pipe rehabilitation methods shall comply with the provisions found in latest edition of the *UG Technical Provisions*.

1. Design considerations

a. Pre and post rehabilitation inspection

Clean and inspect the host pipe before rehabilitation. This will allow assessment of the pipe's structural integrity, will clear settled material and other debris that may interfere with rehabilitation efforts, and provide the location of special interest areas such as service connections. A post installation inspection will confirm that service reinstatement is complete.

b. By-pass pumping

Include provisions for by-pass pumping in the design.

c. Host pipe classification

Classification of the host pipe into one (1) of two (2) categories determines the liner wall thickness design method. The host pipe may be classified as either partially deteriorated or as fully deteriorated.

1.) Partially deteriorated

A partially deteriorated host pipe can structurally support the soil and surcharge loads throughout the design life of the liner. Partially deteriorated pipes may have longitudinal cracks that result in a diameter distortion of up to ten (10) percent.

2.) Fully deteriorated

A fully deteriorated pipe is either unable to structurally support soil or live loads or is expected to reach this condition during the lifetime of the liner. This condition is evidenced by missing portions of the host pipe or when the pipe has lost its original shape.

d. Liner thickness design

The liner thickness design reflects the host pipe classification and whether the pipe is a gravity or pressure sewer. Liner thickness sizing should follow guidelines found in ASTM F1216, appendix X1.

B Sliplining

Sliplining is an approved rehabilitation method for circular gravity sewers and force mains. This rehabilitation method pulls or pushes a liner pipe inside a host pipe. Design considerations for this rehabilitation method include:

1. Liner pipe design

Base the liner pipe design on existing host pipe and site conditions. The design should address a number of pipe parameters including:

a. Liner pipe material

Liner pipe material shall be high density polyethylene (HDPE) or UGWYCO/KCK approved equal.

b. Liner pipe diameter

- 1.) Liner pipe diameter selection should balance maintaining the hydraulic capacity of the existing collection system with providing adequate clearance between the host and liner pipes during insertion.
- 2.) The difference between the inside diameter of the host pipe and the outside diameter of the liner pipe shall be no less than ten (10) percent and no more than twenty (20) percent.

c. Liner pipe capacity

- 1.) The liner must be capable of transporting the design flow.
- 2.) Submit a comparison of pre and post construction line capacities with the pipe design submittal.

d. Liner pipe wall thickness

- 1.) The liner pipe wall thickness is generally determined using the same analysis used for new pipe installations which account for internal and external forces acting on the pipe.
- 2.) Design for gravity flow:
 - a.) Pay particular attention to the hydrostatic load on the liner created when the water table rises above the crown of the liner.
 - b.) This analysis should rely upon a factor of safety of two (2) for situations where it can be reasonably assumed the host pipe will provide significant structural support for the liner. The factor of safety should be determined as the ratio of the critical buckling pressure to the hydrostatic load.

- c.) The analysis should assume a factor of safety greater than two (2) if it is not reasonable to assume the host pipe will structurally support the liner.
- 2. Pre-installation survey
 - a. Host pipe inspection
 - 1.) Determine the condition of the host pipe by inspection to evaluate the feasibility of this rehabilitation method.
 - 2.) Conduct closed circuit TV inspection prior to bidding the contract, making note of the following:
 - a.) Obstructions;
 - b.) Protruding service lines;
 - c.) Crushed pipe walls;
 - d.) Offset joints; and
 - e.) Lateral connections.
- 3. Host pipe cleaning
 - a. Clean the host pipe prior to installation to assure ease of installation.
- 4. Liner pipe installation
 - a. Liner pipes installation by either the push or pull method is acceptable. The contractor shall determine the installation method.
 - b. Liners installed using the pull method should utilize a constant load type wench. Require continuous measurement of the load placed on the pipe with a gauge. Require the contractor take the necessary steps to assure that the pull force does not exceed the tensile strength of the pipe for liner pipes pulled into place.
- 5. Access pits
 - a. Provide adequate space for installing liners. The space required for insertion holes will vary in size and shape depending upon a number of factors such as:
 - 1.) Depth of the host pipe;
 - 2.) Diameters of the host and liner pipes;

- 3.) Prevailing soil conditions; and
- 4.) Liner stiffness.
- b. Base the space allotted for insertion holes upon:
 - 1.) An entry slope down to the springline of the host pipe with a grade of 2.5:1;
 - 2.) A minimum length of level excavation equivalent to twelve (12) times the diameter of the liner; and
 - 3.) A minimum width that reflects the soil type, height of the water table, and diameter of the pipe.
6. Annular space grouting
 - a. The annular space may grout filled for pressure systems depending upon specific project conditions and anticipated loadings.
 - b. The annular space shall be grout filled for gravity systems to increase ring stiffness of the liner pipe.
 - c. The allowable grouting pressure of the pipe, assuming an appropriate factor of safety, should not be exceeded while filling the annular space.
7. Lateral line reconnection
 - a. Relaxation period

A minimum twenty four (24) hour relaxation period is required to allow the liner to return to its original dimension following installation before work begins to connect lateral lines to the liner.
 - b. Connection
 - 1.) Lateral lines are typically connected to the liner by excavating and exposing the connection point and using a saddle or a tee to make the connection.
 - 2.) Provide adequate space to excavate and expose the connection points.
8. Terminal connections
 - a. Provide terminal connections to join the liner with the existing system.
 - b. Seal the annular space at terminal connection points to prevent ground

water from entering.

- c. Liners for pressure systems require connection of the liner to various system appurtenances with a pressure rated connection.

9. Concrete encasement

Concrete encase the host and liner pipes with a minimum thickness of six (6) inches around the pipe at the following points:

- a. Where host pipe has been partially removed;
- b. At insertion points; and
- c. At service and lateral connections.

10. Technical specifications

Technical specifications for sliplining should establish performance based guidelines rather than specify construction means and methods. The minimum guidelines specified should include:

- a. List required submittals which may include, but not limited to, the following:
 - 1.) Liner pipe material including allowable pulling load;
 - 2.) Sealant for terminations;
 - 3.) Saddles;
 - 4.) Fittings and adaptors;
 - 5.) Couplings and Clamps;
 - 6.) Description of equipment; and
 - 7.) Description of similar projects.
- b. Establish a minimum level of experience for the sliplining contractor;
- c. Establish required level of experience for butt fusion joining of HDPE pipe;
- d. Establish handling and storage guidelines for the lining pipe;
- e. Specify liner pipe;
- f. Specify joint sealant;
- g. Specify grout fill (if required);

- h. Establish installation guidelines including excavation, flow diversion, liner preparation and insertion, liner joining, end seals, anchorage and encasement, service and lateral connections and new manholes; and
- i. Establish inspection and cleaning procedures.

C Pipe Bursting

Pipe bursting pipe rehabilitation methods shall comply with the provisions found in latest edition of the *UG Technical Provisions*.

1. Subsurface investigation
 - a. Soil and groundwater conditions affect the feasibility pipe bursting methods for a particular application.
 - b. Extensive subsurface explorations are generally the first necessary step in design.
 - c. Place soil borings at insertion and access pit locations.
2. Pre-construction inspection and cleaning
 - a. Clean the host pipe prior to construction to assure ease of installation.
 - b. Conduct a closed circuit TV inspection to locate service connections and assess the condition of the pipe.
3. Upsizing limitations
 - a. Upsizing pipe diameters by as much as thirty (30) percent is common, although upsizing greater than thirty (30) percent is becoming less uncommon.
 - b. Estimated ground displacement and required pulling force are factors that may limit the upper range of feasible upsizing.
 - c. Other important factors limiting the allowable upsizing is the location of the water table, soil type and depth of bury.
4. Excavation of service lines

Include provisions in the design for excavating the service lines before bursting operations begin to:

 - a. Protect the service lines from damage.
 - b. Facilitate by-pass pumping operations to redirect flow from the service lines around the construction zone.

5. Access pits

- a. Provide adequate space for insertion and reception pits.
- b. The space required will vary in size and shape depending upon a number of factors such as:
 - 1.) Depth of the host pipe;
 - 2.) Diameters of the host and liner pipes;
 - 3.) Prevailing soil conditions; and
 - 4.) Liner stiffness.

6. Pipe design

- a. Generally, the long term loading conditions govern the required wall thickness for gravity lines, although consideration for the pull (tensile) strength is necessary.
- b. Add a ten (10) percent wall thickness allowance to serve as a sacrificial layer to account for scarring and gouging during installation.

7. Reconnection of service lines

Include provisions in the design for reconnecting service lines.

VI. PUMP STATION DESIGN

A Applicability and Approval

1. The Water Pollution Control Department must approve the inclusion of all pump stations in sanitary sewerage improvement plans.
2. The developer and the developer's agents must attend a pre-design conference with the Water Pollution Control Department to request approval.
3. The materials submitted for force main and pump station approval shall comply with requirements detailed in the Design Memorandum – Preliminary Design Plan section.
4. The force main design and layout shall comply with the standards set forth in the Sanitary Sewer Design Criteria section of this document.

B General

1. Pump station facilities shall comply with the requirements of the relevant building codes adopted by the UG.
2. The Water Pollution Control staff shall review and approve all pump station design and equipment.
3. All pump stations shall have a minimum of two (2) pumps. Provide pumps that are the same size for stations with only two (2) pumps.
4. Pumps shall be capable of passing three (3) inch diameter solids. Pump suction and discharge openings shall be at least four (4) inches in diameter.
5. Size discharge and suction lines to have a normal operating velocity ranging between two (2) and eight (8) feet per second at the range of anticipated flow.
6. Connect pump discharge lines to the side of a header or manifold. Do not connect discharge lines to the bottom of the header or manifold to avoid plugging of check valves and piping with solids.
7. Pump prime movers shall be non-overloading over the entire pump curve.

8. Equip pumps with internal cartridge type mechanical seals. External and component type seals shall not be acceptable unless approved by the appropriate UG representative.
9. The pump manufacturer shall test all pumps including hydrostatic and operating tests.
10. Equipment located in wet wells shall be suitable for use in corrosive conditions.
11. All electrical equipment subject to wet well gases shall conform to and be installed according to the requirements of the National Electric Code Class 1, Division 1, Group D area.
12. All pump station ventilation systems shall comply with NFPA 820 guidelines.
13. All pump station combustible gas detection systems shall comply with NFPA 820 guidelines.
14. All pump stations shall have adequate space for the installation of additional units if needed, and for the safe servicing of all equipment.
15. All pump stations shall be of durable construction, fire and weather resistant, and with outward-opening doors.
16. Pump stations conveying combined sewage and pump stations conveying separate sanitary sewage from sewers thirty (30) inches or larger in diameter shall be preceded by readily accessible bar racks with a clear opening that falls within the range of one (1) to one and three quarters (1.75) inch. Include a mechanical hoist with bar rack installations.
17. Equip pump stations conveying sanitary sewage from sewers smaller than thirty (30) inches in diameter with either a removable bar screen or a basket for trash removal, at Owner's request. Include a mechanical hoist with bar screen or basket installations.
18. Where high groundwater conditions are anticipated, consider the buoyancy of the pump station structures and, if necessary, make adequate provisions for protection.
19. Waterproof the underground structures of all pump stations.
20. Slope all pump station floors at least three (3) inches in every ten (10) feet to a suitable drain or sump as required. Do not cross

connect floor drains with the potable water system. Provide floor drains with deep seal p-trap and trap primer system or approved trap guard as required.

21. The wet well bottom shall slope a minimum vertical to horizontal slope of 1.75:1 to a flat bottom portion located beneath the suction lines. The width of the flat bottom portion shall not be more than twice the diameter of the suction bell.
22. Seal water, where required, shall be either potable water or filtered volute water. Seal water pressure must be greater than the discharge pressure of the pump. Equip seal water lines with pressure gauges, pressure reducing valves, flow indication, shut-off valves, and solenoid valves for flow control.
23. Provide lockable access doors and hatches constructed of corrosion resistant material.
24. Provide mastic tape joint wrap or approved equal to supplement recommended joint sealing method for precast wet well sections.
25. In areas where excessive moisture could cause hazards to safety or damage to equipment, provide a means for dehumidification.
26. Provide potable water service to every pump station.
27. Provide an approved type backflow preventer and main shut-off valve for all public potable water supply connections. A freeze-proof, backflow preventive yard hydrant, as approved by the Board of Public Utilities (BPU), may be installed in lieu of a backflow preventer and hot box.
28. Provide fire hydrants at pump stations where the storage of combustible materials is anticipated.
29. Provide a dedicated suction line for each pump or configure common suction lines to insure similar hydraulic and operating conditions.
30. Light pump stations throughout according to the standards set by the Illuminating Engineering Society of North America.
31. All electrical work shall conform to the requirements of the National Electrical Code and to relevant state and/or local codes.
32. The electrical work for emergency and standby power systems shall conform to the requirements of the International Building Code and to relevant state and/or local codes.

33. Fully evaluate the potential for sulfide and odor generation based on characteristics and properties of odor causing compounds and the principles of control.
 - a. Provide an appropriate sulfide control system as required.
 - b. Equip all electrical, mechanical, and process equipment with appropriate sulfide protection measures including proper materials and coating systems.
 - c. Outdoor enclosures shall be NEMA 4X stainless steel. Indoor enclosures shall be NEMA 12 in unfinished areas at a minimum. The presence of corrosive gases and chemicals shall be taken into account when providing enclosures.
34. Select construction materials appropriate for use where exposure to hydrogen sulfide and other corrosive gases, greases, oils, and other constituents typically present in wastewater is likely. This is especially important in the selection of metals and coatings. Avoid contact between dissimilar metals or make provisions to minimized galvanic action.
35. Provide adequate heating and cooling to assure safe and efficient equipment operation.
36. Provide a telephone jack inside the station for station monitoring and alarm equipment.
37. Provide a minimum of two (2) paper copies of the operations and maintenance (O&M) manual. The manual shall contain complete operating information for all facility equipment, a complete set of approved shop drawings and a copy of the as-built station plans. Provide the O&M manual in electronic format also.

C Station Type

1. Acceptable pump station types are listed below. The UG may approve alternative pump station types.
 - a. Dry well
 - 1.) Flooded suction; and
 - 2.) Wet well mounted with vacuum primed pumps.
 - b. Wet well
 - 1.) Submersible pump and motor; and

- 2.) Wet well centrifugal with motor located above the wet well.
2. Pump stations with ultimate design flow rates less than 700 gpm shall be either a dry well-wet well mounted type or a dry well-flooded suction type using submersible type pumps in the dry well. Grinder pump stations will be considered for approval either for low flow conditions or for temporary service conditions.
3. Pump stations with larger design flow rates (>700 gpm), shall be either a dry well-flooded suction type or a wet well station type. Larger pump station type shall be justified based upon economic and construction considerations.
4. Dry well-wet well mounted
 - a. Dry well-wet well mounted pump stations shall be manufactured by Smith and Loveless or an approved equal.
 - b. The suction lift shall be within manufacturer allowable limits.
 - c. Wet well mounted pumping systems shall be vacuum primed.
 - d. Pump equipment and station valves shall be effectively isolated from the wet well.
 - e. Provide priming lock loop in pump station discharge piping and other piping modifications as required to assure self priming of pumps.
 - f. Stations with buried steel, such as recessed wet well-mounted stations, shall have cathodic protection on the underground steel structure.
5. Dry well-flooded suction
 - a. Equip dry well-flooded suction pump stations with pumps manufactured by Smith and Loveless, Fairbanks Morse, Flygt, or an approved equal.
 - b. Wet wells shall be watertight and corrosion protected.
 - c. Divide the wet well into two interconnected sections and provide a means to isolate each section to facilitate repairs and cleaning.
 - d. Provide shaft driven flooded suction pump installations with sufficient access for shaft maintenance.
 - e. Dry wells shall have a sump to facilitate dewatering. Size the sump to remove the maximum pump seal water discharge which would occur

in the event of a pump seal failure. Equip the sump pump with a shut-off and double check valve to remove leakage or drainage with discharge above the maximum high water level of the wet well. Pipe pump seal leakage directly to the sump. Sump pump construction and material shall be adequate for an applicable environment and be capable of passing solid spheres up to $\frac{3}{4}$ -inch diameter.

- f. Cover wet wells or otherwise protect them against contamination.
 - g. Completely separate the dry well from the wet well. Common walls must be gas tight.
 - h. The wet well and dry well ventilation systems must be separate.
 - i. Provide dry well access preferably by means of a conventional staircase. Provide an access ladder equipped with fall protection measures when a staircase cannot be justified. Special conditions may require use of elevators.
6. Wet well/submersible pump stations
- a. Provide explosion proof motors designed specifically for submergence in and conveyance of raw wastewater.
 - b. Equip pump stations with submersible pumps manufactured by Fairbanks Morse, Flygt, or an approved equal.
 - c. Provide submersible pumps and motors that meet both Underwriters Laboratory and National Electric Code requirements.
 - d. Provide submersible pumps equipped with a method to detect shaft seal failure. Configure the system to shut off all power to the pump motor and send an alarm signal upon detection of moisture leakage past the seal.
 - e. Design submersible pump stations such that the pumps are easily removable and replaceable without a need for a worker to enter the wet well.
 - f. Install instrumentation placed in wet wells in a manner to be easily removable and replaceable without a need for a worker to enter the wet well.
 - g. Design electrical supply and control circuits to allow disconnection at a junction box located outside of and adjacent to the wet well. Protect terminals and connectors using tight seals and separate strain relief.
 - h. Locate pump motor starter and/or disconnect outside the wet well and

protect using a conduit seal or other appropriate sealing method meeting the requirements of the National Electric Code. Equipment exposed to weather shall be NEMA 4X stainless steel. Otherwise, provide equipment rated NEMA 3R.

- i. Locate valves in a vault that is physically separate from the wet well. Equip the valve vault with a means to drain or pump water to the wet well. Equip the drain line or force main with a means to prohibit wastewater from flowing from the wet well to the valve vault during surcharge conditions. Valve vaults are rated Class 1, Div 2, Group D. Any instrumentation located in the valve vault shall be rated for the area and shall be installed in a manner conforming to the National Electric Code.
- j. Pump power cords shall meet the requirements of the National Electric Code standards for flexible cords in wastewater pump stations.
- k. Provide power cord terminal fittings with a stainless steel strain relief accessory. The fittings shall facilitate field connecting.
- l. Provide a wet well top with a formed cable tray to route pump power cords from the wet well to the adjacent splice box or junction box. Support each pump power cord on the underside of the wet well lid with a stainless steel strain relief accessory. See detail illustrated in Appendix B.

7. Wet well/ centrifugal with motor located above the wet well

- a. Equip pump stations with pumps manufactured by Fairbanks Morse, Gorman-Rupp, or an approved equal.

D Station Capacity

1. Size pumps to convey the design peak hourly flow rate with the largest pump out of service.
2. Size and configure the pump station in accordance with conditions proposed in the design memorandum. Base the pump station size on the ultimate build-out flows unless the UG approves sizing based on an interim design flow with provisions in the design for upgrading the facility to ultimate build-out flows.
3. Consider providing variable frequency drives so the facility can operate at varying pumping rates and can convey flow at the rate it receives flow. The issues to consider when evaluating the use of variable frequency drives include:

- a. Impact to receiving facility (Stations with constant speed pumps discharge to receiving facilities in slugs which may adversely affect operations if the receiving facility is a treatment plant);
- b. Evaluate the installation, operating, and maintenance costs for variable frequency drives and constant speed drives. Include a cost differential to account for the smaller wet well requirement for VFD installations;
- c. Stations with constant speed motors typically require larger wet wells with longer detention times and lend to the generation and release of odor producing compounds; and
- d. Evaluate the availability of pumps that will operate in a favorable portion of the pump curve over a range of speeds and flows at high efficiencies.

E Wet Well Design

1. Provide corrosion resistant Bilco hatches rated for H2O loading, or approve equivalent.
2. Provide wet wells with a sign identifying the area as a confined space.
3. All hardware used inside the wet well shall be stainless steel material.
4. Equip submersible pump station wet wells with stainless steel rail guides and rail guide mounting brackets.
5. Wet well inlet designs shall:
 - a. Not contain a freefall of influent into the well to avoid air entrainment and release of odors;
 - b. Not contain abrupt changes in direction of the flow directly upstream of the wet well inlet;
 - c. Not result in entrance flow velocities greater than four (4) feet per second; and
 - d. Not permit differential velocities and thus rotation of the water in the wet well.
6. Do not locate adjacent pump intakes closer than 2.5 times the intake bell diameter to avoid interference between adjacent intakes.

7. Eliminate discontinuities such as corners by installing fillets that are a minimum of forty five (45) degrees and preferably are sixty (60) degrees.
8. Provide hopper bottom wet wells for submersible type pump stations that limit the area which settled solids can accumulate to the area directly beneath the pump intakes.
9. Unless variable frequency drives are provided, considerations for sizing the wet well shall include the minimum pump cycle time and the design fill time. Determine the effective wet well volume using a fill time of not greater than thirty (30) minutes based on the design average flow unless the facility purpose is to provide flow equalization. Base the minimum pump cycle time on the pump manufacturer's recommendations.
10. Wet well sizing shall be such that the minimum pump operating cycle is not less than five (5) minutes.
11. The pump station layout shall provide sufficient access to the wet wells for vacuum trucks.

F Layout and Siting

1. Locate pump station facilities either on UG property or on property for which easement has been acquired.
2. Site the pump station wet well top and finish floor elevations for all structures a minimum of three (3) feet above the one hundred (100) year flood elevation, or three (3) feet above the highest recorded flood elevation, whichever is higher, to protect to such elevations. For instances where flood data is not available for a site, base the level of protection on a hydrologic analysis of the drainage basin.
3. Provide security fences for pump station facilities.
 - a. Provide a six (6) foot PVC vinyl coated (either black or dark green) chain link fabric fence unless otherwise approved.
 - b. Equip the fence with a twelve (12) foot access gate that is capable of opening in either direction.
 - c. Locate the access gate to provide convenient facility access.
 - d. The minimum acceptable fabric shall be No. 9 gage with 2-inch diamond mesh.

4. Provide an all weather road with asphalt or concrete paving.
5. Provide UG approved facility parking.
6. Provide necessary storm drainage. Grade the site to direct surface drainage away from the station.
7. Provide seeding or sod and trees or shrubs to present a finished appearance.
8. Provide vent openings with provisions that prevent entrance by birds, other animals, and rain for wet wells and dry wells.
9. The layout shall provide for ease of pump and piping removal.

G Power Supply/Electrical

1. Coordinate the design of the pump station facilities with the servicing electrical utility.
2. The power supplied to the facility must be sufficient for pump motor starting, lighting and ventilation systems, and other necessary auxiliary equipment.
3. Supply all pump station facilities with a backup generator disconnect.
 - a. Provide a double throw fused at both sources, 3-pole disconnect with center position off, main power at top, and generator at bottom (on-off-gen).
 - b. Confirm the availability of a sufficiently sized generator.
4. Provide all pump stations with an alternate power source as approved by the Owner. The alternate power source may be a second power source independent of the primary source (preferable when available), a back-up power generator, or a backup generator disconnect.
5. Alternatively, provide an overflow or storage catchment system, as approved by the Owner, in place of providing an independent or standby power source. Facilities that can provide a minimum of twelve (12) hours of storage in the wet well and collection system at average design flow without basement flooding of bypassing may not require emergency power or additional catchment facilities.

6. Pump stations relying on use of portable power generating equipment as a back-up power supply shall provide sufficient storage capacity with an alarm system to allow time for power loss detection and transportation and connection of the power generating equipment.
7. Emergency backup power generators, where provided, shall:
 - a. Be protected from operating conditions that would result in damage to the equipment. Provide measures to monitor for conditions of low oil pressure and overheating. The protection shall be capable of shutting down the engine and activating an alarm;
 - b. Provide adequate power to start pump motors and continuously operate under all connected loads;
 - c. Be located above grade with adequate ventilation;
 - d. Be provided with instructions indicating the need for regular starting and running at full loads;
 - e. Be protected from damage at the restoration of regular power;
 - f. Be provided with provisions that allow the engine to start and attain operating speed before assuming a load; and
 - g. Be equipped with both automatic and manual start-up and load transfer capabilities unless only manual start-up and load transfer is justified.
8. All pump stations shall have a 120V power source sufficient in size to power a twenty (20) A receptacle, an exhaust fan and lights.
9. All motor starters shall be NEMA rated.
10. Control power voltage shall be 120 V.
11. Hand-off-auto switches shall be water tight.
12. Bury electrical feeders underground and rout in either a conduit or a duct bank as required by Owner.
13. Material used for buried and exposed conduit is subject to UG approval. Conduit material shall be:
 - a. PVC coated rigid steel;
 - b. Aluminum;

- c. Galvanized rigid conduit (exterior-above grade only); or
 - d. UG approved equal.
14. Pump controls shall have an Elapsed Time Meter (ETM) and shall have a means to detect phase loss. Install Time Mark phase monitors, or UG approved equal, on starters. Phase monitors shall be able to drop the control circuit on loss of phase, plus have an extra set of contacts for remote alarms. Call out model numbers in the plans and specifications.
 15. Equip pump stations with surge suppression and lightening arresters at the service entrance.
 16. Provide proper grounding and bonding systems.

H Monitoring and Control

1. Locate monitoring and control equipment above grade outside the wet well. Exceptions may be made for recessed wet well-mounted stations and flooded suction dry well stations.
2. Provide pump control equipment that has proper overload protection for anticipated air temperatures.
3. Provide controls for pumps, their prime movers, and pump accessories that will operate without dangerous overload.
4. Where installing two (2) or more pumps, make provisions for alternation. Provide Time Mark alternator relays, as approved by the Water Pollution Control staff. Call out model numbers in the plans and specifications.
5. Provide a means to monitor and display pump run times.
6. Provide wet well water level sensing devices of any of the following approved types:
 - a. MultiTrobe;
 - b. Bubbler systems;
 - c. Float systems; and
 - d. Pressure transducers.
7. Locate water level sensing devices to minimize the affect from turbulent flows. Where necessary, install stilling tubes.

8. Equip all pump stations with alarm systems. Provide a Raco Verbatim, SCADA-ready unit, or an approved equal, with a minimum of eight (8) digital channels and one (1) analog channel. Alarm systems shall operate independent of the primary and secondary power supply systems. Allocate the channels for a duplex station as follows:
 - a. Channel 1 High wet well level
 - b. Channel 2 Phase loss
 - c. Channel 3 Run time #1
 - d. Channel 4 Run time #2
 - e. Channel 5 Pump fail
 - f. Channel 6 Pump fail
 - g. Channel 7 Low wet well level
 - h. Channel 8 Intrusion or unauthorized entry
 - i. Channel 9 Pulse totalizer (analog)
9. Provide two (2) additional channels for each additional pump. Allocate the additional channels by continuing to group together the run time and pump fail channels.
10. Equip all pump stations with an autodialer and/or radio SCADA devices compatible with existing equipment to report alarms.
11. When providing program logic controller, it shall be an Allen Bradley SLC 505 Series Programmable Logic Controller, or an approved equal. Radios shall be by Microwave Data Systems, or an approved equal.
12. Installation of electrical equipment shall conform to the applicable state and local electrical codes and the National Electrical Code.
13. Provide a magnetic flow meter to measure effluent flow, as required by Owner.
 - a. Locate the magmeter in a vault.
 - b. Provide meter rated for submersible and explosion proof service.
 - c. Configure pipe to include a bypass around the flow meter and include

a means to isolate the meter from the flow for maintenance.

- d. Where the Owner does not require a flow meter, provide a meter vault that allows easy entry and access to the force main.
- 14. Provide a totalizer for pump station flow.
- 15. Provide a gas detection system for normally occupied spaces and install according to NFPA 820.
- 16. Provide pressure gauges on the suction and discharge piping of each pump. The pressure gauge on the suction piping shall be the compound gauge type. An alternative to placing a gauge on the discharge of each pump is to place a single gauge on the common discharge header or manifold.
- 17. All pressure gauges shall be diaphragm/snubber type and shall read in psi. All pressure gauges should be capable of reading twice the design pressure.

I Ventilation

- 1. Provide adequate ventilation for all pump stations. Wet wells equipped with mechanical equipment requiring maintenance or inspections require permanently installed ventilation systems.
- 2. Fire protection and ventilation measures shall be in accordance with the requirements of the applicable fire code, building code, NFPA, and local codes.
- 3. Equip below grade dry wells, rooms, compartments, pits, and other enclosures intended for occupancy with a forced air ventilation system that provides one hundred (100) percent fresh air at a minimum of six (6) air changes per hour if continuously operated and at least thirty (30) air changes per hour if operated intermittently. Configure intermittent systems to activate upon entrance to the dry well.
- 4. To conserve heat, consider providing a two speed ventilation system that ventilates at an initial rate of thirty (30) complete air changes per hour for ten (10) minutes and automatically switches to a reduced rate of six (6) complete air changes per hour.
- 5. The NEC Area Electrical Classification for the dry well (unclassified, Class 1, Group D, Division 1 or Division 2) will vary based on the type of dry well and the ventilation provided. See NFPA 820 for additional information.

6. Provide heresite coating for HVAC equipment, electrical controls, and panel to protect against corrosion.
7. Conveniently locate and clearly mark switches for operation of ventilation equipment.
8. Interconnect ventilation systems designed to operate intermittently with the respective pit lighting system.
9. Consider automatic controls where ventilation systems are intermittently operated.
10. Manual ventilation/lighting switch shall override automatic control.
11. Configure two speed ventilation systems to increase the ventilation rate automatically in response to detection of hazardous concentrations of gases.
12. Provide flow detection devices connected to alarm signaling systems for continuous ventilation systems. The systems shall indicate ventilation failure.
13. Dry wells with a depth greater than fifteen (15) feet shall have ventilation systems with multiple inlets and outlets.
14. Dampers shall not be used on fresh air or exhaust ducts.
15. Provide automatic heating equipment in all dry wells as required.
16. If ventilation systems are used to derate a room, then provide both local and remote alarms for ventilation system failure and combustible gas detection for all hazardous areas classified in accordance with NFPA 820 Section 7.5.2. Display alarms in accordance with NFPA 820 Section 7.5.3.
17. All fans shall contain fan wheels constructed from a non-sparking material.
18. Air ducts shall not contain fine screens or other obstructions.

J Appurtenances

1. Each pump shall have a positive-acting check valve with an external arm located on the discharge line.
2. Provide isolation valves following the check valve on each discharge line.

3. Provide isolation valves in the dry well on the suction line of each pump for dry well flooded suction type pump stations.
4. Under no circumstance shall isolation valves or check valves be located in the wet well.
5. Provide a means to easily remove and replace check valves by incorporating a harnessed sleeve coupling, a harnessed flange coupling adaptor, or a dismantling joint, into the pipe layout.
6. Provide A.R.I., or an approved equal, air release, air/vacuum or combination valves where required.
7. Equip pump stations with a portable pump connection to the force main with rapid connection capabilities and appropriate valves for emergency pumping capability where required.
8. Provide restrained piping with watertight joints.
9. Provide surge protection features, where required, to protect the force main and pump station from surge conditions.
10. Protect underground surfaces against corrosion.
11. Provide crane-ways, hoist beams, eyebolts, or other adequate facilities for servicing or removal of pumps, motors, or other heavy equipment.
12. Provide openings in floors, roofs, or wherever necessary for removal of heavy or bulky equipment.
13. Provide a convenient tool board or other facilities, as needed, for proper pump station equipment maintenance.
14. Provide stairways or ladders between all floors and in pits or compartments intended for routine entrance.
15. Stairways or ladders shall have handrails on both sides, and treads of non-slip material. Stairs are preferred in areas where there is frequent traffic or where supplies are transported by hand. They shall have risers not exceeding seven (7) inches and tread widths that are a minimum of eleven (11) inches.
16. All handrails, stairways, ladders, and gratings shall be aluminum.

K Plans and Specifications

Because of the project specific nature of the plans and specifications and due to the possible variability in pump station types, pump station design, and pump

station features, this section offers general minimum guidelines for preparing project plans and specifications and is not intended to be all inclusive. The designer should refer to the Plans, Specifications, Right-of-Way Maps and Legal Descriptions section of this document for additional requirements for pump station and force main contract documents.

The design engineer is responsible for preparing plans and specifications that are project specific and address both the applicable guidelines listed in this section and the project specific requirements. The project plans and specifications shall comply with and be supplemental to the conditions set forth in the latest edition of the UG *Technical Provisions*.

1. Project plans

Supplement the project plans with a copy of the platted lots served by the facility. The minimum general requirements for the project plan set include the following:

- a. Civil site plan sheet

Tie down the locations of all improvements shown on the site plan by providing X, Y, and Z coordinates where appropriate. The site plan layout sheet shall show the following minimum features:

- 1.) North arrow and scale;
 - 2.) Existing structures and improvements;
 - 3.) Existing utilities and associated easements/right-of-ways; and
 - 4.) Proposed development including but not limited to the following:
 - a.) Proposed utilities and associated easements/right-of-ways;
 - b.) Facility and access road foot print;
 - c.) Facility buildings, vaults, and other structures;
 - d.) Finish floor elevations for the facility structures;
 - e.) Facility permanent and temporary construction easements;
and
 - f.) Site drainage improvements.

- b. Civil detail sheet

In general, the minimum requirements for the detail sheet shall include, where applicable, details for the following:

- 1.) Trenching details;

- 2.) Piping details;
- 3.) Fencing details; and
- 4.) Planting plan.
- c. Building plan, elevations and detail sheet
Provide details for each building in plan and elevation view showing the following minimum information:
 - 1.) North arrow and scale;
 - 2.) Overall building dimensions, room dimensions for each room, wall thicknesses for all walls, and dimensions for each wall penetration;
 - 3.) Detail the roofing and siding systems;
 - 4.) Foundation details;
 - 5.) Mechanical system details;
 - 6.) Fire protection system schematic and details; and
 - 7.) Electrical plans.
- d. Pump station piping plan sheets shall provide the following:
 - 1.) North arrow and scale;
 - 2.) All pump station and yard piping and valves;
 - 3.) Location tie downs (X, Y, and Z coordinates) for each bend, valve, and other significant feature;
 - 4.) Pipe material and size; and
 - 5.) Pump locations.

L Pump Station Acceptance Testing

Due to the variability of possible pump station types and features, the general procedures for pump station acceptance testing should be fashioned to suit each particular installation. Appendix C contains guidelines for acceptance testing that are not intended to be all inclusive. Refer to force main testing requirements found in the Technical Provisions.

The design engineer is responsible for tailoring an acceptance testing plan suitable for the facility that addresses both the applicable guidelines listed in

Appendix C and the system specific testing requirements for facility components such as emergency generator, odor control, ventilation, and gas detection systems.

M Pump Station Design Review Checklist

1. Appendix D contains a pump station design review checklist.
2. The checklist shall be completed and included with the submittal material.

VII LOW PRESSURE SEWER

A Use and Applicability

1. Gravity sewers are the preferred method of providing sewer service. Where gravity sewers are not feasible low pressure sewers may be considered.
2. The UG Water Pollution Control Department, or designee, must approve the use of low pressure sewers for each specific application before a preliminary plan is prepared for review.
3. The designer shall provide the following minimum information for approval evaluation:
 - a. An evaluation of the existing sanitary sewer system serving the area detailing why use of low pressure sewers is necessary.
 - b. An evaluation of the existing collection system from the low pressure sewer system connection point to the treatment plant confirming that capacity exists for conveying the development's additional design flow.
 - c. A topographic map identifying:
 - 1.) The drainage basin containing the project area;
 - 2.) The project area;
 - 3.) Zoning in the project area;
 - 4.) Existing sanitary sewer system downstream of the project area; and
 - 5.) Finish floor elevations for all intended structures and invert elevations for proposed tie in points.
 - d. A life cycle cost analysis comparing low pressure sewers with alternative systems. The analysis should consider initial construction and annual operating and maintenance costs. Clearly state the assumed useful life for each alternative.
4. Once the use of low pressure systems is approved, then the designer shall submit three copies of a preliminary plan to the UG Water Pollution Control Department for review. The UG will only review complete submittals. Complete submittals shall contain all requirements in Section B.

B Preliminary Plan Submittal

The preliminary plan submittal shall include the following information:

1. Hydraulic analysis;
2. General layout;
3. Plan and profile sheets;
4. LPS detail sheets; and
5. Easements

1. Hydraulic analysis

a. Branch analysis

Perform a hydraulic branch analysis in accordance with Environment One Corporation guidelines using the example analysis table shown in Appendix E as a template to summarize results.

- 1.) Perform the branch analysis for ultimate build-out conditions to determine:
 - a.) The pipe diameters throughout the system;
 - b.) The flow and velocity in each pipe branch; and
 - c.) The dynamic and static head requirements for each system pump.
- 2.) The branch analysis shall illustrate consideration of the following design parameters:
 - a.) Minimum finish floor elevation and minimum pump elevation for each lot served;
 - b.) Elevations and stationing of each high and low points along the proposed pressure main layout;
 - c.) Pipe length in each branch;
 - d.) The maximum number of pumps operating simultaneously in each pipe branch. The maximum number of pumps operating simultaneously shall be based on the USEPA Albany Study results shown in Table VIII-1;
 - e.) The accumulative maximum number of pumps operating for each branch (includes all upstream branches) from a point at the end of a branch;
 - f.) The maximum anticipated flow in each branch based on an average flow rate of eleven (11) gallons per minute per pump;

Table VIII-1
Maximum Number of Pumps Operating Simultaneously

Number of Grinder Pumps Connected	Maximum Daily Number of Pumps Operating Simultaneously
1	1
2-3	2
4-9	3
10-18	4
19-30	5
31-50	6
51-80	7
81-113	8
114-149	9
147-179	10
180-212	11
213-245	12
246-278	13
279-311	14
312-344	15
345-377	16
378-410	17
411-443	18
444-476	19
477-509	20
510-542	21
543-575	22
576-608	23
609-641	24
642-674	25
675-707	26
708-740	27
741-773	28
774-806	29
807-839	30
840-872	31
873-905	32
906-938	33
939-971	34
972-1,004	35

Source: USEPA Albany Study

- g.) The pipe diameter in each system branch. Base the diameter selection on a balance between meeting the maximum velocity greater than two (2) feet per second requirement and keeping frictional head losses at an acceptable level;
 - h.) The estimated friction loss for each branch based on use of an accepted friction head loss equation;
 - i.) The accumulative friction loss for each branch determined by beginning at the system outfall and summing the friction losses for successive upstream branches;
 - j.) The maximum static head for each branch;
 - k.) The maximum total head for each branch; and
 - l.) Demonstrate the pumps in each branch operate on a favorable portion of the pump curve by plotting the maximum total head in each branch on the pump curve.
- b. Retention time analysis
 - 1.) Report the cumulative retention time at the extremities of the system based on 200 gallon per day per home flow rate.
 - 2.) For existing septic tank neighborhoods, only those homes to be connected initially should be included.
 - 3.) For new subdivisions, this analysis should be based on a uniform 50% build out level (every other lot). The UG may request use of other build out scenarios.
 - 4.) Report the predicted hydrogen sulfide buildup based on the estimated retention time. Estimate the hydrogen sulfide buildup using an accepted estimation technique such as the method illustrated in the USEPA *Odor and Corrosion Control in Sanitary Sewerage Systems and Treatment Plants* design manual.
- 2. General layout

The general layout sheet shall show the following system features:

 - a. North arrow and scale;
 - b. List all datum plane and survey reference points. The project control benchmark should be an established benchmark and identified as to location, description, and elevation. Vertical control shall be tied to NGVD29, National Geodetic Vertical Datum 1929. The horizontal control shall be tied to NAD83, the Kansas State Plane Coordinate

System.

- c. Existing and proposed development including all lots, both present and future, to be served by the LPS;
 - d. Existing sanitary sewer system including gravity and pressure sewers;
 - 1.) Include existing sanitary sewer manholes.
 - 2.) Provide the manhole locations, UG manhole numbers, and all invert elevations of incoming and outgoing lines and the grade elevations.
 - 3.) Provide the pipe diameter, pipe material and line slope for the existing gravity lines shown.
 - e. Proposed sewer alignment including the LPS mains, discharge lines, and each LPS pump stations. Indicate the length and diameter of each line; and
 - f. Location of all LPS appurtenances including in-line flushing assemblies, cleanouts, air release, air/vacuum, and combination valves and discharge line check and stop valves.
3. Plan and profile sheets
- a. Show and appropriately label all existing and proposed utilities in both plan and profile views.
 - b. The plan shall show all existing and proposed utility easements and right-of-way.
 - c. The profile shall show the existing grade as a solid line and the proposed grade as a dashed line.
 - d. The plan and profile sheets shall contain the following information:
 - 1.) Low pressure mains
 - a.) Show each main line in plan view. Show main line stationing in increments of one hundred (100) feet and normally increasing from left to right. Label main line with length, diameter, pipe material, and pipe wall thickness.
 - b.) Show the property lines for all private property within easement and right-of-way boundaries;

- c.) Layout of mains shall minimize the line length while including the fewest abrupt direction changes.
- d.) Show location ties for all pipe direction changes.
- e.) Show locations for all reinforced concrete encasements and areas of riprap protection.
- f.) Extend pressure mains to the project property boundary to serve any tributary areas which lie outside of the project boundary and do not currently have direct access to a sanitary sewer main.

2.) Pump discharge lines

- a.) Locate the grinder pump station discharge line a minimum of five (5) feet from any property line.
- b.) Do not route the grinder pump station discharge line beneath decks, patios, driveways, sidewalks, or other improvements.
- c.) Show the connection of the discharge line to the pressure main for each lot or proposed building.
- d.) Station and label each pump discharge line with length, diameter, and pipe material and pipe wall thickness.
- e.) Show the discharge line check and ball valves. For new developments, tie the valves to two (2) locations on the lot or property. For all other projects, tie the pump unit to a corner of the building with two (2) measurements.
- f.) The pump discharge line for a property shall not cross another lot or property line or lot line extension to the back of the street curb.
- g.) For new developments in which the individual builders will install the pump unit, provide a pump discharge line for each lot or proposed building through any proposed street right-of-way and any proposed utility easements and terminate in a ball valve and check valve. Locate the ball valve and check valve directly adjacent to, but outside of, any proposed utility easements and street right-of-ways on the lot it serves.
- h.) Show septic tanks and sanitary service lines for existing buildings.

3.) System components

- a.) Show all pumping units, in-line flushing assemblies, end cleanouts, valves, and curb stops and label with stationing, location ties (northing and eastings), and top elevations. Locate the in-line flushing assemblies, end cleanouts, valves and curb stops in easily accessible unpaved areas.
- b.) Show the distance to the nearest existing manhole for new receiving manholes placed on an existing line.
- c.) Show the interior flow angle between incoming new pressure main and outgoing existing mainline at receiving manhole. The minimum interior flow angle shall be ninety (90) degrees.
- d.) Equip the receiving manhole with an odor control unit when required by the UG. When required, the following note shall be included on drawings: "Install a canister in the receiving manhole containing a high activity, chemically treated activated carbon specifically designed for use in odor control applications, such as Calgon Carbon Corporation's Sweet Street Odor Control Unit or an approved equal."

4. LPS detail sheets

- a. In general, the minimum requirements for the detail sheet shall include, where applicable, details for the following:
 - 1.) Trenching details;
 - 2.) Pipe encasement detail;
 - 3.) Low pressure main connection detail at receiving manhole;
 - 4.) End cleanout assembly detail (see Appendix F);
 - 5.) In-line flushing assembly detail;
 - 6.) Typical grinder pump discharge piping and curb stop detail;
 - 7.) Air release valve assembly detail;
 - 8.) Reinforced concrete encasement detail;
 - 9.) Riprap detail; and
 - 10.) Trench check detail.

- b. Include the following notes, when applicable, on the detail sheets:

- 1.) "Provide underground reinforced detectable marking tape marked 'CAUTION SEWER LINE BURIED BELOW' by Terra Tape or approved equal for all low pressure piping."

Place tracer wire in place of marking tape for pipe installed using horizontal directional drilling methods.

- 2.) "Tracer wire for pressure sewer mains and discharge piping shall be high molecular weight polyethylene trace wire, 1-14AWG, by Paige Electric or approved equal. Splicing shall be with 3M DBY/DBR direct bury splice kits. Tracer wire lead connections to be located in 'in-line' flushing assembly boxes."
- 3.) "Two forty five (45) degree bends shall be used to accomplish a change in direction of ninety (90) degrees."
- 4.) "Pumps shall NOT be connected to the low pressure system until the pressure main has been tested, inspected, and approved by the Unified Government of Wyandotte County/Kansas City, Kansas."

5. Easements

- a. Locate all low pressure sewer lines in one of the following:

- 1.) A platted utility easement;
- 2.) A platted sanitary sewer easement;
- 3.) A sanitary sewer easement dedicated to the UG;
- 4.) A street right-of-way; or
- 5.) Be covered by a low pressure sewer Service Agreement.

- b. Submit preliminary plats, draft easements, and executed Service Agreements with the preliminary plan submittal.

C Technical Considerations

1. General

- a. Select main line diameter based on a minimum flow velocity of two (2) feet per second.
- b. The minimum diameter of the pressure main shall be 1 ½ inches and the minimum diameter of the pump discharge line shall be 1 ¼ inches.

- c. Base the pipe design upon the standards of design for pressure sewers.
- d. Material for pressure mains and pump discharge lines shall be:
 - 1.) High density polyethylene (HDPE) for lines less than two (2) inches in diameter;
 - 2.) Either HDPE or PVC for lines two (2) inches and greater in diameter;
 - 3.) The minimum wall thickness shall be SDR 21 for PVC pipe material and DR 11 for HDPE pipe material.
 - 4.) HDPE pipe materials shall conform to ASTM D 3350 cell classification 345464C.
 - 5.) PVC pipe shall conform to AWWA C900 and ASTM D2241.
- e. The minimum depth of bury over the top of pipe shall be forty two (42) inches.
- f. Pressure main layout shall conform to the design guidelines for stream and road crossings listed in the Sanitary Sewer Design Criteria.
- g. Provide reinforced concrete encasements and riprap protection to protect the pressure main at all creek crossings. Additionally, encase pressure mains with reinforced concrete where the main routes within thirty (30) inches of a storm sewer.
- h. Install cleanout/flushing stations at terminal end of each main, every thousand (1,000) to fifteen hundred (1,500) linear feet of straight run, and where two (2) or more mains come together.
- i. Provide check valves and full-ported stop valves at the pump station and at the junction between each discharge line and main line.
- j. Locate air release valves, when included, at the beginning of each downward leg in the system and also at intervals of two thousand (2,000) to twenty five hundred (2,500) feet on all horizontal runs with no clearly defined high point in the layout.
- k. Locate air/vacuum valves, when included, at all system high points, at all significant grade changes, and at two thousand (2,000) foot intervals on long ascending or descending runs.
- l. Locate combination air valves, when included, at system high points and at two thousand (2,000) foot intervals on long ascending or descending runs.

- m. The drop in the receiving manhole shall not exceed two (2) feet as measured invert-to-invert from the inside face of the manhole walls. The pressure main may enter the receiving manhole at greater than two (2) foot drop provided an inside drop is constructed in accordance with UG standard details. The pressure main may not enter the receiving manhole less than forty two (42) inches below grade and may not enter in the cone section.
 - n. Line the interior of the receiving manhole with a protective coating system in accordance with provisions found in the UG *Technical Provisions*.
 - o. All manhole lids or covers must comply with applicable *Technical Provisions*.
2. Grinder pump station
- a. Provide stations manufactured by Environment One Corporation or by a UG approved equal.
 - b. Equip with semi-positive displacement progressive cavity type pumps.
 - c. Adapt the generic grinder pump station specifications found in Appendix G to suit the project conditions.
3. Pump station location
- a. Locate either in the basement of the building served or below grade near the structure served.
 - b. Locate a minimum of ten (10) feet from nearest basement wall or wall footing, or such that a minimum slope of one (1) horizontal to one (1) vertical can be maintained from the top of ground to the bottom of excavation, whichever is greater.
 - c. Locate a minimum of ten (10) feet from the nearest property line.
 - d. Locate a maximum of twenty (20) feet from the building served.
4. Alarm/disconnect panel location
- a. Attach alarm/disconnect panel to the side of the building and within view of the grinder pump station.
 - b. Install alarm/disconnect panel with the panel bottom a minimum of four (4) feet above the existing grade.
 - c. Panel installation shall be in accordance with the National Electric

Code.

5. Electrical wiring

- a. Design and install electrical wiring and connection to the existing electrical service in accordance with the National Electric Code, applicable local building codes, and the requirements of the electrical utility.
- b. Design and install electrical wiring and connection to the existing electrical service in conformity to the provisions found in the sample specifications found in Appendix H.
- c. Provide one hundred (100) amp service equipped with breakers for each grinder pump station.

6. Service line

- a. Locate pump stations replacing septic tanks in close proximity to the existing service line. Expose the existing service line for inspection and approval by a UG inspector before the new system becomes operational.
- b. All buildings connecting to grinder pump stations are subject to UG inspection to verify all sewage and no extraneous connections such as building foundation drains, roof drains, and sump pumps connect to the pump station.

D Contract Documents/As-built Drawings

1. Provide contract drawings for low pressure sewer systems that comply with the requirements set forth in the Plans, Specifications, Right-of-Way Maps and Legal Descriptions section of this document.
2. Provide contract specifications that are project specific and are supplemental to applicable sections of the *UG Technical Provisions and Standard Drawings for Roads and Sewers*.
3. Provide as-built drawings that emphasize deviations from the contract drawings.

E Ownership and Maintenance

1. The UG shall own and maintain the LPS mains.
2. The property owner shall own the service lines, pump stations, and pump discharge lines.

3. The UG shall accept limited maintenance responsibility for some portions of low pressure sewer systems as outlined in Chapter 30 of the 1988 Code of Ordinances City of Kansas City, Kansas, *Sewers and Sewage Disposal*. The UG will accept maintenance responsibility only for compliant low pressure sewer systems for which the system Owner has a signed agreement on file and pays the UG a monthly maintenance fee.

F Low Pressure Sewer Plan Review Checklist

1. Appendix I contains a LPS submittal review checklist.
2. Designers shall complete the checklist and include with the submittal material.

G Low Pressure Sewer Lighting Panel Checklist

1. Appendix J contains a LPS lighting panel checklist.
2. Designers shall complete the checklist and include with the submittal material.

APPENDIX

Appendix A

Unified Government - Sanitary Review: Gravity Main Checklist

Name of Development: _____

Review No.: _____

Review Date: _____

General

- | | | | | |
|-----------------|--|----------|--------------|----------|
| 1 | Validate that aerial crossing, pump station, inverted siphons, force main, or LPS are not present. If present forward a copy of the plans to an engineering supervisor for the review of the aforementioned elements of the sanitary sewer system. | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 2 | Validate that the cover sheet is sealed and signed by an engineer licensed in the state of Kansas. | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 3 | Validate that the cover sheet contains an approval block for the County Engineer. | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 4 | Validate that a completed KDHE sewer extension permit application with flow calculations has been submitted. | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 5 | Validate that the plans or a separate cover sheet show all land in the watershed that have potential for gravity flow through the project area. | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 6 | Validate that manhole numbering and stationing is logical and consistent between the plan and profile and that adequate UG node numbers for existing lines are shown. Sanitary and storm sewer maps (with UG node numbers) and as-built drawings may be obtained from the Sewer Maintenance Department (913-573-5535). | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 7 | Validate that all existing utilities and proposed sanitary and storm sewers are shown and are consistent between the plan and profile sheets. | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 8 | Validate that the cover sheet contains a statement from the engineer describing his efforts to determine the existing utilities, the sources of information, and which utility locates were surveyed. | OK _____ | Revise _____ | NA _____ |
| <i>Comment:</i> | | | | |
| 9 | Validate that the following note referencing the UG Technical Provisions and Standard Drawings is in a prominent location: | OK _____ | Revise _____ | NA _____ |

Appendix A

"All work in public easements and Right-of-Way and all erosion control work must comply with the latest edition of the Technical Provisions & Standard Drawings for Roads and Sewers, of the Unified Government of Wyandotte County/Kansas City, Kansas. If any of the general notes conflict with the Technical Provisions & Standard Drawings for Roads and Sewers, of the Unified Government of Wyandotte County/Kansas City, Kansas, the UG's standards shall override."

Comment:

- | | | | | |
|----|---|----------|--------------|----------|
| 10 | Validate that UG standard details are not present in the drawing set and that required special details not covered by UG standard details are included. | OK _____ | Revise _____ | NA _____ |
|----|---|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 11 | Validate that each manhole is shown with a coordinate pair identifying the manhole. (may be shown as a leader to each manhole or in table) | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 12 | Validate that the location of the project benchmark is shown and that the datum is acceptable (State Plane Coordinate NAD 83). | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|---|----------|--------------|----------|
| 13 | Validate that offsite easements encompassing the limits of work have been submitted and approved. | OK _____ | Revise _____ | NA _____ |
|----|---|----------|--------------|----------|

Comment:

Flow Analysis

- | | | | | |
|----|---|----------|--------------|----------|
| 14 | Validate that the proposed system is adequately sized to carry the flow from the potential upstream service area. If the potential upstream service area is less than 36 acres the minimum pipe size of 8" is adequate. If greater than 36 acres check flow calculations. | OK _____ | Revise _____ | NA _____ |
|----|---|----------|--------------|----------|

Comment:

- | | | | | |
|----|---|----------|--------------|----------|
| 15 | Validate that the downstream sewer system has adequate capacity for the proposed development.
- Check with the SMD for a report of know problems.

- If the sites generates less than 0.10 cfs peak hourly flow, and there is not a history of flow problems downstream, then the downstream capacity is acceptable. | OK _____ | Revise _____ | NA _____ |
|----|---|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 16 | Validate that the design of all sanitary sewer improvements are based on the design peak hourly flow rate with an approximate allowance for inflow and infiltration. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

Appendix A

- | | | | | |
|----|--|----------|--------------|----------|
| 17 | Validate that pipe slopes shown correspond to slopes used in pipe design calculations and verify that a full pipe flow velocity is between 2.7 and 10 feet per second. If velocity is greater than 10 feet per second verify that there is a separate manhole detail showing protection against erosive force. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

Plan View

In order to meet the layout requirements of items 22, 23, and 28 it is typical to locate sanitary sewer under the street pavement.

- | | | | | |
|----|--|----------|--------------|----------|
| 18 | Validate that the horizontal alignment of gravity sewers is straight between manholes. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 19 | Validate that easements are shown on the plan view and that they correspond with the platted easement. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 20 | Validate that sanitary sewers are not located under wetlands, ponds, lakes or wet/dry detention ponds. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|---|----------|--------------|----------|
| 21 | Validate that the sanitary sewer layout is located primarily in the ROW, that side yard and backyard runs are minimized, and that crossing angles with other utilities are greater than 45 degrees. | OK _____ | Revise _____ | NA _____ |
|----|---|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 22 | Validate that the layout of the sanitary sewer provides a corridor for the installation of water main which will maintain a minimum horizontal separation of 10 feet between parallel water and sanitary sewer lines without unnecessary street crossings by either utility. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 23 | Validate that service connections are not connected to interceptor sewers, manholes, or force mains, service is provided adjacent to every platted lot, service lines are shown for all lots, do not cross property lines, do not run longitudinally in a street or alley, and extend to the property line of the building served. Large service connections from institutional or commercial/industrial sites may be to manholes. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 24 | Validate that duplexes have a separate sewer service connection for each unit. | OK _____ | Revise _____ | NA _____ |
|----|--|----------|--------------|----------|

Comment:

- | | | | | |
|----|--|----------|--------------|----------|
| 25 | For attached houses, other than duplexes, validate that: | OK _____ | Revise _____ | NA _____ |
| | a. They have a common sewer service connection. | | | |

Appendix A

b. The individual house services are ganged outside of the foundation. OK _____ Revise _____ NA _____

c. Covenants or plat restrictions provide for common maintenance of the ganged sewer service. OK _____ Revise _____ NA _____

Comment:

26 Validate that manhole covers are located away from curb, sidewalk, and drainage swales. OK _____ Revise _____ NA _____

Comment:

27 Validate that bolted manhole lids are shown on interceptor sewers. OK _____ Revise _____ NA _____

Comment:

28 Validate that a manhole/junction box is located within 10 feet of a property or benefit district boundary in order to provide connection to potential upstream service areas. OK _____ Revise _____ NA _____

Comment:

29 Validate that branch lines have a terminal manhole. OK _____ Revise _____ NA _____

Comment:

30 Validate that flow change in direction in manholes is not greater than 90°. OK _____ Revise _____ NA _____

Comment:

31 Validate that each manhole has convenient access and that the grading within access route and within 15 feet of each manhole does not exceed 6:1. OK _____ Revise _____ NA _____

Comment:

32 Validate that manholes are located outside of natural and manmade watercourses. When manholes located in the watercourse are justified in the design memorandum validate that they have bolt down lids. OK _____ Revise _____ NA _____

Comment:

33 Validate that stream crossings meet the following design criteria: OK _____ Revise _____ NA _____

- sewer line crosses nearly perpendicular to the stream flow.
- upstream and downstream trench checks are included.
- sewer line has concrete encasement or is DIP material.
- upstream and downstream manholes located outside the likely meander of the stream.

Comment:

34 Validate that manholes have a minimum 18 inch length of precast wall between penetrations. A manhole invert plan is required to demonstrate the minimum wall when ever any of the following conditions apply: OK _____ Revise _____ NA _____

- any pipe into or out of the manhole has a diameter of more than 18 inches.

Appendix A

- the angle between any two adjacent pipes is less than 117 degrees.

Comment:

Profile View

- 35 Validate that the drop through manhole meets the following: OK _____ Revise _____ NA _____
- for changes in flow direction up to and including 45 degrees, provide a drop of 0.2 feet.
 - for changes in flow direction between 45 and 90 degrees, provide a drop of 0.4 feet.
 - or an outside drop is provided.

Comment:

- 36 Validate that a manhole/junction box is located at every convergence of flows (except service connections); at every horizontal bend; at every change in pipe material, diameter, or slope; and at distances not to exceed 500 feet for diameters of 18 inches or less, and not to exceed 600 feet for pipe diameters larger than 18 inches. OK _____ Revise _____ NA _____

Comment:

- 37 Validate that the pipe material is PVC, DIP, Lined Reinforced Concrete, Composite Pipe or that deviation is justified in the approved designed memorandum. OK _____ Revise _____ NA _____

Comment:

- 38 Validate changes in pipe material take place at a manhole. OK _____ Revise _____ NA _____

Comment:

- 39 Validate that pipe size does not decrease in the direction of flow. OK _____ Revise _____ NA _____

Comment:

- 40 Validate that the minimum cover requirement of 6 feet is satisfied. OK _____ Revise _____ NA _____

Comment:

- 41 Validate that the existing utilities and proposed storm lines are shown and correlate with the plan view. OK _____ Revise _____ NA _____

Comment:

- 42 Validate there is a minimum of 2 feet clear space between crossing sanitary and storm sewer lines. OK _____ Revise _____ NA _____

Comment:

- 43 Validate that the proposed sanitary sewer line has a minimum of 2 feet clear space lower than existing water lines. OK _____ Revise _____ NA _____

Comment:

- 44 Validate that embankment fill conditions do not exist or are mitigated. Refer to figure 5609.8.R. OK _____ Revise _____ NA _____

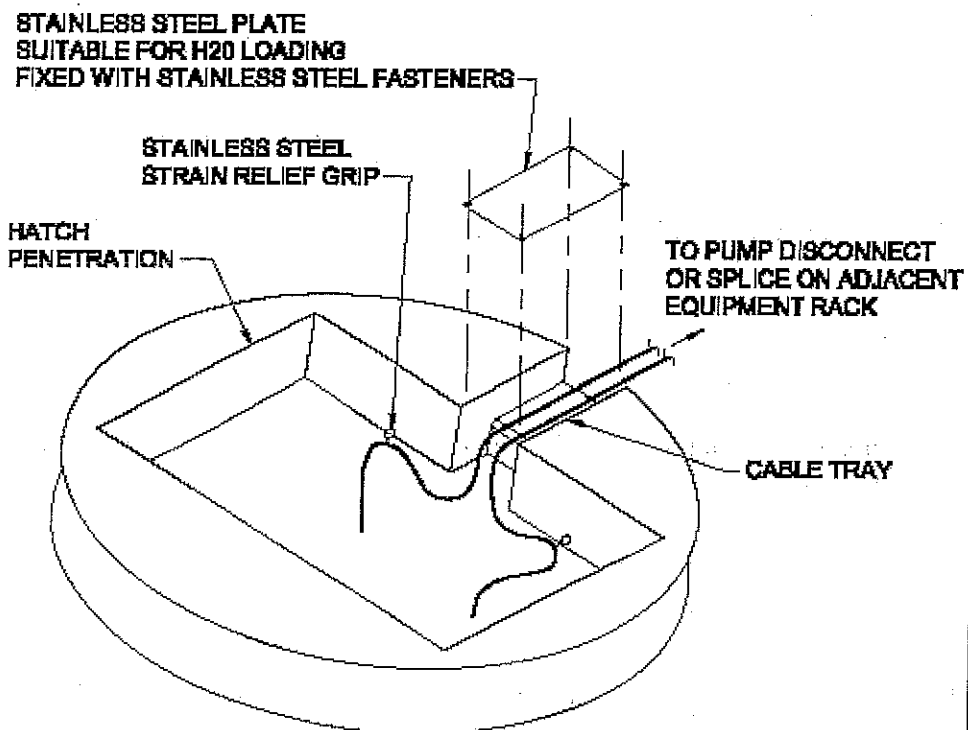
Comment:

Appendix A

45	Validate that slope anchors are provided or are not needed. (Necessary if slope is greater than 20% and if there is a vertical drop greater than 8' in a reach) <i>Comment:</i>	OK _____	Revise _____	NA _____
46	Validate that the maximum depth of cover does not exceed 20 feet or that strength calculations are provided. If depth of cover is greater than 20 feet recalculate the strength analysis. <i>Comment:</i>	OK _____	Revise _____	NA _____
Plat				
47	Validate that rights of way and easements are shown and provide adequate side distance from the edge of easement for maintenance (Easements to be 15' minimum or depth to flow line, which ever is greater, with pipe centered in easement). <i>Comment:</i>	OK _____	Revise _____	NA _____
48	For industrial/commercial/institutional properties verify that building footprints including roof overhang and footing do not encroach on the ROW or easements. <i>Comment:</i>	OK _____	Revise _____	NA _____
49	Validate that each manhole is provided with easements sufficient for maintenance activities. <i>Comment:</i>	OK _____	Revise _____	NA _____
50	Validate that minimum serviceable floor elevations, MSFE, are established on the plat for each lot where any of the following apply: - where a sewer pipe in road has less than 9 feet of cover. - where a lot is served by a sewer main in a location other than road way fronting the lot. - where the final grade elevation at the building setback line is lower than the back of curb on the adjacent. - where a lot is unusually deep and any portion of the allowable building site is lower than the back of curb. <i>Comment:</i>	OK _____	Revise _____	NA _____

Appendix B

B Wet Well Top with a Formed Cable Tray



NOTE:

SIZE CABLE TRAY DEPTH AND WIDTH BASED ON THE SIZE AND NUMBER OF POWER CORDS IN WET WELL.

PUBLIC WORKS DEPARTMENT, ENGINEERING DIVISION
UNIFIED GOVERNMENT

SEPT 2006

Appendix C

C Pump Station Acceptance Testing Guidelines

The acceptance testing should confirm or address the following:

General

1. The pump manufacturer must have a representative conducting the acceptance testing for the pumps.
2. Start each pump and compare discharge pressure head and flow rate with the design operating point. Flow rate shall be checked with a portable non intrusive flow meter if the station is not equipped with a flow meter. If necessary, trim impellers to operate near the design operating point.
3. Cycle pumps through each of the operating conditions anticipated for the station and confirm proper operation of the level controls, the pump sequencer, and the pressure and flow rate for each of the operating conditions.
4. Check amperage draw of motor internal thermostats to insure amperage is below manufacturer's maximum allowable and determine if properly installed in the motor circuit.
5. Measure motor winding resistance, operating voltage and amperage to insure any unbalance is within the manufacturer's allowance.
6. If VFD, check the line hertz and the VFD volts/hertz ratio.

Wet Well

1. Confirm the wet well is clear of all debris.
2. Check that the wet well level indicating system is installed correctly and is adjusted for the specified operating water levels.

Piping and Valves

1. Piping is level or continuously rising to prevent air pockets from forming.
2. Valves operate properly. Confirm check valves are installed in the right flow direction.
3. Check valve springs or lever weights are properly adjusted.
4. All piping has been pressure tested in accordance with requirements found in the Technical Provisions.

Appendix C

Submersible Sewage Pumps

1. Guide rails are securely anchored at the top and bottom with a midrail guide in place if the rail length exceeds twenty feet.
2. Return elbow is securely installed with fasteners tightened.
3. Pumps seat properly.
4. Lifting device is operational. Ensure there are no sharp edges to cut power cables.
5. Confirm the power cord is continuous in the wet well without splices or junction boxes.
6. Check liquid level in motor if fluid filled and add as required.
7. Measure resistance in the pump seal chamber for moisture content and check moisture detector to insure it is properly installed, operating and connected in the motor control circuit and/or a fault alarm and/or indicator lights.

Switchboards and MCCs

1. Verify the nameplate information.
2. Verify that the main and feeder circuit breakers or fuses are rated as designed.
3. Verify that all controls, switches, and indication lights are furnished as specified on the front of each bucket.
4. View each piece of equipment operating and with the control schematic intended and that all lights and alarms function as well.
5. Verify that all remote control (stop/start) devices are installed at the equipment and function as designed.
6. Verify that the appropriate labels are on the front of each bucket.

Ground Fault System Test

1. When provided, be sure to review a written record of the ground fault system test.

Automatic Transfer Switch

1. Test transfer switches by connection of normal and standby sources.

Appendix C

2. De-energize the normal source and observe that the switch transfers to the standby source and then returns to the normal source when it is restored.
3. Observe that all auxiliary contacts that alarm or operate other devices perform their intended functions as indicated.

Panelboards and Transformers

1. Check the rating of all panelboards and their circuit breakers.
2. Verify that the panelboard schedule is installed and correct.
3. Check nameplate ratings of all transformers.

Variable Frequency Drives

1. Check all remote and local controls for pump VFDs.
2. Double check the range of operation of each VFD and that the minimum operating speed and ramp times are set appropriately for the required pump control scheme.
3. Verify that the human/machine interface is set on the appropriate units.
4. Compare the speed calibration with the readouts on the SCADA system when part of design.
5. Provide a hardcopy of all parameters and settings in VFD programming.

Instrumentation

1. Check that all instrumentation is installed at its appropriate level.
2. Verify the units, calibration range, and set point of each instrument and compare with readouts on a SCADA system when present.
3. Operate any equipment controlled by instruments and verify correct operation.
4. Verify instrumentation indication and alarms at any alarm panels and in the SCADA system.

Lighting

1. Operate all manual switches.

Appendix C

2. Check light levels and quality.
3. Test operation of photocells and emergency lighting.

Pressure Switches, Float Switches, Limit Switches and Protective Relays

1. Operate switches and relays to verify their intended control.

Control Scheme Tests

1. Test all electrical controls by trial operation of control equipment to see that each interlock and control function operates to conform to the description of operation.

SCADA System

1. Generate all alarms and status at the PLC panels and verify their presence on the screen.
2. Verify all analog signals on operator screens; compare the values of their ranges with those on each transmitter.
3. Operate all equipment from the operator screen to verify remote operation.
4. Verify symbology, color, and design of screen.
5. Verify that SCADA system alerts autodialer or other communication system as designed.
6. If dial-in option is available with remote computer, test that it operates as designed.

Appendix D

D Pump Station Review Checklist

For sewage pumping stations designed to serve more than one single family residence.

Pump Station Site

Protected from the 100 year flood.

OK _____ Revise _____ NA _____

Comment:

Reliability

One or more of the following backup provisions required:

OK _____ Revise _____ NA _____

Comment:

- ☐ A power supply transfer switch and connection for a portable generator.
- ☐ An automatic power supply transfer switch and dedicated emergency generator on-site.
- ☐ Connection of the pump station to at least two independent power supplies from separate sub-stations, with automatic transfer switch.
- ☐ Piping which permits quick connection of a portable internal combustion engine wastewater pump. This portable pump must be owned by the sewer authority and have a pumping capacity equal to or greater than the firm capacity of the pump station. The wet well and adjacent interceptor must have adequate capacity to provide two hours of storage above the high level alarm prior to surcharging any section of upstream sewer line which results in backup into a building sewer service line.

Alarm

One or more of the following alarm systems required.

OK _____ Revise _____ NA _____

Comment:

- ☐ Red Light and Horn Alarm

Appendix D

- ☐ Radio Alarms
- ☐ Telephone Dialer

Pump Design

Pumps shall be capable of passing spheres of at least three inches in diameter. The requirement is not applicable to grinder type pumps.

OK_____Revise_____NA_____

Comment:

Pump suction and discharge openings shall be at least four inches in diameter. This requirement is not applicable to grinder type pumps.

OK_____Revise_____NA_____

Comment:

A minimum of two pumps shall be provided.

OK_____Revise_____NA_____

Comment:

Each pump should be capable of pumping the design peak flow, minimum requirement is the projected peak hourly flow. Peak hourly flow is usually between 2 and 5 times average daily flow.

OK_____Revise_____NA_____

Comment:

Head Calculations

Pump curve matches system curve at specified head and discharge.

OK_____Revise_____NA_____

Comment:

Appendix D

Dry Well

A separate sump pump shall be provided to dewater leakage, ground water seepage or condensation. All floors shall be sloped to drain the dry well.

OK _____ Revise _____ NA _____

Comment:

Wet Well

The wet well floor should have a minimum slope of 1 to 1.75.

OK _____ Revise _____ NA _____

Comment:

The flat bottom of the wet well should be as minimal as possible, preferably twice the diameter of the suction bell or the submersible pump.

OK _____ Revise _____ NA _____

Comment:

Valves should not be installed in fixed positions in the wet well. Under no conditions should the operator have to routinely enter the wet well for operation or maintenance of valves.

OK _____ Revise _____ NA _____

Comment:

The detention volume in the wet well between the low level pumps on and pumps off elevations should be adequate to provide a minimum pump cycle time of 5 minutes or more.

Minimum Pump Cycle Time

$$\text{Cycle time} = \frac{4(V)}{D}$$

V = Gallons of pumped volume (low level on to pumps off)

D = Gallons per minute (pump rate)

OK _____ Revise _____ NA _____

Comment:

Appendix D

Valve Vaults

The vault should have provisions for dewatering. The floor may have a french drain. Drain piping which discharges to the wet well may be installed, however some provision to prevent wet well gasses from flowing back to the valve vault must be included, e.g., plumbing trap. If a sump pump is installed the design must preclude freezing.

OK _____ Revise _____ NA _____

Comment:

Ventilation

Where the pumps are located below the ground surface, mechanical ventilation is required in dry wells.

OK _____ Revise _____ NA _____

Comment:

There shall be no interconnection between the wet well and dry well ventilation system and air intakes should be as far away from vents as possible.

OK _____ Revise _____ NA _____

Comment:

Continuous ventilation shall provide at least 6 complete air changes per hour.

OK _____ Revise _____ NA _____

Comment:

Intermittent ventilation shall provide at least 30 complete air changes per hour. Intermittent systems shall be activated upon entrance into the dry well.

OK _____ Revise _____ NA _____

Comment:

Appendix D

Flow Measurement

Running time meters, which may be used to estimate flow, should be included.

OK____Revise____NA____

Comment:

At larger pump stations, average daily flows in excess of one MGD, flow meters should be installed to provide accurate flow data.

OK____Revise____NA____

Comment:

Pressure Tests

Upon completion of construction of the force main, including backfill and all trench compaction a pressure test shall be performed upon the entire force main.

OK____Revise____NA____

Comment:

Bypass Line

If an emergency overflow line is installed it must discharge to the surface, it shall not discharge into a storm sewer pipe.

OK____Revise____NA____

Comment:

Include a flap gate or similar device to prevent the entrance of animals and it shall discharge at a location that is easily visible.

OK____Revise____NA____

Comment:

Appendix D

Force Mains

At the operational pumping rate a velocity of two (2) to eight (8) feet per second shall result in the force main.

OK _____ Revise _____ NA _____

Comment:

The minimum force main diameter for raw wastewater shall be 4 inches except when grinder pumps are utilized.

OK _____ Revise _____ NA _____

Comment:

An air relief or an air/vacuum relief valve should be located at high points along the course of the force main in which the design engineer anticipates the need for such valves to prevent air locking or excessive negative pressures within the force main.

OK _____ Revise _____ NA _____

Comment:

The force main shall terminate at a manhole or other flow control structure.

OK _____ Revise _____ NA _____

Comment:

Thrust forces in pressurized pipelines shall be restrained or anchored to prevent excessive movement and joint separation under all projected conditions. Acceptable methods include thrust blocking and various types of restrained joints.

OK _____ Revise _____ NA _____

Comment:

Construction Materials

The design includes approved force main materials.

OK _____ Revise _____ NA _____

Comment:

Appendix D

- ☐ Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR) and Fittings, AWWA C900 or AWWA C905.
- ☐ Ductile Iron Pressure Pipe, ANSI A21.50 and ANSI A21.10.
- ☐ Approved alternative (Additional materials may be approved by the UG on a case by case basis).

Reviewer Signature _____

Reviewer Title _____

Date _____

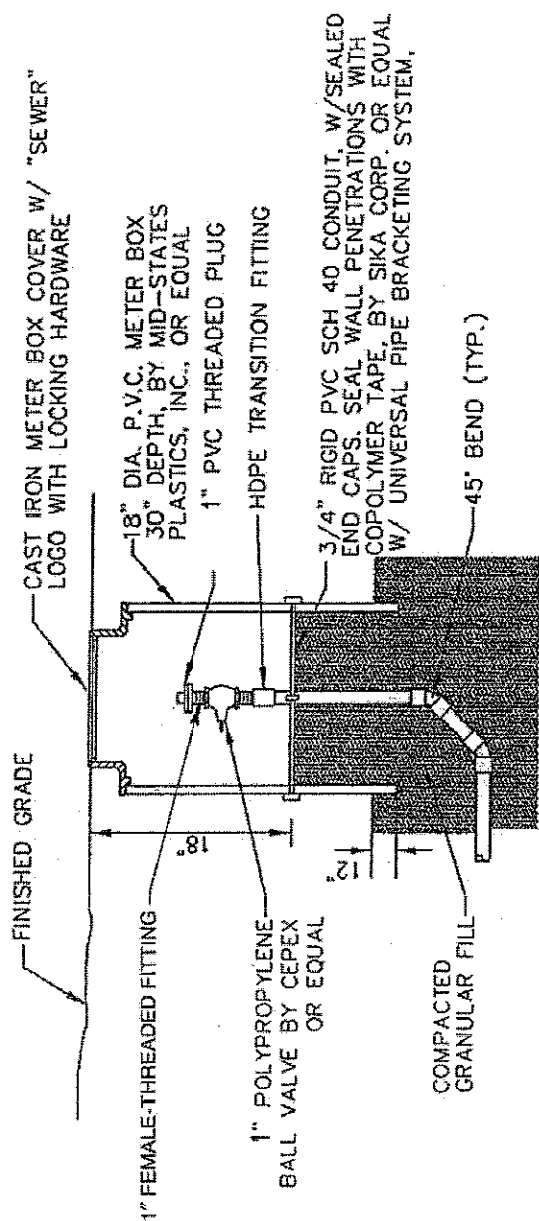
Branch Analysis Example

Name of Project:
Engineer:
Date:
Pipe Material:

[illegible]

Appendix F

F End Flushing Assembly Detail



END FLUSHING ASSEMBLY

Appendix G

G Grinder Pump Station Sample Specification

DIVISION 11 - EQUIPMENT

SECTION 11200 - PACKAGE GRINDER PUMP STATION

PART 1 GENERAL

1.1 SCOPE:

All equipment under this section will be provided by Owner. Contractor shall be responsible for all work associated with taking delivery, handling, storage and protection, installation, startup, field testing, and coordination of manufacturer's field services.

Equipment will be manufactured by Environment/One Corporation, Model 2000 Series.

PART 2 PRODUCTS

2.1 OPERATING CONDITIONS:

- A. The pumps shall be capable of delivering 15 gpm against a total dynamic head of 0 feet (0 psig) and 9 gpm at 138 feet (60 psig) without overloading the motor nameplate amperage. The pumps must also be able to operate at negative heads without overloading the motors.
- B. The grinder pump stations shall be of simplex or duplex design as indicated on the drawings. All pump motors shall be of the same horsepower throughout the project area.
- C. Characteristics of the liquid to be pumped are as follows:
 - 1. Domestic wastewater

2.2 GENERAL CONSTRUCTION

- A. Pump and Appurtenances:
 - 1. Pump

The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. The rotor shall be through-

Appendix G

hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specifically compounded ethylene propylene synthetic elastomer. The material shall be suited for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, good aging properties, and outstanding wear resistance.

2. Grinder

The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one piece stainless steel motor shaft. The grinder impeller assembly shall be securely fastened to the pump motor shaft. The grinder shall be of the rotating type with a stationary hardened and ground stainless steel shredding ring spaced in accurate close annular alignment with the driven impeller assembly, which shall carry two hardened type 400 series stainless steel cutter bars.

This assembly shall be dynamically balanced and operate without the noise level exceeding 60 dB over the entire range of recommended operating pressures. The grinder shall be constructed so as to eliminate clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:

- a. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
- b. The inlet shroud shall have a diameter no less than 5 inches.
- c. At maximum flow rate, the velocity through the cutting mechanism must not exceed 4.0 feet per second.
- d. The impeller mechanism must rotate at a nominal speed no greater than 1800 rpm.

The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects", such as paper, wood, plastic, glass, rubber and the like, to finely divided particles which will pass freely through the passages of the pump and the 1-1/4 inch diameter discharge piping.

Appendix G

3. Tank and Integral Access way

Model 2010 High Density Polyethylene Construction. The tank shall be made of high density polyethylene, with a melt index of 2.0 grams/10 minutes or lower to assure high environmental stress cracking resistance. Corrugated sections are to be made of a double wall construction with the internal wall being generally smooth to promote scouring. Corrugations of outside wall are to be of a minimum amplitude of 1-1/2 inch to provide necessary transverse stiffness. Any incidental sections of a single wall construction are to be a minimum 1/4 inch thick. All seams created during tank construction are to be thermally welded and factory tested for leak tightness. Tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to maximum external soil and hydrostatic pressure.

The tank shall be furnished with one EPDM grommet fitting to accept a 4.50 inch OD sewer pipe (SDR 35 and SDR 26). Tank capacities and dimensions shall be as indicated in the purchase order.

The access way shall be an integral extension of the wet well assembly and include a tamper-proof cover assembly providing low profile mounting and water tight capability. Access way design and construction shall enable field adjustment of station height in increments of 4 inches or less.

The station shall have all necessary penetrations molded in and factory sealed. No field penetrations shall be acceptable.

All discharge piping shall be constructed of 304 series stainless steel and terminate outside the access way bulkhead with a stainless steel, 1 1/4 inch female NPT fitting. The discharge piping shall include a stainless steel ball valve rated for 200 psig. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.

The access way shall include a single NEMA 6 electrical quick disconnect for all power and control functions, factory installed with access way penetrations warranted by the manufacturer to be watertight. The access way shall also include a 2 inch PVC vent to prevent sewage gas from accumulating in the tank.

Appendix G

Models 2012 & 2014 High Density Polyethylene Construction.

The tank shall be made of rotationally molded high density polyethylene, with a melt index of 2.0 grams/10 minutes or lower to assure high environmental stress cracking resistance. The tank shall have a nominal thickness of ½ inch. All seams created during tank construction are to be thermally welded and factory tested for leak tightness. Tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to maximum external soil and hydrostatic pressure.

The tank shall be furnished with one EPDM grommet fitting to accept a 4.50 inch OD pipe. Tank capacities and dimensions shall be as indicated on the purchase order.

The access way shall be an integral extension of the wet well assembly and include a lockable cover assembly providing low profile mounting and watertight capability. Access way design and construction shall facilitate field adjustment of station height in increments of 4 inches or less without the use of any adhesives or sealants requiring cure time before installation can be completed.

The station shall have all necessary penetrations molded and factory sealed. No field penetrations shall be acceptable.

All discharge piping shall be constructed of 304 series stainless steel and terminate outside the access way bulkhead with a stainless steel, 1 1/4 inch female NPT fitting. The discharge piping shall include a stainless steel ball valve rated for 200 psig. The bulkhead penetration shall be factory installed and warranted by the manufacturer to be watertight.

The access way shall include a single NEMA 6 electrical quick disconnect for all power and control functions, factory installed with access way penetrations warranted by the manufacturer to be watertight. The access way shall also include a 2 inch PVC vent to prevent sewage gases from accumulating in the tank.

Models 2015 & 2016 Fiberglass Reinforced Polyester Resin.

The tank shall be custom molded of fiberglass reinforced polyester resin and shall be furnished with one inlet grommet to accept a 4.50 inch OD pipe. Tank capacities and dimensions shall be indicated in purchase order.

Appendix G

The access way shall be an integral extension of the FRP tank and shall be made of high density polyethylene of a grade selected for environmental stress cracking resistance. It shall have an access opening at the top to accept a lockable fiberglass cover.

4. Core Unit

The Grinder Pump Station shall have cartridge type easily removable core assemblies containing pump, motor, grinder, all motor controls, check valve, anti-siphon valve, electrical quick disconnect and wiring. The watertight integrity of each core unit shall be established by 100% factory test at a minimum of 5 psig.

5. Mechanical Seal

The core shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring.

6. Valves

- a. Check Valve: The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the stainless steel discharge piping. The check valve shall provide a full-port passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Working parts shall be made of a 300 series stainless steel and fabric reinforced synthetic elastomer to ensure corrosion resistance, dimensional stability, and fatigue strength. A non-metallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a back pressure of less than 1.0 psig. The valve body shall be an injection molded part made of glass filled PVC.
- b. Anti-Siphon Valve: The pump shall be constructed in a positively-primed flooded suction configuration. As added assurance that the pump cannot lose prime, even under negative pressure conditions in the discharge piping system, the pump shall be equipped with a factory installed, integral anti-siphoning air relief valve, in the discharge piping immediately below the check valve. This valve shall automatically open when the pump is off.

Appendix G

7. Electrical Motor

As a maximum, the motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, squirrel cage induction type with a low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. The motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc., for the application.

8. Controls

All necessary controls shall be located in the top housing of the core unit. The top housing shall be attached with stainless steel fasteners.

Non-fouling wastewater level detection for controlling pump operation shall be accomplished by monitoring the pressure changes in an integral air-bell level sensor connected to a pressure switch. The level detection device shall have no moving parts in direct contact with the wastewater. High-level sensing shall be accomplished in the manner detailed above by a separate air-bell sensor and pressure switch of the same type.

To assure reliable operation of the pressure sensitive switches, each core shall be equipped with a breather assembly, complete with a suitable means to prevent accidental entry of water into the motor compartment. The grinder pump shall be furnished with a length of 6 conductor 14 gauge, type SJOW cable, pre-wired and watertight to meet UL requirements.

9. Alarm/Disconnect Panel

Each grinder pump station shall include a NEMA 3R, Alarm/Disconnect Panel. The audio alarm shall be a printed circuit board in conjunction with an 86 dB buzzer with quick mounting terminal strip mounted in the interior of the enclosure.

PANEL shall suitable for wall or pole mounting. The enclosure shall include a hinged, pad lockable cover, secured dead front and component knockouts.

Appendix G

For each core, the panel shall contain one (1) 15 amp, double pole circuit breaker for the power circuit and one (1) 15 amp single pole circuit breaker for the alarm circuit. The panel shall contain terminal blocks, integral power bus, push to run feature and a complete alarm circuit. The panel shall also include a receptacle for connection of a portable auxiliary power generator.

The Alarm/Disconnect Panel shall include the following features: audio & visual alarm, push to run switch, and high level (redundant) pump starting control. The alarm sequence shall be as follows:

- a. When liquid level in the sewage wet-well rises above the alarm level, visual and audio alarms are activated. The contact on the alarm pressure switch closes. The redundant pump starting system is energized.
- b. The audio alarm may be silenced by means of an externally mounted, push-to silence button.
- c. Visual alarm remains illuminated until the sewage level in the wet-well drops below the "off" setting of the alarm pressure switch.

The visual alarm lamp shall be inside a red fluted lens at least 2 5/8 inch in diameter and 1 11/16 inch in height. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 3R rating. For duplex units, in addition to the above, two high level indicator lights shall be mounted behind the access cover.

During high level alarm conditions the appropriate light will illuminate to indicate which pump core requires servicing.

The audio alarm shall be capable of being de-activated by depressing a push-type switch which is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure.

10. Corrosion Protection

All materials exposed to wastewater shall have inherent corrosion protection i.e., cast iron, fiberglass, stainless steel, PVC. Any exterior steel surfaces are to be suitably protected against corrosion. Galvanized steel is prohibited. Connections between dissimilar metals shall be insulated to prevent galvanic corrosion.

11. Serviceability

Appendix G

The grinder pump core unit shall have two lifting hooks complete with nylon lift-out harness connected to its top housing to facilitate easy core removal when necessary. All mechanical and electrical connections must provide easy disconnect accessibility for core unit removal and installation. A push to run feature will be provided for field trouble shooting. All motor control components shall be mounted on a readily replaceable bracket for ease of field service.

12. Safety

The grinder pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired grinder pump in its tank shall be listed by Underwriters Laboratories, Inc.

13. Manuals

The equipment shall be furnished to the Owner with three copies of detailed wiring diagrams, operation and maintenance manual, and detailed installation instructions for each type of unit.

PART 3 EXECUTION

3.1 INSTALLATION

Installation procedures shall be as recommended by the pump manufacturer, the Hydraulic Institute Standards, and as required herein.

3.2 FACTORY PERFORMANCE TESTING

Each grinder pump core shall be submerged and operated for 5 minutes (minimum). Included in this procedure will be the testing of all appurtenances components such as, the anti-siphon valve, check valve, discharge piping, level sensors, each unit's dedicated controls, respective alarm/disconnect panel, etc. All factory tests shall incorporate each of the above listed items. Actual appurtenances and motor controls which will be installed in the field, shall be particular to the tested pump. A common set of appurtenances and motor controls for all pumps will not be acceptable. Certified test results shall be supplied showing the operation of each grinder pump at two (2) different points on its curve, with the maximum pressure no less than 60 psi.

3.3 MANUFACTURER'S INSTALLATION AND START-UP SERVICES

Manufacturer shall provide a factory-trained technician to perform installation, start-up, and field testing services prior to acceptance by the Owner. Services shall include: (1) train Contractor on proper installation of equipment, (2) train

Appendix G

Contractor on proper testing procedures, (3) inspect all installations and review all test results. All equipment and materials necessary to perform testing shall be the responsibility of the Contractor. This will include, as a minimum, a portable generator (if temporary power is required), ammeter, and water in each basin.

Upon completion of the start-up and testing, the Contractor shall obtain from Manufacturer and submit to the Engineer the Manufacturer's start-up authorization form describing the results of the tests performed for each grinder pump station tested, and bearing the signature of the manufacturer's authorized technician, signifying approval of the installation and test results. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed.

3.4 WARRANTY AND GUARANTEE

The Manufacturer shall provide the following warranty from the Substantial Completion of the project. The warranty shall be a full parts-and-labor warranty for pump core assembly, basin, wiring and panel, including diagnostic time, beginning at the date of Substantial Completion of the project and according to the following schedule. This schedule represents the manufacturer's responsibility for parts and labor on warranty items with the balance due by the Owner.

<u>Year</u>		
1	100%	Required Warranty
2	100%	Required Warranty
3	100%	Extended Warranty
4	100%	Extended Warranty
5	87.5%	Extended Warranty
6	75%	Extended Warranty
7	62.5%	Extended Warranty
8	50%	Extended Warranty
9	37.5%	Extended Warranty
10	25%	Extended Warranty

END OF SECTION 11200

Appendix H

H Electrical Wiring and Connection Sample Specification

DIVISION 16 – ELECTRICAL

SECTION 16000 - ELECTRICAL REQUIREMENTS FOR PACKAGE GRINDER PUMP STATIONS

PART 1 GENERAL

- 1.1 SCOPE: Electrical work can be generally summarized, but not limited to, the following:
 - A. Installation of wiring connections to equipment specified in other Divisions.
 - B. Complete installation of wiring, and other electrical systems as specified in individual work sections of Division 16.
- 1.2 SYSTEMS TO BE INSTALLED:
 - A. The work covered by this specification shall include furnishing all labor, materials, equipment and services required to construct and install the complete electrical system shown on the accompanying plans and specified herein. This work shall include but not be limited to the following:
 - 120/240 VAC, single-phase, 60 Hertz, 3-wire, service for grinder pump stations.
 - Grounding systems.
 - Control systems.
 - B. This project will require the temporary removal of the customer electric service meter at each location where a grinder pump station will be installed. The Contractor will be required to contact the local utility company and make arrangements for the temporary removal of each service meter and the reinstallation of this service meter. The Contractor shall also coordinate with the individual electrical service customers to minimize inconvenience to the customers. Failure to properly coordinate this work could result in the Contractor being liable for loss of property and/or business revenue.
 - C. The installation of equipment and wiring shall be coordinated with the established construction schedule.
- 1.3 APPLICABLE STANDARDS:
 - A. National Electric Code (NEC)
 - B. American National Standards Institute (ANSI)

Appendix H

- C. National Electric Manufacturers Association (NEMA)
- D. Underwriters Laboratories, Inc. (UL)
- E. Institute of Electrical and Electronic Engineers (IEEE)

1.4 SUBMITTALS:

- A. Submit as specified in Division 1.
- B. Compliance submittals shall include but not be limited to the equipment and material manufacturers' catalog cuts, specifications and equipment drawings. All equipment normally supplied with nameplate data shall have such nameplate data submitted for approval.
- C. Where field support of equipment or materials is required, such materials and structures shall be detailed and submitted for review.

PART 2 PRODUCTS

2.1 GENERAL:

All materials shall be reasonably perfect, new materials of the best design, manufacture, quality and workmanship, free from defects, deterioration, abuse, mishandling or neglect. Industrial or specification grade materials are to be used throughout. Materials damaged or deteriorated from any cause whatsoever will not be permitted and shall not be used. All materials shall bear the Underwriters Laboratories, Inc., labels and markings.

2.2 RACEWAYS AND CONDUITS:

Unless otherwise noted, all raceways and conduits shall be hot-dipped, galvanized rigid steel. Raceway and conduit sizes shall be as indicated or required by the NEC for the number and size of conductors installed.

- A. Conduit: All conduit joints shall be cut square, threaded, reamed smooth and drawn up tight. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Exposed conduits shall be run parallel to and at right angles to building lines.
 - 1. Bends or off sets shall be made with standard conduit ells and fittings. Field bends shall be made with an approved bender or hickey.
 - 2. Metal conduit shall be continuous from box to box and shall be secured to all boxes with locknuts and bushings in such a manner that each system shall be electrically continuous throughout.

Appendix H

2.3 WIRES AND CABLES:

- A. Existing power cables shall be reused where in good condition and suitable for intended installations.
- B. Where new cables are required, comply with the following requirements:
 - 1. Provide electrical wires, cables, and connectors of manufacturers' standard materials, for the application indicated. Conductor material shall be copper, solid or stranded, No. 12 AWG, unless otherwise noted.
 - 2. Wiring shall be factory-fabricated wires of sizes, ampacity and ratings for the applications and services indicated. Conductor insulation shall be thermoplastic or cross-linked polyethylene. Insulation shall be rated type "THWN" (75°C) for dry and wet locations. Conductor insulation shall be rated for 600 volt AC operation.

2.4 BOXES AND FITTINGS:

- A. Provide electrical boxes and fittings as required for a complete electrical installation. Boxes shall be hot-dipped galvanized steel with galvanized steel covers. Hardware shall be cadmium plated or bronze screws and bolts. Indoor boxes shall be NEMA Type 1 enclosure with knockouts. Piano-hinged gasketed cover and interior mounting panel oil tight JIC boxes shall be provided for enclosing terminal blocks and control relays.
- B. Outdoor boxes shall be galvanized steel with drip lip and galvanized steel covers fastened with bronze or cadmium-plated screws and bolts or cast iron with galvanized finish and flanged bolted covers. Outdoor boxes shall be NEMA Type 3R enclosure with knockouts.

2.5 GROUNDING:

- A. Provide electrical grounding systems per NEC requirements, with assembly of materials, including cable/wires, connectors, terminals (solderless lugs), grounding rods/electrodes, bonding jumper braid, surge arrestors, and additional accessories needed for a complete installation. Ground conductors shall be solid for #4 AWG and smaller with ASTM Class B stranded in size #2 AWG and larger. Grounding rods shall be copper-clad steel, sizes as indicated on drawings. Exothermic welds are acceptable for welding wire to wire or wire to ground rods.
- B. Ground rods shall be driven such that top of rod is 6 inches below grade

Appendix H

- C. Installation of grounding system shall comply with recognized industry practices and shall be coordinated with other work in progress.

2.6 ELECTRICAL IDENTIFICATION:

- A. Underground-type plastic line markers shall be bright-colored, continuous-printed plastic tape, intended for direct-burial service and not less than 6 inches wide by 4 mils thickness and shall be used to identify buried location of cable. Cable/conductor identification bands shall be standard write-on type, vinyl cloth with a clear vinyl protective shield, self-adhesive cable/conductor marker of the wrap-around type, and shall be used to identify cable and/or wire terminations within the panel boards.

PART 3 EXECUTION

3.1 INSTALLATION OF BOXES AND FITTINGS:

- A. Installation of electrical boxes and fittings shall be as indicated and in accordance with the Manufacturer's written instructions and in accordance with recognized industry practices to fulfill project requirements. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached or solidly embed electrical boxes in concrete or masonry. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.

3.2 INSTALLATION OF RACEWAYS AND CONDUITS:

- A. No conductors or cables shall be installed in raceway system until the raceway system has been completed. Care shall be used to prevent damage to conductors or insulation. Cable lubricants shall be used as necessary. All conductors in each conduit shall be pulled-in simultaneously.
- B. All underground cables shall be continuous from origin to panel equipment termination, or intermediate pull or splice boxes. Where taps and splices are necessary and approved, they shall be made in approved splice boxes with suitable connectors as noted herein.
- C. All cable terminals, taps and splices shall be made secure with solderless pressure-type connectors or spring connectors unless otherwise specified. Splices shall be properly taped with vinyl plastic tape. Any splices made which are located in wet areas shall first use rubber tape covered with a vinyl plastic tape.

Appendix H

3.3 INSTALLATION OF ELECTRICAL IDENTIFICATION:

- A. Installation of electrical identification products shall be in accordance with the manufacturer's recommendations and with recognized industry practices.
- B. During backfilling/top-soiling of each exterior underground electrical cable, install continuous underground-type plastic line marker located directly over the buried line at 6 inches to 8 inches below the finished grade.

3.4 FIELD TESTING:

- A. Contractor shall provide all testing equipment required to perform electrical system checks and tests.
- B. Test all wire, cable and electrical equipment installed or connected to assure proper installation, setting, connection, and functioning as indicated. Conduct all tests, in the presence of the Engineer, Owner and manufacturer's field representative, if present. Contractor shall be responsible for all damage to equipment or material due to improper test procedures or test apparatus handling.
- C. Megger all 600 volt insulated wire with a 500 volt megger for one minute. The minimum resistance of the cable insulation shall be 1,000,000 ohms.
- D. Megger tests on cable shall be performed on installed systems not on the reel, and with motors and controls disconnected from the circuit.
- E. All electrical controls shall be tested by trial operation of the control equipment after all wiring is completed to see that each interlock and control function operates as indicated on schematic diagrams as well as with the manufacturer's operating instructions.

END OF SECTION 16000

Appendix I

I Low Pressure Sewer Preliminary Plan Submittal Review Checklist

Hydraulic Analysis

Complete branch analysis performed and submitted.

OK_____Revise_____NA_____

Comment:

Projected flow velocities greater than two (2) feet per second.

OK_____Revise_____NA_____

Comment:

All system pumps operating in a favorable portion of their pump curves.

OK_____Revise_____NA_____

Comment:

Retention time analysis performed and submitted.

OK_____Revise_____NA_____

Comment:

Predicted hydrogen sulfide levels submitted.

OK_____Revise_____NA_____

Comment:

General Layout

Existing sanitary sewer system shown with features such as pipe diameter, pipe material, pipe slopes, and manhole numbers shown.

OK_____Revise_____NA_____

Comment:

Appendix I

All lots to be served under ultimate build out conditions shown.

OK____Revise____NA____

Comment:

Proposed LPS alignment shown on the general layout sheet including length and diameter of each line and location of all LPS appurtenances.

OK____Revise____NA____

Comment:

Plan and Profile

All existing utilities shown and labeled in plan and profile views.

OK____Revise____NA____

Comment:

Existing and proposed grade elevations shown on profiles.

OK____Revise____NA____

Comment:

LPS mains shown in plan view with stationing and labeling.

OK____Revise____NA____

Comment:

Location ties provided for all pipe direction changes.

OK____Revise____NA____

Comment:

LPS mains extend to project property boundary to extend future service to adjacent areas with no direct access to the sanitary sewer system.

OK____Revise____NA____

Comment:

Appendix I

All reinforce concrete encasements and riprap protection areas shown.

OK_____Revise_____NA_____

Comment:

The pump discharge lines are shown properly stationed and labeled and are not less than five feet from any property line.

OK_____Revise_____NA_____

Comment:

The pump discharge line layout is not beneath an existing or proposed improvement.

OK_____Revise_____NA_____

Comment:

The pump discharge line connection to the low pressure main is shown.

OK_____Revise_____NA_____

Comment:

The discharge line terminates at ball and check valves located adjacent to the low pressure main easement.

OK_____Revise_____NA_____

Comment:

The discharge line valve locations are provided.

OK_____Revise_____NA_____

Comment:

Septic tanks and sanitary sewer service lines for existing affected buildings shown.

OK_____Revise_____NA_____

Comment:

Appendix I

All pumping units and system appurtenances shown with stationing and labeling.

OK_____Revise_____NA_____

Comment:

Interior flow angle between incoming low pressure main and existing gravity line at the receiving manhole exceeds ninety (90) degrees.

OK_____Revise_____NA_____

Comment:

Receiving manhole shown receiving protective interior lining. Appropriate protective lining note is shown.

OK_____Revise_____NA_____

Comment:

LPS Detail

Appropriate details are shown.

OK_____Revise_____NA_____

Comment:

Call out for either underground detectable tape or tracer wire is shown.

OK_____Revise_____NA_____

Comment:

Easements

All low pressure mains shown in an easement or right-of-way.

OK_____Revise_____NA_____

Comment:

Appendix I

Preliminary plats, draft easements and executed service agreements submitted.

OK____Revise____NA____

Comment:

Technical Considerations

Verify that LPS systems were accepted as part of the preliminary plat review.

OK____Revise____NA____

Comment:

Minimum depth of bury of forty two (42) inches over top of pipe maintained.

OK____Revise____NA____

Comment:

Pipe materials and wall thicknesses are appropriate.

OK____Revise____NA____

Comment:

Design includes reinforce concrete encasements and riprap protection where required.

OK____Revise____NA____

Comment:

Cleanout and flushing stations included where required.

OK____Revise____NA____

Comment:

Air release, air/vacuum and/or combination valves included where required.

OK____Revise____NA____

Comment:

Connection of low pressure main to receiving manhole meets design guidelines.

Appendix I

OK____Revise____NA____

Comment:

Manhole lids for new manholes comply with Technical Provision guidelines.

OK____Revise____NA____

Comment:

Grinder pump stations are manufactured by an acceptable manufacturer.

OK____Revise____NA____

Comment:

Grinder pump station locations comply with requirements.

OK____Revise____NA____

Comment:

Alarm/disconnect panel location is in compliance with requirements.

OK____Revise____NA____

Comment:

Reviewer Signature_____

Reviewer Title _____

Date _____

Appendix J

J Lighting Panel Checklist

Unified Government of Wyandotte County and Kansas City Kansas Existing Lighting Panel Checklist

Property Owner _____ Property Address _____ Owner Telephone _____	NORMAL POWER SOURCE TYPE _____
---	---

☐ 100 AMP SERVICE AND ABOVE ☐ 240V/120V _____

1 ☐ Spare 20 Amp, 2 Pole Breaker

Lighting Panel Information

Manufacturer _____
 Model Number _____
 Breaker Type _____
 Main Breaker Size _____ Amp

2 ☐ Space for 20 Amp, 2 Pole Breaker

☐ Obtain New 20 Amp, 2 Pole Breaker
 Manufacturer _____
 Model _____

☐ Existing Four 20 Amp, 1 Pole Breakers
☐ Existing Four 15 Amp, 1 Pole Breakers
☐ Existing Two 20 Amp, 1 Pole Breakers
 Two 15 Amp, 1 Pole Breakers

☐ Panel can accept dual element Breakers
 Manufacturer _____
 Model 2-20A, 1P. _____
 2-15A, 1P. _____
 1-20A, 2P. _____

3 ☐ Obtain Two 2-20A, 1P Breakers
 One 1-20A, 2P Breaker

4 ☐ Obtain Two 2-15A, 1P Breakers
 One 1-20A, 2P Breaker

5 ☐ Obtain One 2-20A, 1P Breakers
 One 2-15A, 1P Breaker
 One 1-20A, 2P Breaker

☐ 60 AMP SERVICE OR 100 AMP W/O MODIFICATION METHODS
☐ 240V/120V _____

6 ☐ Space to tap load side service conductors in meter box

7 ☐ Meter box contains second on load side for connection

8 ☐ New meter box needed

☐ New cables to lighting panel
☐ New conduit to lighting panel