Integrated Testing and Engineering Company of San Antonio, L.P.
Geotechnical & Environmental Engineering • Construction Services • Geologic Assessment

E.A. Palaniappan, Ph.D., P.E.
Murali Subramaniam, Ph.D., P.E.
Kausi Subramaniam, B.S.

August 12, 2020

D. R. Horton, Inc.
5419 North Loop 1604 East
San Antonio, Texas 78247

Attention: **Ms. Leslie Ostrander, P.E.**
Email: lkostrander@drhorton.com

Re: Subsurface Exploration and Pavement Analysis
Frio Road (Entry Road)
1,131.8 Acre Riverstone Tract
San Antonio, Texas

InTEC Project No. S191159-P-A3

Ladies & Gentlemen:

Integrated Testing and Engineering Company of San Antonio (InTEC) completed a **subsurface exploration and pavement thickness evaluation report** (InTEC Project No. S191159-P dated November 07, 2019). As requested, additional pavement sections for collector type streets are presented. All other recommendations remain the same as in the original report.

We appreciate and wish to thank you for the opportunity to be of service to you on this project. If we can be of additional assistance during the foundations explorations, and materials testing-quality control phase of construction, please call us.

Sincerely,
InTEC of San Antonio, L.P.

08/12/2020

Murali Subramaniam, Ph. D., P.E.

Table No. 1 Minimum Flexible Pavement Recommendations – CBR = 4.0

Collector Type Street

	Asphaltic Concrete, Inches			Aggregate Base	Geogrid	Subgrade	Structural Number
	Type D	Type C	Type B	inches		inches	
Collector	3.00	-	-	21.50	No	See Note	4.33
	3.00	7.00	-	-	No	See Note	4.40
	-	4.00	-	14.50	Yes	See Note	4.22
	-	5.00	-	14.50	No	See Note	4.23
	3.00	3.00	-	11.50	No	See Note	4.25
	3.00	3.00	5.00	-	No	See Note	4.34

Notes:

- Subgrade should be verified by InTEC
    - Subgrade Plasticity Index values should be less than or equal to 20
- All applicable guidelines should be followed:
    - Such as for asphalt: Item 205 of City of San Antonio Specifications for Construction.

Table No. 2 Input Parameters used in Asphalt Pavement Section Calculation

	Collector
ESAL	2,000,000
Reliability Level	R-90
Initial and Terminal Serviceability	4.2 and 2.5
Standard Deviation	0.45
Service Life	20 years

Calculations

CBR = 4.0

Subsurface Exploration and Pavement Analysis Proposed New Streets 1,131.8 Acre Riverstone Tract San Antonio, Texas		
	InTEC Project Number: **S191159-P-A3**	Date: 08/12/2020

Tensar.

SpectraPave4 PRO™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

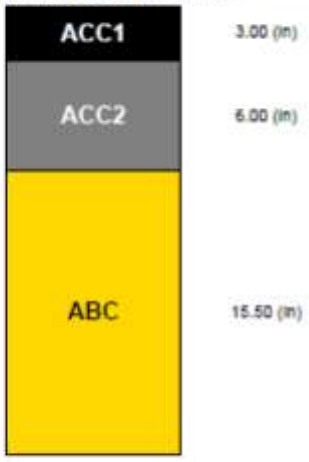
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.440	N/A
ACC2	Dense-graded Asphalt Course	70	0.140	N/A
ABC	Aggregate Base Course	20	0.140	1.0

Stabilized Section Material Properties

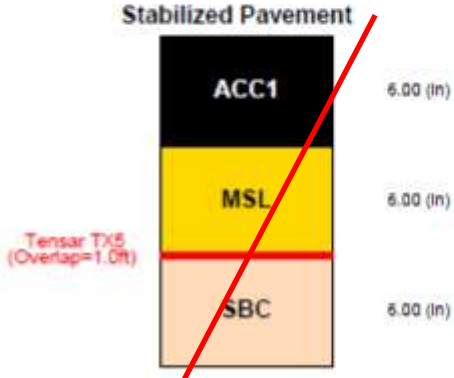
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70	0.420	N/A
MSL	Mechanically Stabilized Base Cour	20	0.265	1.0

Unstabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.330
Calculated Traffic (ESALs) = 2,384,000

Stabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.590
Calculated Traffic (ESALs) = 3,511,000

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.

Subsurface Exploration and Pavement Analysis Proposed New Streets 1,131.8 Acre Riverstone Tract San Antonio, Texas	**Collector**	
	InTEC Project Number: **S191159-P-A3**	Date: 08/12/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.49	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

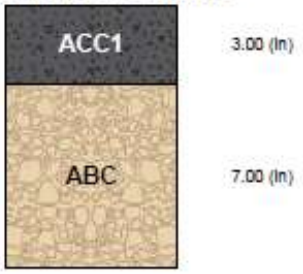
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.440	1.0

Stabilized Section Material Properties

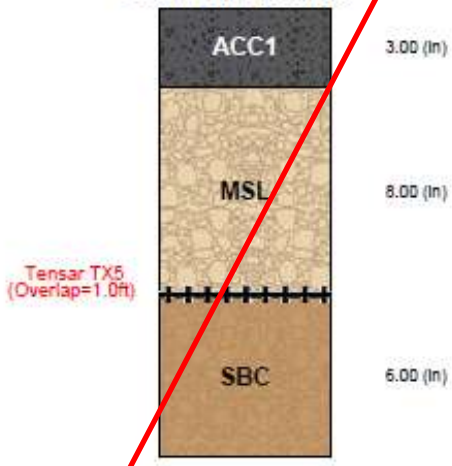
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.236	1.0
SBC	Subbase Course	16.00	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.400
Calculated Traffic (ESALs) = 2,354,000

Stabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 3.644
Calculated Traffic (ESALs) = 710,000

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.

Subsurface Exploration and Pavement Analysis Proposed New Streets 1,131.8 Acre Riverstone Tract San Antonio, Texas	**Collector**	
	InTEC Project Number: **S191159-P-A3**	Date: 08/12/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

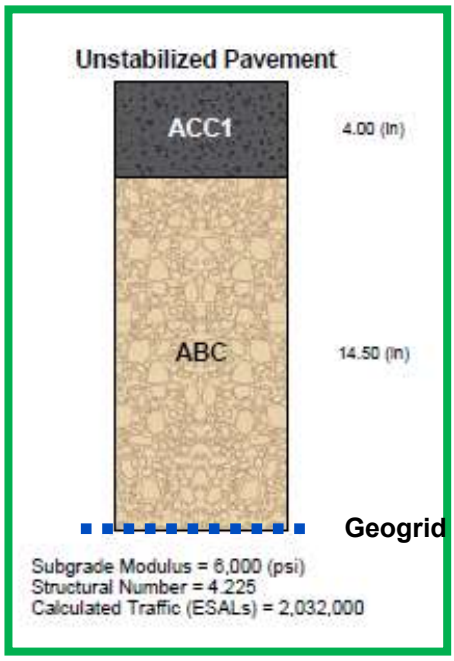
D50 <= 27mm (Base course)

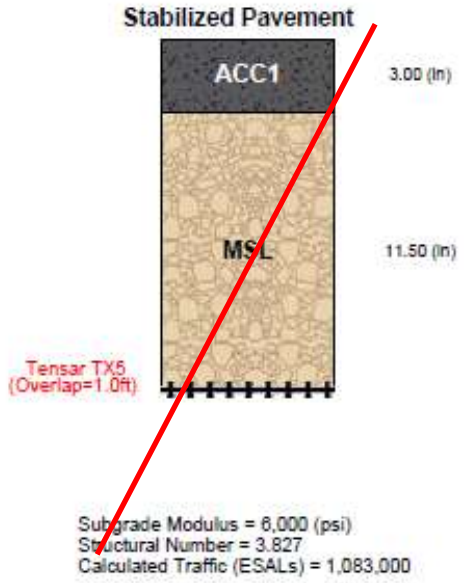
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.170	1.0

Stabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.218	1.0





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.

Subsurface Exploration and Pavement Analysis
Proposed New Streets
1,131.8 Acre Riverstone Tract
San Antonio, Texas

Collector

InTEC Project Number:
S191159-P-A3

Date:
08/12/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

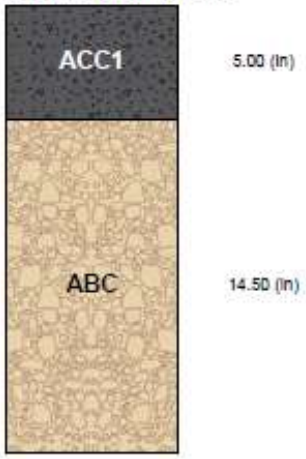
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

Stabilized Section Material Properties

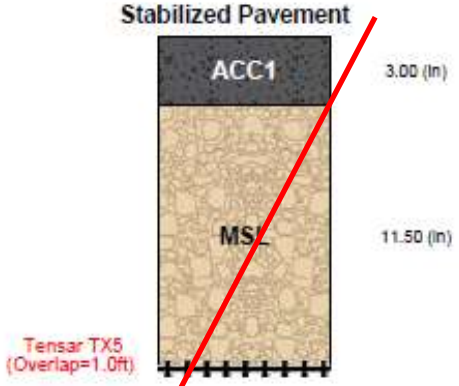
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.218	1.0

Unstabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.230
Calculated Traffic (ESALs) = 2,048,000

Stabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 3.827
Calculated Traffic (ESALs) = 1,083,000

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.

Subsurface Exploration and Pavement Analysis Proposed New Streets 1,131.8 Acre Riverstone Tract San Antonio, Texas	**Collector**	
	InTEC Project Number: **S191159-P-A3**	Date: 08/12/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

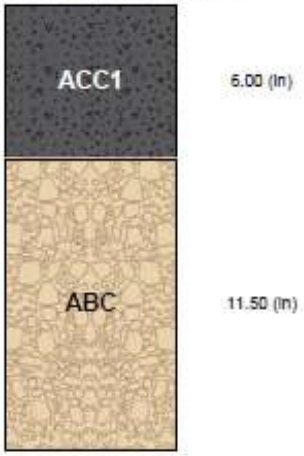
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

Stabilized Section Material Properties

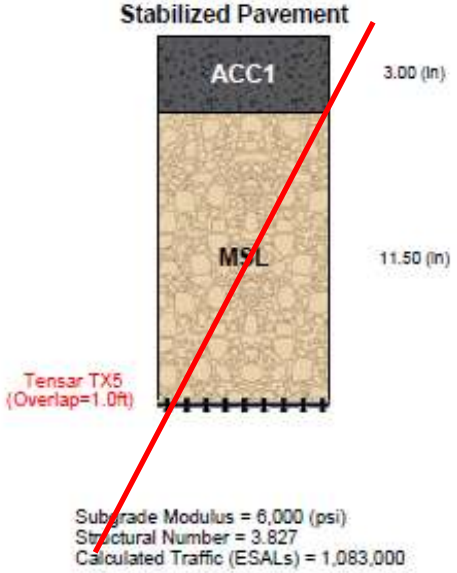
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.218	1.0

Unstabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.250
Calculated Traffic (ESALs) = 2,111,000

Stabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 3.827
Calculated Traffic (ESALs) = 1,083,000

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.

Subsurface Exploration and Pavement Analysis Proposed New Streets 1,131.8 Acre Riverstone Tract San Antonio, Texas	**Collector**	
	InTEC Project Number: **S191159-P-A3**	Date: 08/12/2020

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

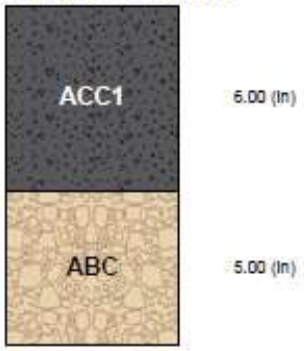
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.340	1.0

Stabilized Section Material Properties

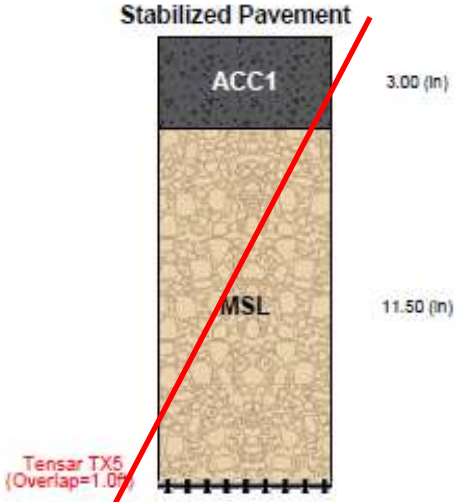
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.216	1.0

Unstabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 4.340
Calculated Traffic (ESALs) = 2,421,000

Stabilized Pavement



Subgrade Modulus = 6,000 (psi)
Structural Number = 3.827
Calculated Traffic (ESALs) = 1,083,000

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.

Subsurface Exploration and Pavement Analysis Proposed New Streets 1,131.8 Acre Riverstone Tract San Antonio, Texas	**Collector**	
	InTEC Project Number: **S191159-P-A3**	Date: 08/12/2020

Appendix

Subsurface Exploration and Pavement Analysis Proposed New Streets 1,131.8 Acre Riverstone Tract San Antonio, Texas		
	InTEC Project Number: **S191159-P-A3**	Date: 08/12/2020

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled*. No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed*. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org