Section 1

DESIGN CRITERIA

Section 1.1

DESIGN PROCEDURES

1.1.1 Contract Documents and Standard Technical Specifications – Standard Contract Documents shall be used on all City projects except for State or Federal funded projects, developer projects or those projects specifically exempted by the City Engineer. When additional documents are required for specially funded projects, they will be provided by the Project Engineer.

The City of Topeka/Shawnee County "Standard Technical Specifications", including all current revisions, shall be used on all projects except those projects for which a special funding source requires the use of other specific specifications.

1.1.2 Project Document Submittal - The following table gives the number of sets of project documents to be submitted at appropriate stages unless otherwise indicated:

	City or County Administered Project	Developer Project	KDOT Administered Project *	Utility Companies (each)
Concept	3		3	
Field Check	3	3	3	1
Right-of-Way Plans	3		3	
Office Check	3❶	3❶	3	1
Final Plans	3	7(2)❷	3	
Bidding Documents	20❸(3)❷		3(2)❷	
As Built Drawings	1	1	1	

❶ 1 additional set of plans and title sheet shall be submitted for all projects which need KDHE approval.

❷ The number within the parenthesis is the number of additional half-size plan sets which are to be submitted.

❸ Drawings - 20 sets, Manuals - 27 sets

* Additional sets of project documents shall be submitted to KDOT in accordance with their design requirements.

The project documents shall include the following items at each respective stage:

Concept - title sheet marked "Concept"; plan and profile sheets showing existing topography and proposed horizontal and vertical alignments; and typical sections.

Field Check - title sheet marked "Field Check"; typical sections; plan and profile sheets showing horizontal and vertical alignment, all associated improvements, existing utilities, existing right-of-way, and proposed right-of-way, permanent easements and temporary easements; drainage plan; cross sections, and a construction cost estimate.

Right-of-Way Plans - title sheet marked "Right-of-Way Plans"; plan and profile sheets showing horizontal and vertical alignment, all associated improvements, existing utilities, existing right-of-way, proposed right-of-way, permanent easements and temporary easements; typical sections; and cross sections.

Office Check - title sheet marked "Office Check"; drainage plan; typical sections; plan and profile sheets showing horizontal and vertical alignment, all associated improvements, existing utilities, existing right-of-way, proposed right-of-way, permanent easements and temporary easements, and all construction notes; intersection plan details including curb return profiles; geometric/paving details; cross sections; all standards; a construction cost estimate, and a project manual.

Final Plans - completed plans; project manuals; construction cost estimate; title sheet with Design Engineer's seal affixed; all permits including, but not limited, to KDHE, NPDES, DWR, and Corps of Engineers.

Bidding Documents -
Before the project can be advertised, Document 020, "Invitation to Bid", must be emailed to the Contracts & Procurement office. No later than the date of the first advertisement of the project to bid, the following number of contract documents must be provided: 20 sets of approved plans; and 27 sets of approved project manuals (20 sets with bidding pull-outs).

To be provided to the Engineering Division at least 48 hours prior to the bid date: the signed and sealed Engineer's Estimate and 10 – 8 1/2” x 14” bid tab sheets;

As Built Drawings - 1 set of full-size blue line prints of the Final Plans modified to show all changes made during construction and marked "As Built" and one CD disk of the “As Built” drawings.

1.1.3 Subsurface Investigation - Subsurface exploration shall be required to determine the locations of any rock ledges and the associated rock excavation quantity, the presence and relative quantity of ground water, the soil bearing capacities, the pavement design parameters, and any other, project specific, geotechnical requirements which may be deemed necessary. The boring information shall be shown on Field Check and subsequent plans.

1.1.4 Utility Location and Coordination – All new utility construction undertaken within the City limits must be installed underground. Temporary exceptions may be granted by the City Public Works Director for emergencies or for short term building construction. Permanent exceptions may also be allowed as outlined in Sec. 130-693 of the City Code. It is the City’s intent

that each utility occupies a specific location within the right-of-way. Refer to Model ROW Corridor Sheets 1-4 in Section 3.1, Standard Detail Drawings, for designated utility locations for different right-of-way/easement situations.

The following procedure shall be followed to identify and resolve existing utility conflicts:

1. The Design Engineer, after consultation with each utility company, will be required to indicate on the plans accurate locations, both horizontally and vertically, of all utilities located within the construction limits. Each utility company shall provide the Design Engineer with adequate assistance and information to accurately determine said locations, including maps, charts, and records, as well as flagging, marking in the field, probing, or actual exposure of the utility line.

2. Upon completion of the field check plans, the Design Engineer shall submit one set of "Utility Field Check Plans" along with a "Project Utility Conflicts List, Form A", which identifies locations of potential conflicts to each utility company. Included in this submittal will be a tentative project letting date established by the City Engineer.

3. The utility companies shall review the "Utility Field Check Plans" and "Project Utility Conflicts List" and verify their facilities are all inclusive and accurately located, both horizontally and vertically. After this review, the utility companies shall identify on the "Utility Field Check Plans" a proposed alignment for facilities which have been identified as being in conflict with the project. The "Project Utility Conflicts List" shall be completed by indicating a proposed resolution to the conflict and a timetable for completion of proposed remedial action. The set of marked "Utility Field Check Plans" and a completed, signed and dated copy of the "Project Utility Conflicts List" shall be returned to the Design Engineer within 3 weeks of their receipt. The utility companies are to notify the Design Engineer of any pre-existing easements they have within the project limits.

4. The Design Engineer shall then schedule a utility coordination meeting between all parties involved to discuss the potential conflicts, the proposed remedial actions, and tentative relocation timetable.

5. Upon completion of the office check plans, the Design Engineer shall submit one set of "Utility Office Check Plans" with each conflict and remedial action clearly identified on the plans, along with a "Project Utility Conflicts List" which identifies conflicts, to each utility company. Included in this submittal will be an update on the scheduled letting date, as determined by the City Engineer.

6. Each utility company shall submit a firm timetable for the initiation

and completion of proposed relocation work which satisfies the date established by the City Engineer for utility relocation.

7. If it is determined by the City Engineer that it will be impractical for a utility company to relocate part of their conflicting facility prior to construction, it shall be the utility company's responsibility to submit to the Design Engineer a detailed description of relocation work proposed to be completed during construction and a firm timetable for that work. The Design Engineer will include this information in the project manual as a "Supplementary Condition".

1.1.5 "As Built" Drawings - All projects within the City must have "As Built" drawings prepared and submitted to the Project Engineer by the Design Engineer. These "As Built" drawings shall be a full-size blue line set of the Final Plans, marked "As Built", and modified to reflect all changes made during construction. A CD must also be submitted for as-built plans in pdf format.

The Engineer performing construction staking services shall be responsible for measuring "As Built" sanitary sewer and storm sewer flowline elevations and top of manhole and inlet elevations, located vertically into the NAVD29. Vertical (elevation) error tolerance will be less than 0.1 foot. Structure locations must be corrected to reflect as-built locations with coordinates located horizontally into the state plane coordinate system, NAD83, Kansas North Zone. Horizontal location error tolerance will be less than 0.2 foot. All other field modifications should also be documented. The project construction inspector shall be responsible for preparing red-marked plans that reflect field modifications made during construction with information obtained from the construction staking party, and shall be delivered to the Design Engineer for preparation of "As-Built" plans.

1.1.6 - Developer Plan Approval - When developer project plans are submitted for approval, they must be accompanied by a copy of a letter to the developer from the Design Engineer advising the developer that prior to the City's acceptance of the project for maintenance, all fees charged to the project by the City shall be paid by the developer. Fees charged are for such items as Plan Review, Construction Inspection, Material Testing and Sewer Line Televising by Water Pollution Control. The Design Engineer must include a construction cost estimate when submitting developer project plans for approval. The submittals for a developer project must be reviewed by the Project Engineer for general compliance with the project plans before a pre-construction meeting will be held. The City accepts no responsibility for any improvements until all work is completed, all fees are paid, and the project is accepted for maintenance.

1.1.7 -- Spatial Data Delivery Standards

All data layers developed by the consultant and used on a project that has a GIS/Spatial data component must include the following:

1) Should be submitted in one of the following Format – ESRI ARCINFO export format with no compression(*.E00), AutoCAD dxf format or ESRI shapefile format which contains at least (.shp,.shx., .dbf) files.

2) Coordinate system -- All data will use the following coordinate system – Horizontal Datum: North American Datum 1983(NAD83), Kansas North Zone. Vertical Datum: North American Vertical Datum 1929(NAVD29); Units are in feet.

3) Metadata -- All data layers must have metadata that conforms to the Federal Geographic Data Committee Standards (FGDC); see references below.

4) Media – All information will be written to CDROM, using ISO9000 standard and include documentation describing the files contained on the CDROM.

Federal & State Spatial Data Transfer Standard:

http://www.fgdc.gov/standards/projects/FGDC-standards-projects/SDTS/index_html

http://www.fgdc.gov/metadata/geospatial-metadata-standards

1.1.8 – Survey Control Monuments

Records showing available local survey control monuments for NAD83 and NAVD29 are available from the Office of the City of Topeka Public Works/Engineering Division/Design-Records Section. The records for NGVD29 survey monuments are also available on the City of Topeka website at www.topeka.org/department/public_works/benchmarks/.

1.1.9 -- Construction Stormwater Permit

Any project or combination of projects where construction activities will disturb one (1) or more acres must receive authorization to discharge stormwater runoff under the Kansas Department of Health and Environment (KDHE) construction stormwater general NPDES permit. A project disturbing less than one acre may also require authorization to discharge stormwater runoff when KDHE believes the water quality impact warrants consideration.

Application for the construction stormwater permit is made by completing a Notice of Intent (NOI) form from the Kansas Department of Health and Environment and submitting it at least 60 days before starting construction. For projects located within City right-of-way and/or easements, the Design Engineer shall complete the NOI form for the City Manager to sign as permittee. For development projects located on private property, the developer is responsible for obtaining the permit to discharge stormwater runoff from the site. The permit fee for stormwater runoff from construction activities is $60 per year. The primary requirement of the general permit is that a Stormwater Pollution Prevention (SWP2) plan be developed and implemented. Some of the common methods used to prevent stormwater pollution are installation of silt fence and inlet protection. The purpose of the construction stormwater program is to protect the waters of the State from

contamination. When the soil disturbing activity is completed and final stabilization of the site covered by the NOI is achieved, the permittee must notify KDHE to terminate the authorization to discharge.

PROJECT UTILITY CONFLICT LIST

Project No:	**Description:**
Letting Date:	**Relocation Completion Date:**
Engineer:	**Contact:**
Utility:	**Contact:**
Design Stage:	**Date:**

Station	Offset	Utility Description	Conflict	Resolution	Relocation Date

List prepared by:

_____
Design Engineer

Conflicts investigated and proposed resolution noted by:

_____ Date:_____
Utility Representative

FORM A

Project Utility Coordination Meeting Agenda

Project No.:
Date:

Project Discussion:

1. Description
2. Timeframe

Utilities Affected:

	Conflicts	Station	Resolution	Relocation Date
1. Water				
2. Gas				
3. Electric				
4. Cable TV				
5. Other _____				

Other Items of Discussion:

Attendees:

Project Engineer ☐
City Traffic Engineer ☐
City Water Division Rep. ☐
Telephone Co. Representative ☐
Gas Co. Representative ☐
Electric Co. Representative ☐
Cable TV Representative ☐
Consultant ☐
Other_____ ☐

FORM B

CHECKLIST FOR DESIGN COORDINATION
PROJECT NO._____

PROJECT TYPE: CIP ☐ DEVELOPER ☐ BENEFIT DISTRICT ☐

THE FOLLOWING PARTIES HAVE BEEN CONTACTED FOR COORDINATION WITH THIS PROJECT:

UTILITIES (FOR LOCATIONS OF EXISTING UTILITIES OR NEEDED RELOCATIONS):

☐ TELEPHONE

☐ GAS

☐ WATER

☐ ELECTRIC

☐ OTHER _____

GOVERNMENTAL AGENCIES (PERMITS OR APPROVALS):

☐ KANSAS DEPARTMENT OF TRANSPORTATION

☐ KANSAS TURNPIKE AUTHORITY

☐ SHAWNEE COUNTY PUBLIC WORKS

☐ DIVISION OF WATER RESOURCES

☐ CORPS OF ENGINEERS

☐ KANSAS DEPARTMENT OF HEALTH & ENVIRONMENT

OTHER INTERESTED PARTIES:

☐ ADJACENT PROPERTY OWNERS

☐ NEIGHBORHOOD ASSOCIATIONS

☐ SUPPLIERS _____

Section 1.2

STREET DESIGN CRITERIA

1.2.1 General - Streets are divided into five street functional classifications:

Principal Arterial
Minor Arterial
Collector
Minor Collector
Local

Street functional classification designations for streets are shown on the Topeka /Shawnee County Functional Classification Map. This map is available in the office of the Topeka Planning Department or at the City of Topeka website at www.topeka.org/planning/transportation_planning.shtml.

Work and materials shall conform to the City of Topeka/Shawnee County "Standard Technical Specifications" and all current revisions which is available at the City of Topeka website at www.topeka.org/publicworks/design_rightofway_section.shtml.

1.2.2 Minimum Right-of-Way Requirements - The following table provides the minimum right-of-way widths for each of the respective street functional classifications.

	Right-of-way Width (ft)
Principal Arterial	105
Minor Arterial	105
Collector	75
Minor Collector	75
Local:	
Residential Area	60
Industrial Area	75

The minimum local cul-de-sac right-of-way radius shall be 60 feet, measured from the radius point to right-of-way.

Additional minimum right-of-way requirements at intersections of principal arterials with principal arterials shall be as follows:

1. at each intersecting corner, a triangular area measuring 52 feet along two sides;
2. on the approach side of all intersection legs, a 12 foot wide strip with its long side measuring 202 feet from the right-of-way line of the cross street, followed by a 10:1 taper section;
3. on the departure side of all intersection legs, a 12 foot wide strip with

its long side measuring 52 feet from the right-of-way line of the cross street, followed by a 15:1 taper section

This criteria shall apply to:

1. Subdivision platting or replatting;
2. Acquisition or disposal of right of way in conjunction with improvement projects in areas platted or developed under former criteria.

1.2.3 Street Design Criteria - The following information is the street design criteria for each of the respective street functional classifications.

Deviations from this criteria may be permitted when it can be shown that strict adherence to the criteria would involve: irreparable damage to existing improvements of considerable value; unrealistically wide construction limits due to long backslopes; avoidable damage to valuable trees, shrubbery, and landscaping features; or other unusual circumstances making use of criteria unrealistic. Deviations from this criteria must be approved by the City Engineer.

All other elements of design shall be in accordance with "A Policy on Geometric Design of Highways and Streets" and all current revisions as published by the American Association of State Highway and Transportation Officials.

Principal Arterial:

Design Speed (mph)	40

Border Area is the area located between the back of curb and the right-of-way line.

Minimum Border Area (ft)	20

Additional Right-of-Way width may be required to accommodate the number of lanes plus a minimum border area on each side of the roadway.
Number of lanes shall be determined based on a capacity analysis.

Minimum Lane Width:

Through (ft)	11
Common Center Turn (ft)	12
Left or Right Turn Only (ft)	11

Alignment:

Percent Grade:	Minimum	0.6
	Maximum	6
Minimum K value:	sag vertical curve	64
	crest vertical curve	44
Cross Slope (in/ft)		0.375

Divisional Island (raised):

Min. Width (toe to toe of curb and gutter, type III) (ft)	7.5
Min. Length (ft)	100

Minor Arterial:

Design Speed (mph)	40

Border Area is the area located between the back of curb and the right-of-way line.

Minimum Border Area (ft)	20

Additional Right-of-Way width may be required to accommodate the number of lanes plus a minimum border area on each side of the roadway.
Number of lanes shall be determined based on a capacity analysis.

Minimum Lane Width:	
Through (ft)	11
Common Center Turn (ft)	12
Left or Right Turn Only (ft)	11
Alignment:	
Percent Grade: Minimum	0.6
Maximum	6
Minimum K value: sag vertical curve	64
crest vertical curve	44
Cross Slope (in/ft)	0.375
Divisional Island (raised):	
Min. Width (toe to toe of curb and gutter type III) (ft)	7.5
Min. Length (ft)	100

Collector:

Design Speed (mph)	35
Minimum Lane Width:	
Through (ft)	11
Common Center Turn (ft)	12
Left or Right Turn Only (ft)	11
Minimum Pavement Width (back to back of curb) (ft):	39

The minimum pavement width does not allow for on-street parking.

Alignment:	
Percent Grade: Minimum	0.6
Maximum: Residential Area	8
Industrial Area	6
Minimum K value: sag vertical curve	50
crest vertical curve	30
Minimum Horizontal Curve Radius (centerline) (ft)	545
Cross Slope (in/ft)	0.375

Minor Collector:

Design Speed (mph)	30
Minimum Lane Width (ft):	11

Minimum Pavement Width (back to back of curb) (ft):			39
Alignment:			
Percent Grade: Minimum			0.6
Maximum: Residential Area			10
Industrial Area			6
Minimum K value: sag vertical curve			40
crest vertical curve			20
Minimum Horizontal Curve Radius (centerline) (ft)		@ 30 mph	355
		@ 25 mph[1]	210
Cross Slope (in/ft)			0.375

The percent grade for the approach area where vehicles store while waiting to enter an intersection for a minimum tangent distance of 25 feet back from the PC or PT for the intersection return radius shall not exceed 3 percent.

Minimum intersection return radius (ft):	24

[1] Curves of radius less than 355 feet must be posted.

Local:

Design Speed (mph)	30
Minimum Pavement Width (back to back of curb):	
Residential Area (ft)	29
Industrial Area (ft)	41
Minimum Pavement Cul-De-Sac Radius (radius point to back of curb) (ft):	45
Maximum Cul-De-Sac Length (ft)	800*

*A maximum length of 1200 feet may be allowed if the cul-de-sac serves less than 30 houses or 300 trips/day. The cul-de-sac length is measured along the centerline of the cul-de-sac stem from the right-of-way line of the intersected street to the back of curb on the bulb at the intersection with the extension of centerline of the cul-de-sac stem.

Alignment:			
Percent Grade: Minimum			0.6
Maximum: Residential Area			10
Industrial Area			6
Minimum K value: sag vertical curve			40
crest vertical curve			20
Minimum Horizontal Curve Radius (centerline) (ft)		@ 30 mph	355
		@ 25 mph[1]	210
Cross Slope (in/ft)			0.375

The percent grade for the approach area where vehicles store while waiting to enter an intersection for a minimum tangent distance of 25 feet back from the PC or PT for the intersection return radius shall not exceed 3 percent.

Minimum intersection return radius (ft): 24

[1] Curves of radius less than 355 feet must be posted.

1.2.3.1 Sidewalks and Curb-Cut Ramps - Sidewalks shall be constructed on both sides of the street to a minimum width of 5' and located 1' inside of the right-of-way line for streets with a functional classification of Principal Arterial, Minor Arterial or Collector. Streets with a functional classification of Minor Collector or Local shall have sidewalks constructed on both sides of the street to a minimum width of 4' located one foot inside the right-of-way line. If the 4 feet minimum width is provided rather than 5 feet, a widened area must be provided at least every 200 feet for the passing of two wheelchairs. This requirement can be met by providing a modified section of sidewalk 8' long with the sidewalk tapered from 4' wide to 5' wide in a distance of 2' either side of the 5' wide section (see Ramp and Walk Details) or through a private driveway approach (see Miscellaneous Details).

The sidewalk cross slope shall be 2.0% maximum, sloped toward the street. The sidewalk cross slope shall be extended to the right-of-way line. The standard cross slope between the sidewalk and the back of curb is 1/2" per foot but may be modified with the approval of the City Engineer.Curb-cut ramps shall be provided at all crosswalks and shall be in accordance with the latest revisions of the Americans with Disabilities Act. Detectable warning areas on ramps will be used at street crossings and at commercial driveways. If there is a grade change along sidewalk approaching an alley (caused by a 6” curb, etc.), then the detectable warning areas should also be used in this situation.

1.2.3.2 Cutback Parking – Cutback parking will only be allowed on local streets with adjacent property zoned higher than residential or in front of a church. Additional right-of-way may be required to be dedicated so that the parking area and sidewalk are located within the right-of-way limits. In addition, the following requirements must be met:

- Corner setback must be a minimum of 40 feet and a minimum of 20 feet from a crosswalk if present or 30 feet from the crosswalk if a signal is present.
- The parking depth must be at least 18.5 feet with a curb radius of at least 10 feet.
- Parking stalls must be at least 9 feet wide if stalls are at 90 degrees. The stall width measured parallel to the street must

be at least 12.7 feet at 45 degrees, 10.4 feet at 60 degrees and 9.3 feet at 75 degrees.

- The parking area pavement thickness must be at least 6 inches of concrete.
- All work will be done at the property owner's expense including any utility adjustments.
- Once built, the cutback parking area is for public parking and can not be signed for a business.
- Sidewalk adjacent to curb must be a minimum width of 6 feet.
- An Agreement will be required between the property owner and the City indicating that the property owner will be responsible for maintaining the cutback parking area.

1.2.4 Pavement Design Criteria - The following information is the pavement design criteria for each of the respective street functional classifications. This criteria specifies methods and parameters which shall be used when designing pavement systems for streets. The criteria for principal arterials, minor arterials and collectors is summarized in Table 1.2-1, Pavement Design Criteria.

A geotechnical report that provides site-specific recommendations for the construction of all streets including subgrade treatment must be prepared and submitted to the City Engineer for review and approval. See Sec. 1.2.4.1. for geotechnical report requirements.

Deviations from this criteria may be permitted, or mandated by the City Engineer, based upon project specific circumstances. Deviations from this criteria must be approved by the City Engineer.

Principal Arterials:
Pavements for principal arterials shall be designed using the Highway Pavement Structural Design method, as described in the AASHTO Guide for Design of Pavement Structures. Information necessary to describe the site's subgrade shall be obtained from an approved geotechnical investigation. The following additional criteria shall be used in designing principal arterial pavements.

Analysis period	30 years
Reliability	90%
Initial serviceability	4.5
Terminal serviceability	2.5

Minor Arterials:
Pavements for minor arterials shall be designed using the Highway Pavement

Structural Design method, as described in the AASHTO Guide for Design of Pavement Structures. Information necessary to describe the site's subgrade shall be obtained from an approved geotechnical investigation. The following additional criteria shall be used in designing minor arterial pavements.

Analysis period	30 years
Reliability	90%
Initial serviceability	4.5
Terminal serviceability	2.5

Collectors:
Pavements for collectors shall be designed using the Highway Pavement Structural Design method, as described in the AASHTO Guide for Design of Pavement Structures. Information necessary to describe the site's subgrade shall be obtained from an approved geotechnical investigation. The following additional criteria shall be used in designing collector pavements:

Analysis period	25 years
Reliability	90%
Initial serviceability	4.5
Terminal serviceability	2.0

Minor Collectors:
Pavement thicknesses shall be six (6) inches for concrete (rigid) pavements or eight (8) inches for asphaltic concrete (flexible) pavements. These thicknesses are for pavements which are constructed on treated subgrade as specified in the Geotechnical Report and in accordance with Section 3, Earthwork and Grading, paragraph 7. Subgrade and 8. Subgrade Preparation, of the "Standard Technical Specifications". The following additional criteria shall be used in designing minor collector pavement:

Pavement Service Life:	25 years

Locals:
Pavement thicknesses shall be six (6) inches for concrete (rigid) pavements or eight (8) inches for asphaltic concrete (flexible) pavements. These thicknesses are for pavements which are constructed on treated subgrade as specified in the Geotechnical Report and in accordance with Section 3, Earthwork and Grading, paragraph 7. Subgrade and 8. Subgrade Preparation, of the "Standard Technical Specifications". The following additional criteria shall be used in designing local pavement:

Pavement Service Life:	25 years

1.2.4.1 Geotechnical Report – A geotechnical report that provides site-specific recommendations for the construction of public streets must be

submitted for all street or road functional classifications (principal arterials, minor arterials, collectors, minor collectors and locals).

The report must be approved before the project will be released for construction.

Prior to plan approval, the Project Engineer will require three (3) approved copies of the geotechnical report, sealed by a Kansas licensed Professional Engineer or a Kansas licensed Geologist.

At a minimum, the following items must be addressed in the report:

1) Suitable material shall be defined as entirely imperishable with that portion passing the No. 40 Sieve having a liquid limit not exceeding 40 and a plasticity index not exceeding 25 when tested in accordance with ASTM D 4318. The liquid limit is the water content of the soil at the change between the liquid and the plastic states and shall be tested in accordance with ASTM D4318. The plastic limit is the water content at the boundary between the plastic and semi-solid states as stated in ASTM D 4318-83. The plasticity index is the numerical difference between the liquid limit and the plastic limit. If the on-site soils do not meet these requirements, the geotechnical report must specify how the on-site soils will be modified to achieve these requirements. As an alternative, the geotechnical engineer may specify alternative liquid limits and/or plastic indices for consideration, provided adequate justification is given.

2) The report must identify and evaluate the on-site soils to be used for fill. The evaluation for on-site soils must include all the following as a minimum:
   i) Sieve analysis
   ii) USCS classification
   iii) Atterberg limits
   iv) Maximum dry density (ASTM D 698)
   v) Optimum moisture content
   vi) Moisture density curve (Standard Proctor)

3) The geotechnical report must clearly and precisely detail the soil treatment, placement, incorporation and compaction procedures to be used so that the treated subgrade will not pump or be deformed by loaded trucks hauling material to the paver. Details not specifically covered in the geotechnical report shall conform to the requirements specified in the latest edition of the "Standard Specifications for State Road and Bridge Construction", Kansas Department of Transportation.

1.2.4.2 Pavement Design Report - Prior to the final approval of plans for principal arterial, minor arterial or collector projects, a pavement design report shall be submitted detailing a rigid and a flexible pavement design with proposed subgrade treatment. Pavement system construction costs shall be

assigned to each design in the report. Also included in the report, shall be a complete listing of parameters used and assumptions made when the pavement system was designed. Geotechnical investigation reports shall be submitted as an appendix to the report.

TABLE 1.2-1

PAVEMENT DESIGN CRITERIA

Principal Arterials:

Analysis Period	Criteria - 30 years
Design ESAL's	Design Engineer
Reliability	Criteria - 90%
Overall Deviations	Design Engineer
Pavement Properties	Design Engineer
Subgrade Properties	Geotechnical Report
Serviceability Loss	Criteria - 2.0

Minor Arterials:

Analysis Period	Criteria - 30 years
Design ESAL's	Design Engineer
Reliability	Criteria - 90%
Overall Deviations	Design Engineer
Pavement Properties	Design Engineer
Subgrade Properties	Geotechnical Report
Serviceability Loss	Criteria - 2.0

Collectors:

Analysis Period	Criteria - 25 years
Design ESAL's	Design Engineer
Reliability	Criteria - 90%
Overall Deviations	Design Engineer
Pavement Properties	Design Engineer
Subgrade Properties	Geotechnical Report
Serviceability Loss	Criteria - 2.5

1.2.5 Access Management and Driveway Location Policy - The two criteria to be used for checking the design suitability for access by any driveway or street are: Location Criteria and Design Elements Criteria.

Deviations from this criteria may be permitted, with the approval of the City Engineer, when existing conditions preclude strict conformance. In those instances accepted engineering principles will be applied consistent with site conditions to achieve the best practical solution. The accepted solution should be that which conforms closest to the current design standards.

1.2.5.1 Location Criteria - The location criteria for an access point for a driveway or street is relative to the proximity of intersecting streets and driveways and defines the separation needed for the safety of the motorist.

The location of access points shall minimize conflicts with vehicle turning movements. The following information is the minimum location criteria applicable to each driveway or street, subject to the design elements criteria. This information is further divided into spacing criteria and corner clearance criteria.

1.2.5.1.1 Spacing - The following information is the minimum spacing criteria applicable to driveways or streets for accessing each respective street functional classification, subject to the design elements criteria. The spacing distance is measured from edge of pavement to near edge of pavement.

The minimum spacing of an intersecting street shall be 1 mile between any two parallel principal arterial or minor arterial and 1/4 mile between any two parallel collectors. Streets with street functional classifications lower than collector may intersect a principal arterial only under special conditions or topographic constraints.

Principal Arterial:
The minimum spacing between driveways shall be 500 feet if there is no raised median and 300 feet if there is a raised center median. No more than one access driveway will be allowed per lot, including contiguous lots under common ownership, unless additional access driveways would improve the safety and operation of the roadway. Direct private residential driveway access to arterial streets is not permitted unless there is no other reasonable access to the general street system.

No two intersections, public or private, on the principal arterial shall be closer than 500 feet.

Minor Arterial:
The minimum spacing between driveways shall be 300 feet with no raised median and 200 feet with a raised center median. No more than one access driveway will be allowed per lot, including contiguous lots under common ownership unless additional access driveways would improve the safety and operation of

the roadway. Direct private residential driveway access to arterial streets is not permitted unless there is no other reasonable access to the general street system.

No two intersections, public or private, on the minor arterial shall be closer than 300 feet.

Collector:
No two intersections, public or private, on the collector shall be closer than 200 feet. The maximum distance from any point on the collector to an intersecting street with a street functional classification higher than collector shall be 1 mile.

Minor Collector or Local:
Residential properties:
One driveway per parcel for parcels with less than 90 feet of frontage and 2 driveways per parcel for parcels with more than 90 feet of frontage. Additional driveways may be allowed if the average volume of traffic on the driveway exceeds 50 vehicles per day.

Non-residential properties:
One driveway for the first 135 feet of frontage, and an additional driveway for each additional 300 feet of frontage provided that the non-residential driveways are at least 80 feet apart from each other.

The minimum distance between any two street intersections on the minor collector or local shall be greater than 200 feet. The maximum distance from any point on the minor collector to an intersecting street with a street functional classification higher than minor collector shall be 1/2 mile.

The maximum block length between any two local street intersections shall be 1,200 feet. From any point on the local street, no more than three local-local intersections may be crossed before accessing a street with a street functional classification higher than local.

1.2.5.1.2 Corner Clearance - Corner clearance is the distance at the intersection approach of two streets that is reserved for the efficient operation of the intersection. The corner clearance is measured along the right-of-way line of the street onto which the driveway is accessing from the edge of pavement of the intersecting street to the near edge of the driveway.

The following tables provide the minimum corner clearance criteria applicable to each driveway or street for accessing each respective street functional classification.

Minimum Corner Distance (ft)
(Approach & Departure)

Right and Left Ingress and Egress Allowed

Principal Arterial	500
Minor Arterial	300
Collector	200
Minor Collector	80
Local	80

Minimum Corner Distance (ft)
(Approach & Departure)

Only Right Ingress and Egress Allowed

Principal Arterial	300
Minor Arterial	200
Collector	200
Minor Collector	80
Local	80

Streets or driveways with minimum corner distances which only allow for right turn ingress and egress must be designed with a driveway channelization median preventing left turn ingress and egress.

1.2.5.2 Design Elements Criteria - The following information is the minimum design elements criteria applicable to each driveway, subject to the location criteria. See Figures 1.2.5.2.1 through 1.2.5.2.3 for details.

1.2.5.2.1 Driveway Location - Residential driveways shall be located such that the entire driveway, including driveway flares, shall be contained within the property frontage extended at right angles to the curb. Exceptions may be allowed with written consent of any adjacent affected property owners.

Commercial driveways shall be located such that the entire driveway, including radii and any acceleration or deceleration lanes, shall be a minimum of 5 feet from the property line as measured along the curb between the property line extended at right angles to the curb and the point on the curb where the driveway radius intersects the curb.

1.2.5.2.2 Driveway Grade - The maximum driveway grade shall be 10 percent.

1.2.5.2.3 Driveway Flares or Radii - The driveway flares for a residential driveway shall be 5 feet. The allowable driveway radii for a two-way commercial driveway shall be a minimum of 15 feet and a maximum of 20 feet.

1.2.5.2.4 Driveway Width - The following table provides the allowable driveway widths for specific driveway types with access to specific street functional classifications. The driveway width is measured perpendicular to the centerline of the driveway. The preferred residential driveway width shall be used unless approved otherwise by the City Engineer.

Driveway Type	Minor Collector Local	Principal Arterial Minor Arterial Collector
Residential:		
Preferred	13 ft	13 ft
Minimum	10 ft	12 ft
Maximum	24 ft	24 ft
Commercial:		
Two-way:		
Minimum	25 ft	30 ft
Maximum	35 ft	35 ft

1.2.5.2.5 Curb Opening - The following table provides the allowable curb opening for specific driveway types with access to specific street functional classifications. The preferred residential driveway curb opening shall be used unless approved otherwise by the City Engineer.

Driveway Type	Minor Collector Local	Principal Arterial Minor Arterial Collector
Residential:		
Preferred	23 ft	23 ft
Minimum	20 ft	22 ft
Maximum	34 ft	34 ft
Commercial:		
Two-way:		
Minimum	55 ft	60 ft
Maximum	75 ft	75 ft

The preceding table specifies allowable curb opening information for a driveway which intersects the street at a 90 degree angle and does not incorporate a driveway channelization median preventing left turn ingress and egress.

1.2.5.2.6 Residential Driveway Angle of Intersection - A residential driveway may intersect the street at an acute angle which may vary from 90 degrees to a minimum of 45 degrees. The angle shall be that angle made by the centerline of the driveway with the centerline of the street or tangent to the centerline at the point of intersection, if located on a curve.

1.2.5.2.7 One-Way Commercial Driveway - The acute angle for the intersection of a one-way commercial driveway with the street may vary from 90 degrees to a minimum of 45 degrees. The angle shall be that angle made by the centerline of the driveway with the centerline of the street or tangent to the centerline at the point of intersection, if located on a curve. The driveway width for a one-way commercial driveway shall be 14 feet, if accessing a local or minor collector street, and 16 feet, if accessing a collector, minor arterial or principal arterial street. The driveway radii for a one-way commercial driveway shall be 5 feet for the driveway radius opposite the acute intersection angle and a minimum of 15 feet for the driveway radius opposite the obtuse intersection angle.

1.2.5.2.8 Speed Change Lanes - An acceleration or deceleration lane may be required in connection with driveways which access a principal arterial, minor arterial or collector. The following criteria shall be used to determine if an acceleration or deceleration lane is required. Deviations from this criteria may be permitted, or mandated by the Traffic Engineer or the City Engineer, based upon project specific circumstances. Deviations from this criteria must be approved by the Traffic Engineer and the City Engineer.

Acceleration Lane - An acceleration lane shall be required if:

1. the street's ADT exceeds 10,000 vehicles per day,
2. the street's operating speeds equal, or exceed, 40 miles per hour, and
3. the driveway's right turn egress movements equal, or exceed, 75 vehicles per hour during any peak period.

Right Turn Deceleration Lane - A right turn deceleration lane shall be required if:

1. the street's ADT exceeds 10,000 vehicles per day,
2. the street's operating speeds equal, or exceed, 35 miles per hour,
3. the driveway's volume equals, or exceeds, 1,000 vehicles per day, and
4. the driveway's right turn ingress movements equal, or exceed, 40 vehicles per hour during any peak period.

Left Turn Deceleration Lane - A left turn deceleration lane shall be required if:

1. the street's ADT exceeds 10,000 vehicles per day,
2. the street's operating speeds equal, or exceed, 35 miles per hour,
3. the driveway's volume equals, or exceeds, 1,000 vehicles per day, and
4. the driveway's left turn ingress movements exceeds 10 percent of the street's peak period traffic volume or 100 vehicles per hour.

The minimum width of a speed change lane shall be 11 feet.

The minimum allowable speed change lane length, including the taper, shall be 380 feet for an acceleration lane and 315 feet for a deceleration lane.

Additional length may be required for deceleration lanes to accommodate the stacking of vehicles waiting to turn. The following table provides information concerning additional storage length for left turn movements.

Number of Turning Vehicles per Hour	30	60	100	200	300
Additional Storage Length (ft)	25	50	100	175	250

The minimum allowable speed change lane taper ratio shall be 15:1 for an acceleration lane and 11.5:1 for a deceleration lane.

1.2.6 Street Signs in Residential Areas – Street name signs are required at each intersection of two streets. Stop signs are required where a residential street intersects with an arterial or collector street. Stop signs and street name signs must be installed prior to the roadway opening for traffic. At least two weeks notice must be given to the Traffic Operations Section requesting the signs be installed prior to the roadway opening for traffic. Signs will be provided and installed by the City with the cost of the materials and labor billed to the project.

(Drawing attached in hard copy)

	Minimum Corner Clearance
Local	80 feet

Driveway Width = Dimension "A" = 13' Preferred

For Locals and Minor Collectors:
Dimension "A" = 10' Minimum
24' Maximum

For Collectors, Minor Arterials, and Principal Arterials:
Dimension "A" = 12' Minimum
24' Maximum

Curb Opening = Dimension "B" = 23' Preferred

For Locals and Minor Collectors:
Dimension "B" = 20' Minimum
34' Maximum
For Collectors, Minor Arterials, and Principal Arterials:
Dimension "B" = 22' Minimum
34' Maximum

Residential Driveway

Figure 1.2.5.2.1

(Drawing attached in hard copy)

Minimum Corner Clearance	
Principal Arterial	500′
Minor Arterial	300′
Collector	200′
Minor Collector/Local	80′

Driveway Width = Dimension "A"

For Locals and Minor Collectors:
Dimension "A" = 25' Minimum
35' Maximum
For Collectors, Minor Arterials, and Principal Arterials:
Dimension "A" = 30' Minimum
35' Maximum

Curb Opening = Dimension "B"

For Locals and Minor Collectors:
Dimension "B" = 55' Minimum
75' Maximum
For Collectors, Minor Arterials, and Principal Arterials:
Dimension "B" = 60' Minimum
75' Maximum

Two-Way Commercial Driveway

Figure 1.2.5.2.2

(Drawing attached in hard copy)

Driveway Width = Dimension "A"

For Locals and Minor Collectors:
Dimension "A" = 14'

For Collectors, Minor Arterials, and Principal Arterials:
Dimension "A" = 16'

Minimum Corner Clearance:	
Principal Arterials	**500′**
Minor Arterials	**300′**
Collector	**200′**
Minor Collector/Local	**80′**

One-Way Commercial Driveway

Figure 1.2.5.2.3

Section 1.3
STORM SEWER SYSTEM DESIGN CRITERIA

1.3.1 General – The design criteria established herein shall be used for design of storm sewer system components. The storm sewer system is defined as the pipes, channels, culverts, curb and gutter, inlets, outlets and associated structures used to convey stormwater runoff from one location to another. Storm sewer system components include but are not limited to enclosed pipe systems; structures under principal arterials, minor arterials, or collectors, open natural or man-made channels, and overflow channels and swales. For purposes of these design criteria, the storm sewer system does not include detention and retention structures, and stormwater quality best management practices. Requirements, criteria, specifications, and guidance for the design of best management practices for detention, retention and stormwater quality are established in Topeka Municipal Code (TMC) Chapter 13.35 and with additional detail provided in the City of Topeka Stormwater Design Policy Handbook. However, TMC Chapter 13.35 and the Handbook may refer to these design criteria where necessary.

Storm sewer design shall conform to generally accepted engineering practices and design shall be prepared by a Professional Engineer licensed in the state of Kansas.

Work and materials shall conform to the "Standard Technical Specifications" and all current revisions.

All drainage systems shall include provisions to handle the overflow above the design storm. The overflow system shall have the capacity to convey the excess flow from the 100-year storm with 1 foot of freeboard. The excess flow from the 100-year storm shall not extend beyond the limits of the right-of-way or drainage easements.

Elements of the storm sewer system shall be designed for the following return frequencies:

Enclosed systems	10 year
Bridges, culverts, and non-enclosed system conduits under principal arterials, minor arterials or collectors	50 year
Channels	100 year
Overflow channels and swales	100 year

The 100-year storm overflow for any structure crossing a street shall not exceed a depth of 6 inches measured at the crown of the street. A minimum of one foot of freeboard shall be provided from the 100-year storm water surface to the minimum opening of any habitable structure.

Point discharges (roof drains, flumes, etc.) are not allowed to discharge from private property within 5 feet of a public right-of-way. No more than 1.5 cfs (10-yr.) is allowed to discharge out a private driveway into a public street. Deviations from this criterion must be approved by the City/County Engineer.

1.3.2 Hydrology — For purposes of storm sewer system design, the Rational Formula may be used to determine peak flow for any area less than 10 acres (commercial) or 15 acres (residential). For areas larger than 10 acres (commercial) and 15 acres (residential), an approved computer-based rainfall runoff model / program such as EPA-SWMM or TR-55 shall be used to determine the amount of runoff. The Rational Formula shall not be used to size detention, retention, and other BMPs. The Rational Formula is defined as:

$$Q = k C i A$$

where: Q = peak runoff, cfs
c — runoff coefficient
i — rainfall intensity, inches per hour
A = area, acres
k = dimensionless coefficient used to account for antecedent moisture conditions as follows:

Return Period	k
10 years or less	1.0
25 years	1.1
50 years	1.2
100 years	1.25

In no case shall the product (C * k) be greater than 1.0.

Runoff Coefficients listed in the following table are classified with respect to the general character and projected development of the tributary area and are subject to the interpretation and judgment of the Design Engineer and the approval of the City/County Engineer.

Description of Area	Runoff Coefficients
Business:	
Downtown or Shopping Center	0.70 – 0.95
Neighborhood	0.50 - 0.70
Urban Residential:	
Single Family	0.30 – 0.60
Multi —Family (Detached)	0.40 – 0.70
Multi —Family (Attached)	0.60 – 0.80
Suburban Residential	0.25 – 0.40

Apartment	0.50 – 0.70
Industrial:	
Light	0.50 – 0.80
Heavy	0.60 – 0.90
Parks, Cemeteries	0.20 – 0.30
Railroad Yard	0.20 – 0.35
Unimproved	0.20 – 0.30

Composite Runoff Coefficients:

Pavement:	
Asphalt and Concrete	0.85 – 0.95
Brick	0.80 – 0.90
Gravel	0.75 – 0.90
Roofs	0.80 – 0.95
Lawns, Sandy Soil	0.10 – 0.20
Lawns, Heavy Soil	0.15 – 0.35

When using the rational method, rainfall intensity shall be taken from Table 1.3—1, Rainfall Intensity Table, City of Topeka and Shawnee County, Kansas; which was developed using Atlas 14 Rainfall Data. Duration shall be considered to equal the time of concentration and shall be estimated by the Design Engineer using applicable elements of overland flow, gutter flow, channel flow and pipe flow to the point under consideration.

TABLE 1.3-1

RAINFALL INTENSITY TABLE
CITY OF TOPEKA and SHAWNEE COUNTY, KANSAS

THIS TABLE CONTAINS AVERAGE RAINFALL INTENSITIES IN INCHES PER HOUR

Duration (Hr:Min)	Return Period						
	1 yr	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
	Intensity (in/hr)						
0:05	4.82	5.71	7.16	8.38	10.08	11.40	12.72
0:06	4.51	5.34	6.68	7.80	9.44	10.65	11.86
0:07	4.22	4.99	6.24	7.29	8.82	9.95	11.08
0:08	3.95	4.67	5.86	6.84	8.26	9.34	10.39
0:09	3.73	4.40	5.53	6.45	7.78	8.81	9.80
0:10	3.53	4.18	5.24	6.12	7.38	8.34	9.30
0:11	3.36	3.97	5.00	5.83	7.01	7.96	8.86
0:12	3.21	3.79	4.78	5.58	6.70	7.62	8.49
0:13	3.08	3.64	4.59	5.36	6.43	7.32	8.15
0:14	2.97	3.51	4.43	5.17	6.20	7.06	7.86

0:15	2.87	3.40	4.28	5.00	6.00	6.80	7.60
0:16	2.77	3.28	4.14	4.84	5.80	6.61	7.37
0:17	2.69	3.18	4.02	4.70	5.63	6.42	7.16
0:18	2.62	3.10	3.91	4.57	5.47	6.25	6.96
0:19	2.55	3.02	3.81	4.46	5.34	6.10	6.79
0:20	2.49	2.94	3.71	4.35	5.21	5.95	6.63
0:21	2.43	2.87	3.63	4.25	5.09	5.82	6.48
0:22	2.38	2.81	3.55	4.16	4.98	5.70	6.34
0:23	2.33	2.75	3.47	4.07	4.88	5.58	6.21
0:24	2.28	2.70	3.40	3.99	4.79	5.47	6.09
0:25	2.23	2.65	3.34	3.92	4.70	5.37	5.97
0:26	2.19	2.60	3.27	3.85	4.61	5.28	5.86
0:27	2.15	2.55	3.21	3.78	4.53	5.19	5.76
0:28	2.12	2.51	3.16	3.71	4.46	5.10	5.66
0:29	2.08	2.46	3.10	3.65	4.38	5.02	5.57
0:30	2.06	2.44	3.06	3.60	4.34	4.90	5.48
0:31	2.01	2.38	3.00	3.53	4.25	4.86	5.40
0:32	1.98	2.35	2.95	3.48	4.18	4.79	5.31
0:33	1.95	2.31	2.91	3.43	4.12	4.72	5.23
0:34	1.92	2.28	2.86	3.38	4.06	4.65	5.16
0:35	1.89	2.24	2.82	3.33	4.00	4.59	5.08
0:36	1.86	2.21	2.78	3.28	3.94	4.52	5.01
0:37	1.84	2.18	2.74	3.23	3.89	4.46	4.94
0:38	1.81	2.15	2.70	3.19	3.84	4.40	4.87
0:39	1.78	2.12	2.66	3.14	3.78	4.34	4.80
0:40	1.76	2.09	2.62	3.10	3.73	4.28	4.74
0:41	1.73	2.06	2.59	3.06	3.68	4.23	4.67
0:42	1.71	2.03	2.55	3.02	3.63	4.17	4.61
0:43	1.69	2.00	2.52	2.98	3.58	4.12	4.55
0:44	1.67	1.97	2.49	2.94	3.53	4.07	4.49
0:45	1.65	1.95	2.45	2.90	3.49	4.01	4.43
0:46	1.63	1.92	2.42	2.86	3.44	3.96	4.37
0:47	1.61	1.89	2.39	2.82	3.40	3.91	4.32
0:48	1.59	1.87	2.36	2.79	3.35	3.86	4.26
0:49	1.57	1.84	2.33	2.75	3.31	3.81	4.20
0:50	1.55	1.82	2.30	2.71	3.26	3.77	4.15
0:51	1.53	1.79	2.27	2.68	3.22	3.72	4.10
0:52	1.51	1.77	2.24	2.65	3.18	3.67	4.05
0:53	1.49	1.75	2.21	2.61	3.13	3.63	3.99
0:54	1.47	1.73	2.18	2.58	3.09	3.58	3.94
0:55	1.45	1.71	2.16	2.55	3.05	3.54	3.89
0:56	1.43	1.69	2.13	2.51	3.01	3.49	3.84

0:57	1.41	1.67	2.10	2.48	2.97	3.45	3.79
0:58	1.39	1.65	2.08	2.45	2.93	3.41	3.75
0:59	1.37	1.63	2.06	2.42	2.91	3.29	3.70
1:00	1.35	1.61	2.04	2.40	2.89	3.27	3.65
1:05	1.31	1.58	2.01	2.37	2.85	3.23	3.60
1:10	1.24	1.49	1.90	2.24	2.69	3.06	3.41
1:15	1.17	1.42	1.80	2.13	2.56	2.90	3.23
1:20	1.12	1.35	1.72	2.02	2.43	2.76	3.08
1:25	1.07	1.29	1.64	1.93	2.32	2.64	2.94
1:30	1.02	1.23	1.57	1.85	2.22	2.52	2.81
1:35	0.98	1.18	1.51	1.77	2.13	2.42	2.70
1:40	0.95	1.14	1.45	1.71	2.05	2.33	2.60
1:45	0.91	1.10	1.39	1.64	1.98	2.24	2.50
1:50	0.88	1.06	1.35	1.59	1.91	2.17	2.42
1:55	0.85	1.02	1.30	1.53	1.85	2.09	2.34
2:00	0.83	1.00	1.27	1.50	1.81	2.05	2.29
2:05	0.80	0.96	1.22	1.44	1.73	1.97	2.19
2:10	0.78	0.94	1.18	1.39	1.68	1.91	2.13
2:15	0.75	0.92	1.15	1.36	1.63	1.85	2.07
2:20	0.73	0.90	1.12	1.32	1.59	1.80	2.01
2:25	0.71	0.88	1.09	1.28	1.54	1.76	1.96
2:30	0.70	0.86	1.07	1.25	1.50	1.71	1.91
2:35	0.68	0.84	1.05	1.22	1.47	1.67	1.86
2:40	0.66	0.82	1.03	1.20	1.45	1.63	1.82
2:45	0.65	0.80	1.01	1.18	1.42	1.60	1.78
2:50	0.64	0.78	0.99	1.16	1.40	1.58	1.76
2:55	0.63	0.77	0.97	1.14	1.38	1.56	1.74
3:00	0.62	0.75	0.95	1.12	1.36	1.54	1.72
3:15	0.57	0.70	0.90	1.05	1.28	1.44	1.60
3:30	0.54	0.65	0.82	0.97	1.16	1.32	1.48
3:45	0.51	0.63	0.78	0.92	1.10	1.26	1.40
4:00	0.49	0.61	0.74	0.87	1.05	1.20	1.34
4:15	0.47	0.58	0.71	0.83	1.00	1.14	1.28
4:30	0.45	0.56	0.68	0.80	0.96	1.09	1.22
4:45	0.43	0.54	0.66	0.76	0.92	1.05	1.17
5:00	0.41	0.52	0.64	0.74	0.89	1.01	1.13
5:15	0.40	0.50	0.62	0.71	0.87	0.97	1.09
5:30	0.39	0.48	0.60	0.68	0.85	0.95	1.07
5:45	0.38	0.46	0.58	0.66	0.83	0.93	1.05
6:00	0.37	0.44	0.56	0.64	0.81	0.92	1.03
6:30	0.34	0.40	0.51	0.60	0.74	0.85	0.95
7:00	0.32	0.38	0.48	0.57	0.68	0.78	0.87

7:30	0.30	0.36	0.46	0.54	0.65	0.74	0.83
8:00	0.29	0.35	0.44	0.51	0.62	0.70	0.79
8:30	0.28	0.33	0.42	0.49	0.59	0.67	0.75
9:00	0.27	0.32	0.40	0.47	0.56	0.64	0.72
9:30	0.25	0.30	0.38	0.45	0.54	0.62	0.69
10:00	0.25	0.29	0.37	0.43	0.52	0.59	0.67
10:30	0.24	0.28	0.35	0.42	0.50	0.57	0.65
11:00	0.23	0.27	0.34	0.40	0.48	0.55	0.63
11:30	0.22	0.26	0.33	0.39	0.47	0.53	0.61
12:00	0.21	0.25	0.32	0.38	0.46	0.52	0.59
13:00	0.20	0.24	0.30	0.35	0.43	0.49	0.55
14:00	0.19	0.23	0.28	0.33	0.40	0.46	0.52
15:00	0.18	0.21	0.27	0.32	0.38	0.44	0.49
16:00	0.17	0.20	0.26	0.30	0.36	0.42	0.47
17:00	0.16	0.19	0.25	0.29	0.35	0.40	0.45
18:00	0.16	0.19	0.23	0.28	0.33	0.38	0.43
19:00	0.15	0.18	0.23	0.26	0.32	0.36	0.41
20:00	0.15	0.17	0.22	0.25	0.31	0.35	0.39
21:00	0.14	0.17	0.21	0.24	0.30	0.34	0.38
22:00	0.14	0.16	0.20	0.24	0.28	0.32	0.37
23:00	0.13	0.15	0.19	0.23	0.28	0.31	0.35
24:00	0.12	0.15	0.18	0.22	0.26	0.29	0.33

The following criteria shall be utilized to determine Tc for storm sewer design:

$$T_c = T_i + \Sigma T_t$$

where: T_c = time of concentration, minutes
T_i = inlet time or the overland flow component, minutes
T_t = travel times between the first inlet and the point under consideration, minutes

The minimum time of concentration shall be 5 minutes.

The Inlet Time shall be calculated as follows:

$$T_i = 1.8\,(1.1 - C_{10})\frac{\sqrt{L}}{\sqrt[3]{S}}$$

where: T_i = inlet time, minutes
C_{10} = 10-year runoff coefficient
L= length of overland flow, ft
S= slope, percent

The maximum length of overland flow shall be 500 feet.

The minimum inlet time shall be 5 minutes and the maximum inlet time shall be 15 minutes.

Travel times shall be calculated using known velocities derived from the Manning Equation.

1.3.3 Inlet Design — Inlets shall be designed to limit gutter flows, for non-sump inlets, for a 10-year storm as follows:

Street Width	Maximum Allowable Spread
29 feet or less	10.5 feet from back of curb
greater than 29 feet	11.5 feet from back of curb

Inlets in a sump condition may pond water to a level no more than 6 inches deep measured at the crown of the street for the 100-year event.

The width of spread of gutter flows and the ratio of intercepted flow to total flow for inlets shall be determined using the design curves for Type I and Type Il—P inlets (Appendix A. 1).

The maximum inlet spacing is 400 feet unless approved otherwise.

The crowns of pipes entering a structure shall be at or above the crown of the outlet pipe and a minimum fall of 0.2 feet shall be provided across the invert. For structures with multiple pipes, odd entrance angles or transitions, a minimum fall of 0.5 feet shall be provided across the invert. If lack of elevation is critical, the drop through the structure may be decreased to 0.1 feet where the joining pipes are on the same alignment and approval is given by the City/County Engineer.

Hydraulic gradients shall be calculated for all storm sewers by an approved method. Hydraulic grade line data shall be submitted with office check plans. The hydraulic gradient shall be at least 0.5 feet below the minimum inlet opening.

Inlet design data shall be presented in a tabular format and shall contain the following information for each inlet for the design frequency:

- Area that drains to each inlet
- Runoff coefficient for the area
- Time of concentration for the area
- Intensity associated with the time of concentration
- Total flow at the inlet (including any upstream bypass) Total flow entering the inlet Total flow bypassing the inlet
- Width of spread
- At sump locations, what happens to Q_{100}

1.3.4 Pipe Design and Layout

1.3.4.1 Pipe Design — Pipes and other structures shall be designed using the Manning Equation as follows:

$$Q = A\frac{1.49}{n}R^{2/3}\sqrt{S}$$

where: Q= discharge (Flow), cfs
A= area, ft^2
R= hydraulic radius, A/P, ft.
P= wetted perimeter, ft.
S= slope, ft/ft
n= roughness coefficient

Reinforced concrete pipe is allowed for all storm sewer applications and is required in the public Right-of-Way and Public Easements. Other pipe materials, such as HDPE or aluminized corrugated metal pipe, may be proposed outside the critical area and within the Right-of-Way or easements upon submittal of sufficient design specifications, but must be pre-approved by the City/County Engineer. The critical area is defined as located one foot outside the back of curb or edge of pavement on one side of the street to one foot outside the back of curb or edge of pavement on the opposite side of the street). The roughness coefficient for concrete pipe shall be 0.012. The roughness coefficient for corrugated steel pipe shall be as shown in the following table:

Helical
(2 2/3" x 1/2")

Size	12"	15"	18"	21"	24"	36"	48"	60"-120"
n	0.012	0.013	0.014	0.015	0.016	0.018	0.020	0.024

Helical
(3"x1")

Size	36"	48"	54"	60"	66"	72"	78"-144"
n	0.021	0.023	0.023	0.024	0.025	0.026	0.027

Pipe capacity required shall be determined using the intensity associated with the time of concentration from the most remote point on the system upstream from the pipe under consideration, and the product (C * A) that represents the sum of the total contributing areas and their runoff coefficients.

The minimum pipe size shall be 15 inches except in BMP applications or within Stormwater Management Easements.

The minimum cover above the top of pipe shall be 30 inches unless otherwise approved.

The minimum velocity shall be 3 feet per second for a pipe based on the Manning's equation.

The maximum velocity within the system shall be 15 ft/sec.

Maximum exit velocities shall be as follows:

Outlet Channel Type	Maximum Exiting Velocity
Natural, grass lined or unimproved channel	5 ft/sec
Improved channel with rip—rap lining	10 ft/sec
Improved channel with concrete or grouted rip-rap lining	15 ft/sec

Energy dissipators may be used where exit velocities exceed the maximum velocity.

Hydraulic Gradients for the system shall be computed using an approved method. Hydraulic grade line data shall be submitted with office check plans. The hydraulic gradient shall be at least 0.5 feet below the minimum inlet opening.

Pipe design data shall be presented in a tabular format and shall contain the following information for the system for the design return frequency:

- Contributing area
- Runoff coefficient for the area
- Time of concentration (including pipe travel time)
- Flow intensity
- Pipe size
- Roughness coefficient
- Slope
- Capacity
- Velocity

The Q_{100} flow must be reviewed within the storm sewer system to see if overflow swales are required at sump locations.

1.3.4.2 Pipe Layout — The layout of pipes shall minimize the length of pipe under the roadway. Pipes which cross the roadway shall cross perpendicular to the centerline of the roadway. Pipes which run parallel to the roadway shall have a minimum clear distance of 1 foot behind the back of curb. Pipes which discharge between two houses in a residential area should be extended to a minimum of 25 feet beyond the back of the houses.

1.3.4.3 Erosion Control for Pipes — All pipe culverts and storm sewers shall include end sections. Riprap or clean broken concrete scour protection, 2 feet in depth and extending 2 feet back under the end of the end section, shall be

provided for all culverts and storm sewers at a minimum. The stone size and horizontal extent of the riprap will be determined based on exit velocity from the pipe. Where unusually high velocities or scour potential exists, concrete headwalls with energy dissipators should be substituted for the standard end section. Box culverts shall include concrete aprons on the downstream end unless it is a "natural channel bottom" design. Riprap or broken concrete scour protection should also be provided depending on outlet velocities and wingwall configuration.

Entrance velocities shall be determined at all pipe and box culvert inlets to assess the need for erosion control measures. Concrete drop inlets should also be considered to increase culvert hydraulic efficiency and provide for erosion control.

1.3.5 Channel Design — The City's Buffer Area Ordinance (TMC Chapter 17.10) limits the alteration of natural waterways that have a contributing drainage area of 40 acres or more (See TMC Chapter 17.10 and City Ordinance No. 17837 for specific information).

In addition, a permit from the State of Kansas Division of Water Resources will be required for new obstructions or channel changes if the drainage basin above the channel location drains an area greater than 640 acres. In addition, for projects that may involve placing materials in a lake, river, stream, dry streambed or wetland, contact the US Army Corps of Engineers to determine if the project you are planning is within jurisdictional waters and is a regulated activity. The Corps has the sole authority to make this determination.

1.3.5.1 General — These criteria shall be applicable in the planning, analysis, and design of all types of open channels. Open channels shall be analyzed and designed for uniform flow using Manning equation:

$$Q = A\frac{1.49}{n}R^{2/3}\sqrt{S_o}$$

where: Q= discharge (Flow), cfs
A= area, ft^2
R= hydraulic radius, A/P, ft.
P= wetted perimeter, ft.
S_0= channel bottom slope, ft/ft
n= roughness coefficient

Roughness coefficients listed in the following table are classified with respect to the general character of the channel and are subject to the interpretation and judgment of the Design Engineer and the approval of the City/County Engineer.

Type of Channel & Description	Value or Range	
Natural Channels:		
Channel between banks:		
Clean, straight, full stage, no rifts or deep pools	0.030	
Irregular side slopes & bottom with some weeds & stones	0.045	
Same as above, with more stones	0.050	
Weedy, deep pools and some timber	0.070	
Very weedy, deep pools, crooked and heavy brush & trees	0.100	
Overbank areas (floodplains):		
Pasture, no brush, medium grass height	0.030 – 0.045	
Cultivated areas, mature crops	0.030 – 0.050	
Brush, medium to dense with heavy weeds	0.045 – 0.150	
Wooded areas, heavy timber, some undergrowth & fallen trees	0.080 – 0.120	
Artificial Channels (lined):		
Grass (good stand with minimal maintenance):	Grass 12”	Grass 4”-6”
Channel Depth less than 2 feet	0.070	0.040
Channel Depth greater than 2 feet	0.040	0.030
Riprap:		
Mean Stone size, d_{50}[1] = o. 75 feet	0.038	
Mean Stone size, d_{50}[1] = 1. 50 feet	0.042	
Concrete:		
Trowel Finish	0.013	
Float Finish	0.015	
Unfinished	0.017	
Shotcrete, not wavy	0.019	
Shotcrete, wavy	0.021	
Rough asphalt or brick in mortar	0.015	

A minimum of 1 foot of freeboard shall be provided above the 100-year storm water surface elevation to the top of the channel bank. All open channels, natural or artificial, shall provide adequate capacity to convey the 100-year storm flow, plus the required freeboard. Natural channels may utilize overbank areas to provide this capacity, but these areas must be carefully analyzed to determine the effects that increased surface roughness and surface obstruction have on conveyance ability. In areas where overbank flow occurs, a minimum of 1 foot of freeboard shall be provided from the 100-year storm water surface to the minimum opening of any habitable structure.

To provide adequate protection from erosion, wash checks, flumes, outfall erosion protection, energy dissipators, and stone riprap or concrete channel linings

shall be designed to protect for the 5-year storm. The top elevations for all linings and structures shall be placed at or above the anticipated water surface elevation for the 5-year storm peak flow. The remainder of the channel cross section may be vegetated but must be designed to withstand 100-year velocities in the channel.

1.3.5.2 Erosion Control for Point Discharges Within A Channel — Erosion control measures shall be provided when a storm sewer, culvert or any concentration of surface runoff discharges into any type of channel. Direction of discharge release should be no more than 30 degrees off parallel from the receiving flow, unless computations are provided to show that the discharge will be non-erosive.

Concentrated drainage from paved or grassed swales, curb openings or other sources must be conveyed from the natural or artificial channel bank to the channel bottom in a manner which protects the channel bank from erosion. If a concrete flume is used for this purpose, the cross section shall be determined by a hydraulic analysis. The flume shall be designed to convey the 5-year storm flow, with the assumption that the bottom slope of the flume is equal to the slope of the swale which discharges into the flume. If the flume discharges into a natural or grass lined artificial channel, riprap or broken concrete scour protection shall be provided.

1.3.5.3 Artificial Channel Design Criteria — Grass lined channels are preferred for artificial channels. Other types of lining may be approved depending on the circumstances.

The following criteria shall apply for the design of artificial open channels.

1.3.5.3.1 General — All channels with bends shall take water surface super elevation into account. The channel radius shall be properly designed unless the angle of deflection is very small or other measures have been taken to provide adequate protection.

When possible, the angle between the centerlines of two connecting channels shall not exceed 45 degrees. In all situations, and particularly where the angle exceeds 45 degrees, protection shall be provided to control erosion.

In residential areas, 4:1 channel side slope is desired with a minimum of 3:1 required for grass lined channels. For riprap or concrete lined channels, a minimum 2:1 side slope is required.

1.3.5.3.2 Grass Lined Channels — Grass lined channels shall be designed for subcritical flow. Subcritical flow shall be verified for the normal depth by calculating the Froude Number. For trapezoidal channels, the Froude Number is calculated by the formula:

$$Fr = \sqrt{\frac{Q^2 T}{gA^3}}$$

where: FR=Froude Number (dimensionless)
Q= discharge, cfs
T= top width of water surface, ft
A= area, ft^2
g= acceleration of gravity (32.2 ft/sec^2)

Subcritical flow Is considered present when the Froude Number is less than one. Supercritical flow exists when the Froude Number is greater than one.

For a given channel cross section, roughness, and bottom slope, both the 5-year storm flow and the 100-year storm flow shall be analyzed).

The maximum allowable velocities for grass lined channels shall be as follows:

	Easily Eroded Soils	Erosion Resistant Soils
5-year storm (Erosion Control)	3 - 5 fps	4 - 6 fps
100-year storm (Capacity)	4 - 6 fps	5 - 7 fps

Roughness coefficients shall be determined in accordance with Section 1.3.5.1.

Grass chosen for channel linings should be erosion resistant, thick rooted to inhibit weed growth and able to live without watering or other maintenance. The best grasses are sod forming grasses such as smooth brome and Bermuda grass. Fescue is acceptable when seeded at rates sufficient to assure complete coverage.

Temporary erosion control measures must be provided to ensure the development of a good stand of grass following channel construction. Temporary erosion control blankets, turf reinforcement mats or other approved methods shall be required with all grass lined channels. The protections shall be provided to a level at or above the expected 2-year storm event.

Where channel bottom slopes are steep due to natural topography, such that flow would be supercritical or the maximum velocities exceeded, wash checks shall be provided and designed in accordance with the City of Topeka Standard Technical Specifications and details, with full scour protection provided on the downstream side.

Flexible liners must be designed to meet a variety of design objectives and serve a variety of roles in the construction of a project where prismatic channels are required for conveying stormwater runoff. Flexible channel linings are best suited to conditions of uniform flow and moderate shear stresses. Channel reaches with accelerating or decelerating flow (expansions, contractions, drops and backwater) and waves (transitions, flows near critical depth, and shorelines) will require special analysis and may not be suitable for flexible channel linings.

Erosion control protection shall be provided at all channel curves and junctions.

1.3.5.3.3 Riprap Lined Channels — Rip—rap linings may be approved if flow, bottom slope, velocity or channel cross section preclude the use of grass lined channels. Often flow in rip—rap lined channels will be supercritical. Supercritical flow shall be verified for the normal depth by calculating the Froude Number. When flow is found to be supercritical, the Energy Grade Line will be determined by adding the velocity head to the Hydraulic Grade Line. The Energy Grade Line shall be used for determination of channel cross section and depth requirements, unless specific measures are provided to ensure that supercritical flow will be maintained for the entire length of the channel.

Roughness coefficients shall be determined in accordance with Section 1.3.5.1.

Rip—rap linings shall be provided to convey a minimum of the 5-year storm flow. Each individual situation shall be carefully examined to determine whether there is a need for protection for greater storm flows. In compound channels, the lower section of the channel shall be completely lined as a minimum. The need for an underlying filter cloth or granular filter blanket shall be assessed.

The rock or broken concrete rubble specified for use as riprap shall be based on the d60 particle size, of which 50 percent of the mixture is finer by weight. The rip—rap lining shall have a minimum thickness of 1.5 times the largest expected stone diameter.

1.3.5.3.4 Concrete Lined Channels — Concrete lined channels are generally discouraged. Limited applications of concrete flumes may be approved where necessary for flow collection and conveyance due to site conditions such as steep slopes and high velocities. Sufficient energy dissipation is required.

Roughness coefficients shall be determined in accordance with Section 1.3.5.1.

The analysis of the proposed channel section for capacity shall account for the variable roughness of the concrete and grass linings.

Due to the expected high velocities, concrete linings shall be provided to convey the 10-year storm flow. With compound channels, the entire lower section of the channel shall be lined. Specific situations may require concrete lining protection for flows greater than the 10-year storm flow.

Concrete linings shall be continuously reinforced and will generally be required to have an underdrain to reduce pressures caused by seepage or high groundwater levels.

1.3.5.4 Typical Channel Cross Sections — The typical sections illustrated in Figures 1.3-1 through 1.3-3 show the minimum and maximum criteria to be adhered to in the cross-sectional design of channels.

1.3.6 Easements – Permanent public drainage easements shall be dedicated to the City/County for operation and maintenance of open channels that will carry flow. All maintenance within the permanent public drainage easement shall be the right, duty and responsibility of the property owner(s) of the property in which the

easement is so located, unless otherwise approved. However, if maintenance is neglected or subject to other unusual circumstances and is determined to be a hazard or threat to public safety by the director of utilities or designee, corrective maintenance may be performed by the governing jurisdiction with costs assessed to and borne upon, said property owner(s).

1.3.6.1 Engineered Channels – Easements shall be as wide as the top of bank width plus 10 feet on each side. Easements shall be continuous between street rights-of-way. When an improved channel begins or ends at a point other than the right-of-way of a dedicated street, a 15-foot or wider easement graded so as to permit access by truck shall be dedicated from the end of the channel to a street right-of-way. These are minimum requirements.

Generally, easements shall be required for swales that collect stormwater runoff from more than two acres or as required by the City/County.

1.3.6.2 Roadside Channels – Roadside ditches are engineered channels that are located wholly or partly within the street right-of-way. Roadside ditches in the street right-of-way do not require an easement. Otherwise, roadside ditches shall have a dedicated easement from the street right-of-way extending to five feet outside of the top of the outside bank of the channel.

Figure 1.3-1

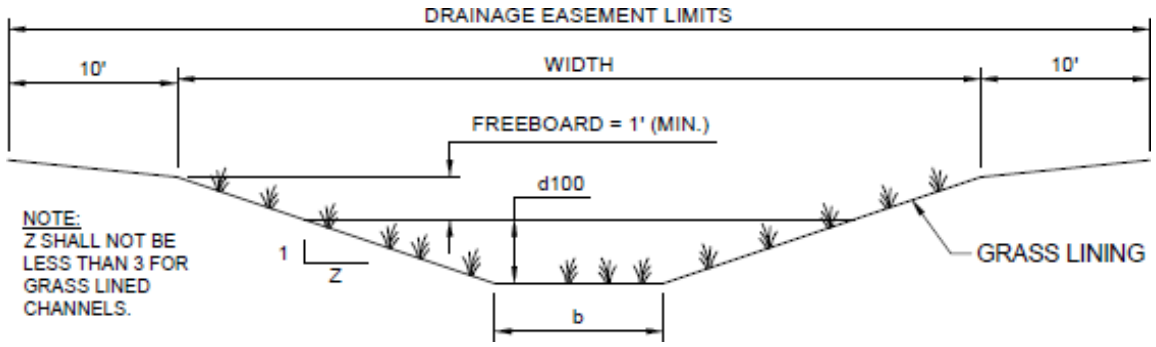


Figure 1.3-2

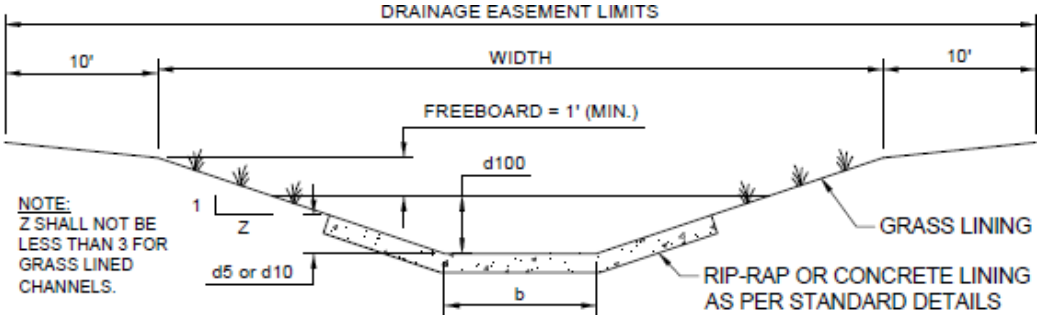
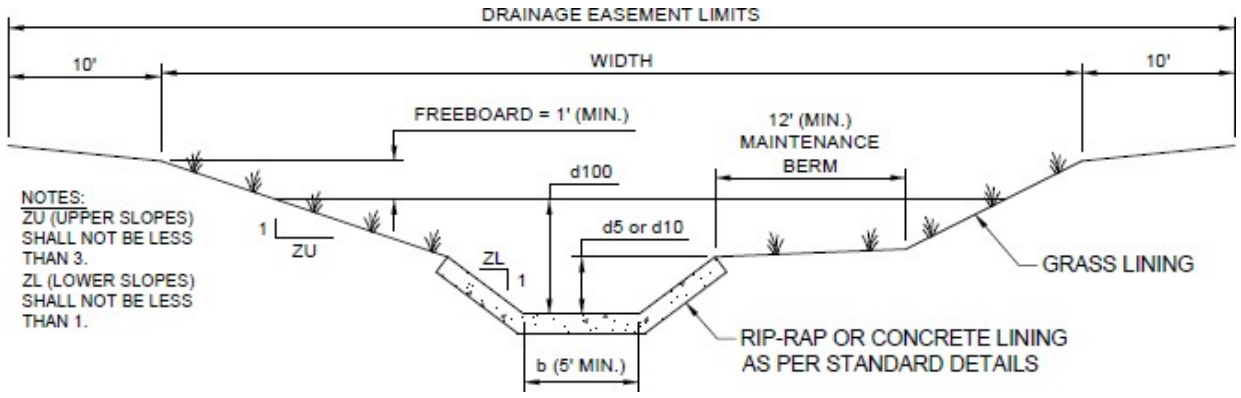


Figure 1.3-3



1.3.7 Plat Requirements — At the Preliminary Plat stage, the developer must provide the City/County with the necessary site information and assessment of the downstream drainage system to determine any special requirements necessary for the proposed development.

The developer is responsible for all drainage calculations needed to design the on—site drainage system regardless of the size of the development.

1.3.7.1 Preliminary Plat Drainage Report Requirements — Drainage reports submitted to the Planning Agency must be signed and sealed by a Professional Engineer, licensed to practice in the State of Kansas. Refer to the City of Topeka Stormwater Design Policy Handbook for Report requirements.

1.3.7.2 Channel Selection Requirements -

A specific channel type shall be selected based on the existing topography, space requirements, proposed development, required buffer easements, cost considerations and aesthetics. After selecting a channel type, the design engineer shall proceed with the hydraulic analysis (natural channels) or preliminary hydraulic design (artificial channels) in accordance with applicable sections of this criteria.

1.3.7.2.1 Natural Channels — These channels exhibit several desirable characteristics which favor their selection whenever feasible. They are generally stabilized, with low velocities, resulting in low long-term maintenance needs. They can provide desirable green space for park and recreational areas and generally require less disturbance of wooded areas than an artificial channel.

Increased runoff due to development can affect the stability of natural channels. The changes in water surface elevation and limits of inundation due to increased

runoff must also be thoroughly investigated. The following items must be specifically addressed. Other items which are not referred to in this discussion should be addressed by the Design Engineer if the specific situation warrants.

The design engineer must determine profiles for the design storm flows in the channel which are attributable to the developed land use conditions. To compute water surface profiles, cross sections must be prepared for key locations in the channel from known topographical information. Other necessary data includes estimates of roughness coefficients, starting water surface elevation, and channel reach lengths.

Water surface profiles may be determined using a variety of methods which take into account changes in channel slope, roughness, cross section, and velocity and also shall consider losses due to sudden drops, bridge openings, and other obstructions. Among the most commonly used methods are the direct and standard step backwater computation methods which are detailed in several open channel flow textbooks. Computer programs such as the HEC—RAS program are also available to assist the design engineer in computation of water surface profiles.

All computations shall be clearly presented in tabular or graphical form. This will allow for easy interpretation by the reviewer and will serve as the basis for determination of the limits of inundation.

Proposed easements shall be based on the expected limits of inundation determined from the design storm water surface profile for developed conditions and topographical information. Drainage easements shall cover the entire area which will be inundated during the 100 year storm, unless specific provisions for obstructions in the overbank area have been made in the analysis. The design engineer shall also provide adequate easement to allow for future erosion of the channel bank and maintenance access to the channel.

Required elevations for habitable structures shall be determined by adding the required freeboard to the water surface elevation. These elevations shall be presented on the final subdivision plat.

The Design Engineer shall determine the expected increase in velocity in the channel due to design storm flows for developed conditions. The design storm for erosion control is the 5 year storm. If the expected increase is judged to be significant, depending on soil type and channel geometry, erosion control measures should be considered to help maintain channel stability.

1.3.7.2.2 Modified Natural Channels —

Filling portions of the overbank areas that would have conveyed part of the design storm flow requires special analysis. Filling will reduce the channel area and increase the water surface elevation and velocity, resulting in greater erosion potential. Erosion control measures shall be provided for both the natural channel section and fill slopes if the resulting velocity and soil type indicate erosion will occur. Fill slopes shall not exceed a slope of 4 horizontal to 1 vertical.

Modifying sections of the natural channel may be desirable to increase land use efficiency or to allow efficient crossings of the natural channel. Realigned

sections shall be designed in accordance with the requirements for artificial channels, unless the specific conditions warrant otherwise. The cross sectional and slope characteristics based on the preliminary design shall then be incorporated into the standard analysis required for the natural channel. Realigned portions of natural channels will generally be allowed to revert to the natural condition.

Any type of proposed crossing of a natural channel which restricts the cross sectional area of the channel must be specifically addressed by the Design Engineer. A preliminary hydraulic design of the structure must be performed to provide the information necessary to analyze the natural channel upstream from the crossing. The design engineer shall state structure flow, elevations, size and other assumptions. These items shall be incorporated into the analysis and discussion of the natural channel. All structures will be analyzed for inlet and outlet control situations to determine which situation governs the upstream water surface elevations. Private crossings shall be maintained by the owner after construction. All public crossings will be maintained by the City. Permits for channel changes may be required from the Division of Water Resources.

1.3.7.2.3 Artificial (Constructed) Channels —

If properly designed, constructed, and maintained, artificial channels can be an asset to the property in which they are located, by providing attractive open spaces and recreational areas. On the other hand, these types of channels commonly become eyesores which require almost constant maintenance. A wide range of options are open to the design engineer and land developer, depending on the desired function and aesthetic results.

Preliminary design shall be performed in accordance with Section 1.3.5 and will serve as the basis for drainage easement width determination. The following information shall be clearly presented:

1 . Types of channel lining
2 . Design storm flows
3 . Roughness coefficients
4 . Velocities
5 . Normal depths
6 . Bottom slopes
7 . Discussion of whether flow L is sub—critical or super—critical
8 . Typical cross sections (graphical)
9 . Freeboard used for easement determination
10 . Description of erosion control measures which may be required.

If crossings of the proposed channel are required, the design engineer shall perform a preliminary hydraulic design of the structure. The upstream drainage width determination shall account for any expected backwater effects.

Proposed easements shall be adequate to contain the design storm flow, plus the required freeboard. At crossing locations, easements shall be provided to cover the entire area which is expected to be inundated by backwater due to the design storm flow.

Provisions must be made for maintenance access to the proposed channel. In some cases, a maintenance berm must be provided either at the top of the channel bank for standard channels or on a stepped bank for compound channels. Specific requirements for maintenance access are shown on the Typical Channel Cross Sections in Section 1.3.5.4.

1.3.7.3 Final Plat Channel Selection Requirements — The final plat shall dedicate the proper type and size of drainage easement as necessary to meet the requirements. An easement will be required whenever any of the following situations exist:

1. A concentrated offsite drainage flow enters the plat area,
2. Any public storm drainage system discharges into the plat area.

Easements must be defined with the plat legend and appropriately designated on the plat.

Other drainage related easements, such as storm sewer, detention, surface overflow and others will be necessary in specific instances and must also be designated and defined on the plat.

The following standard notes shall be placed on the final plat when the referenced easements are contained on the plat.

> DRAINAGE EASEMENT: "Drainage easements are hereby established as shown to provide for the unobstructed overland flow of surface water and/or the construction and maintenance of pipe, flume, ditch or any or all improvements for the drainage of said water, all as may be determined and/or approved by the director of the applicable department of public works. Property owners shall not place any permanent or semi—permanent obstruction in said easement. All maintenance within the drainage easement (DE) shall be the right, duty and responsibility of the property owner (s) of the property in which the easement is so located, however, if maintenance is neglected or subject to other unusual circumstances and is determined to be a hazard or threat to public safety by the director of the applicable department of public works, corrective maintenance may be performed by the governing jurisdiction with costs assessed to and borne upon, said property owner (s).
>
> Officials representing the applicable department of public works shall have the right to enter upon the easement for purposes of periodic inspection and/or corrective maintenance.

Section 1.4

SANITARY SEWER DESIGN CRITERIA

1.4.1 General - Sanitary sewer design in the City of Topeka and within the service areas surrounding the City of Topeka shall conform to: 1) the current City of Topeka wastewater plan 2) the WPCF Manual of Practice No. 9 (ASCE Manuals and Reports on Engineering Practice No. 37) entitled "Design and Construction of Sanitary and Storm Sewers" and 3) the "Minimum Standards of Design for Water Pollution Control Facilities" and all current revisions as published by the Kansas Department of Health and Environment, except as modified herein.

Work and materials shall conform to "Standard Technical Specifications" and all current revisions.

Deviations from this criteria must be approved by the Water Pollution Control Superintendent and the City Engineer.

1.4.2 Type of Sewers - Separate sewers will be required for the collection of wastewater and stormwater. Roof, areaway, window well or foundation drains shall not be connected to sanitary sewers.

1.4.3 Design Period - Lateral sewers and main sewers shall be designed to handle the estimated ultimate population of the area served as set forth in the Facilities Plan. Interceptor sewers shall be designed to accommodate the development expected in at least a 25 year period. As approved by the City Engineer, staged development may be accepted for major lines with smaller initial sewers and later parallel construction.

1.4.4 Basis of Sewer Design -

1.4.4.1 Design Flows - New sewers should be designed with the best available information. If possible the information should be obtained from direct wastewater flow measurements using a reliable measuring device.

Where reliable flow measurements are not available, the following design data shall be used:

Type of Development	Average Flow	Peak Flow *
Residential	70 gpcpd	300 gpcpd
Commercial	5,000 gpapd	7,500 gpapd
Industrial	5,000 gpapd	7,500 gpapd

* Peak flow includes wet weather inflow and infiltration allowance.
gpcpd – gallons per capita per day
gpapd – gallons per acre per day

1.4.4.2 Pipe Sizing - The Manning Equation shall be used in sizing sanitary sewer pipes:

$$Q = A \frac{1.49}{n} R^{2/3} \sqrt{S}$$

where: Q = discharge, cfs
A = area of conduit, ft^2
R = hydraulic radius, A/P, ft.
P = wetted perimeter, ft.
S = slope, ft/ft
n = roughness coefficient

The roughness coefficient "n" to be used for all types of pipe materials shall be 0.013 unless a variance is approved by the City Engineer.

The minimum pipe size to be used in the design of public gravity sewers shall be 8 inches in diameter.

1.4.4.3 Velocity of Flow - The minimum velocity for pipes flowing full or half full shall be 2 feet per second. The maximum full velocity shall be 10 feet per second. Where the estimated, ultimate population does not result in a peak flow which will provide a cleansing velocity of at least 2 feet per second, a slope greater than the minimum requirement shall be provided, if elevation differentials are available, to obtain such velocity. The pipe slopes required to provide the stated minimum velocity are given in the following table:

Slopes required for V = 2 fps
For Full and Half Full Flow
(n = 0.013)

Pipe Diameter (inches)	Slope (%)
8	0.400
10	0.248
12	0.194
15	0.145
18	0.114
21	0.092
24	0.077
27	0.065
30	0.057
33	0.051
36	0.045

1.4.4.4 Design Depth of Flow - Sewers up to and including a diameter of 18 inches shall carry the design flow at a depth of 1/2 full. Sewers larger than 18 inches in diameter shall carry the design flow at a depth of 2/3 full.

1.4.4.5 Minimum Depth of Cover - Sewers shall be designed to serve basements where possible. Normally the minimum depth of sewers and manholes shall be 5 feet. The absolute minimum depth of earth cover over the sewer pipe shall be 30 inches. Where this depth of cover is not available, protection shall be provided by earth fill, concrete encasement or use of ductile iron pipe with polyethylene lining.

1.4.5 Manholes -

1.4.5.1 Gradients Through Manholes - Where two sewers of the same size are joined by a manhole, a drop of 0.2 feet shall be allowed through the manhole. If lack of elevation is critical, the drop through the manhole may be decreased to 0.1 feet where the joining pipes are on the same alignment.

Manhole inlet and outlet flowline elevations shown on the Drawings shall be the actual elevation at the manhole wall. Sanitary sewer pipe lengths are calculated from center of manhole to center of manhole. Multiplying the pipe length times the slope of that pipe gives the elevation difference between manhole centerlines. After adding the 0.2 feet drop through the manhole, multiply half of the manhole diameter times the appropriate pipe slope and either add to or subtract from the manhole centerline elevations to obtain the inlet and outlet flowline elevations at the manhole wall.

Where two sewers of different sizes are joined by a manhole, the invert of the larger pipe shall be lowered to provide a continuous energy gradient through the manhole. This may be achieved by placing either the crowns or the 0.8 depth points of the two pipes at the same elevation.

1.4.5.2 Manhole Spacing - Except where impossible to do so, all manholes shall be located in public right-of-way or in areas accessible to power equipment such as in easements on paved parking areas. The maximum distance between manholes shall not exceed 400 feet unless approved otherwise by the City Engineer. Paved access is preferred for all manholes but if not provided then unobstructed access is mandatory.

Where sewers are located in rear easements, manholes are to be provided in street right-of-way at each end of the block. Intermediate manholes may also be required in easement if blocks exceed 400 feet in length. For sewers located in rear easements, the sewer serving the last lot in a block should be extended through the last lot and a manhole placed in street right-of-way.

The sewer serving the last lot in a development should be extended through the last lot and a manhole installed if future development can occur on the adjacent land. A 5 feet length of sewer should be stubbed out of the last manhole and the invert of the manhole formed. A bond breaker shall be installed between the poured invert and manhole floor in case the expected future alignment changes.

1.4.5.3 Shallow Manholes - Where manholes are less than 7 feet deep, short cones or flat tops shall be used.

1.4.6 Inverted Siphons - Siphons should be avoided if at all possible as they require additional maintenance. Inverted siphons should have at least two barrels with a minimum pipe diameter of 6 inches. They should be provided with necessary appurtenances for flushing and maintenance. For easy hydraulic removal of solids, the following maximum slopes shall be used on the rising leg: 6 inch pipe - 11 1/2 degrees, 8 inch to 12 inch pipe - 22 1/2 degrees, greater than 12 inch pipe - 45 degrees.The inlet and outlet structures shall have adequate clearances for rodding. Sufficient head shall be provided and pipe sizes selected to maintain velocities of at least 3 feet per second for average flows. Inlet and outlet head losses must be considered. The structures should be arranged so that average flows are carried in one barrel and so that either barrel may be taken out of service for cleaning.

1.4.7 Aerial Crossings - Ductile iron pipe with Protecto 401 lining must be utilized for aerial crossings. All pipe joints must be adequately supported. Consideration must be given to insulating the pipe to prevent freezing, especially on small lines. Deviations must be approved by the City Engineer.

1.4.8 Highway and Railroad Crossings - Where sewer lines are installed under highways or railroads, adequate protection shall be provided to prevent a failure of the crossing. A steel casing pipe of adequate diameter and thickness, as determined by the affected authority, shall be installed by boring, jacking or tunneling from at least the toe of slope to toe of slope of the highway or railroad. The carrier pipe (sewer or force main) shall be constructed of ductile iron with a polyethylene lining or C900 heavy wall PVC with push-on joints. Wood blocking shall be attached to each joint of carrier pipe with steel straps (use either 3 or 4 blocks per pipe). The void between the casing pipe and the carrier pipe shall be filled with fine dry sand blown into place. The ends of the casing pipe shall be sealed with concrete collars. In lieu of wood blocking and sand fill, approved stainless steel and/or plastic casing spacers may be used. Railroad crossings shall meet the requirements of the American Railway Engineering Association or those of the individual railroad.

1.4.9 Service Lines - No wyes will be installed on new sewers except where service lines are required under future pavement. Use risers where sewer is over 13 feet deeper than proposed top of building foundation. Sewer service taps will be made by Water Pollution Control Division.

1.4.10 Protection of Water Supplies - Sewer lines constructed of ductile iron with a polyethylene lining or plastic pipe may be constructed within 10 feet of a private water supply well provided a length of pipe is centered on the well. All other sewer lines must be at least 50 feet from a private water supply well.

Where a gravity sanitary sewer line is laid parallel with a water line, the horizontal distance between them shall be 10 feet, measured from edge to edge. The sewer and the water lines shall be laid in separate trenches with undisturbed earth between them.

Where sewer lines cross water lines, the sewer shall be constructed of ductile iron with a polyethylene lining or plastic pipe. One 20 foot length of pipe shall be centered on the crossing. Where the water line is at least 2 feet above the sewer, no special requirements are needed.

1.4.11 Pump Station and Force Main Design

1.4.11.1 General - Pump stations and force mains shall be designed in accordance with guidelines issued jointly by the Engineering Division and the Water Pollution Control Division (WPC). Preliminary design concepts and pumping capacity shall be approved by the Engineering Division and WPC.

Sewage pumping stations shall be protected from flooding. Protection from a 100 year recurrence interval should be considered. The station should be located where it will be readily accessible to maintenance personnel.

For large pumping stations, the use of separate dry well and wet well is preferable. The designer should coordinate with the Water Pollution Control Division before beginning design concepts.

For small stations, the use of submersible pumps is preferred. A separate valve vault shall be located adjacent to the wet well. Vault shall be covered by a fiberglass enclosure to house the pump control panel. Wet well liquid level shall be controlled by a pressure sensing level regulation system.

All stations shall have a minimum of two pumps, set for alternate operation.

Pump stations must be designed to pump the maximum hourly flow with storage for shorter term peaks provided in the wet well. The wet well should be designed so that with any combination of inflow and pumping, the cycle of operation of the pumps will not be less than 5 minutes and the maximum retention time in the wet well will not exceed one hour.

1.4.11.2 Guidelines for Design and Specifications of Pump Stations (Submersible) -

1.4.11.2.1 General Requirements - These guidelines pertain to wastewater pumping stations generally consisting of a concrete wetwell with two or more submersible pumps; a separate valve vault; a prefabricated FRP building to house and protect all related electrical equipment, discharge piping and valves; and all required appurtenances. Also, the design should include an overflow pipe to a creek that will overflow before sewerage can back up into a house basement. This overflow can be located in the wetwell or in a manhole upstream.

These guidelines shall be followed in the design and specification of all wastewater pumping stations connected to or discharging into the municipal wastewater collection system maintained or operated by the Water Pollution Control Division. These guidelines do not apply to major wastewater pumping stations, which have a separate drywell.

Plans and Specifications shall be reviewed by WPCD personal before final design is put out for bid.

In addition to the requirements set forth in the Standard Technical Specifications of the City of Topeka, the designs, drawings, and specifications for wastewater pumping stations shall incorporate the following minimum requirements. This will include submitting 5 paper copies of O & M manuals and one in electronic form.

A pump station performance test shall be performed before the pump station goes on line.
To do this – plug the influent line fill the wet well with water, time and measure drawdown for each pump and do the same thing with both pumps running. This is to determine the actual GPM of each pump and of both pumps together.

A representative from the Water Pollution Control Division shall be included in the final walk through.

1.4.11.2.2 Wetwell - One precast concrete wetwell shall be provided. All joints between the base slab and precast members and joints between precast sections shall be permanently sealed watertight for the life of the wetwell in accordance with the Standard Specifications of the City of Topeka.

All interior surfaces of the wetwell shall be coated with 2 or more coats of light-colored, shop or field-applied epoxy coating to a dry film thickness of at least 60 mils. Concrete surfaces shall have cured at least 28 days and shall be brush blasted prior to application of the coating. The coating shall be air or airless spray or roller applied and shall be Ameron "Amerlock 400 Epoxy", Tnemec "Series 104 H. S. Epoxy", Raven "404" or Sauereisen "Sewergard No. 210 series."Amer-Plate T-Lock", not less than 0.065-in thick may be used instead of epoxy coating.

The inside of the wetwell shall be marked with footmarks so that an operator can look into the wetwell and tell the depth of the water.

The use of lifting holes in precast wetwell sections to facilitate handling and installation will not be permitted.

1.4.11.2.3 Valve Vault - A reinforced, cast-in-place concrete or precast concrete valve vault having the approximate dimensions of 6' X 6' X 5' deep shall be furnished and installed. The base slab of the vault shall be cast-in-place and shall be sloped to a drainage sump, or to a hole over gravel. The use of a floor drain and drain line extending from the vault to the wetwell will not be acceptable. A suitable recess shall be provided in the top of walls to accept and support grating panels. The top of the valve vault wall for the building shall be 6" higher than the surrounding ground elevation.

1.4.11.2.4 FRP Building - An all-weather, modular type, fiberglass reinforced plastic building shall be installed on the valve vault to house electrical

equipment and to protect piping and valves. The building shall be the product of a manufacturer regularly engaged in the production of high quality fiberglass reinforced plastic buildings.

Building plan dimensions shall be a minimum of 6'-0" X 6'-0" X 7'-6" at the peak sloping to 7'-0" at the sidewalls.

The building shall be one-piece laminated construction with no visible joints and double wall, insulated construction with mounting flange suitable for direct bolting to the valve vault. Walls and roof shall be insulated with polyurethane and shall have an R value of at least 7. Wall or roof construction utilizing dead air space as an insulator will not be acceptable.

The plastic laminate shall be fiberglass reinforced isophthalic polyester resin with UV inhibitor. Surfaces shall have resin rich layer at least 5 mils in thickness and shall be white in color. The laminate shall have at least 25 percent glass content and shall have a flame spread rating of 25 or less.

Field cutting of plastic laminate will be permitted only when acceptable to the Engineer. Cut or trimmed edges of each panel and all penetrations shall be thoroughly coated with a compatible resin to protect the reinforcement and prevent wicking.

The building shall be provided with an insulated fiberglass reinforced plastic or insulated stainless steel pedestrian access door complete with a full-length stainless steel piano hinge, lockable door knob keyed to WPCD standard lock, galvanized stop chain, and a closed cell neoprene perimeter gasket.

A turbine-type ventilator, 8" X 8" or larger, a vent with weather louvers and insect screen, and an interior florescent light shall be provided. The vent shall be installed in the building wall near the bottom of the wall.

Two lifting eyes shall be provided in the roof of the building

The building shall be as manufactured by Engineered Fiberglass Composites, Tomah, Wisconsin or Kenco Plastics Co., Necedah, Wisconsin or approved equal.

1.4.11.2.5 Submersible Pumping Units - Unless otherwise permitted, at least two submersible pumping units shall be installed in the wetwell. Each unit shall consist of a centrifugal pump, a close-coupled electric motor, discharge base and elbow, sliding bracket, guide rails and bracket, lifting chain, wetwell access hatch, and pump controls.

1.4.11.2.5.1 Pumps - Flygt, ABS or Barbarian shall manufacture the pumps. The products of other manufacturers will not be acceptable.

Pump performance shall be stable and free from cavitations and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.006 inch or ½ mil per inch of casing wearing ring diameter, whichever is greater.

All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the vibration displacement (peak-to-peak) as measured at any point on the machine shall not exceed 4.0 mils.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

All wetted assembly fasteners shall be AISI Type 316 stainless steel.

1.4.11.2.5.1.1 Impeller - The impeller shall be non-clog design, capable of passing solids, fibrous material, heavy sludge and other matter found in normal sewage applications. The impeller shall be cast iron accurately machined and polished to remove hollows or projections that might encourage cavitations. The impeller shall be enclosed, single or two vane, single suction type. The impeller is to be dynamically balanced and secured to a straight fit on the shaft by means of a key and hex nut to prevent loosening by torque from either forward of reverse rotation.

Balance vanes shall be provided on the impeller back shroud. Running clearances between the vanes and adjacent housing surfaces shall be such as to reduce pump discharge pressure at the lower mechanical seal sufficiently to permit the oil in the oil chamber housing to effectively lubricate the lower seal.

1.4.11.2.5.1.2 Wearing Rings - Renewable wearing rings shall be securely fastened to the impeller casing front cover to provide either an axial or radial running clearance. As an alternative, the use of an axially adjustable wearing plate arranged to permit adjustment of the axial running clearance between the impeller and plate will also be acceptable. The wearing plate shall have an outward spiraling groove designed to force stringy solids outward and away from the impeller.

1.4.11.2.5.1.3 Oil Chamber Housing - The oil chamber shall contain an inspection plug, drain plug, and vent plug.

1.4.11.2.5.1.4 Mechanical Seals - Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and running in an oil chamber. The lower seal unit between the pump and oil chamber shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper seal unit between the oil chamber and stator housing shall contain one stationary tungsten carbide ring and one positively driven rotating carbon ring. Each interface shall be held in contact by an independent spring system designed to withstand maximum suction submergences. The seals shall require neither maintenance nor adjustment and shall be easily inspected and replaceable.

Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring, acting between the upper and lower units and requiring a pressure differential to

offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended periods of time.

1.4.11.2.5.1.5 Sealing of Mating Surfaces - All mating surfaces of major components shall be machined and fitted with oil resistant (Buna-N) O-rings where watertight sealing is required. Sealing shall be accomplished by O-ring contact of four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain gasket or seal compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

1.4.11.2.5.1.6 Discharge Base - Both, a cast iron discharge base and discharge elbow, shall be furnished by the pump manufacturer for each pumping unit. The base shall be sufficiently rigid to firmly support the guide rails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the wetwell. The face of the discharge elbow inlet flange shall be perpendicular to the floor and make contact with the face of the pump discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ANSI/ASME B16.1, Class 125.

The pump and motor assembly shall be automatically connected to and supported by the discharge base and guide rails so that the unit can be removed from the wetwell and replaced without the need for operating personnel to enter the wetwell.

1.4.11.2.5.1.7 Sliding Bracket - Each pump shall be provided with an integral, cast iron, self-aligning guide rail, sliding bracket. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions.

1.4.11.2.5.1.8 Guide Rails - Each pumping unit shall be equipped with one or more guide rails constructed of Schedule 40S Type 304 stainless steel pipe. Guide rails shall be sized to fit the discharge base and the sliding bracket. Guide rails shall extend upwards from the discharge base to the wetwell access hatch at the top of the wetwell. If the guide rails are over 20 feet in length an intermediate support shall be provided. An upper guide rail bracket shall be provided and shall be AISI Type 304 stainless steel. The upper guide bracket shall be provided with a support bracket for float, sensor, and power cables.

1.4.11.2.5.1.9 Lifting Chain - The pump manufacturer shall provide a chain that is suitable for removing and installing each pump. The chain shall be AISI Type 304 stainless steel. A suitable stainless steel chain hook shall be provided at the top of the wetwell.

1.4.11.2.5.1.10 Wetwell Access Hatch - An access hatch shall be provided in the top of the wetwell. The pump manufacturer shall provide the access hatch. The hatch shall be of all-aluminum construction and suitable for a live load of 300 pounds per square foot. The hatch shall be a double leaf type constructed of structural shapes and reinforced diamond pattern checkered plate. Structural shapes and plates shall have a thickness of not less than ¼ inch. Each leaf shall be provided with two hinges, torsion bars, or other devices to assist opening, an automatic hold-open arm, a retractable handle, and a padlock hasp. The frame shall be provided with strap anchors bolted or welded to the exterior. All aluminum surfaces to be in contact with concrete or mortar shall be given a heavy coat of Kop-Coat "Bitumastic Super Service Black" or Tnemec "46-449 Heavy Duty Black" coal tar paint.

The hatch shall be provided with a lifting chain hook, a stainless steel guide rail support bracket, and a stainless steel support bracket for the sensor and power cables. Also, a hatch safety net "121" as manufactured by Safe Approach, Inc. shall be installed.

1.4.11.2.5.1.11 Tools, Supplies and Spare Parts - The following shall be supplied:

One (1) set of all special tools required for normal operation and maintenance.
One extra set of mechanical seals for each pump.
Two complete sets of gaskets, O-rings, etc. for each pump.
One complete set of all bearings for each pump.
Two sets of wear rings for each pump.

1.4.11.2.5.2 Electric Motor - Each pump shall be driven by an air-cooled, totally submersible electric motor furnished by the pump manufacturer. Each motor shall be rated 208-230/460 volts, 60 Hz, 3-phase, and shall have a nameplate rating which exceeds by 10% the maximum horsepower required by the pump at the specified duty point. The stator housing shall be an air-filled, watertight casing. Motor insulation shall be moisture resistant, Class F, 155 C. Each motor shall be NEMA Design B for continuous duty with a maximum 1800 RPM. (If 3-phase power is unavailable contact WPCD for acceptable options.)

Each motor bearing shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The bearings shall have a calculated AFBMA L_{10} Life Rating of 40,000 hours when operating at maximum operating head.

Each motor shall be capable of continuous operation in air (unsubmerged) for at least 24 hours under pump full load conditions without exceeding the temperature rise limitations for the motor insulation system.

The cable entry water seal design shall be such that a specific fastener torque is not required to ensure a watertight and submersible seal. The use of epoxies, silicones, or other secondary sealing systems will not be acceptable. The cable entry junction box and motor shall be separated by a stator lead sealing gland or terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

Each motor, as a minimum, shall contain a moisture detector and three winding temperature detectors. Each motor shall be provided with relays or monitoring devices for mounting in the motor control center as required to provide motor shutdown contacts to be wired into the pump starter control circuit as indicated on the contract drawings.

Each pump shall be supplied with motor power cables and control cables for the pump protection devices. Each power cable assembly shall contain a grounding conductor. All cables shall be rated for submersible use, which shall be indicated by a code or legend permanently embossed in the cable. Cable sizing shall conform to NEC requirements. The pump supplier shall supply enough cable to terminate all conductors in the junction box as indicated on the drawings, with enough slack in the cable to keep the cable from being damaged.

Cable in the wetwell shall be supported by stainless steel Kellums or woven grips to prevent damage to the cable insulation.

1.4.11.2.6 Discharge Piping and Valves - Discharge piping and valves shall comply with the following minimum requirements.
At the beginning of the force main, outside of the valve vault, install a valve and valve box. Then install a flanged tee with the branch facing up and end the pipe attached to that branch one foot above the ground with a blind flange. This will allow for by-pass pumping around the pump station from the wetwell to the force main.

Piping shall be sized to provide a minimum velocity of 2 fps and a maximum velocity of 8 fps.

The interior of all ductile iron pipe and fittings shall be lined with polyethylene or coated with Protecto 401 Ceramic Epoxy or Coropipe II WasteLiner as manufactured by Madison Chemical Industries, Inc.

An asphaltic coating shall be applied to the exterior of all ductile iron pipe and fittings intended for buried service and shall conform to ANSI/AWWA C151/A21.51.
The exterior of all buried ductile iron piping shall be protected from corrosion by a seamless low-density polyethylene tube conforming to ANSI/AWWA C105/A21.5 with a minimum thickness of 8 mils.

All piping shall be restrained to preclude joint separation. The use of restraining devices which utilize set screws bearing against the pipe wall to resist thrust will not be acceptable, however, Mega-Lug will be allowed with approval of the Engineer.

1.4.11.2.6.1 Wet Well Piping - Unless otherwise permitted, all pump discharge piping located inside the wetwell shall be flanged ductile-iron pipe, Class 53 for pipes 8" and larger, or Schedule 80, PVC with flanged joints for 4" and 6" diameter pipes.

Flange diameter and drilling shall conform to ANSI/ASME B16.1, Class 125.

The interior of all ductile iron pipe and fittings shall be lined with polyethylene or coated with Protecto 401 Ceramic Epoxy or Coropipe II WasteLiner as manufactured by Madison Chemical Industries, Inc.

The exterior of all piping in the wet well shall be coated with Tnemec 46-413.

All PVC pipe joint preparation, cutting and jointing operations shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Primer and solvent cement shall comply with ASTM F656 and ASTM D2564, respectively and shall be selected specifically for the size of pipe and ambient air temperature at the time of application. All joints shall be allowed to cure undisturbed for at least one hour at ambient temperatures above 40F and two hours at temperatures below 40F. Solvent welding of joints will not be permitted at temperatures below 20F.

Flange bolts, nuts, and washers shall be AISI Type 304 stainless steel and shall conform to the requirements of ASTM F593 and F594, respectively. A flat washer shall be provided under the head and nut of bolts in contract with PVC pipe flanges.

Flange gaskets shall be 1/8 inch thick Buna-N, full-face type. Natural rubber will not be acceptable.

Anti-seize compound shall be liberally applied to the threaded portion of all stainless steel bolts during assembly to prevent galling. Anti-seize compound shall be Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Never-Seez "Pure Nickel Special", or Permatex "Nickel Anti—Seize".

Link Seal shall be used to seal discharge piping through the wetwell wall.

1.4.11.2.6.2 Buried Piping - Piping connecting the wetwell discharge piping to the valve vault piping shall be Class 50 or heavier, shall be lined with polyethylene or coated with Protecto 401 Ceramic Epoxy or Coropipe II WasteLiner as manufactured by Madison Chemical Industries, Inc., push-on joint or mechanical joint pipe conforming to ANSI/AWWA C151/A21.51.

Push-on and mechanical joints shall conform to ANSI/AWWA C111/A21.11, except gaskets shall be Buna-N. Natural rubber gaskets will not be acceptable.

The exterior of all buried piping shall be protected from corrosion by a seamless polyethylene tube conforming to ANSI/AWWA C105/A21.5. As an alternative, buried piping may be wrapped in polyethylene and totally or partially encased in flowable fill or Portland cement concrete provided adequate flexibility is provided at wall penetrations to prevent settlement of the encasement from damaging the pipe.

1.4.11.2.6.3 Valve Vault Piping - All discharge piping inside the valve vault shall be thickness Class 53 or heavier, lined with polyethylene or coated with Protecto 401 Ceramic Epoxy or Coropipe II WasteLiner as manufactured by

Madison Chemical Industries, Inc., with flanged joints and flanged fittings.

Flanges shall be ductile iron, ANSI/AWWA C115/A21.15, flat faced. The use of hollowback or "cavitated" flanges will not be acceptable.

Fittings shall be gray or ductile iron and shall conform to ANSI/AWWA C110/A21.10.

Flange bolts and nuts shall be unfinished carbon steel and shall conform to ASTM A307. Nuts shall also comply with ANSI/ASME B18.2., heavy semi-finished pattern. Gaskets shall conform to the requirements for section 6.01 Wet Well Piping.

The exterior surfaces of all pipe and fittings installed inside the valve vault shall be shop primed with Kop-Coat "340 Gold Primer", Tnemec "37-77 Chem Prime", or Ameron "Amercoat 3153A Universal Primer". Following installation, exterior surfaces of pipe, fittings, valves, and fasteners shall be thoroughly cleaned and painted with two coats of alkyd enamel conforming to Fed Spec TT-E0489, Class A. The color shall be light tan.

Properly sized Link Seal shall be used to seal pipe through the walls of the valve vault and wetwell.

1.4.11.2.6.4 Check Valves - A check valve shall be furnished and installed in each pump discharge line inside the valve vault.

Check valves for 4 inch and larger discharge piping shall be of the unobstructed waterway, quick closing, spring-loaded, horizontal swing type with iron body, flanged ends, and bronze trim. Hinge pins shall be stainless steel with both ends extending through bronze-bushed bearings and outside stuffing boxes with grease lubricated packing or O-ring seals. Flanges shall be flat faced with ANSI/ASME B16.1, Class 125 diameter and drilling. Check valves shall be American Flow Control "52SC", M&H "style 259-02", or Mueller "A2600-6-02".

Check valves smaller than 4 inch shall be Class 125 horizontal swing type with iron body and flanged ends. All seats, seat rings, pins, bushings, and other parts subject to wear shall be bronze. Flanges shall be flat faced with ANSI/ASME B16.1, Class 125 diameter and drilling. Swing check valves shall be Milwaukee "F-2974", Stockham "G-931", or Walworth "fig 8928F".

1.4.11.2.6.5 Isolation Valves - An isolation valve shall be furnished and installed on the discharge side of each check valve. Isolation valves 6" and smaller may be epoxy lined resilient seat gate valves with a Buna-N gate or eccentric plug valves. Isolation valves larger than 6" shall be flanged-end, eccentric plug valves as manufactured by DeZurik or Milliken, without exception.

Valves shall be fully lined with 10 mils dft of epoxy in accordance with AWWA C550. The lining shall be holiday free. Exterior surfaces shall be shop coated with a universal rust-inhibitive primer suitable for field painting with alkyd enamel.

Each valve shall have a raised seat cast in the body with welded-in nickel overlay not less than 0.050 inch thick on all surfaces in contact with the plug face. The overlay shall be at least 90 percent pure nickel and shall have a Brinell hardness of at least 200.

The plug shall be of one-piece construction and shall have a cylindrical or spherical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug surfaces shall be faced with Buna-N.

Unless otherwise required, each valve shall be furnished with a manual actuator designed to open and close the valve under all operating conditions.

Valves shall be provided with a totally enclosed geared actuator with 6-inch diameter or larger handwheel. The direction of rotation of the handwheel to open the valve shall be left (counter-clockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

Geared actuators shall be rated for a differential pressure across the valve, on the seating side, of 100 psi. Manual actuators shall produce the required torque with a maximum pull of 80 pounds shall withstand without damage or permanent distortion a pull of 200 pounds. All actuators shall be sealed to prevent the entrance of water when submerged to a depth of 20 feet.

Eccentric plug valves shall be installed with the plug shaft in the horizontal position so that the plug will be in the upper half of the body when the valve is open.

1.4.11.2.7 Miscellaneous Metals -

1.4.11.2.7.1 Anchor Bolts - Unless otherwise permitted, all anchor bolts shall be cast-in-place, shall have a diameter of at least 5/8 inch or as recommended by the manufacture, and shall be either headed or "L" shaped. All anchor bolts, nuts, and washers shall be AISI Type 304 stainless steel.

When permitted by the Owner, the use of a threaded rod adhesive anchor system in lieu of cast-in-lace anchor bolts will be acceptable. The system used shall be limited to the Hilti "Hit C-100: HY-150 or the ITW Ramset/Redhead "Epcon Ceramic 6" system. The use of expansion anchors will not be acceptable.

1.4.11.2.7.2 Grating - All grating shall be FRP or aluminum and shall be securely anchored in place so that it will not rock or tip. Bearing bar depth and spacing shall ensure that the grating does not deflect more than 1/300, or a maximum of ¼ inch, when a 250 psf uniform live load is imposed on the panel.

A hinged section of grating shall be provided to allow easy access to the piping and valves.

1.4.11.2.7.3 Wall Sleeves - Wall sleeves shall be constructed of Schedule 40 steel pipe and shall be hot-dip galvanized after fabrication.

1.4.11.2.7.4 Wet Well Vent Pipe - The vent pipe shall be of the configuration indicated on the attached figures and shall be Schedule 10 (minimum) stainless steel pipe.

1.4.11.2.7.5 Structural Shapes and Plates - All structural shapes and plates installed in the valve vault shall be ASTM A36 and shall be hot-dip galvanized after fabrication.

All structural shapes and plates installed in the wet well shall be AISI Type 304 stainless steel. Members fabricated by welding shall be AISI Type 304L or 316L.

1.4.11.2.7.6 Manhole Steps - Manhole steps shall be installed in the valve vault immediately beneath and centered on the hinged section of grating and shall be the City standard. Manhole steps shall not be provided in the wetwell.

1.4.11.2.8 Electrical - Electrical equipment shall be of the type and quality set forth herein. Items of equipment installed inside the FRP building shall be arranged for easy access and logical order.

All work shall be performed and all materials shall be in accordance with the National Electrical Code, the National Electrical Safety Code, and applicable local regulations and ordinances. Where required by applicable codes, material and equipment shall be listed by Underwriters' Laboratories, or other testing organizations which are acceptable to the governing authority.

1.4.11.2.8.1 Pump Control Station - A pump control station shall be furnished and installed inside the FRP building.

The control system shall be specifically designed to control the pumps and motors provided via a PLC and a 2 float backup system and shall consist of, but not necessarily be limited to, an enclosure, motor control panel, 120v control transformer, circuit breakers, motor starters, 3 position maintained (HOA) selector switches (22mm knob), indication lights, motor protective devices, wetwell level regulating system, accessories, and all other components specified herein or otherwise required for a complete, properly operating pump control system.

All components of the station shall conform to applicable NEMA and NEC Requirements.

1.4.11.2.8.1.1 Enclosure - All controls shall be housed in a NEMA 1 painted steel enclosure.The enclosure shall be dead front with separate, self-contained, duplex motor control panel inside for mounting of controls and to protect electrical equipment. The enclosure shall be at least 48 inches high by 48 inches wide. The panel shall be hinged to the side of the enclosure and shall swing outward for access to the back of the panel. The enclosure shall be provided with an outward opening door having a continuous side hinge. The

enclosure and related equipment shall be suitable for mounting inside the FRP valve vault cover.

1.4.11.2.8.1.2 Circuit Breakers – A circuit breaker sized to comply with NEC requirements shall be provided for each pump. The circuit breakers shall be as manufactured by Allen-Bradley, Square D, or Cuttler-Hammer.

1.4.11.2.8.1.3 Motor Starters - Each pump motor shall be provided with a NEMA rated across-the-line magnetic motor starter with ambient-compensated overload relays and quick-trip heaters. Motor starters shall be manufactured by Allen-Bradley, Cuttler-Hammer, or Square D.

1.4.11.2.8.1.4 Moisture and Heat Sensors – When the sensor in the stator housing senses the presence of moisture in the motor, a relay coil shall illuminate a control panel mounted indicating light and provide status to a PLC.

A pump motor high heat condition shall deactivate the pump and provide status to a PLC.

1.4.11.2.8.1.5 Power Monitoring System – A 3-phase monitor, ***Time Mark model 2644*** or equivalent, shall be provided to continuously monitor 208-240/480v 3-phase incoming power and deactivate the pumps and provide status to a PLC due to loss of phase, under-voltage or out of phase. A single phase power monitor, ***Time Mark model 260*** or equivalent, shall be provided to continuously monitor 208-240v incoming power and deactivate the pumps and provide status to a PLC due to a power loss or under-voltage condition.

1.4.11.2.8.1.6 Control Transformer – A control transformer shall be provided. (The control transformer shall not be located inside of the control panel.) The transformer shall be sized to supply 120 volts to the pump controls.

1.4.11.2.8.1.7 Accessories – The following accessories shall be provided.

a. A lighting arrestor shall be provided and mounted outside the control panel.

b. One hour-meter, ***Cramer model 635G*** or equivalent, shall be mounted on the control panel for each pump.

c. Transient surge protection to prevent damages to control components from power line surges or power line spikes and shall meet the requirements of UL 1449.

d. Terminal blocks for all connections to the control panel and for all connections between the control components and mounting plates.

e. One 120v low profile strobe light shall be furnished and installed on top of the FRP building.

f. One 208-240v, thermostat-controlled electric baseboard heater shall be furnished and installed inside the FRP building.

1.4.11.2.8.2 Pump Control and Wetwell Level Regulation System - Pump sequencing and wetwell level shall be controlled by a PLC. The PLC shall be capable of monitoring and controlling the pump station. The following inputs will be monitored by the PLC: Power failure, phase loss, pump in auto, pump running, pump failure, float switch high, float switch low and wetwell level (as provided by a submersible (0-10 psi) pressure transducer). The following outputs will be controlled by the PLC: Pumps on/off, lead/lag and alternation, local alarm (red strobe). The design engineer shall provide to the City the operating parameters of the lift station. The City will program the PLC to control the lift station within the engineers design parameters.

1.4.11.2.8.2.1 SCADA System - The SCADA system shall include one Microwave Data Systems model 9710 microwave radio; Andrews type LDF4-50A ½" heliax coaxial cable and grounding kit; one 10dB Yagi 900MHz antenna and mounting kit; one Polyphaser model IS-B50HN-C2 radio lightening protection; two Andrews model L4PNM-RC N-male connectors; and a 3ft N-male to N-male radio to Polyphaser jumper.

1.4.11.2.8.3 Conduit - A separate electrical conduit shall be provided between the wetwell and the valve vault for each pump and the level regulation system.
All electrical conduit inside the wetwell or buried shall be nonmetallic. Where indicated PVC coated rigid steel shall be provided. All other conduit shall be E.M.T.

1.4.11.2.8.3.1 Rigid Polyvinyl Chloride (PVC) Conduit - PVC conduit shall be heavy wall, Schedule 40 conduit, and UL labeled for aboveground Spec W-C-1094, NEMA TC-2, and UL-651 standards.

1.4.11.2.8.3.2 PVC-Coated Rigid Steel Conduit - The conduit shall be rigid steel. Before the PVC coating is applied, the hot-dip galvanized surfaces shall be coated with an epoxy-acrylic primer to ensure a bond between the steel substrate and the coating. A two-part red urethane chemically cured coating shall be applied to the interior of all conduit and fittings. The internal coating shall be applied at a nominal 2 mil thickness. The urethane internal coating shall afford sufficient flexibility so as to permit field bending without cracking or flaking of the interior coating.

The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be greater than the tensile strength of the PVC coating. The thickness of the PVC coating shall be a minimum of 40 mils.

All fittings, conduits, mounting hardware, and accessories shall be PVC coated. All hollow conduit fittings shall be coated with the same red interior urethane coating as described above. The manufacturer shall encapsulate screw heads on the conduits with a corrosion-resistant material.

Couplings shall have longitudinal ribs 40 mils in thickness to protect them from wrenches or pliers.

All damaged coatings shall be repaired according to the manufacturer's instructions.

PVC-coated rigid steel conduit shall be as manufactured by Robroy Industries or equivalent.

1.4.11.2.8.4 Installation of Conduit - Conduit installation, in general, shall conform to the following requirements;

a. Two or more conduits in the same general routing shall be parallel with symmetrical bends.

b. Conduit shall be rigidly supported by galvanized hardware and framing materials, including nuts and bolts.

c. Conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.

d. All conduits that enter enclosures shall be terminated by fittings which ensure that the NEMA rating of the enclosure is not affected or changed.

e. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

f. Conduits through roofs or walls shall be sealed watertight.

g. Conduit shall be neatly grouted into any openings cut into concrete structures.

h. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

i. Underground nonmetallic conduit which turns out of concrete, masonry, or earth shall be connected to metallic conduit before emergence, with 90 degree elbows of steel conduit indoors and PVC-coated rigid steel conduit outdoors.

j. Underground conduit bend radius shall be not less than 2 feet at vertical risers nor less than 3 feet elsewhere.

k. Underground conduits and conduit banks shall have 2 feet minimum earth cover except where indicated otherwise.

l. Conduits not encased in concrete and passing through concrete which have one side in contact with earth shall be grouted in place and sealed watertight.

m. Underground conduits shall be sloped to drain from the FRP building to the wetwell.

1.4.11.2.8.5 Sealing of Conduits - Conduit extending from the wetwell to the valve vault shall be sealed as set forth in the NEC.

1.4.11.2.8.6 Grounding - Electrical system grounding and equipment grounding shall be installed in compliance with the National Electrical Code and shall conform to the following applicable requirements:

a. All ground conductors shall be bare or green insulated in accordance with the National Electrical Code, soft drawn copper cable, not smaller than No. 12 AWG/

b. Ground cable splices and joints which will be inaccessible upon completion of construction shall meet the requirements of IEEE Standard 837, and shall be Cadweld "Exothermic" or Burndy "Hyground" type.

c. Ground cable near the base of a structure shall be in earth and as far from the structure as the excavation permits but not closer than 6 inches.

d. Lighting fixtures and convenience outlets shall be grounded through the conduit system.

e. Convenience outlet receptacles shall be grounded by a ground conductor in addition to the conduit connection.

f. Ground connections to equipment and ground buses shall be by copper ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be by clamp type lugs added under permanent assembly bolts or under new bolts drilled and added through enclosures other than explosion-proof, or by grounding locknuts or bushings.

g. The grounding system shall be bonded to station piping by connection to the first flange inside the building on a discharge pipe which will form a good ground connection. The connection shall be made with a copper bar or strap by drilling and tapping the flange and providing a bolted connection.

h. Ground conductors on equipment shall be formed to the contour of the equipment and firmly supported.

i. All ground connection hardware, bolts, and nuts shall be high strength, high conductivity copper alloy.

j. Ground rods shall be ¾ inch diameter by 10 feet long, with a copper jacket bonded to a steel core.

1.4.11.2.8.7 Load Center - A single-phase load center with NEMA 1 enclosure

shall be furnished and installed inside the building. The load center shall be sized for six-20 amp, single pole, 115 volt, single-phase circuit breakers. The electric heater, GFI receptacle, and overhead light shall be powered by the load center. Suitable circuit breakers shall be provided.

1.4.11.2.8.8 Disconnect - One disconnect switch sized for anticipated station loads shall be furnished and installed inside the station.

1.4.11.2.8.9 Transfer Switch - In the event of power failure, the station must be equipped for operation utilizing a portable generator. One emergency generator transfer switch sized according to the station main disconnect shall be furnished and installed inside the building. A chase nipple shall be installed through the building wall to allow connection of the generator to the transfer switch inside the building.

1.4.11.2.8.10 Wall Switches - Switches on ac lighting panel load circuits through 249 volts shall be 20 amperes, 120/277 volts, Hubbell "1221" through "1224". Wall switches shall be mounted 3' – 6" above floor or grade.

1.4.11.2.8.11 GFI Receptacle - Two 20 amp, 125 volt Hubbell "GF-5362" FJI duplex receptacles shall be installed inside the FRP building, one on the wire gutter and one above the sump pump location.

1.4.11.2.8.12 Junction Boxes and Wiring Gutters - Indoor boxes larger than switch, receptacle, or fixture type) and gutters shall be constructed of sheet steel and galvanized after fabrication. Similar enclosures outdoors shall be provided with neoprene gaskets on the hinged doors or removable covers. Box and gutter sizes, metal thickness, and installation details shall comply with the National Electrical Code.

1.4.11.2.8.13. Cable - Cables in power, control, indications, and alarm circuits operating at 600 volts or less, except where lighting, multi-conductor control, and instrument cables are permitted or required, shall be 600 volt power cable.

Cable for electronic circuits to instrumentation, metering, and other signaling and control equipment shall be two- or three- conductor instrument cable twisted for magnetic noise rejection and protected for electrostatic noise by a total coverage shield.

Section 1.5

WATER DISTRIBUTION DESIGN CRITERIA

1.5.1 General - Water distribution system design within the Urban Service Area of the City of Topeka/Shawnee County shall conform to the "Policies Governing the Design of Public Water Supply Systems in Kansas" and all current revisions as published by the Kansas Department of Health and Environment.

Water Systems installations must be:

1. Designed, constructed, tested, and disinfected in accordance with the current minimum standards of design for public water supply systems in Kansas as developed by the secretary pursuant to K.S.A 65-171h and amendments thereto;
2. Designed by a professional engineer as defined by K.S.A. 74-7003, and amendments thereto;

Water Systems installations and materials shall conform to the latest revisions of the following standards:

1. City of Topeka "Standard Technical Specifications"
2. American Water Works Association (AWWA) Standards

Fire flow requirements and hydrant spacing shall be as determined by the latest revisions of the following publications and shall be consistent with the flows required to meet the current Class Rating for the City of Topeka as determined by Insurance Services Office (ISO):

1. AWWA Manual M31 "Distribution System Requirement for Fire Protection".
2. "Fire Suppression Rating Schedule" (FSRS) by ISO.

The above criteria generally constitutes the following minimum specifications:

1. System pressure of 35 psi.
2. Hydrant spacing of 900 feet (max.) in residential areas and 500 feet (max.) in commercial and high density residential areas.
3. Fire flow requirements of 1000 - 1200 gpm for residential areas and 1500 - 2000 gpm for commercial and high density property.
4. Water Line Size:
   - Residential - 6" for hydrant placement and 4" (in limited lengths) for domestic use.
   - Commercial - 8" for hydrant placement and 6" (in limited lengths) for domestic use.
   - High Density - Same as for Commercial.

Deviations from this criteria must be approved by the Utilities Director and City Engineer.

Section 1.6

BRIDGE DESIGN CRITERIA

1.6.1 General - Bridge design in the City of Topeka shall conform to the "Standard Specifications for Highway Bridges" and all current revisions as published by the American Association of State Highway and Transportation Officials. Bridge design and detailing shall conform to the Bridge Manual and all current revisions as published by the Kansas Department of Transportation.

Work and materials shall conform to the "Standard Specifications for State Road and Bridge Construction" and all current revisions as published by the Kansas Department of Transportation.

Deviations from these criteria must be approved by the City Bridge Engineer and the City Engineer.

Section 1.7

STREET LIGHTS

Section 1.7.1 General – The street lighting system shall consist of one or more control centers, the distribution system, street light poles, luminaries and any other appurtenances required to provide a complete, operable street lighting system. Components of the system shall conform to the City of Topeka's Specifications.

The street lighting design and layout shall be based on the ILLUMINANCE criteria for continuous lighting in the latest edition of the American National Standard Practice for Roadway Lighting, Illuminating Engineering Society (IES). The standard spacing in the table below has been determined based on street classification.

STANDARD LUMINAIRE SPACING (LLF = 0.69)

Street Classification	Location	Luminaries	Light Pole	Spacing
Local - Residential (29')	Single Side	150 watt Post Top	14 ft.	150 ft.
Local – Industrial (41')	Single Side	250 watt Cobra Head	30-A-6	250 ft.
Collector (39')	Single Side	150 watt Post Top	14 ft.	150 ft.
Other Classification	*	*	*	*

* As determined by a photometric analysis

Note:

1) At locations where additional lighting may be required such as around curves or at intersections, the pole spacing should be reduced to improve the lighting levels.
2) Appropriate City of Topeka personnel shall have the ability to approve minor adjustments in the maximum spacing of lights to place on lot lines.

Street lighting in residential areas shall consist of post top style luminaries mounted to 14 feet aluminum round, tapered poles. The poles will be either in plain finish or powder coated black. Street lighting in non-residential areas shall consist of street light poles with 30-feet or 40-feet mounting heights. The use of single member luminaire arms (Type A) is

preferred and should be used whenever possible in lieu of the truss-style luminaire arms (Type B).

All street light poles shall have minimum setback of 3 feet from the back of curb to the center of the pole. In addition, street light poles in residential areas shall be installed on the property lines or as close to the property line as possible to avoid conflicts with driveways and to minimize the amount of ambient street light shining into adjacent houses.

The lamps shall be High Pressure Sodium (HPS) and shall be one of the following:

a. 400-watt lamps shall be rated at 50,000 lumens with a 40,000-hour rated life.
b. 250-watt lamps shall be rated at 30,000 lumens with a 40,000-hour rated life.
c. 150-watt lamps shall be rated at 16,000 lumens with a 40,000-hour rated life.

Street lights in residential areas shall be 150-watt HPS lamps while non-residential areas shall contain 250-watt or 400-watt HPS lamps.

The distribution system shall be underground. Internal ribbed HDPE conduit which is schedule 40 and orange in color is required for all circuit cables. HDPE conduits shall be the size for the circuits but in no case shall be less than 1” in diameter. Except where it crosses the street, distribution conduits and cable shall be behind the back of curb or outside the edge of pavement. The distribution cable shall be sized so that voltage drop does not exceed five percent (5%) at any point in the system. The Engineer MUST submit voltage drop calculations to support this requirement.

Conductors for the distribution system shall typically be No. 4 AWG but in no case larger than No. 2 AWG. Pole and bracket cable shall be No. 12 AWG, 2-conductor stranded copper conforming to IMSA Specification 19-1.

All street lighting circuits shall be 240 volts and shall be laid out in a way that maximizes the use of each control center. Each lighting circuit shall be contained in a separate conduit, except for the conduit run between the control center and the adjacent junction box. In that case, one 3-inch conduit shall be installed from the control center to a Type II junction box that is installed adjacent to the cabinet. Distribution cable for each of the lighting circuits shall be routed through this conduit to the junction box.

Junction boxes shall be installed where splices in the distribution cable are required or where sharp 90 degree bends in the conduit are required. The installation of junction boxes in sidewalks should be avoided while the installation of boxes in streets and driveways is unacceptable. Type II junction boxes shall be used where more than two conduits enter/exit the box. Type I junction boxes shall be used where one or two conduits enter/exit the box. Junction boxes shall be installed at least 2 feet from the back of curb to the center of the box and no closer than 2 feet to any street light pole.

The electrical system shall conform to the requirements of the National Electrical Code and service standards issued by the utility which will be supplying power to the street light system. The Engineer shall coordinate and verify the location of proposed feed points with the utility company to ensure availability of service.

Control centers should be located adjacent to the sidewalk or at least 5 feet from the back of curb to the center of the control center where no sidewalk exists. When the location of the control center has been finalized and power has been verified with the utility company, the City will provide the Engineer with an address and an identification number for each proposed control center. The address and identification number shall be placed in the lower right corner of the street lighting plan sheet above the title block. In addition, luminaries shall be numbered using the identification as described in the following City of Topeka Street Light Identification Process.

Alignment of street lights can be single sided or staggered as per the developer's design.

Three standard lights will be approved for the City of Topeka street light criteria. (Detail sheets can be requested from City of Topeka Traffic Operations Division).

DRAINAGE BASIN MAP

DIAGRAM PAGES 1-23
1-24
1-38
1-39