Via email: ksterrett@hgcons.com

November 21, 2018

Mr. Kevin Sterrett, P.E.
Hg Consult, Inc.
1411 NE Todd George Road
Lee's Summit, Missouri 64086

Re: Pavement Evaluation
Cobey Creek Multi-Use Development
Lee's Summit, Missouri
Geotechnology Project No. J033444.01

Dear Mr. Sterrett:

Presented herein are the results of the pavement evaluation performed for the referenced project. This report includes our project understanding, conclusions, and support data. The services documented in this report were provided in general accordance with the scope of services described in Geotechnology's proposal P033444.01 dated November 5, 2018. The project was authorized by a representative of Hg Consult, Inc. (Hg Consult).

1.0 PROJECT DESCRIPTION AND LOCATION

The project includes the phased construction of an approximately 100-acre, multi-use development in Lee's Summit, Missouri. Four phases are planned and the development will ultimately include four commercial/retail lots, 88 multi-family units, 174 residential lots, a stormwater detention basin, and asphalt pavements. The project site is located on the north side of Missouri 150 Highway approximately 0.5 mile east of SW Market Street. The site location and general topography of the area as per the 2015 U.S.G.S. maps of the vicinity are shown on Figure 1. A plan of the preliminary development is presented as Figure 2.

2.0 TRAFFIC VOLUME

The traffic volumes listed on Figure 2 are summarized in Table 1.

Table 1. Cobey Creek Multi-Use Development Traffic Data

Daily Traffic Volume	Ayva Boulevard Aspen Drive	Cobey Creek[1]	Delaney Drive[2] Tyler Road Cobey Creek[3] Corbin Drive	Mikayla Court Caiden Court Tyler Circle Carter Road Faith Drive Savanna Drive Delaney Drive[4]	Melissa Drive
Vehicle Type	**Number of Vehicles**				
Passenger Vehicle	5000	2,500	2,000	500	400
WB-50 Tractor Trailer	4	2	None	None	None
Trash Truck	2	2	2	2	2
School Bus	2	2	2	2	2
Delivery Vehicles	10	10	6	2	2

[1] North of Missouri 150 Highway to Aspen Drive
[2] North of Aspen Drive to Cobey Creek Drive
[3] North of Aspen Drive to Delaney Drive
[4] North of Cobey Creek Drive

3.0 TRUCK FACTORS

The number of 18-kip equivalent single axle loads (ESALs) that each roadway will be subjected was calculated using the *Standard Urban Truck Distribution Factors* provided by the City of Lee's Summit; this document is included as Appendix A. These factors are summarized in Table 2.

Table 2. Vehicle Type and Corresponding Truck Factor

Vehicle Type	Truck Factor
Passenger Vehicle	0.0002
WB-50 Tractor Trailer	2.37
Trash Truck	1.28
School Bus	0.37
Delivery Vehicles	0.012

4.0 ESAL CALCULATIONS

The number of 18-kip equivalent single axle loads (ESALs) that each roadway will be subjected per day was calculated using the daily traffic volume summarized in Table 1 and the corresponding truck factors summarized in Table 2. The results of these calculations are presented in Table 3.

Table 3. Daily Roadway ESALs

Roadway	Vehicle Type	Daily Traffic Volume	Truck Factor	ESALs	
				Per Vehicle Type	Daily Total
Ayva Boulevard Aspen Drive	Passenger Vehicle	5,000	0.0002	1.0	13.9
	WB-50 Tractor Trailer	4	2.37	9.48	
	Trash Truck	2	1.28	2.56	
	School Bus	2	0.37	0.74	
	Delivery Vehicles	10	0.012	0.12	
Cobey Creek[1]	Passenger Vehicle	2,500	0.0002	0.5	8.66
	WB-50 Tractor Trailer	2	2.37	4.74	
	Trash Truck	2	1.28	2.56	
	School Bus	2	0.37	0.74	
	Delivery Vehicles	10	0.012	0.12	
Delaney Drive[2] **Tyler Road Corbin Drive Cobey Creek**[3]	Passenger Vehicle	2,000	0.0002	0.4	3.772
	WB-50 Tractor Trailer	None	2.37	0	
	Trash Truck	2	1.28	2.56	
	School Bus	2	0.37	0.74	
	Delivery Vehicles	6	0.012	0.072	
Mikayla Court Caiden Court Tyler Circle Carter Road Faith Drive Savanna Drive Delaney Drive[4]	Passenger Vehicle	500	0.0002	0.1	3.424
	WB-50 Tractor Trailer	None	2.37	0	
	Trash Truck	2	1.28	2.56	
	School Bus	2	0.37	0.74	
	Delivery Vehicles	2	0.012	0.024	
Melissa Drive	Passenger Vehicle	400	0.0002	0.08	3.404
	WB-50 Tractor Trailer	None	2.37	0	
	Trash Truck	2	1.28	2.56	
	School Bus	2	0.37	0.74	
	Delivery Vehicles	2	0.012	0.024	

[1] North of Missouri 150 Highway to Aspen Drive
[2] North of Aspen Drive to Cobey Creek Drive
[3] North of Aspen Drive to Delaney Drive
[4] North of Cobey Creek Drive

The number of lifetime ESALs that each roadway will be subjected to was determined by multiplying the daily ESALs by the City of Lee's Summit's pavement design life of 35 years. The results of these calculations are presented in Table 4.

Table 4. Lifetime Roadway ESALs

Roadway	Daily ESALs	Design Life	Anticipated Lifetime ESALs		
			No Growth	0.5% Growth[5]	1.5% Growth[6]
Ayva Boulevard **Aspen Drive**	13.9	35 years	177,573	193,555	230,845
Cobey Creek[1]	8.66		110,632	120,589	143,822
Delaney Drive[2] **Tyler Road** **Corbin Drive** **Cobey Creek**[3]	3.772		48,187	52,524	62,644
Mikayla Court **Caiden Court** **Tyler Circle** **Carter Road** **Faith Drive** **Savanna Drive** **Delaney Drive**[4]	3.424		43,742	47,679	56,865
Melissa Drive	3.404		43,486	47,400	56,532

[1] North of Missouri 150 Highway to Aspen Drive
[2] North of Aspen Drive to Cobey Creek Drive
[3] North of Aspen Drive to Delaney Drive
[4] North of Cobey Creek Drive
[5] A value of 1.09 corresponds to a 0.5% growth factor
[6] A value of 1.30 corresponds to a 1.5% growth factor

5.0 PAVEMENT DESIGN

The asphaltic concrete pavement design method prescribed by the American Association of State Highway and Transportation Officials (AASHTO) requires calculation of Equivalent 18-kip Single Axle Loads (ESALs) for the roadway, which are dependent on frequency and type of vehicular traffic, the pavement type and thickness, the subgrade modulus, the desired pavement life and terminal serviceability, precipitation, drainage, type and thickness of asphaltic concrete and aggregate base.

The subgrade modulus is generally derived from California Bearing Ratio (CBR) test results. For this design, Geotechnology used a CBR value of 2 based on our local experience in the City of Lee's Summit area. Pavement design parameters used in the AASHTO method are summarized in Table 5.

Table 5. Summary of AASHTO Method Design Parameters

Design Parameter		Flexible Pavement (Asphalt)
Design Life[1]		35 years
Subgrade Support		CBR = 2.0
		Subgrade Resilient Modulus = 3,120 psi
Terminal Serviceability[1]		2.5
Reliability[1]		95 percent
Standard Deviation[2]		0.45
Initial Serviceability[3]		4.2
Drainage Coefficient[4]		1.0
Layer Coefficient	Asphaltic Concrete Surface	0.42
	Asphaltic Concrete Base	0.40
	MoDOT Type 5 Aggregate Base	0.14
	Chemically Stabilized Subgrade	0.06

[1] City of Lee's Summit Section 5200 Street Design Criteria
[2] AASHTO recommended value for new flexible pavements
[3] Average value for flexible pavements at the AASHO Road Test
[4] The drainage coefficient is based on a fair draining subgrade nearly saturated 5 to 25 percent of the time

5.1 Asphalt Pavement Evaluation

Using the pavement design parameters listed in Table 5, the number of lifetime ESALs was determined for various asphaltic concrete pavement sections. Lifetime ESALs is the volume of traffic a pavement can tolerate before rehabilitation, resurfacing or reconstruction is typically required. However, regular maintenance (such as sealing of cracks and joints, and preservation of drainage) is required for a pavement section to achieve its design life. Results of the pavement evaluation are presented in Table 6. The computer program *WinPAS 12* was used to determine the pavement section. The WinPAS output report for each pavement section is presented as Appendix B.

Table 6. Asphalt Pavement Section Evaluation

Pavement Layer Material				Structural Number	Lifetime ESALs
Asphaltic Concrete Surface, inches	Asphaltic Concrete Base, inches	MoDOT Type 5 Base, inches	Chemically Stabilized Subgrade, inches		
2	4	6	6	3.64	119,500
2	4	8	6	3.92	189,600
2	4	9	6	4.06	236,800

5.2 Evaluation of Geogrid-Reinforced Asphalt Pavement Sections

Using the pavement design parameters listed in Table 5, the number of lifetime ESALs was determined for various asphaltic concrete pavement sections that include the placement of geogrid below the MoDOT Type 5 base course. The computer program SpectraPave4 Pro prepared by Tensar International Corporation was used to perform the pavement evaluation and a summary of these pavement sections is presented in Table 7. The *SpectraPave4 Pro* output report for each pavement section is presented as Appendix C. City of Lee's Summit approved geogrid products are included in Appendix D; however, the geogrid selected should be compatible with MoDOT Type 5 base course.

Table 7. Asphalt Pavement Section with Geogrid-Reinforced Base Course

Pavement Layer Material				Structural Number	Lifetime ESALs
Asphaltic Concrete Surface, inches	Asphaltic Concrete Base, inches	MoDOT Type 5 Base, inches	Type 2 Biaxial Geogrid		
2	4	6	Yes	3.916	188,000
2	4	7	Yes	4.064	238,000
2	4	10	Yes	4.52	477,000

Note: Tensar recommends a minimum 6-inch layer of crushed rock

6.0 CONCLUSIONS

Presented in this report are various asphaltic concrete pavement sections that can be used for the Cobey Creek Multi-Use Development. This development includes multiple roadways with various traffic volumes. The pavement section selected for a particular roadway should have a lifetime ESAL value that meets or exceeds the anticipated lifetime ESALs for that roadway.

7.0 ATTACHMENTS

The following attachments are included in and complete this report:

Figure 1 – Site Location and Topography
Figure 2 – Cobey Creek Preliminary Development Plan with Traffic Volumes
Appendix A – Standard Urban Truck Distribution Factors
Appendix B – Asphaltic Concrete Pavement Design/Evaluation *WinPAS 12* Output
Appendix C – *SpectraPave 4 Pro* Output
Appendix D – City of Lee's Summit Public Works Approved Products List

* * * * * *

If you have a question or comment concerning this pavement evaluation, or if we may be of further service to you, please contact the undersigned.

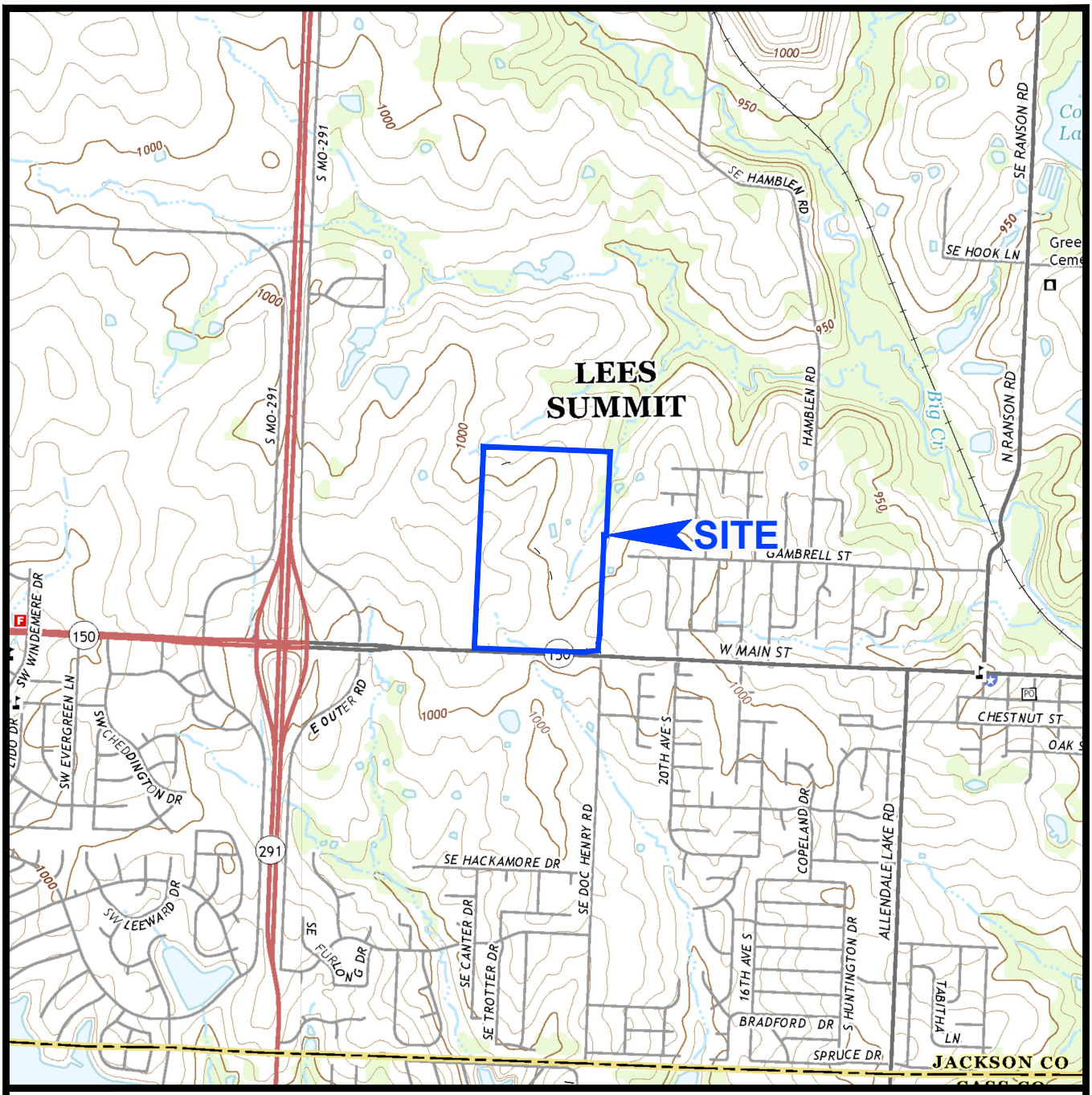
Respectfully submitted,

GEOTECHNOLOGY, INC.

Matt McQuality, P.E.
Office Leader

Nov 21, 2018

MHM/JAW:mhm/ljd



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Pleasant Hill and Raymore, Missouri quadrangles, last revised in 2015.

0 2,000 4,000

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: MHM	App'vd By: JAW
Date: 11-21-18	Date: 11-21-18	Date: 11-21-18

GEOTECHNOLOGY INC
FROM THE GROUND UP

Pavement Evaluation
Cobey Creek Multi-Use Development
Lee's Summit, Missouri

SITE LOCATION AND TOPOGRAPHY

Project Number
J033444.01

FIGURE 1

OWNER: DENNIS J. & JANA D. WEAVER
ZONED: RLL (RESIDENTIAL LARGE LOT
USE: AGRICULTURE / HORTICULTURE VACANT LAND

PROPERTY LINE

5000 ADT
4 WB-50
2 Trash Trucks
2 School Buses
10 Single Units
(Delivery Vehicles)

5000 ADT
4 WB-50
2 Trash Trucks
2 School Buses
10 Single Units
(Delivery Vehicles)

2000 ADT
2 Trash Trucks
2 School Buses
6 Single Units
(Delivery Vehicles)

500 ADT
2 Trash Trucks
2 School Buses
2 Single Units
(Delivery Vehicles)

2000 ADT
2 Trash Trucks
2 School Buses
6 Single Units
(Delivery Vehicles)

500 ADT
2 Trash Trucks
2 School Buses
2 Single Units
(Delivery Vehicles)

500 ADT
2 Trash Trucks
2 School Buses
2 Single Units
(Delivery Vehicles)

2500 ADT
2 WB-50
2 Trash Trucks
2 School Buses
10 Single Units
(Delivery Vehicles)

400 ADT
2 Trash Trucks
2 School Buses
2 Single Units
(Delivery Vehicles)

PROPERTY LINE

CITY LIMITS
CITY OF LEE'S SUMMIT

PROPERTY LINE

OWNER: KNOTT HOLDING COMPANY
ZONED: DISTRICT A (AGRICULTURE / HORICULTURE VACANT LAND)

OWNER: CITY OF GREENWOOD
ZONED: DISTRICT A (RESIDENTIAL VACANT LAND)

CITY LIMITS
CITY OF GREENWOOD

OWNER: CITY OF GREENWOOD
ZONED: RESIDENTIAL VACANT LAND

OWNER: CHRIS RHODE
ZONED: R-1 (SINGLE FAMILY RESIDENTIAL)
USE: SINGLE FAMILY RESIDENTIAL

OWNER: WESELY P. & DEBRA L. SHANAHAN
ZONED: R-1 (SINGLE FAMILY RESIDENTIAL)
USE: SINGLE FAMILY RESIDENTIAL

OWNER: D & J DEVELOPMENT COMPANY
ZONED: R-1 (SINGLE FAMILY RESIDENTIAL)
USE: SINGLE FAMILY RESIDENTIAL

FIGURE 2

0 100' 150' 200'
SCALE IN FEET

NO.	REVISION	DATE	BY	CK/APP
1	PER CITY'S COMMENTS	05/22/18	SPW	RKS

IF THIS IS NOT A BLUE INK SEAL AND THE SIGNATURE IN BLUE INK, THE PLAN IS A COPY AND MAY CONTAIN UNAUTHORIZED ALTERATIONS. THE CERTIFICATION CONTAINED ON THIS DOCUMENT SHALL NOT APPLY TO ANY COPIES

STATE OF MISSOURI
R. KEVIN STRUBE
NUMBER E-21889
NUMBER E-26440
May 22 , 2018

Consult Inc engineers planners
11010 Haskell Street, Suite 210, Kansas City, Kansas 66109
CORPORATE LICENSE No. E2010000573 (MO.) / E-1736 (KS.)

PRELIMINARY DEVELOPMENT PLANS
PHASING PLAN

COBEY CREEK
CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI

X-REF NO.
16-059 BASE

DRAWING NO.
16-059 PDPe

DATE
August 7, 2018

JOB NO.
16-059

SHEET 4 OF 11

APPENDIX A

Standard Urban Truck Distribution Factors

Standard Urban Truck Distribution factors

	VaDOT Method			Asphalt Institute			AAHSTO D Tables	
	AC	PCC		IV-4	minor art. IV-5		SN = 5 AC	t = 9.0 PCC
Vehicle Types	**Truck Factor**	**Truck Factor**	**Vehicle Types**	**Truck Factor**	**Truck Factor**	**Vehicle Types**	**Truck Factor**	**Truck Factor**
Passenger Cars	0.0002	0.0003	Passenger Cars	0.00004	0.0002	Passenger Cars	0.0002	0.0002
Buses (school)	0.37	0.56	Buses (school)	0.37	0.24	Buses (school)	0.37	0.35
Other 2-axle/4-tire Trucks	0.37	0.56	Other 2-axle/4-tire Trucks	0.002	0.002	Other 2-axle/4-tire Trucks	0.012	0.012
2-axle/6-tire trucks	0.37	0.56	2-axle/6-tire trucks	0.37	0.24	2-axle/6-tire trucks	0.37	0.35
3 or More Axle Trucks	1.28	1.92	3 or More Axle Trucks	1.28	1.02	3 or More Axle Trucks	1.28	2.10
3 axle Tractor-trailers	1.28	1.92	3 axle Tractor-trailers	1.07	0.71	3 axle Tractor-trailers	1.07	1.00
4 axle Tractor-trailers	1.28	1.92	4 axle Tractor-trailers	1.85	0.71	4 axle Tractor-trailers	1.85	2.32
5 axle Tractor-trailers	1.28	1.92	5 axle Tractor-trailers	2.39	0.97	5 axle Tractor-trailers	2.37	4.02
6+ axle Tractor-trailers	1.28	1.92	6+ axle Tractor-trailers	1.54	0.90	6+ axle Tractor-trailers	1.53	2.69
5 axle double trailers			5 axle double trailers			5 axle double trailers		
6+ axle double trailers	1.28	1.92	6+ axle double trailers			6+ axle double trailers		
3 axle truck-trailers			3 axle truck-trailers			3 axle truck-trailers		
4 axle truck-trailers			4 axle truck-trailers			4 axle truck-trailers		
5+ axle truck-trailers			5+ axle truck-trailers			5+ axle truck-trailers		
All truck-trailer combos			All truck-trailer combos			All truck-trailer combos		
All vehicles			All vehicles			All vehicles		

School bus rated for 10 tons (20 kips); Front axle = 6 Kip, Rear axle = 14 Kip

UPS, FedEx, etc. (5-ton trucks; 5 kip front / 5 kip rear axles)

Trash Truck: Front axle =12 kips; rear tandem = 34 kips

40 kips: 10 kip front axle + 15 kip single + 15 kip single
60 kips: 12 kip front axle + 30 kip tandem + 18 kip single
80 kips: 12 kip front axle + 34kip tandem + 34 kip tandem
80 kips: 12 kip front axle + 34kip tandem + 34 kip tridem

80 kips: 12 kip front axle + 32 kip tandem + 18 kip single + 18 kip single
100 kips: 12 kip front axle + 34 kip tandem + 18 kip single + 18 kip single + 18 kip single

APPENDIX B

Asphaltic Concrete Pavement Design/Evaluation *WinPAS 12* Output

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name:
Route:
Location:
Owner/Agency:
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	3.64		**Subgrade Resilient Modulus**	3,120.20	**psi**
Total Flexible ESALs	119,500		**Initial Serviceability**	4.20	
Reliability	95.00	**percent**	**Terminal Serviceability**	2.50	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.42	1.00	2.00	0.84
Asphalt Treated Agg. Base	0.40	1.00	4.00	1.60
Graded Stone Base	0.14	1.00	6.00	0.84
ddaf	0.06	1.00	6.00	0.36
			Σ SN	3.64

Engineer: _____

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name:
Route:
Location:
Owner/Agency:
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	3.92		**Subgrade Resilient Modulus**	3,120.20	**psi**
Total Flexible ESALs	189,600		**Initial Serviceability**	4.20	
Reliability	95.00	**percent**	**Terminal Serviceability**	2.50	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.42	1.00	2.00	0.84
Asphalt Treated Agg. Base	0.40	1.00	4.00	1.60
Graded Stone Base	0.14	1.00	8.00	1.12
ddaf	0.06	1.00	6.00	0.36
			Σ SN	3.92

Engineer: _____

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name:
Route:
Location:
Owner/Agency:
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	4.06		**Subgrade Resilient Modulus**	3,120.20	**psi**
Total Flexible ESALs	236,800		**Initial Serviceability**	4.20	
Reliability	95.00	**percent**	**Terminal Serviceability**	2.50	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.42	1.00	2.00	0.84
Asphalt Treated Agg. Base	0.40	1.00	4.00	1.60
Graded Stone Base	0.14	1.00	9.00	1.26
Chemically Stabilize Subgrade	0.06	1.00	6.00	0.36
			Σ SN	4.06

Engineer: _____

APPENDIX C

SpectraPave 4 Pro Output

Flexible Pavement Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

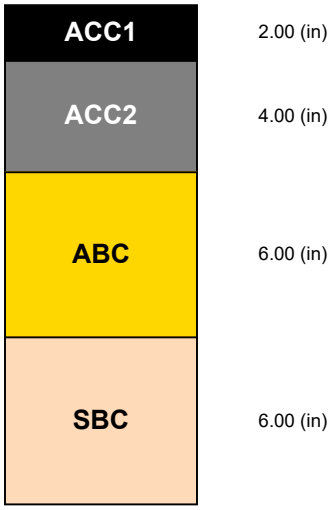
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
ACC2	Dense-graded Asphalt Course	70	0.400	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Chemically Stabilized Subgrade	16	0.060	1.0

Stabilized Section Material Properties

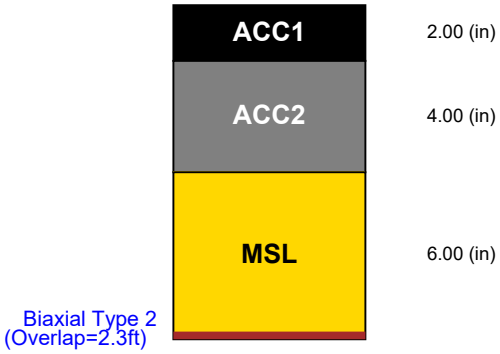
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
ACC2	Dense-graded Asphalt Course	70	0.400	N/A
MSL	Mechanically Stabilized Base Cour	20	0.246	1.0
None	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,120 (psi)
Structural Number = 3.640
Calculated Traffic (ESALs) = 119,000

Stabilized Pavement



Subgrade Modulus = 3,120 (psi)
Structural Number = 3.916
Calculated Traffic (ESALs) = 188,000

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops. **This report is for use of a generic biaxial geogrid ONLY where the specific product has been substantiated by full scale in-ground testing. The user is encouraged to refer to the analysis of the Performance Verified TriAx geogrids in addition to the section shown in this report.**

Project Name	Cobey Creek Development, Lee's Summit, Missouri		
Company Name	Tensar		
Designer		Date	November 19, 2018

Flexible Pavement Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

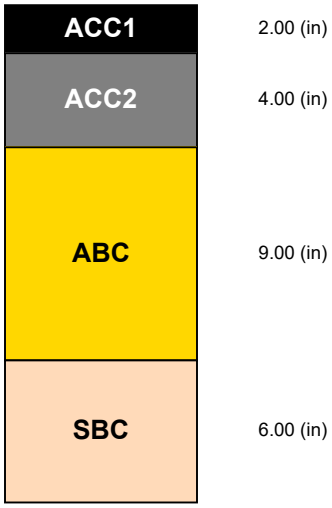
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
ACC2	Dense-graded Asphalt Course	70	0.400	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Chemically Stabilized Subgrade	16	0.060	1.0

Stabilized Section Material Properties

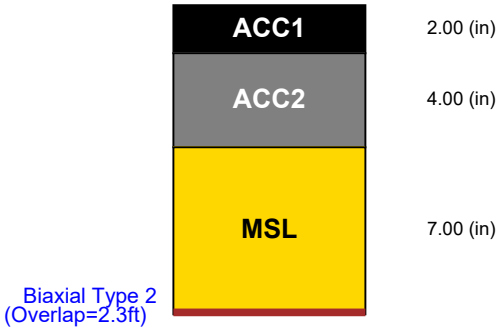
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
ACC2	Dense-graded Asphalt Course	70	0.400	N/A
MSL	Mechanically Stabilized Base Cour	20	0.232	1.0
None	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,120 (psi)
Structural Number = 4.060
Calculated Traffic (ESALs) = 237,000

Stabilized Pavement



Subgrade Modulus = 3,120 (psi)
Structural Number = 4.064
Calculated Traffic (ESALs) = 238,000

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops. **This report is for use of a generic biaxial geogrid ONLY where the specific product has been substantiated by full scale in-ground testing. The user is encouraged to refer to the analysis of the Performance Verified TriAx geogrids in addition to the section shown in this report.**

Project Name	Cobey Creek Development, Lee's Summit, Missouri		
Company Name	Tensar		
Designer		Date	November 19, 2018

Flexible Pavement Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

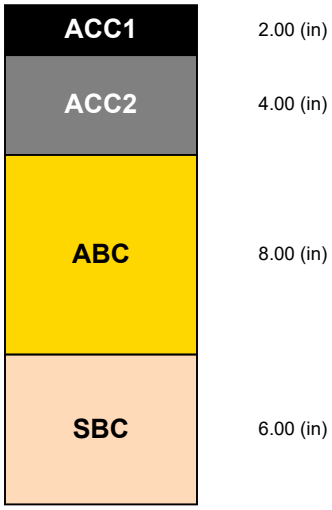
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
ACC2	Dense-graded Asphalt Course	70	0.400	N/A
ABC	Aggregate Base Course	20	0.140	1.0
SBC	Chemically Stabilized Subgrade	16	0.060	1.0

Stabilized Section Material Properties

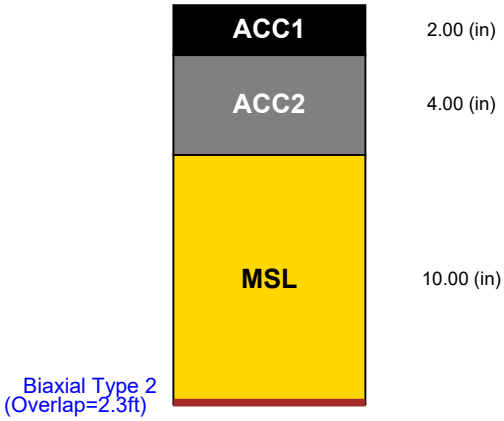
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
ACC2	Dense-graded Asphalt Course	70	0.400	N/A
MSL	Mechanically Stabilized Base Cour	20	0.208	1.0
None	Subbase Course	16	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,120 (psi)
Structural Number = 3.920
Calculated Traffic (ESALs) = 190,000

Stabilized Pavement



Subgrade Modulus = 3,120 (psi)
Structural Number = 4.520
Calculated Traffic (ESALs) = 477,000

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops. **This report is for use of a generic biaxial geogrid ONLY where the specific product has been substantiated by full scale in-ground testing. The user is encouraged to refer to the analysis of the Performance Verified TriAx geogrids in addition to the section shown in this report.**

Project Name	Cobey Creek Development, Lee's Summit, Missouri		
Company Name	Tensar		
Designer		Date	November 19, 2018

APPENDIX D

City of Lee's Summit Public Works Approved Products List

CITY OF LEE'S SUMMIT
PUBLIC WORKS DEPARTMENT

PUBLIC WORKS APPROVED PRODUCTS LIST

This document is provided as a benefit to contractors and suppliers who are performing work in the City of Lee's Summit. The Public Works Approved Products List shall not be used as a substitute for catalog cuts, certifications or shop drawings. This list is updated periodically. The products indicated on the list are approved, but are subject to final field inspection before acceptance.

Vendors wishing to add a product to the list shall submit a Public Works Product Evaluation Form with supporting documentation to the Public Works Engineering Department. Vendors may also submit items, at no cost to the City, for evaluation. Public Works may test new stormwater products. Once a product has been added to the approved products list, minor product changes do not require an evaluation, although the vendor shall submit specification sheets and a sample of the product for the Public Works to inspect. During an initial review, the following will be considered:

- Does the documentation received indicate that the product will perform as stated?
- Does a true need exist for the product in Lee's Summit?
- Will the product be economically competitive?
- Will the product function properly with existing City facilities?
- Will new equipment and new skills be needed to maintain the product?

The vendor supplying the product shall provide specifications and a certification that the product meets and or exceeds Public Works specifications before any testing is performed. Products that are not performing satisfactorily will be removed from the approved products list if the vendor cannot provide timely correction of the problem.

If a vendor is proposing a product that does not meet Public Works specifications, an explanation of why the product meets or exceeds the current specifications must be provided by the vendor in writing. If approved, the product may be tested to determine if the product is satisfactory. If the product is satisfactory, Public Works will consider a revision to the applicable specifications. Products will not be added to the Approved Products List that do not meet Public Works specifications.

Products not performing as required or not supported by vendors or manufacturers are subject to removal from the list. Grounds for removal of products may include, but are not limited to:

- Significant change in product specifications or design without notification to Public Works,
- Failure to correct or replace products that are defective in manufacturing or workmanship,
- Repeated patterns of malfunction of a product not adequately corrected by vendor,
- Unreasonable pricing or timing of repair parts or repair work,
- Excessive delivery times for purchases.

Changes in standard specifications may also necessitate removal of specific products from the list. The product will be retained on the list if it is revised to meet the new criteria.

1. STORMWATER PRODUCTS

MANHOLE CASTINGS

SLAB MANHOLE, FRAME & COVER	**MODEL**
Lee's Summit Part Number	
Frame: LS103A	
Cover: See attached detail	
Clay & Bailey	2002, 2007
Deeter	1332
(Standard Drawings STM-1, STM-2, STM-3)	

STANDARD 24" MANHOLE, FRAME & COVER	**MODEL**
Lee's Summit Part Number	
Frame: LS101A	
Cover: See attached detail	
Clay & Bailey	2007MR, 2007
E.J	1502
R.B. Agarwalla & Co	2007-01-6000
Deeter	1320
(Standard Drawing STM-3)	

MANHOLE STEPS

	MODEL
M. A. Industries	PS-2-PF
American Step Co	ML-13-NCR
(Standard Drawings STM-1, STM-2, STM-3)	

2. GEOGRID

Geogrids shall be extruded, drawn and punched.

Geotextiles shall be woven polypropylene.

The following products have been evaluated, and considered suitable products that meet the intent of the referenced specifications for geogrid used for subgrade improvement under pavements.

Approved Geogrid Products	Approved Woven Geotextile Products
Tensar BX 1200	Tencate / Mirafi HP370
Tensar Triax TX140	Tencate / Mirafi HP570
Tensar Triax TX160	Tencate / Mirafi RS380i
Tencate / Mirafi BXG12	Tencate / Mirafi RS580i

Biaxial Geogrid, Triangular Geogrid and or Woven Geotextiles for Roadway Reconstruction listed in the table above are approved materials. Manufactures may submit materials for review and approval to the City. Those products shall meet or exceed the following standards.

1. Geogrids and Woven geotextiles shall be made of polypropylene.
2. Grid structure shall be either triangular or rectangular in shape.
3. The geogrid shall be integrally formed through punching and drawing of extruded sheets of polypropylene.
4. Manufacturer's Certification: The Contractor shall furnish the manufacturer's certified test results attesting that the material meets the requirements stated in these specifications, including minimum average roll values (MARV) for each type of geogrid used. The test results shall include roll numbers and identification, sampling procedures, and a description of test methods used.

Table 1: Biaxial/Rectangular Shaped Geogrid and Woven Geotextile Properties for Subgrade Improvement / Base Reinforcement

Property	**Test Method**	
Index Properties		MARV
2% Strain, lbs/ft	ASTM D6637	MD[1] = 410 XMD[2] =620
5% Strain, lbs/ft	ASTM D6637	MD[1] = 810 XMD[2] =1,340
Structural Integrity		
Junction Efficiency, %	GRI-GG2	>93%
Flexural Stiffness or Rigidity	ASTM D5732 or D1388	0.22 lb-in
Durability		
Ultraviolet Stability	ASTM D4355	>98%

[1] MD = Machine direction (longitudinal to roll)

[2] XMD = Transverse, or cross, direction (across roll width)

Triangular shaped Geogrid:

1. The geogrid shall be oriented in three substantially equilateral directions so the resulting ribs have a high degree of molecular orientation which continues at least in part through the mass of the integral node.
2. The resulting geogrid structure shall have apertures that are triangular in shape, and shall have ribs with depth-to-width ratios greater than 1.0.

(table of properties on following page)

Table 2: Triangular Geogrid Properties for Subgrade Stabilization

Property	Test Method	Triangular GeoGrid Properties
Durability		
Chemical resistance	EPA 9090 Immersion	90-100%
Ultra-violet light and weathering (500 hrs)	ASTM D 4355	90-100%
Junction efficiency	GRI-GG2-87 GRI-GG1-87	93 %
Radial stiffness at 0.5% strain	ASTM D 6637	15,430 lb/ft min.
Rib Pitch		
Longitudinal	N/A	1.6 in. min.
Diagonal		
Mid-rib depth	N/A	0.05 in. min.
Mid-rib width	N/A	0.04 in. min.