APPENDIX A

PAVEMENT DESIGN

Contents

SECTION A.1: PAVEMENT DESIGN METHOD AND REQUIRED THICKNESSES

A.1-1 Pavement Design Method

AASHTO Guide for Design of Pavement Structures (1986 and 1993), published by The American Association of State Highway and Transportation Officials is the design method used herein and is specified as the design method to be used for any alternate pavement designs that are allowed or required in this regulation. Table A-1: Subdivision Pavement Design Parameters Using AASHTO Method sets out the design parameters used herein for Campbell County & Municipal Subdivision pavements. For definition and explanation of the parameters shown here, see the above mentioned AASHTO guides. Project specific pavement designs are required for residential streets serving over 1,000 residences or commercial/industrial streets serving more than 3,500,000 ESALs or alternative pavement designs proposed under Section A.1-2: Required Thicknesses. Any project specific pavement designs are required to use the design parameters identified in Table A-1: Subdivision Pavement Design Parameters Using AASHTO Method.

Table A-1: Subdivision Pavement Design Parameters Using AASHTO Method

Parameter	Design Values	
	Concrete	Asphalt
Design Life	20 years	20 years
Life Cycle Analysis	50 years	50 years
Drainage Coefficient	1.0	- -
Reliability	80%	80%
Deviation	0.35	0.45
Initial Serviceability	4.2	4.5
Terminal Serviceability	2.5	2.5
Modulus of Rupture	600 psi	- -
Modulus of Elasticity	3,600,000psi	- -
CBR, Minimum	2 (K=50 pci)	3 (MR=2700 psi)
Load Transfer	4.4 (no dowels)	- -
Load Transfer	3.2 (dowels)	- -
20 Year ESAL, Residential Local Street, ≤ 199 Residential Units served	81,000	81,000
20 Year ESAL, Residential Sub-collector Street, 200-500 Residential Units served	203,000	203,000
20 Year ESAL, Residential Collector Street, 501-1000 Residential Units served	406,000 [2]	406,000 [2]
20 Year ESAL, Light Commercial	1,000,000 [1]	1,000,000 [1]
20 Year ESAL, Heavy Commercial/Industrial Street	3,500,000 [1]	3,500,000 [1]
Year 17 to Year 34 and Year 34 to Year 50 ESAL, Residential Local Street, ≤ 199 Residential Units served	53,000	53,000
Year 17 to Year 34 and Year 34 to Year 50 ESAL, Residential Local Street, 200-500 Residential Units served	133,000	133,000
Year 17 to Year 34 and Year 34 to Year 50 ESAL, Residential Local Street, 501-1000 Residential Units served	265,000 [2]	265,000 [2]

Year 17 to Year 34 and Year 34 to Year 50 ESAL, Light Commercial	850,000 [1]	850,000 [1]
Year 17 to Year 34 ESAL, Heavy Commercial/Industrial	2,975,000 [1]	2,975,000 [1]
ESAL, Arterial	Per KYTC Specifications	
Asphalt Surface Layer Coefficient		0.44
Asphalt Base Layer Coefficient		0.40
Crushed Stone Base Layer Coefficient		0.14
Crushed Stone Base with Tensar TX5 Geogrid Layer Coefficient		0.25 for CBR ≥ 3
		0.21 for 2 ≤ BR< 3
Thickness conversion factor, 17 year old asphalt – Residential		0.70
Thickness conversion factor, 34 year old asphalt – Residential		0.60
Thickness conversion factor, 17 year old asphalt – Light Commercial		0.85
Thickness conversion factor, 34 year old asphalt – Light Commercial		0.75
Thickness conversion factor, 17 year old asphalt – Heavy Commercial/Industrial		0.90
Thickness conversion factor, 34 year old asphalt – Heavy Commercial/Industrial		0.80

NOTES:
[1] Engineer shall submit a Traffic Impact Study (TIS) documenting project-specific design ESALs for each commercial/industrial Subdivision generating more than 100 vehicle trips per hour during the AM or PM peak period. If project-specific ESAL loading is greater than 3,500,000, a project-specific pavement design is required.
[2] Project-specific pavement design required for residential streets serving more than 1,000 residential units.

A.1-2 Required Thicknesses

(A) Table A-2: Required Subdivision Street Thicknesses shows the required pavement thicknesses for various Street classifications for Asphalt and Concrete Streets where in situ Subgrade soils can meet the minimum required Subgrade CBR equal to 2 or greater for Concrete pavements or CBR of 3 or greater for Asphalt pavements. These thicknesses were determined using the AASHTO Guide for Design of Pavement Structures (1986 and 1993) and the design parameters identified in Table A-1: Subdivision Pavement Design Parameters Using AASHTO Method. These values meet requirements for a 50 year life cycle without replacement, assuming resurfacing at 17 and 34 years.

Table A-2: Required Subdivision Street Thicknesses								
Street Classification With Number of Residential Units Served[5][6]	Concrete Over Crushed Stone Base (CSB)		Asphalt Over Crushed Stone Base (CSB)			Asphalt Over Crushed Stone Base (CSB) + Geogrid[7]		
	Concrete	CSB	Surface	Base	CSB[1]	Surface	Base	CSB[1]
Residential Local ≤ 199 R.U.	7"[2]	4"	1.5"	5"	7"[4]	1.5"	3"	7"[4]
Residential Sub-collector 200-500 R.U.	8"[2]	4"	1.5"	6"	7"[4]	1.5"	4"	7"[4]
Residential Collector 501-1000 R.U.	9"[2]	4"	1.5"	7.75"	7"[4]	1.5"	5.75"	7"[4]
Light Commercial ≤1 Million ESALS	8.5"[3]	4"	1.5"	8"	7"[4]	1.5"	6"	7"[4]
Heavy Commercial/ Industrial ≤3.5 Million ESALS	10"[3]	4"	1.5"	9.5"	7"[4]	1.5"	7.5"	7"[4]
Arterial	Per KYTC Specifications							

[1] Average thickness. Varies from 1 inch less at centerline to 1 inch greater at gutter apron.
[2] Plain Concrete, tooled skewed transverse Contraction Joints without dowels (see Details C.16 & C.17).
[3] Plain Concrete, with doweled and sawed (non-skewed) transverse Contraction Joints (see Detail C.15).
[4] 6-8 inch KYTC crushed stone base for residential pavements to be installed in one lift (pug milled) and properly compacted (one lift). Any crushed stone base greater in thickness than the above noted 6-8 inches must be installed in two lifts.
[5] Residential Unit means a residential dwelling unit and shall include single-family unattached homes, condominiums, town homes, duplex, triplex and fourplex units, and individual apartment units in a multi-family building.
[6] Number of residential units served for a particular Street is defined as the number of residential units which that Street serves as the sole access or, where a number of residential units are served by more than one access, it is an approximation of the number of residential units served that is equivalent to one access.
- Example 1: A particular section Street serves as the sole access to less than 200 residential units. That Street would then be a Local Street.
- Example 2: An area of existing and future residential development of 450 residential units is served by more than one access Street. Only those Streets that will carry traffic and ESAL loading higher than a Subdivision Street that provides sole access to more than 200 residential units will be classified as a Subcollector Street.
[7] Geogrid shall be Tensar TX5 triaxial geogrid.

(B) Wherever the minimum CBR values for Asphalt or Concrete pavements as defined in Table A-1: Subdivision Pavement Design Parameters Using AASHTO Method cannot be provided by the in situ Subgrade soils, the Engineer shall: 1) submit an engineered Subgrade improvement design that increases the CBR value of the in situ Subgrade soils to the required minimum CBR values for Asphalt and Concrete pavement in Subsection A.1-1: Pavement Design Method; or 2) submit an engineered alternate pavement design that takes into account the substandard CBR values.

(1) Engineered subgrade improvements may include:

a) Undercutting the substandard Subgrade soils and replacing them with documented soils that provide the minimum CBR values, or greater.

b) Providing a chemically stabilized Subgrade (usually lime stabilization) to effectively provide the minimum CBR values, or greater.

c) Utilizing crushed stone base with geotextile and/or Tensar TX5 triaxial geogrid to effectively provide the minimum CBR values, or greater.

(2) Alternative pavement designs may be proposed for Asphalt pavement on subgrades with a CBR value of 2, provided the pavement structure is shown to meet the structural number requirements identified in Table A-3: Structural Numbers for Alternative Asphalt Pavement Designs (CBR =2). Alternative pavement designs are not permitted for Subgrade soils with a CBR less than 2; rather, the subgrade soils shall be improved to CBR equal to 2 or greater, per Subsection A.1-2(B)(1).

Table A-3: Structural Numbers for Alternative Asphalt Pavement Designs (CBR=2)

Street Classification	Structural Number
Local (≤199 Residential Units)	4.09
Sub-collector (200-500 Residential Units)	4.92
Collector (501-1000 Residential Units)	5.60
Light Commercial	5.15
Heavy Commercial/Industrial	6.31

(3) When chemically stabilized Subgrade demonstrates a documented CBR value greater than 3, an alternative asphalt pavement design may be proposed to reduce pavement thickness, provided the pavement structure is shown to meet the structural number requirements identified in Table A-4: Structural Numbers for Alternative Asphalt Pavement Designs.

Table A-4: Structural Numbers for Alternative Asphalt Pavement Designs

Street Classification	Structural Number			
	CBR 4	CBR 5	CBR 6	CBR 7
Local (≤199 Residential Units)	2.85	2.50	2.24	2.04
Sub-collector (200-500 Residential Units)	3.52	3.14	2.84	2.60
Collector (501-1000 Residential Units)	4.09	3.65	3.34	3.07
Light Commercial	4.05	3.75	3.55	3.35
Heavy Commercial/ Industrial	4.87	4.55	4.26	4.05

a) For Asphalt over Crushed Stone Base pavements, the crushed stone base may not be reduced below the thicknesses shown in Table A-2: Required Subdivision Street Thicknesses and minimum total Asphalt thickness of 4.5" local streets), 5.5" (subcollector streets), 6.5" (residential collector streets), and 7.5" (commercial/industrial streets) shall be maintained.

b) There shall be no reduction in thickness for Concrete pavements below those shown in Table A-2: Required Subdivision Street Thicknesses.

c) Alternative pavement designs shall not be permitted for:

i) in situ soils with CBR values greater than 3;

ii) undercut and replaced subgrade soils; or

iii) crushed stone base and geotextile/geogrid subgrade improvements.

A.1-3 Pavement and Pavement Drainage Construction Details

Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways contains important construction details that are a part of these specifications for the pavement, pavement Drainage system, and other utility construction within the Right of Way that can impact pavement performance. Proper construction execution of the details in Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways is important to good pavement performance.

SECTION A.2: USE OF AGGREGATES WITHIN THE RIGHT-OF-WAY

A.2-1 Aggregate Specifications

Table A-5 indicates the specifications for the various aggregate types and their uses in improvement construction within the Street Right-of-way. All aggregates must pass all KYTC aggregate requirements for their intended use as set out in Section 800 of the KYTC Road and Bridge Manual, latest edition.

Table A-5: Aggregate Specification Table

KYTC Specification	Use Within Right-of-Way
Pipe Bedding Sand	Bed and cover for deep sanitary sewer and storm sewer
Concrete Sand	Concrete mix and bed and cover for waterline and power and communication utilities
DGA	Backfill for waterline and power and communication utilities under the Street
57's Crushed Limestone	Concrete pavement aggregate and catch basin crossover construction
57's Gravel	Allowable aggregate for all Concrete not used in Concrete Pavement and Concrete Curb and Gutter
No. 8's Gravel	Allowable aggregate for all Concrete
#4 Crushed Limestone	Required aggregate for Concrete Pavements
Crushed Stone Base	Base material all pavements
Asphalt Aggregates (see Table A-14)	Asphalt pavement aggregates must meet requirements in Section 400 of KYTC Road and Bridge Manual, latest edition, except where noted otherwise in this specification

All aggregates must pass all KYTC aggregate requirements for their intended use as set out in Section 800 of the KYTC Road and Bridge Manual, latest edition.

SECTION A.3: PORTLAND CEMENT CONCRETE (CONCRETE) INFRASTRUCTURE

A.3-1 General Requirement

(A) Materials

Portland cement, water, aggregates, air entraining agents, and admixtures to reduce water, retard set, etc. shall satisfy the material specifications of, and be proportioned, batched, delivered, and cured in accordance with, the Portland Cement Association (PCA), Design and Control of Concrete Mixtures, latest edition, except as noted otherwise in these regulations.

(B) Mix Design

Concrete mix design shall: (1) contain six bags of cement (564 pounds) per cubic yard; (2) be air entrained to an air content of six percent +2 percent using ASTM air entraining admixture; and (3) have a maximum water cement ratio of 0.45, and a maximum slump of four inches. Aggregate type, gradation and weight distribution will vary depending on the intended use, as spelled out in Subsections A.3-2(A), A.3-3(A), and A.3-4(A).

(C) Fly Ash

No fly ash is allowed in the Concrete mix.

(D) Strength

Finished Concrete shall attain a minimum compressive strength at 28 days of 4,000 pounds per square inch.

(E) Ready Mix Suppliers

All Concrete Ready Mix must be provided by Ready Mix plants listed on the KYTC List of Approved Materials (LAM) as a qualified producer. In the alternative, the Ready Mix supplier must supply to the staff an executed original of KTC Form TC-64-764/09 2011 “Certification of Compliance for Freeze Thaw Resistant Concrete Aggregate” for the aggregate used in Concrete mixes prior to commencement of construction. All Ready Mix Concrete suppliers shall submit to the Staff in January of each year mix design verifications for all Concrete mixes that will be supplied during that year for use in Subdivision improvements.

(F) Delivery and Discharge

Concrete shall be delivered and discharged from a truck mixer or agitator truck within the periods specified in Table A-6. Delivery tickets shall have this time clearly shown and be checked for conformance by the Staff. Delivery tickets shall also show the date of the delivery, the Concrete mix supplied, and the design compressive strength. All delivery tickets shall be delivered to Staff. Any Concrete which is not plastic and workable when placed shall be rejected.

Table A-6: Maximum Concrete Discharge Time

Air Temperature	Maximum Discharge Time
Up to 85 degrees Fahrenheit	1.5 hours
More than 85 degrees Fahrenheit	1 hour

(G) Curing

Concrete shall be cured in accordance with Section 601.03.17 of the KYTC specification.

(H) Expansion and Isolation Joints

Expansion and Isolation Joint material used herein shall be pre-formed one-inch thick material, the full depth of the Concrete, and shall conform to KYTC specifications for use in Concrete pavements.

(I) Cold Weather Placement

Concrete may be placed when the ambient air temperature in the shade and away from artificial heat is 40° F (and rising). No concrete shall be placed upon frozen subgrade. Concrete shall be protected from freezing for a period of up to seven days.

(J) Hot Weather Placement

Maintain the temperature of the mixture at or below 90° F during placement. Cease concrete production when the mixture exceeds 90° F until adequate methods are in place to reduce or maintain the mixture temperature. Do not place concrete in areas where the ambient temperature is above 100° F.

A.3-2 Street Pavement Requirements

(A) Aggregates

(1) Aggregates for Concrete Street pavement shall be a blend of No. 467 crushed limestone, No. 8 gravel and concrete sand.

(2) The No. 467 crushed limestone aggregate shall meet the gradation limits shown in Table A-7.

Table A-7: No. 467 Gradation Limits

Sieve Size	Percent Passing
2”	100
1 ½”	93-98*
1"	- -
¾”	35-70
½”	- -
⅜”	10-30
#4	0-5
#8	- -

*Note that the specified percent passing the 1 ½” sieve differs from Section 800 of the KYTC Road and Bridge Manual, latest edition, for No. 467 gradation. The No. 467 crushed limestone for Street pavement in the Regulation must have 2% to 7% retained on the 1½” sieve.

(3) Gradation of the No. 8 gravel and the concrete sand shall meet the requirements of Section 800 of the KYTC Road and Bridge Manual, latest edition.

(4) Minimum cement factor shall be 564 pounds per cubic yard.

(5) Minimum compressive strength at 28 days shall be 4,000 psi.

(6) Maximum water / cement ratio shall be 0.45.

(7) Air entrainment shall be 6% ± 2%.

(8) Maximum slump without mid-range water reducer shall be 4-inches.

(9) Maximum slump with mid-range water reducer shall be 7-inches.

(10) Workability factor shall be between 38 high to 33 low.

(11) Coarseness factor shall be between 73 high to 68 low.

(B) Thickness Requirements

Pavement thicknesses for various classifications of Streets shall be as shown in Table A-2: Required Subdivision Street Thicknesses. Various critical Concrete pavement design and construction details that shall be used in Concrete Subdivision pavements are shown in Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways.

(C) Testing Requirements

(1) One set of three test cylinders shall be made for each day's placement of Street. An additional set of three test cylinders shall be made for each additional 100 cubic yards of placement. One slump, air entrainment and temperature test shall be performed for each set of Concrete test cylinders.

(2) One cylinder shall be tested for compressive strength at no later than seven days and two cylinders at 28 days.

(3) Part of the plastic Concrete sample used for the test cylinders shall be washed to visually confirm that crushed limestone coarse aggregate was used in the Concrete mix.

(4) All Concrete testing shall be performed by a Qualified Materials Testing firm in accord with applicable ASTM specifications, latest editions. The results of all Concrete testing are required to be provided to Staff by the Developer prior to the approval of a Final Plat.

(D) Reinforcing Steel

The use of continuous reinforced concrete pavements is not required but can be considered for streets serving commercial/industrial uses.

(1) Bent bars are not considered reinforcing steel in the contents of this section.

(2) The use of wire mesh in concrete pavements is prohibited.

(E) Placement

(1) Formwork

a) Fixed forms shall have a depth equal to or greater than the thickness of the pavement.

b) Forms shall be of such cross-sections and strength and so secured as to resist the pressure of the Concrete when placed, and the impact and vibration of any equipment which they support, without springing or settlement.

(2) Setting

The Subgrade under the forms shall be compacted and shaped so that the form set shall provide the specified elevation.

(3) Grade and Alignment

The alignment and grade elevation of the forms shall be checked by the Contractor immediately ahead of Concrete placement and corrections made when necessary.

(4) Placement Method

a) All Concrete placement shall conform to ACI Specifications, latest edition.

b) The Concrete shall be mixed in quantities required for immediate use and shall be deposited on the Subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation. The terminus of a continuous pour shall be a Construction Joint per Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways.

c) The Concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary.

d) The Concrete shall be vibrated and consolidated with suitable tools while being placed so that the formation of voids or honeycomb pockets is prevented.

e) Concrete shall not be placed around manholes or other structures until they have been brought to the required grade and alignment.

f) Additional tamping and compaction of surrounding fill material may be required after raising manholes.

(5) Consolidating and Finishing

a) Concrete pavement shall be struck off and consolidated with a mechanical finishing machine, vibrating screed, slipform paver, or by hand-finishing methods such that, after consolidation and final finishing, it shall be at the elevation shown on the approved plans.

b) The finishing method shall incorporate a screed, which will consolidate the Concrete by pressure, vibration, or both.

c) The Concrete shall be brought to a true and even surface, free from rock pockets.

d) Hand-finishing tools shall be kept available for use in case the mechanical finishing machine breaks down.

e) When hand finishing, the pavement shall be struck off and consolidated by a vibrating screed to the elevation as shown on the plans. When the forward motion of the vibrating screen is stopped, the vibrator shall be shut off and not be allowed to idle on the Concrete.

(6) Scraping and Straight Edging

a) The Inspector may require that the pavement be scraped with a straightedge with a minimum width of six feet, equipped with handles long enough to permit it to be operated from the edge of the pavement.

b) When irregularities with the surface elevation are discovered, they shall be corrected by adding or removing Concrete. All disturbed areas shall be floated with a wooden or metal float not less than four feet long and not less than six inches wide and straight edged.

(7) Edging

Before final finishing is completed and before the Concrete has taken its initial set, the edges of the slab and Curb shall be carefully finished with an edger.

(8) Final Surface Finish

a) The final surface of the Concrete pavement and Curb shall have a uniform gritty texture at the grades and cross-sections shown on the plans.

b) A burlap drag or medium broom shall be used as the final finishing method for Concrete pavement.

c) A burlap drag finish shall have a minimum width of at least three feet and have a length that is long enough to cover the entire pavement width.

d) The burlap drag shall be pulled forward across the pavement in the direction in which the pavement is being placed.

e) A broom finish shall be drawn transversely across the pavement using overlapping strokes to produce surface corrugations of uniform appearance approximately $1/16^{th}$ inch in depth.

f) Curbs shall be finished using the same method as the pavement.

(9) Integral Curb

a) Curbs shall be constructed monolithically with pavement extrusion equipment or hand formed prior to the finishing operation.

b) The integral barrier and sloped Curb shall be constructed with or prior to the finished paving operation. Special care shall be taken so that the Curb construction does not create a “cold joint.”

c) Curbs placed immediately following the paving operation shall be sufficiently consolidated with the paving slab and shall not contain voids within or along the back face of the Curb.

d) Integral barrier Curbs along the edges of Street pavement shall contain depressed Curbs not less than 1-3/4 inches above the gutter line at all Driveway entrances and at such other locations as designed on the approved plans.

e) When barrier Curb is used, the Curb may be sawed horizontally to facilitate residential Driveways, approaches, and Sidewalks.

(F) Concrete Street Pavement Joints

(1) Contraction Joints

a) All Contraction Joints shall be placed a maximum of 15 feet on center. Commercial/Industrial Subdivision pavements shall have sawed transverse Contraction Joints with steel dowels that are cut perpendicular across the pavement. All residential pavements shall have tooled or sawed Contraction Joints without dowels. Residential pavement transverse Contraction Joints shall be skewed (except at intersections, paired catch basins and in Cul-de-sacs). See Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways.

b) Sawed joints shall be equal to a depth of one-fourth (1/4) of the pavement thickness continuous across the slab.

c) The timing of the installation of joints shall conform to ACI specifications, latest edition.

d) Contraction Joints cut into fresh Concrete with a jointing tool shall be a minimum 1½ inches deep.

(2) Expansion Joints

There shall be no Expansion Joints in any pavements except at bridge abutments and where required by construction details in Appendix C.

(3) Longitudinal Joints

a) All pavements wider than 15 feet require Longitudinal Joints. Longitudinal Joints may be Construction Joints or tooled/sawed joints.

b) Longitudinal Construction Joints will require 18 inches long #4 deformed bars embedded into each slab at the mid-slab height, no more than four feet on center and no closer than 18 inches to each Contraction Joint.

c) Bent bars may be inserted into fresh Concrete before its initial set.

d) Bent bars shall not be straightened until the Concrete has cured sufficiently to enable bending without fracture of the Concrete slab.

(4) Other Pavement Joints

Other Contraction Joints and Isolation Joints shall be constructed per Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways.

(G) Manholes and On-Street Inlets

Manholes, on-Street inlets, and water valves encountered in the areas to be paved shall be raised or lowered to the surface of the new pavement. On-Street inlets may be separated from the pavement and Curb by boxing out around the inlet. Details for Joint construction at manholes and catch basins are in Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways.

(H) Protection and Opening to Traffic

(1) Traffic shall be prohibited from the pavement until the Concrete has attained a compressive strength of 3,500 pounds per square inch.

(2) Prohibited traffic shall include Contractor's vehicles.

(3) Prior to opening to public traffic, the Developer is responsible for completing, curing and sealing the pavement, including box outs, backfilling the Street, sealing the joints and cleaning the pavement of all debris.

(I) Concrete Pavement Lugs

The purpose of pavement lugs in Subdivision pavements is to provide some additional resistance to Contraction Joints separating during repeated expansion and contraction cycles over the life of the pavement in certain open ended and relatively steep downhill pavement conditions. In these open ended and downhill conditions, resistance to pavement lengthening at contraction joints is substantially reduced as compared to Contraction Joints in long stretches relatively straight pavement. In the long, relatively straight streets, the repetitive adjacent slabs help keep the contraction joints from separating during repeated expansion and contraction cycles. Those conditions which shall require lugs are related to the geometry of the Streets and are as follows (see Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways).

(1) The ends of Cul-de-sacs where the Street grade approaching the Cul-de-sac decreases more than 20 feet vertically, at an average grade of more than six percent, before there is a change in direction of Street Drainage. In this condition, install a lug near the end of the Cul-de-sac across the extension of the two lanes of pavement.

(2) At T-intersections, place a lug on the intersecting street near the intersection, where grade on the intersecting Street is going up from the intersection more than 20 feet vertically, at an average grade of more than six percent, before there is a change in the Drainage direction.

(3) On the main line of a Street pavement where the pavement is going straight and downhill more than 20 feet vertically, at an average grade of more than six percent and the direction of centerline deflects horizontally by more than 30 degrees, place a lug just uphill of the start of the horizontal curve.
a) Lugs shall be placed at least 20 feet uphill from any shallow utility excavation transverse to the pavement.

(4) The Design Engineer may add other lugs in conditions he considers critical to Contraction Joint integrity.

(5) Lug locations are to be shown on construction design and as-built drawings.

(J) Joint Sealing Compound

(1) Joint sealing compound shall conform to the following standard designations:

a) Hot-poured elastic type, as specified by AASHTO, latest edition; or

b) Silicone rubber sealant type (non-sag, self-leveling, or rapid cure) conforming to the KYTC Department of Highways Standard Specifications for Road and Bridge Construction, latest edition; or

c) An approved equal, as determined and approved by Staff.

(2) The application of joint sealant is prohibited at temperatures below 40 degrees Fahrenheit.

A.3-3 Concrete Curb and Gutter Requirements

(A) Aggregates

(1) Aggregates for Concrete Curb and Gutter shall consist of KYTC aggregates approved for use in pavements.

(2) The following quantities and aggregate types shall be provided for one cubic yard of concrete:

a) 1,500 pounds of #57 crushed limestone.

b) 300 pounds #8 gravel.

c) 1,320 pounds of Concrete sand.

(B) Curb Design

(1) 24-inch wide Concrete Curb and gutter shall be used for all Streets Types with Asphalt pavements.

(2) All Streets serving residential developments shall use the sloped curb as shown in Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways.

(3) All Streets serving industrial/commercial developments shall use the six inch barrier Curb.

(C) Concrete Curb over Crushed Stone Base
Concrete Curb over Crushed Stone Base shall be a minimum of seven inches thick at the Curb apron.

(D) Expansion Joints

(1) Expansion Joints shall be placed in Concrete Curbs at each side of Curb inlet catch basins.

(2) Two 3/4-inch diameter, 18-inch long smooth dowels with expansion caps shall be placed in each Expansion Joint location.

(3) Expansion material must go completely through the Curb cross section, preventing Concrete to Concrete contact.

(E) Contraction Joints
Contraction Joints shall be installed in the Curb at a spacing of no more than 10 feet on center.

(F) Standard Details
Details for Concrete Curb and gutter are shown in Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways.

(G) Testing Requirements

(1) One set of three test cylinders shall be made for each day's placement of Street. An additional set of three test cylinders shall be made for each additional 100 cubic yards of placement. One slump, air entrainment and temperature test shall be performed for each set of Concrete test cylinders.

(2) One cylinder shall be tested for compressive strength at no later than seven days and two cylinders at 28 days.

(3) Part of the plastic Concrete sample used for the test cylinders shall be washed to visually confirm that crushed limestone coarse aggregate was used in the Concrete mix.

(4) All Concrete testing shall be performed by a Qualified Materials Testing firm in accord with applicable ASTM specifications, latest editions. The results of all Concrete testing are required to be provided to Staff by the materials testing firm prior to the approval of a Final Plat.

A.3-4 Concrete Public Sidewalks, Pathways, Driveway Aprons and Other Infrastructure

(A) Concrete Mix Design Requirements

(1) Aggregates shall be a blend of No. 57 gravel or crushed limestone, No. 8 gravel and concrete sand.

(2) Gradation of the No. 57 gravel or crushed limestone, the No. 8 gravel and the concrete sand shall meet the requirements of Section 800 of the KYTC Road and Bridge Manual, latest edition.

(3) Minimum cement factor shall be 564 pounds per cubic yard.

(4) Minimum compressive strength at 28 days shall be 4,000 psi.

(5) Maximum water / cement ratio shall be 0.45.

(6) Air entrainment shall be 6% ± 2%.

(7) Maximum slump without mid-range water reducer shall be 4-inches.

(8) Maximum slump with mid-range water reducer shall be 7-inches.

(9) Workability factor shall be between 40 high to 35 low.

(10) Coarseness factor shall be between 63 high to 58 low.

(B) Subgrade

(1) Subgrade for Sidewalks, pathways, and Driveway aprons shall be non-organic and consist of natural clay or sand soils.

(2) Clay soils must be knit together without any loose clay soils. Any material used to finish grade Subgrade shall be bank run sand, KYTC crushed limestone DGA, or crushed recycled Concrete.

(3) Any granular material in excess of two inches thick shall be compacted with a vibrating plate compactor or equivalent.

(4) No gravel and no other crushed limestone gradation will be used for finish grade fill material.

(C) Thickness Requirements

(1) Concrete for public Sidewalks and pathways shall be a minimum of four inches thick.

(2) Residential Driveway aprons shall be a minimum of five inches thick.

(3) Commercial and industrial Driveway aprons shall be a minimum of seven inches thick.

(D) Drive/Apron Requirements
Required Driveway apron layouts and construction details, including required Expansion Joint thickness and location, are shown in Appendix C: Standard Construction Requirements and Details for Streets, Sidewalks, Driveways. Special care must be taken during construction to make sure there is no Concrete-to-Concrete contact under all Expansion Joints.

(E) Edge Drain Installation
When installing Driveway aprons, special care must be taken not to damage the edge drain installed on the outside of the Curb. If the edge drain is damaged, the damaged section must be properly replaced to assure water flow through the edge drain.

(F) Contraction Joint Spacing
For Sidewalks, the maximum spacing of Contraction Joints shall not exceed five feet, except when the Sidewalk or pathway is wider than five feet when the spacing shall not exceed the width of the slab.

SECTION A.4: ASPHALT CONCRETE (ASPHALT) INFRASTRUCTURE

A.4-1 General Requirement

(A) All Subdivision Streets in Campbell County Subdivisions shall be constructed in accordance with the latest edition of the KYTC Roadway Manual, Division 400, except where noted otherwise in this specification.

(B) All Contractors, suppliers and producers must be prequalified by KYTC or demonstrate experience and success on similar projects in order to perform this work.

(C) All construction materials incorporated into the work shall conform to the requirements set forth in the KYTC Roadway Manual.

(D) The Contractor shall notify Staff of the intent to start the project within 24 hours of beginning production.

A.4-2 Mixture Designation and Design

(A) Volumetric Mix Design
The Contractor shall perform the volumetric mix design according to AASHTO R35 and conforming to AASHTO M323 and utilize 50 gyrations.

(B) Mix Design Submittal
At least 72 hours prior to the start of production, the Contractor shall submit the mix design to the Staff and the Applicant's Qualified Material Testing Lab for review.

(C) Aggregate Gradation
Aggregate gradations for base, intermediate and surface mixtures shall conform to KYTC Roadway Manual Division 400 and Table A-8.

Table A-8: Aggregate Gradations			
Sieve Size	1.0 Base Mixture	0.75 Intermediate Mixture	Surface Mixture
1-1/2”	100	- -	- -
1”	90-100	100	- -
3/4”	<90	90-100	- -
1/2”	- -	<90	100
3/8”	- -	- -	90-100
#4	- -	- -	<70
#8	19-45	23-49	25-55
#16	- -	- -	- -
#200	1-7	2-8	2-10

(D) Voids in Mineral Aggregate (VMA), Asphalt Content (AC) and Air Voids (AV) VMA, AC and AV for residential streets shall be as specified in Table A-9 and for commercial/industrial streets as specified in Table A-10.

Table A-9: VMA, AC, and AV for Residential Streets			
	Minimum VMA	Minimum AC	AV
Base Mixture	12%	4%	4%
Intermediate Mixture	13%	4.3%	4%
Surface Mixture	14%	5.4%	3%

Table A-10: VMA, AC, and AV for Commercial/Industrial Streets			
	Minimum VMA	Minimum AC	AV
Base Mixture	12%	4%	4%
Intermediate Mixture	13%	4.3%	4%
Surface Mixture	14%	5.4%	4%

(E) Remaining Mix Design

The remaining mix design shall conform to the applicable KYTC mix designations Class 2 BASE 0.75D PG64-22 or Class 2 BASE 1.0D PG64-22 “Base and Intermediate Mixture” and Class 2 SURF 0.38D PG64-22 “Surface Mixture”.

(F) Recycled Asphalt Pavement and Recycled Asphalt Shingles

Recycled Asphalt Pavement (RAP) may be used but is limited to 25 percent of the mixture by weight in the surface and 30 percent of the mixture by weight in the base. Recycled Asphalt Shingles (RAS) may be used but is limited to 3.0 percent of the mixture by weight. However, when combined, the total amount of RAP and RAS may not exceed 25 percent in the surface and 30 percent in the base with no more than three percent RAS. Warm mix Asphalt technology is allowed on a permissive base similar to the KYTC Standard Specifications. See Table A-11.

Table A-11: Maximum Recycled RAP and RAS in Asphalt Pavement			
	Maximum RAP	Maximum RAS	Maximum RAP and RAS
Base Mixture	30%	3%	30%

Intermediate Mixture	30%	3%	30%
Surface Mixture	25%	3%	25%

A.4-3 Plant Mix Operation

(A) Plant Requirements

(1) Maximum asphalt temperature during plant operations is 330° F.

(2) Minimum asphalt temperature in the truck at the plant is 220° F.

(B) Plant Testing Requirements

(1) The Contractor shall monitor the plant production and perform quality control testing at the Asphalt mixing plant.

(2) Staff shall be provided access to the facility during production and may be present to observe sampling and testing by the Contractor personnel.

(3) A minimum of one test shall be performed per day of paving and additional tests shall be performed for each 1,000 tons produced.

a) The Contractor may perform additional testing as desired to control mix properties.

b) When multiple test samples are obtained, the average value of those results shall be used for acceptance.

c) At the start of production on the project, the first sample shall be obtained after a minimum of 50 tons have been loaded.

d) Samples shall be tested for conformance to gradation and Asphalt content requirements (AASHTO T164 & AASHTO T30).

e) Testing results from any offsite laboratory testing shall be reported to Staff, the applicant and the Qualified Material Testing Lab within 24 hours.

A.4-4 Minimum and Maximum Lift Thicknesses

Minimum and maximum thicknesses for asphalt lifts are indicated in Table A-12.

Table A-12: Minimum and Maximum Lift Thickness		
	Minimum Lift	Maximum Lift
Base	3”	5”
Intermediate	2-1/4”	4-1/4”
Surface	1-1/4”	1-3/4”

A.4-5 Placement Procedures

(A) General

(1) All Contractors must be prequalified by KYTC or demonstrate experience and success on similar projects in order to perform this work.

(2) Immediately before placing Asphalt materials, remove loose and deleterious materials using a power broom or street sweeping equipment.

(B) Subgrade

(1) Asphalt placement is prohibited on subgrade with free water on the surface.

(2) Pavement Subgrade cross slopes shall vary from 3.7 percent to 5 percent depending on the applicable Street cross section.

(C) Overlay

(1) A tack coat shall be evenly applied across the width of the lane at a rate of 0.10 gallons per square yard. Adjust spray bars as necessary to avoid streaks.

(2) A tack coat is not required when placing Asphalt base mixtures on granular base layers.

(3) When Asphalt surface abuts a barrier Curb or similar vertical surface, the abutting surface shall be tack coated prior to construction of the Asphalt course.

(D) Equipment

(1) The Contractor shall furnish dump trucks with clean, smooth metal beds to transport materials and shall use approved and environmentally friendly release agents.

(2) Use of diesel fuel is strictly prohibited in truck beds.

(3) Sufficient trucks should be scheduled to allow for a continuous paving operation without significant delays between trucks.

(4) The Contractor shall furnish a self-propelled paver with the capacity of spreading and finishing all courses to the indicated widths, depths, line, grade and cross section, with a smooth finish, uniform in density and texture.

(5) Rollers must also be self-propelled and capable of reversing smoothly. Steel wheel rollers must be equipped with adjustable scrapers, spray bars, and/or wetting pads to keep wheels clean at all times.

(6) Hand tampers may also be used in tight areas inaccessible by rollers.

(E) Temperatures for Asphalt, Ambient Air and Subgrade

(1) Do not place Asphalt mixtures when the ambient air temperature and existing surface temperatures on the project are less than those specified below or when weather conditions otherwise prevent the proper handling or finishing of the Asphalt mixtures.

a) Minimum ambient air and existing surface temperature shall be 40° F (and rising) prior to placement of Asphalt Base Mixture.

b) Minimum ambient air and existing surface temperature shall be 40° F (and rising) prior to placement of Asphalt Surface Mixture:

(2) The maximum temperature of the mixture shall not exceed 330° F at any time, and the minimum temperature (measured in the truck at the project site) shall not fall below 200° F for all mixtures.

(3) Compaction efforts shall be completed before the Roadway mix temperature falls below 150° F.

(F) Application of Asphalt Mixes

(1) All courses shall be placed and spread as continuously as possible, keeping the number of joints to a minimum.

(2) The longitudinal joint in the final surface course shall be placed along the dividing line between the lanes.

(3) Best paving practices shall be utilized to ensure the proper amount of material at the joint and to make the same number of passes over the joint as the middle of the mat.

(4) The finished Joint shall be smooth and tight and free from voids or coarse material.

(G) Surface Course Application

(1) The surface course application shall be provided no later than 12 months from the date the base Asphalt was placed.

(2) Prior to the surface course application, Staff shall inspect the Asphalt base course. Damage to the Asphalt base course that will affect the structural integrity or future maintainability of the pavement section shall be repaired prior to placement of the surface course.

(3) Damage to Curb and gutter sections identified by Staff that will affect the structural integrity and/or future maintainability of the Curb and gutter shall be removed and replaced prior to the placement of surface Asphalt course.

(4) The surface course shall be compacted to between 1/8” and 1/2” above adjacent Concrete Curb apron.

(5) The pavement surface cross slope shall be three percent.

(6) The joint between Curb and gutter and Asphalt pavements shall be sealed in accord with Subsection A.4-7: Joint Sealing.

A.4-6 Density Testing Requirements

(A) Sampling
All base and surface Asphalt and aggregate materials shall be sampled, tested, and reported by a Qualified Material Testing Lab in accordance with the KYTC Roadway Manual Division 400.

(B) Testing Frequency and Results

(1) Density tests shall be performed at least every 150 feet along each lane of asphalt placed.

(2) At the discretion of Staff, a quality assurance check (including cores) of the sampling and testing may be required if deficiencies are suspected.

(3) Asphalt base and surface courses shall be compacted to an average density of between 90 and 97 percent of solid volume.

(4) Density testing shall be per ASTM D2950 “Density of Bituminous Concrete In Place by Nuclear Density Methods” or ASTM D7113 “Density of Bituminous Mixtures In Place by Electromagnetic Surface Contact Methods”.

A.4-7 Joint Sealing

(A) Compound Material
The Joint Sealing Compound shall conform to the following standard designations:

(1) Hot-Poured Elastic Type, as specified by AASHTO, latest edition; or

(2) Silicone Rubber Sealant Type (Non-Sag, Self-Leveling, or Rapid Cure) conforming to the KYTC Roadway Manual, latest edition; or

(3) An approved equal, as determined and approved by Staff.

(4) The use of AC-20 as joint sealant is prohibited.

(B) Air Temperature
The application of joint sealant is prohibited at air temperatures below 40° F.

(C) Application
(1) Joint Sealant shall be applied to all Joints abutting the Asphalt, which includes the Joint between the base Asphalt and the Curb if the surface course is not going to be applied immediately.

(2) Joint sealant shall be applied to the Curb line immediately upon placement of the surface Asphalt.

A.4-8 Acceptance

(A) All Asphalt pavement materials shall be evaluated by the Staff, per the requirements set forth in this specification and the KYTC Roadway Manual. Asphalt mixtures will be considered acceptable if the test results determine the materials are within the acceptable limits, as shown in Table A-13 and Table A-14. Any materials deemed to be outside of these ranges shall be retested for compliance.

Table A-13: Acceptable Ranges for AC and Density	
Asphalt Content	Density
±0.6%	90%-97%

Table A-14 : Acceptable Gradation Ranges			
Sieve Size	Acceptable Ranges Percent Passing		
	1.0 Base Mixture	0.75 Intermediate Mixture	0.38 Surface Mixture
1-1/2”	94-100	- -	- -
1”	84-100	94-100	- -
3/4”	<90	84-100	- -
1/2”	- -	<90	94-100
3/8”	- -	- -	84-100
#4	- -	- -	<90
#8	14-50	18-54	32-73
#16	- -	- -	- -
#200	1-10	1-10	1-10

(B) When test results are in the “Acceptable Ranges,” the material will be accepted. Staff shall require the Applicant to “Remove and Replace” the materials when the test results indicate they are outside the limits of the “Acceptable Ranges”.

(C) The surface of each course shall be inspected for uniformity and adequate thickness. Base courses shall be placed within a ½ inch tolerance and surface courses within ¼ inch tolerance. All irregularities exceeding the allowable tolerances must be repaired as directed by the Staff.