Summary Report

Performance Evaluation of Pavement & Sidewalks
San Antonio, Texas

June 13, 2017

Terracon Project No. 90171081

Prepared for:

City of San Antonio – Transportation & Capital Improvements
San Antonio, Texas

Prepared by:

Terracon Consultants, Inc.
San Antonio, Texas

June 13, 2017

City of San Antonio – Transportation & Capital Improvements (TCI)
114 W. Commerce, 6th Floor
San Antonio, Texas 78205

Attn: Mr. Luis E. Maltos, P.E.
Capital Programs Manager
E: Luis.Maltos@sanantonio.gov

Re: **SUMMARY REPORT - Performance Evaluation of Pavement & Sidewalks**
City of San Antonio
2007 & 2012 Bond Projects
San Antonio, Texas
Terracon Project No. 90171081

Dear Mr. Maltos:

This report summarizes our services for the referenced project. Our scope of services was performed in general accordance with Terracon Proposal No. P90171081A dated March 21, 2017. Some of the information in this report was discussed in a meeting with City of San Antonio (COSA) personnel on May 2, 2017.

PROJECT INFORMATION

Based on our review of the geotechnical reports and plans provided for each street project, pertinent information about the streets and sidewalks included in this study is presented below.

ITEM	DESCRIPTION
Bulverde Road	▪ The existing road section has three travel lanes in each direction, with concrete median and sidewalks. ▪ Approximate project limits: Loop 1604 to Evans Road. ▪ Concrete pavement surface ▪ Approximate construction date: 2013 ▪ Civil Engineer: Pape Dawson Consulting Engineers ▪ Geotechnical Engineer: Arias & Associates (July, 2009)
De Zavala Road	▪ The existing road section has two travel lanes in each direction with a turning lane in the middle and sidewalks. ▪ Approximate project limits: Cogburn Avenue and Babcock Road. ▪ Asphalt pavement surface ▪ Approximate construction date: 2011 ▪ Civil Engineer: Poznecki Camarillo ▪ Geotechnical Engineer: Arias & Associates (April, 2009)

ITEM	DESCRIPTION
Hunt Lane	▪ The existing road section has two travel lanes in each direction with a concrete median in the middle and sidewalks. ▪ Approximate project limits: Ingram Road and Potranco Road. ▪ Concrete pavement surface ▪ Approximate construction date: 2013 ▪ Civil Engineer: TEDSI ▪ Geotechnical Engineer: Raba Kistner Consultants, Inc. (January, 2009)
Walters Street	▪ The existing road section has four travel lanes in the north direction and two lanes in the south direction with intermediate concrete and landscape medians in the middle and sidewalks. ▪ Approximate project limits: IH-35 and Hood Street. ▪ Asphalt and brick paver pavement surface ▪ Approximate construction date: 2011 ▪ Civil Engineer: CH2M Hill ▪ Geotechnical Engineer: Arias & Associates (December, 2008)
Tezel Road	▪ The existing road section has two travel lanes in each direction with a turning lane in the middle and sidewalks. ▪ Approximate project limits: Timber Path and Culebra Road. ▪ Asphalt pavement surface ▪ Approximate construction date: 2015 ▪ Civil Engineer: Camacho Hernandez and Associates ▪ Geotechnical Engineer: Arias & Associates (September, 2013)
West Vestal	▪ The existing road section has two travel lanes in each direction with and sidewalks. ▪ Approximate project limits: Commercial Avenue and Pleasanton Road. ▪ Asphalt pavement surface ▪ Civil Engineer: Fernandez Frazer White ▪ Geotechnical Engineer: inTeC (October, 2013)

DOCUMENT REVIEW

Design and construction documents (including the geotechnical report and construction drawings) were reviewed. Pertinent information includes the following:

- Pavement design procedures appear to be in general accordance with the COSA Design Guidance Manual.
- Performance and subsequent documentation of laboratory tests related to the characterization of the pavement subgrade can be improved in several of the reports.
- For 3 of the streets, recommendations were provided for only one type of pavement (asphalt or concrete). The other 3 reports included recommendations for both types of pavements.
- Walters Street - The geotechnical report provided recommendations only for concrete pavement. However, the drawings from the civil engineer include pavement sections with asphalt and brick paver surfaces which correspond with our visual observations. We understand that a supplemental design report may have been issued for this project.

- There are no written records of maintenance performed on these streets to date.
- No evidence of maintenance was observed during our visual assessment.

More detailed information is included in the Appendix of this report.

ONSITE VISUAL ASSESSMENT/RELATED CONCLUSIONS

We performed a visual assessment of the streets and sidewalks in late April and early May, 2017. Other pertinent information includes the following:

- Bulverde Road – Concrete pavement performing well and as would be expected based on the age, traffic and other site specific conditions.
- DeZavala Road – Asphalt pavement performing well and as would be expected based on the age, traffic and other site specific conditions.
- Hunt Lane – Most of the concrete pavement performing well and as would be expected based on the age, traffic and other site specific conditions.
    - Some cracked panels of concrete pavement in low areas. Cracks possibly the result of changes in the moisture content of expansive subsurface soils and/or loss of support.
- Walters Street – Most of the asphalt pavement is performing well and as would be expected based on the age, traffic and other site specific conditions.
    - Some cracking in the shoulder and drive lanes.
    - Reports of a thick fill body placed during construction.
    - Brick pavers performing well.
- Tezel Road – Asphalt paving performing well and as would be expected based on the age, traffic and other site specific conditions.
    - Rough transitions from asphalt pavement to concrete bus stop pavement. Important to maintain proper joint sealant at this interface.
- West Vestal Place – Asphalt paving performing well and as would be expected based on the age, traffic and other site specific conditions.
    - Some minor evidence of apparent settlement (depression) along utility alignments.

In summary, based on our visual observations, other design related information presented in this report:

- The design process resulted in a street suitable for its intended use.
- Asphalt and concrete pavement should be considered for every street. There is no “one size fits all” solution.
- The use of concrete pavement for Bulverde Road was appropriate based on several factors including:
    - Shallow, very competent (rock like) subgrade conditions which provide uniform support for the pavement and are expensive to remove in order to construct a thicker asphalt pavement section.

- Continued emphasis should be placed on items such as drainage, joint integrity, and routine maintenance.
- Collaboration between the City and members of the design team is very important to help result in well designed, long lasting, cost effective pavements.

ADDITIONAL INFORMATION

Information concerning the following topics is included in the Appendix.

- Pavement Design Guidance (Asphalt vs. Concrete Pavement) – Expansive Clay Soil Subgrade
- Maintenance Cost Comparison: Asphalt vs. Concrete Pavement
- Subgrade Conditions (approximate depth through soil to bedrock)

Please contact us if you have any questions.

STATE OF TEXAS
CHUCK A. GREGORY
86143
LICENSED
PROFESSIONAL ENGINEER

6-13-17

Sincerely,
Terracon Consultants Inc.
(Firm Registration: TX F3272)

Yatish A. Jakatimath, P.E.
Department Manager

Chuck A. Gregory, P.E.
Senior Principal / Regional Manager

Appendix:
YAJ/CAG

Table 1 – Summary of Pavement/Sidewalk Information
Pavement Design Information from Geotechnical Reports
Visual Observations
Pavement Design Guidance (Asphalt vs. Concrete Pavement-Expansive Clay Soil Subgrade)
Maintenance Cost Comparison: Asphalt vs. Concrete Pavement
Minimum depth through Soil to Bedrock

APPENDIX

Table 1 - Summary of Pavement / Sidewalk Information

S. No.	Street Name	Drawing Dated	Pavement Type	Ride Quality	Sidewalk Condition	Major/Significant Distress
1	Bulverde Road	2013	Concrete	Good	Good	None Observed
2	De Zavala Road	2011	Asphalt	Good	Good	None Observed
3	Hunt Lane	2013	Concrete	Bumpy	Narrow Sidewalks	Major Crack near Ingram Intersection.
4	Walters Street	2011	Asphalt/Brick Pavers	Good	Good	None Observed
5	Tezel Road	2015	Asphalt	Good	Good	None Observed
6	West Vestal	2013	Asphalt	Good	Good Newly constructed	None Observed

PAVEMENT DESIGN INFORMATION FROM GEOTECHNICAL REPORTS

Pavement Design Summary
Terracon Project No. 90171081

AASHTO-93 Design of Pavement / COSA Pavement Design Guide

Typical U.O.N.	STR COEFF
HMAC - Surface	0.44
HMAC - Base	0.38
Base (C.L.S.)	0.14
M/C Subgrade	0
Lime Stabilized Subgrade	0.09
Rock (if present)	0.08
Geogrid (in lieu of lime stabilization)	0.48

1. Bulverde Rd - Arias & Assoc. / Pape Dawson

Arterial Rd - Existing pavements ; Clay to 4 feet; Clayey gravel to 6.5 feet; Limestone

CBR = 6 for Clayey gravel; 10 - Rock / Rock millings; No lab tests for CBR

DESIGN INPUTS

Street Class	Arterial	
	Asphalt	Concrete
RF	95%	95%
Std Dev	0.45	0.35
ISI	4.2	4.5
TSI	2.5	2.5
ESALs	3 M	4.5 M
28 day MOR		600 psi
28 day MOE		4000 ksi
Transfer Coeff		2.9
Drainage Coeff		1.01

ASPHALT PAVEMENT OPTIONS

Option	M/C Sub (in)	Base (in)	Ty B (in)	Surface Ty C or D (in)	SN
A	6	16		4.5	4.22
B	6		8	2.5	4.14
C	6		7.5	3	4.17
D	6	20		3	4.12

CONCRETE PAVEMENT OPTIONS

Option	M/C Subgrade (in)	Subbase (in)	Ty B (in)	Conc. Pave (in)
A	6		2	9
B	6	4		9

1” Asphalt bond break layer required for opt B f’c 4400 psi

NEW PAVEMENT SECTION (From Plans): 9 inches concrete; 6 inches moisture conditioned subgrade.

Notes: Recommended removal of surficial clay soils. Did not address lime treatment of subgrade.

2. De Zavala Rd - Arias & Assoc. / Poznecki - Camarillo

Arterial

CBR = 2 for clay; 6 for chalk, clayey gravel, weathered limestone. No lab test results.

DESIGN INPUTS

Street Class	Arterial	
	Asphalt	Concrete
RF	95%	95%
Std Dev	0.45	0.35
ISI	4.2	4.5
TSI	2.5	2.5
ESALs	3 M	4.5 M
28 day MOR		600 psi
28 day MOE		4000 ksi
Transfer Coeff		2.9
Drainage Coeff		1.01

ASPHALT PAVEMENT OPTIONS

CBR 2

Asphalt – Higher SN due to low CBR

Option	Lime treated Subgrade (in)	Base (in)	Ty B (in)	Surface Ty C (in)	Surface Ty D (in)	SN
A	6	22		3	2	5.76
B	6		10.5		3	5.79

CBR 6

Asphalt

Option	M/C Sub (in)	Base (in)	Ty B (in)	Surface Ty C (in)	Surface Ty D (in)	SN
A	6	14		3	2	4.16
B	6		7.5		3	4.17

CONCRETE PAVEMENT OPTIONS

Option	M/C Sub (in)	Cement stabilized subbase (in)	Ty B (in)	Conc. Pave (in)
1	6		2	9
2	6	6		9

1 inch asphalt bond breaking layer required for Opt 2; f'c = 4400 psi

NEW PAVEMENT SECTION (From Plans):

Sta 16+14.87 to Sta 23+50; Sta 53+00 to Sta 87+05
Option 2: 3 inches Ty. D over 7.5 inches Ty. B over 6 inches moisture conditioned subgrade

Sta 23+50 to Sta 53+00
Option 2: 3 inches Ty. D over 10.5 inches Ty. B over 6 inches lime treated subgrade

Notes: Gave recommendations for lime treated subgrade but no lab test were provided.

3. Hunt Lane - RKCI / TEDSI
Arterial
CBR=- 2; No lab CBR tests reported; 2.5 on proctor curve
DESIGN INPUTS

Street Class	Arterial	
	Asphalt	Concrete
RF	95%	90%
Std Dev	0.45	0.39
ISI	4.2	4.5
TSI	2.5	2.5
ESALs	3 M	4.5 M
28 day MOR		620 psi
28 day MOE		4000 ksi
Transfer Coeff		3.4
Drainage Coeff		0.9

ASPHALT PAVEMENT OPTIONS
SN - Req : 5.43
CBR 2
Asphalt – Higher SN due to low CBR

Option	LIME Sub (in)	Base (in)	Ty B (in)	Binder Ty C (in)	Surface Ty C (in)	SN
A	6	20		3	2	5.48
B	6		10	2	1.5	5.42

Geogrid may be used in lieu of LIME sub

CONCRETE PAVEMENT OPTIONS
Concrete – 20yr

	LIME/CEMENT Sub (in)	Ty B	Conc Pave (in)
	6		11

Concrete – 30yr

	LIME/CEMENT Sub (in)	Ty B	Conc Pave (in)
	6		12

COSA PCC Item 209: f'c 4400 psi

NEW PAVEMENT OPTIONS (From Plans): 12 inches concrete; moisture conditioned subgrade.

Notes: Lime pH and Lime PI were reported; No Unconfined Compressive test for Lime reported. Sulfates contents were checked.

4. Walters Street - Arias & Assoc. / CH2MHILL
Collector street
CBR= 3; Clay and Clayey Gravel; No lab tests.
DESIGN INPUTS

Street Class	Collector	
	Asphalt	Concrete
RF	95%	95%
Std Dev	0.45	0.35
ISI	4.2	4.5
TSI	2.5	2.5
ESALs	3 M	4.5 M
28 day MOR		600 psi
28 day MOE		4000 ksi
Transfer Coeff		2.9
Drainage Coeff		1.01

ASPHALT PAVEMENT – No option provided

CONCRETE PAVEMENT OPTIONS

Option	M/C Sub (in)	CEMENT Stabilized subbase (in)	Ty B (in)	Conc Pave (in)
A	6		4	9
B	6	6		9

1” Asphalt bond break layer required for opt B; f’c 4400 psi
Tensar BX-1100 geogrid required in subgrade.

NEW PAVEMENT (From Plans):

Asphalt Surface: 2 inches Type "D" Asphalt over 10 inches Type "B" Asphalt over 6 inches Lime Treated Subgrade
Brick Paver Surface: Brick paver over 9 inches concrete over 4 inches Type "B" Asphalt

Notes: No lab tests on lime treated soils; No recommendations for use of lime treated soils.

5. Tezel Rd - Arias & Assoc. / Camacho Hernandez & Assoc.
Secondary Arterial
CBR = 1.5 - Lab CBR curve reported.
DESIGN INPUTS

Street Class	Arterial	
	Asphalt	Concrete ** NOT PROVIDED FOR THIS RD
RF	95%	
Std Dev	0.45	
ISI	4.2	
TSI	2.5	
ESALs	3 M	
28 day MOR		
28 day MOE		
Transfer Coeff		
Drainage Coeff		

Req SN: 5.76

ASPHALT PAVEMENT OPTIONS
Asphalt – Higher SN due to low CBR

Option	LIME Sub (in)	Base (in)	Ty B (in)	Surface Ty C or D (in)	SN
A	6	19		6	5.78
B	6	12	5	4	5.82
C	6		10	4	6.04
D	Rock Sub	12	12	2	7.12

Opt D requires removal of all onsite clays and proofroll of rock subgrade.
Must provide minimum 12” base.

CONCRETE PAVEMENT OPTIONS: None

NEW PAVEMENT OPTIONS (From Plans):
4 inches Type "D" Asphalt over 10 inches Type "B" Asphalt, over 6 inches Lime Treated Subgrade

Notes: Lime Series: pH in text but no lab data/graphs. No mention of results for PI or Unconfined Compressive strength when treated with lime.

6. Vestal Pl - Intec / Fernandez Frazer White
Local Type A no BUS
CBR 2.6 - Clay subgrade; No CBR tests in the lab reported; Table 6 - CBR 2.6; Plate No. 8, CBR 2.3
DESIGN INPUTS

Street Class	Arterial	
	Asphalt	Concrete ** NOT PROVIDED FOR THIS RD
RF	70%	
Std Dev	0.45	
ISI	4.2	
TSI	2	
ESALs	100 K	
28 day MOR		
28 day MOE		
Transfer Coeff		
Drainage Coeff	1	

20 yr life

ASPHALT PAVEMENT OPTIONS
Asphalt – Higher SN due to low CBR

Option	LIME Sub	Base	Surface Ty D	SN
A	6	10	2	2.62

CONCRETE PAVEMENT OPTIONS: None

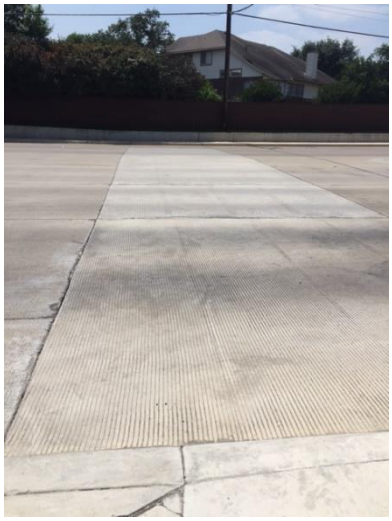
NEW PAVEMENT OPTIONS (From Plans):
1-1/2 inch Type "D" Asphalt, over 6 inches Type "B" Asphalt, over 6 inches Lime Stabilized Subgrade

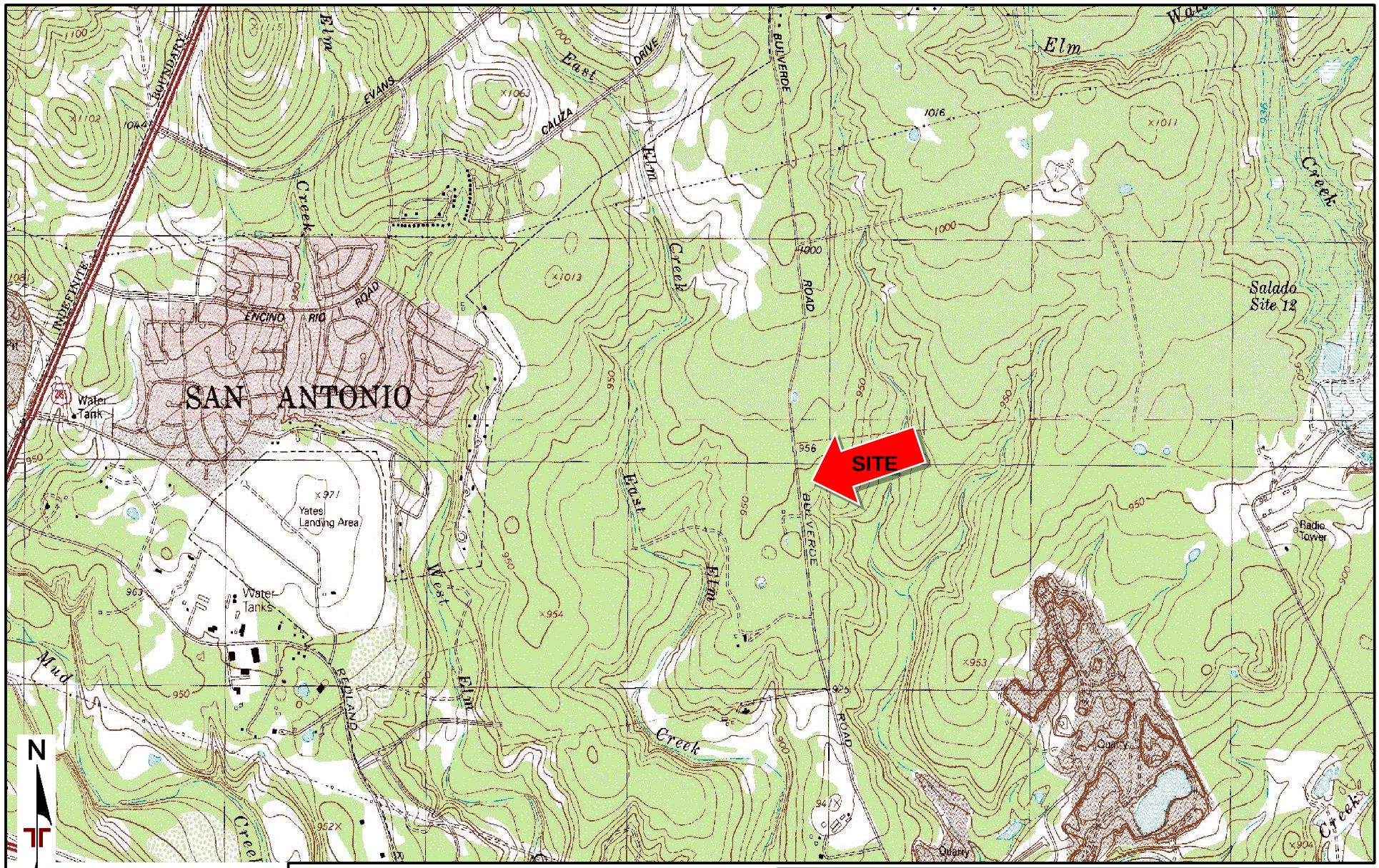
Notes: Existing streets. Lime treated subgrade was addressed using Atterberg Limits, Unconfined Compressive strength and pH.

VISUAL OBSERVATIONS

Bulverde Road Visual Observations

- Panels replaced at 22050 Bulverde Road north bound and south bound except right most south bound lane. Possibly related to the presence of underground utilities.
- North bound and south bound left most lanes appear to be more worn than the middle and right lanes.
- Sidewalk distress at Ravello Hills intersection on the south side of the intersection. This could be distress caused during installation of the new electric pole.
- Some sidewalk replaced in front of Emerald Retirement home. Possibly done during construction of the retirement home.
- Distress on the right most lane in front of the retirement home. Appears to be related to a fire.
- Southbound sidewalk may have been constructed more recently as compared to the street.
- Distress observed around utility man holes in the drive lanes. Higher level of severity on wheel path.

	
Some panels replaced perhaps related to underground utilities	**Sidewalk distress; Appears to be related to installation of utility pole**



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: BULVERDE, TX (1/1/1988) and LONGHORN, TX (1/1/1992).

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	YAJ
Drawn by:	YAJ
Checked by:	CAG
Approved by:	CAG

Project No.	90171081
Scale:	1"=2,000'
File Name:	90171081
Date:	05-01-2017

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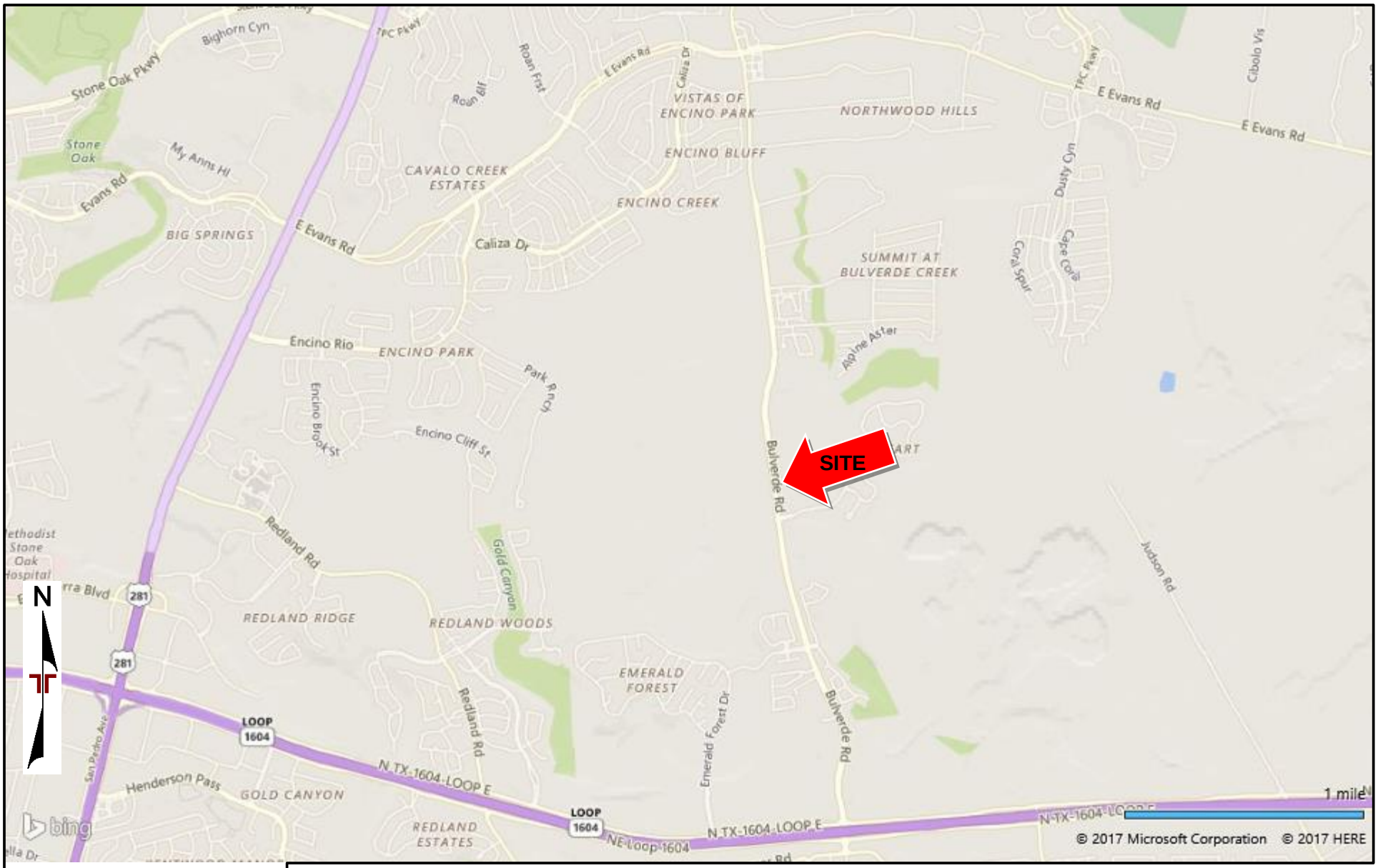
6911 Blanco Rd
San Antonio, TX 78216-6164

BULVERDE ROAD

City of San Antonio - Road and Sidewalk Evaluation
114 W. Commerce, 6th Floor
San Antonio, TX

Exhibit

A-1



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BULVERDE ROAD

City of San Antonio - Road and Sidewalk Evaluation
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San Antonio, TX

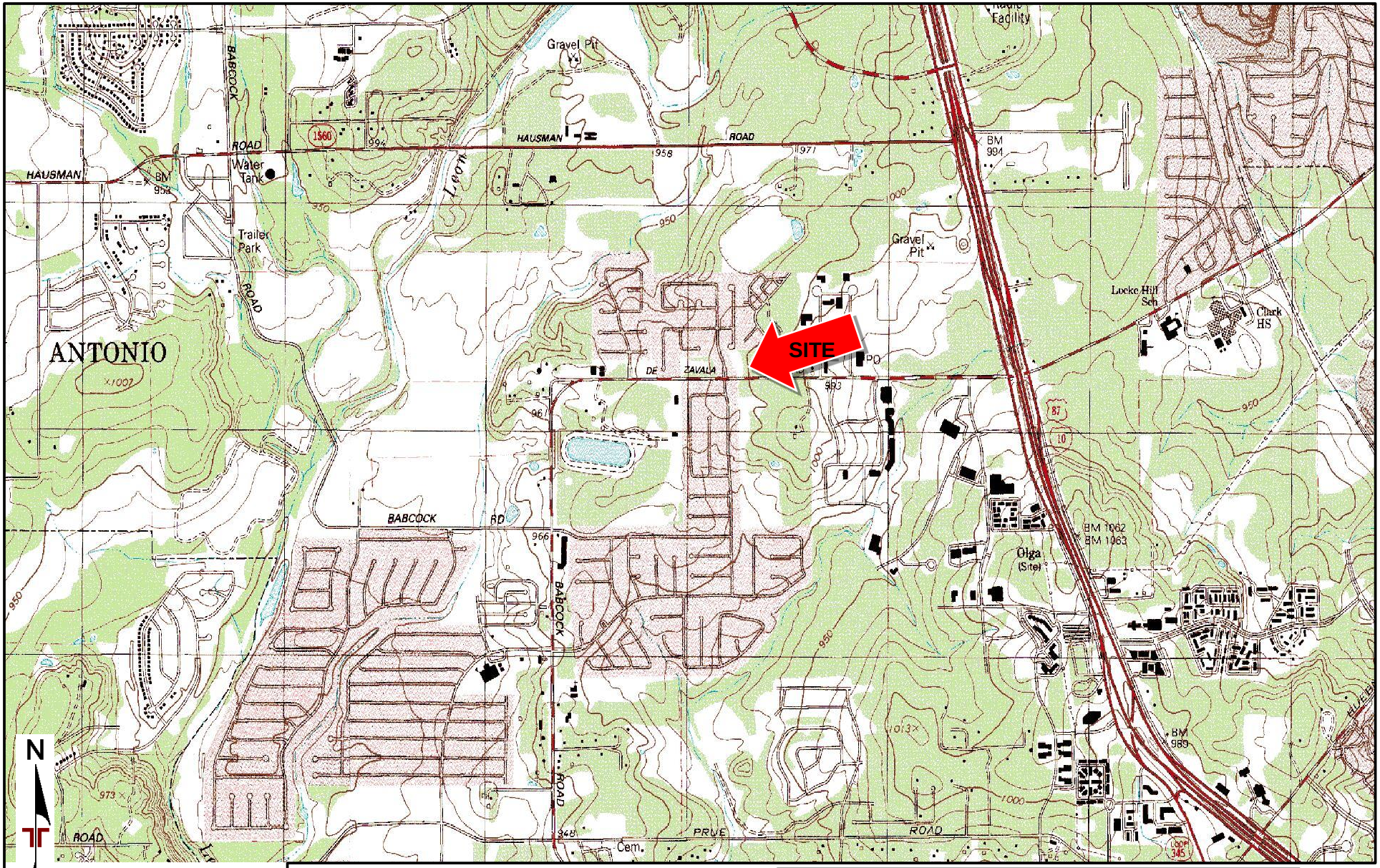
Exhibit

A-2

De Zavala Road Visual Observations

- Rougher ride quality on the east bound right lane as compared to the other three lanes. May be the result of a higher concentration of bus traffic.
- Some minor distresses observed which may be considered as normal part of wear and tear.
- Considerable amount of new construction is being done within the project limits on the street.
- The surface drainage is more towards the east bound right lane past Hart Ranch going towards Babcock Road.
- Some minor distress observed in the sidewalks.

	
No major distresses observed	



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: HELOTES, TX (1/1/1992) and CASTLE HILLS, TX (1/1/1992).

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DEZAVALA ROAD

City of San Antonio - Road and Sidewalk Evaluation
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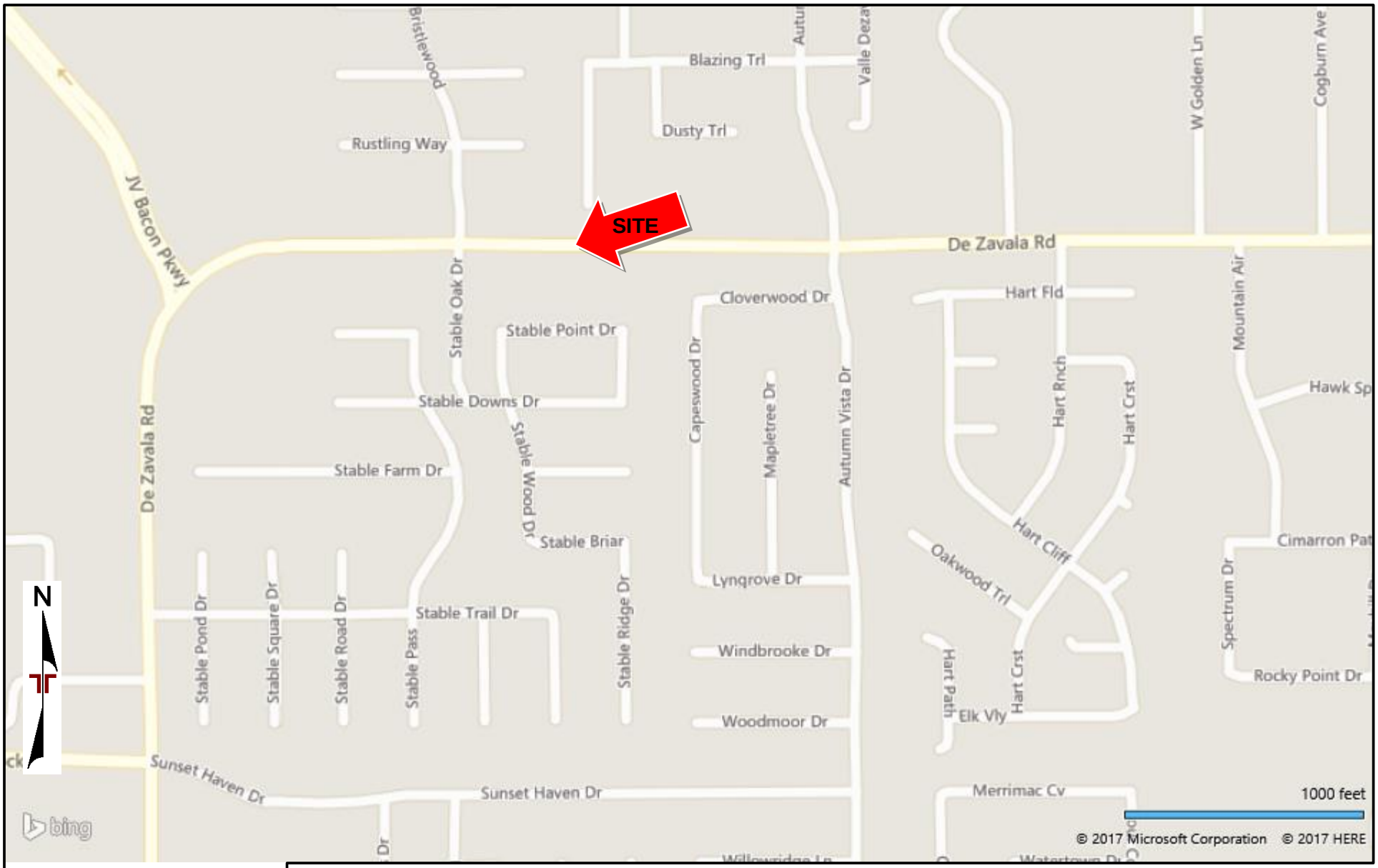
Exhibit

A-3



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DE ZAVALA ROAD

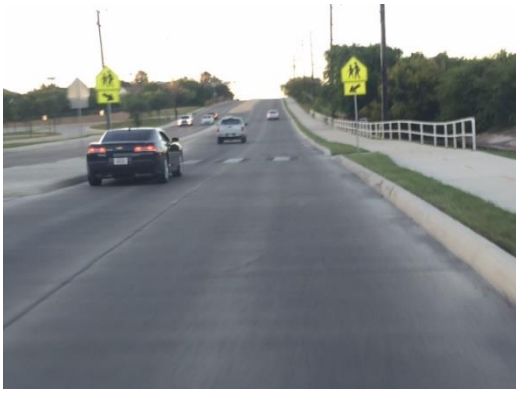
City of San Antonio - Road and Sidewalk Evaluation
114 W. Commerce, 6th Floor
San Antonio, TX

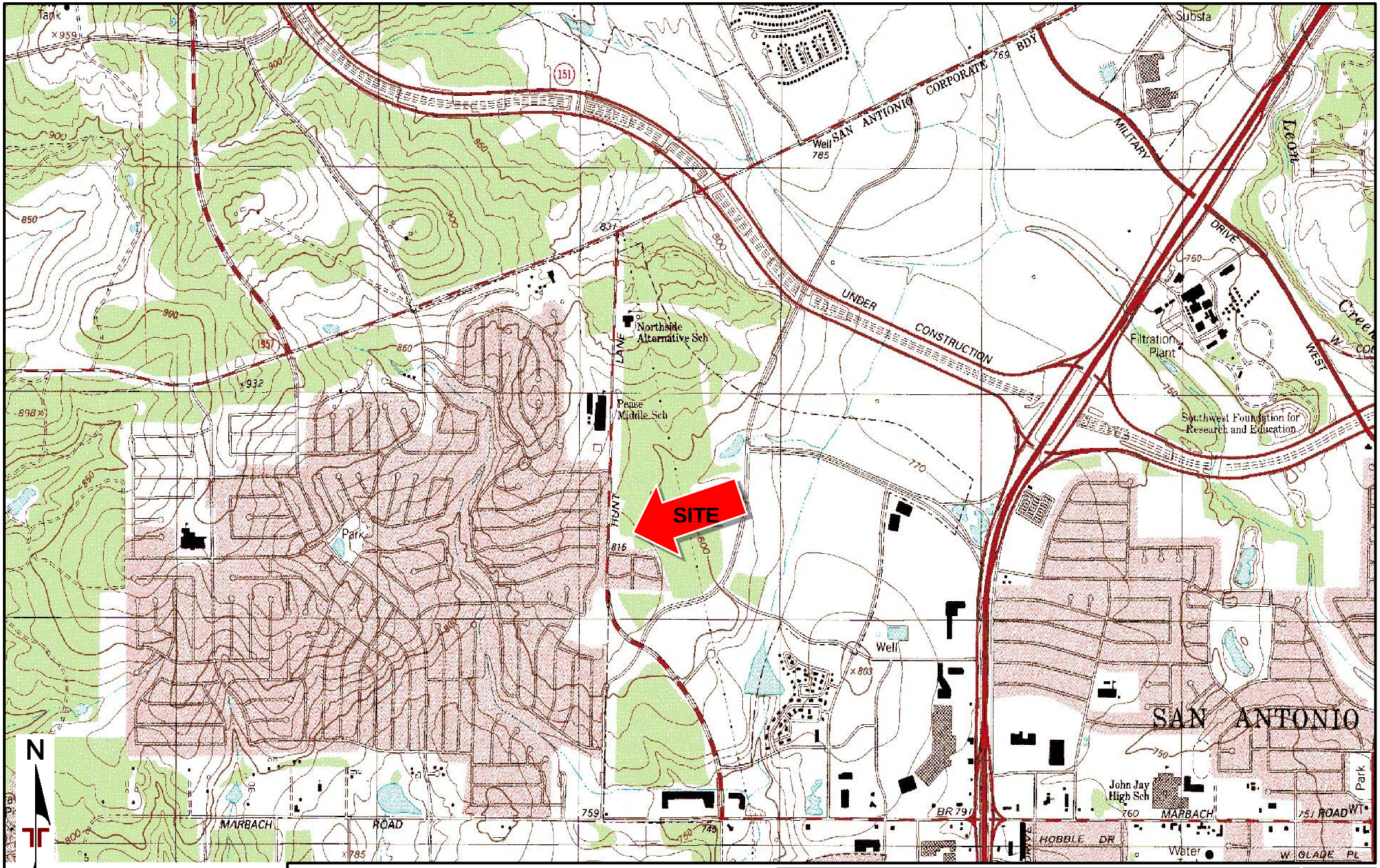
Exhibit

A-4

Hunt Lane Visual Observations

- Slopes towards Potranco Road one side and another half towards Ingram road.
- Severe distress observed in two or three locations.
- Narrow sidewalks.
- Bumpy ride quality.
- Some areas drainage may be a concern.
- Smaller concrete panels.
- Joint sealant may need some attention and maintenance.
- Possible causes for distress include moisture content changes in subsurface soils (and resulting volumetric changes in the soil) or loss of pavement support.

	
Distress panels close to Ingram Intersection	**Signs of water ponding along the curb.**



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HUNT LANE

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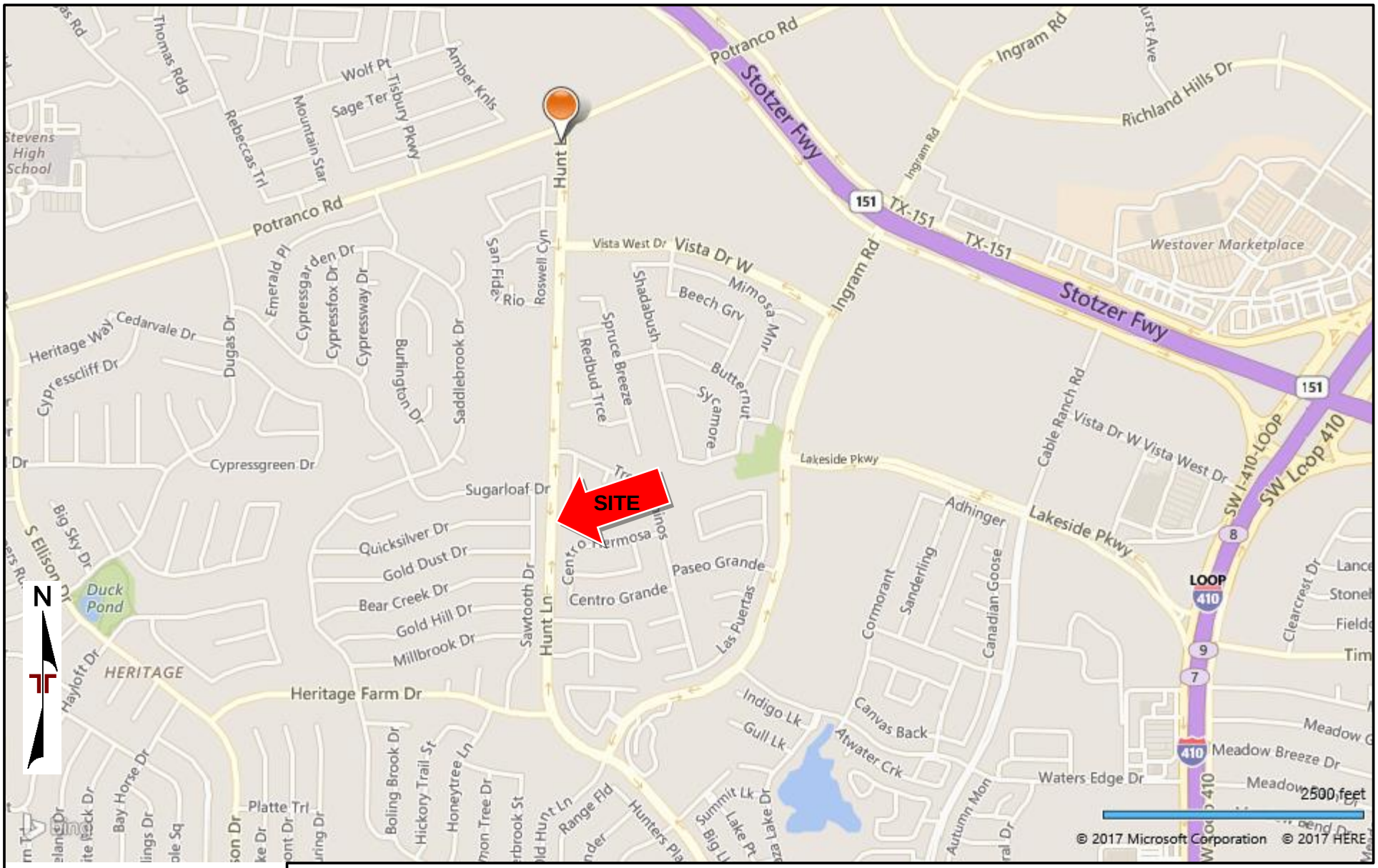
Exhibit

A-5



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Project Manager: YAJ	Project No. 90171081
Drawn by: YAJ	Scale: AS SHOWN
Checked by: CAG	File Name: 90171081
Approved by: CAG	Date: 05-01-2017

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HUNT LANE

City of San Antonio - Road and Sidewalk Evaluation
114 W. Commerce, 6th Floor
San Antonio, TX

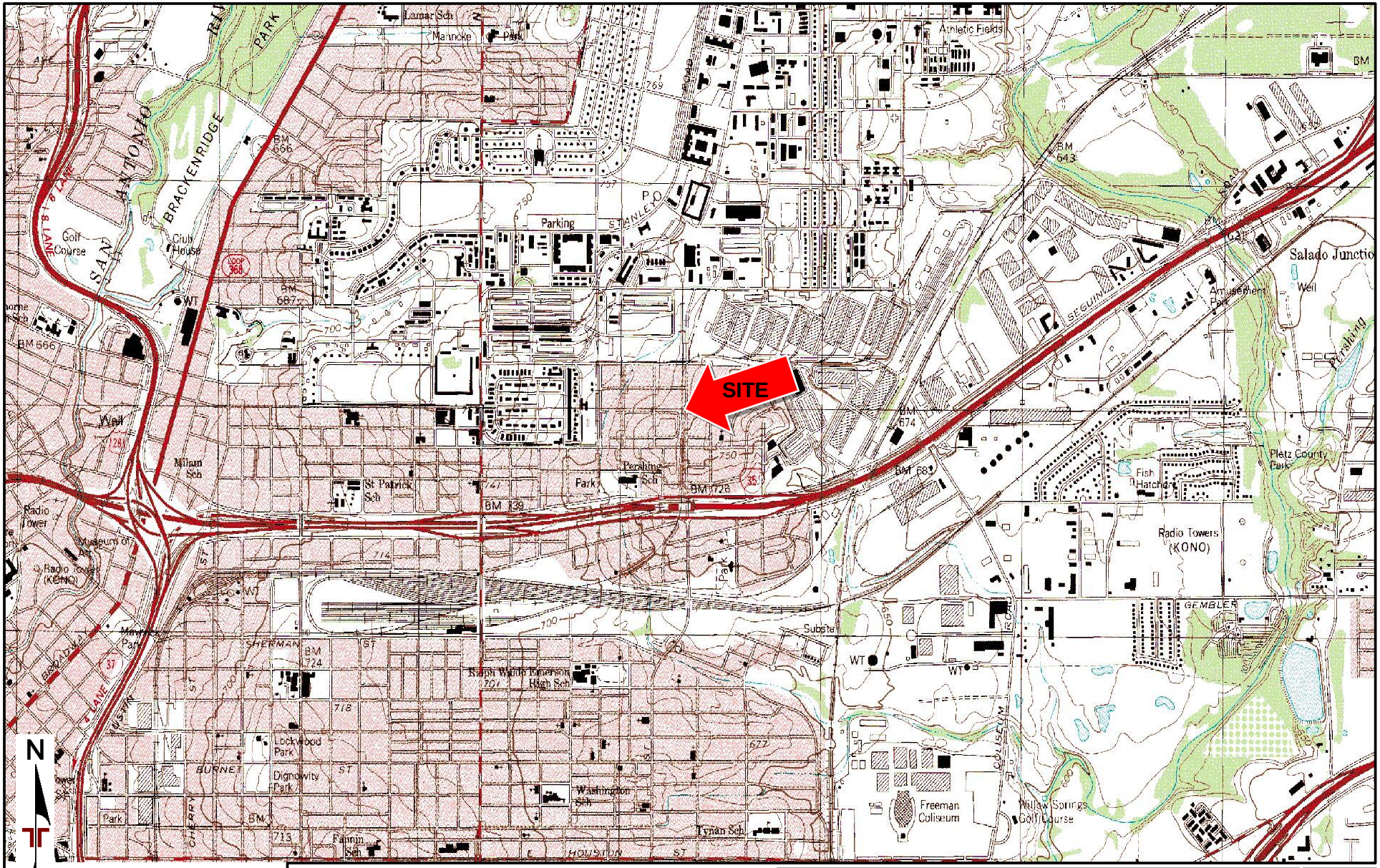
Exhibit

A-6

Walters Street Visual Observations

- Asphalt sidewalk on one side of roadway, approximately 6 to 8 feet wide (possibly old roadway).
- Cracks observed within the asphalt sidewalk. Some crack sealing has been performed in the past within the sidewalk limits.
- Some minor edge cracking observed in multiple locations.
- Separation of lane joints observed.
- Some medium severity cracks observed near the intersection of Reno and Walters.
- Intersections have paver and decorative concrete sections.
- Reports of a thick fill body placed during construction at this location.

	
Distress in sidewalk	**Distress in drive lanes**



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: SAN ANTONIO EAST, TX (1/1/1992).

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N. WALTERS STREET

City of San Antonio - Road and Sidewalk Evaluation
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Exhibit

A-7

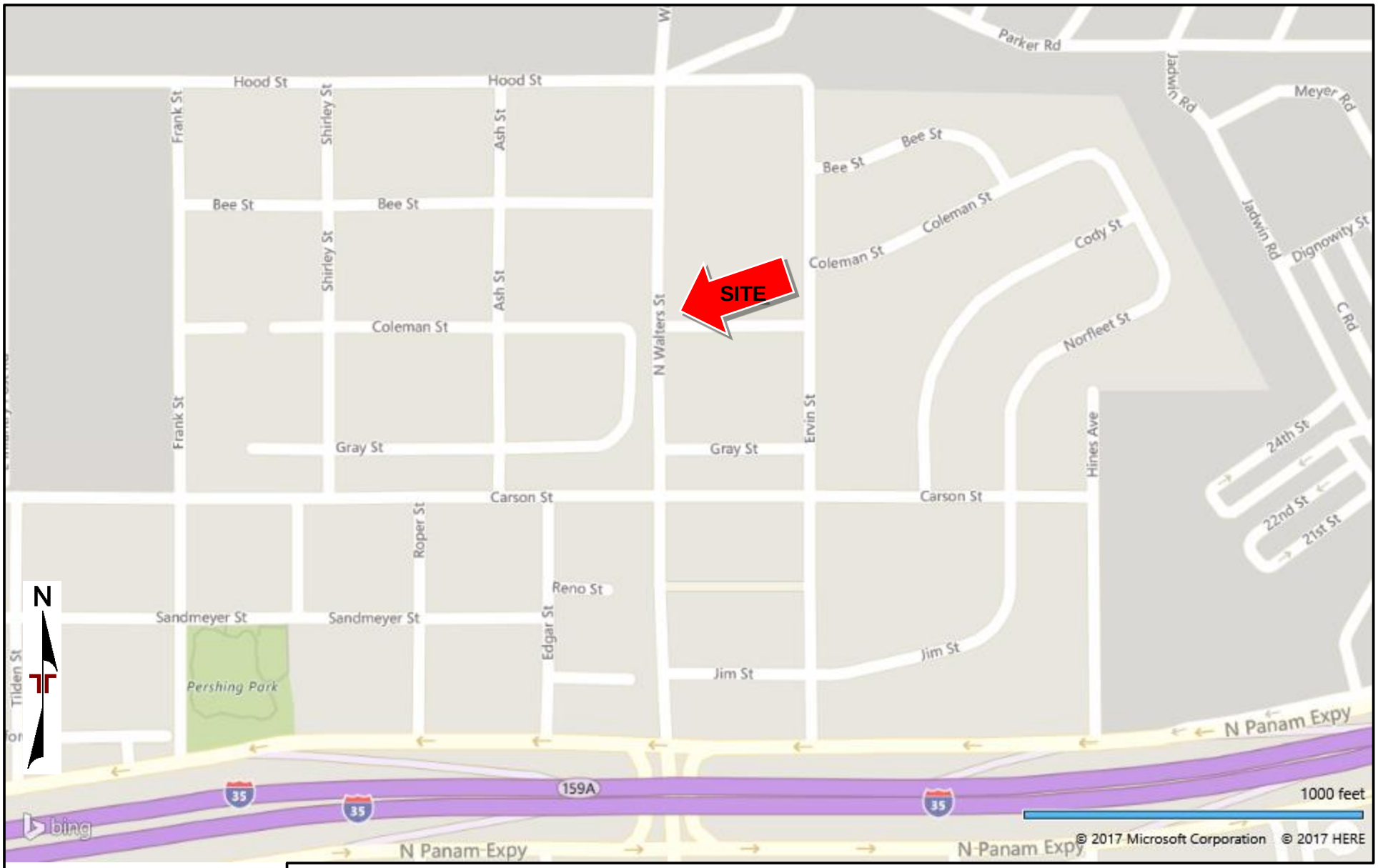

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DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: YAJ	Project No. 90171081
Drawn by: YAJ	Scale: AS SHOWN
Checked by: CAG	File Name: 90171081
Approved by: CAG	Date: 05-01-2017

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6911 Blanco Rd
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N WALTERS STREET

City of San Antonio - Road and Sidewalk Evaluation
114 W. Commerce, 6th Floor
San Antonio, TX

Exhibit
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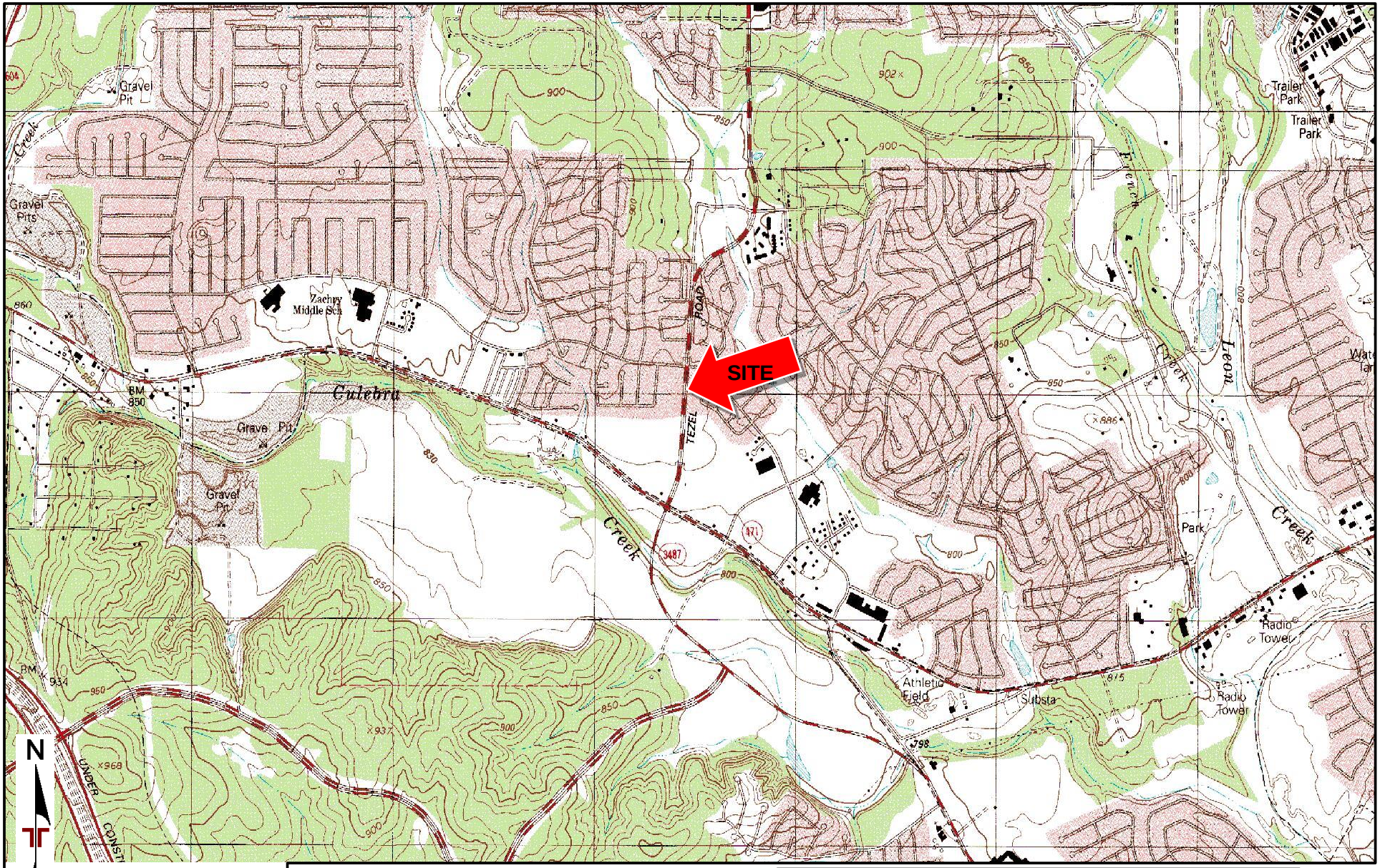
Tezel Road Visual Observations

- Areas around the bus stop concrete may have not been compacted and sealed properly. Rough transition from asphalt and concrete.
- The concrete sections within the bus stop limits are “wavy.”
- Old Marking signs or signs used during the construction phase tend to be visually confusing.
- Depression around manholes.
- Some segregation of aggregates observed on the surface.

	
Intersection of Asphalt Pavement and Concrete bus stop	**Evidence of poor workmanship**



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: HELOTES, TX (1/1/1992) and CULEBRA HILL, TX (1/1/1993).

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Approved by:	CAG

Project No.	90171081
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TEZEL ROAD

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Exhibit

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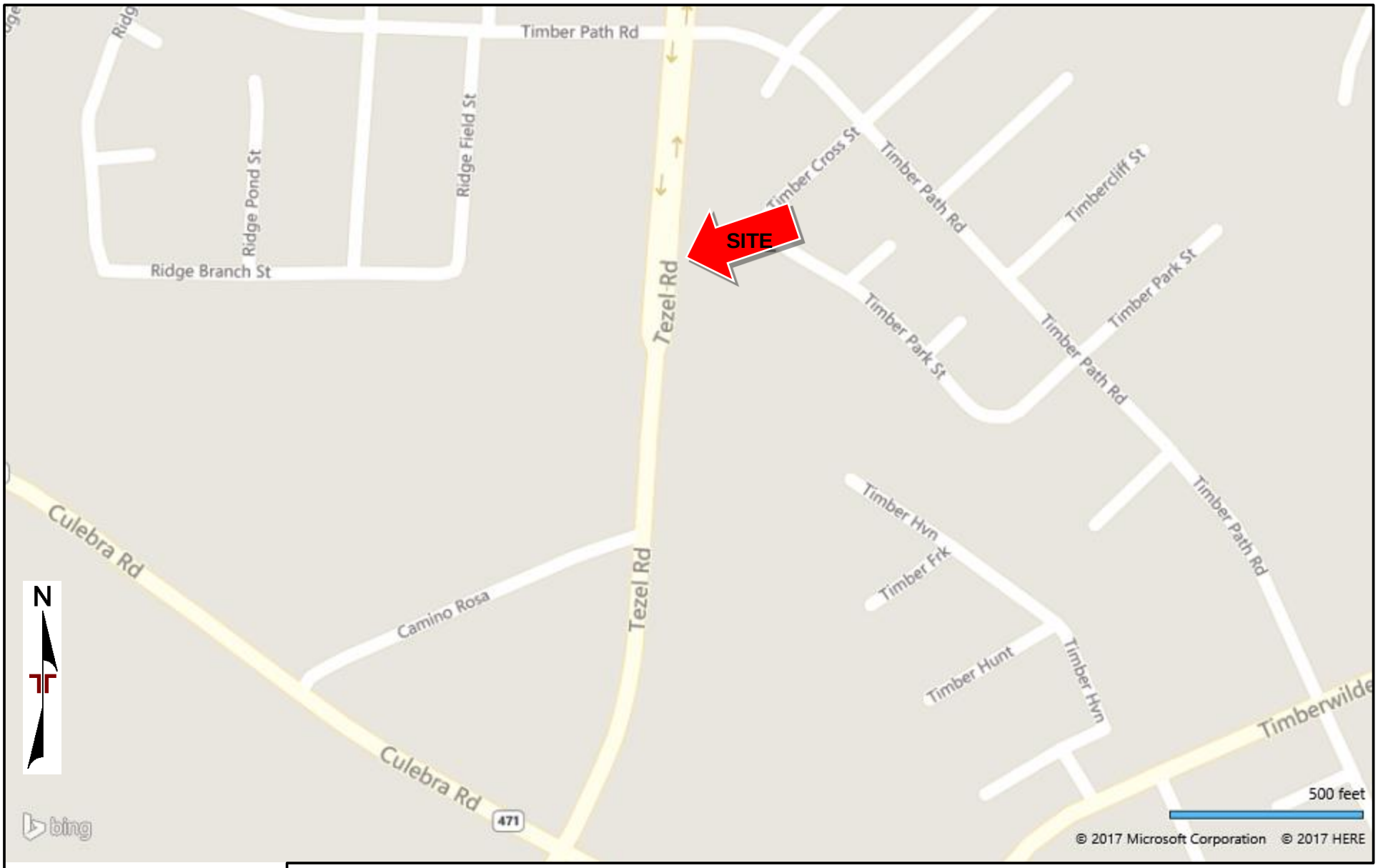

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TEZEL ROAD

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Exhibit

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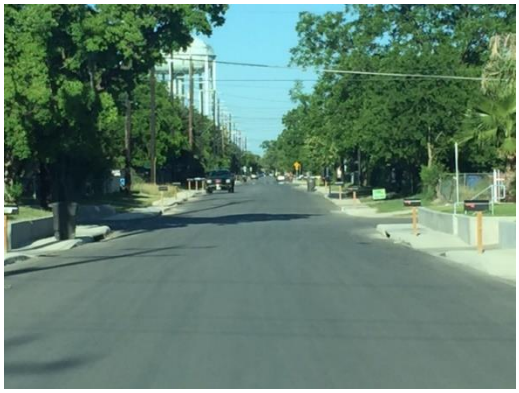
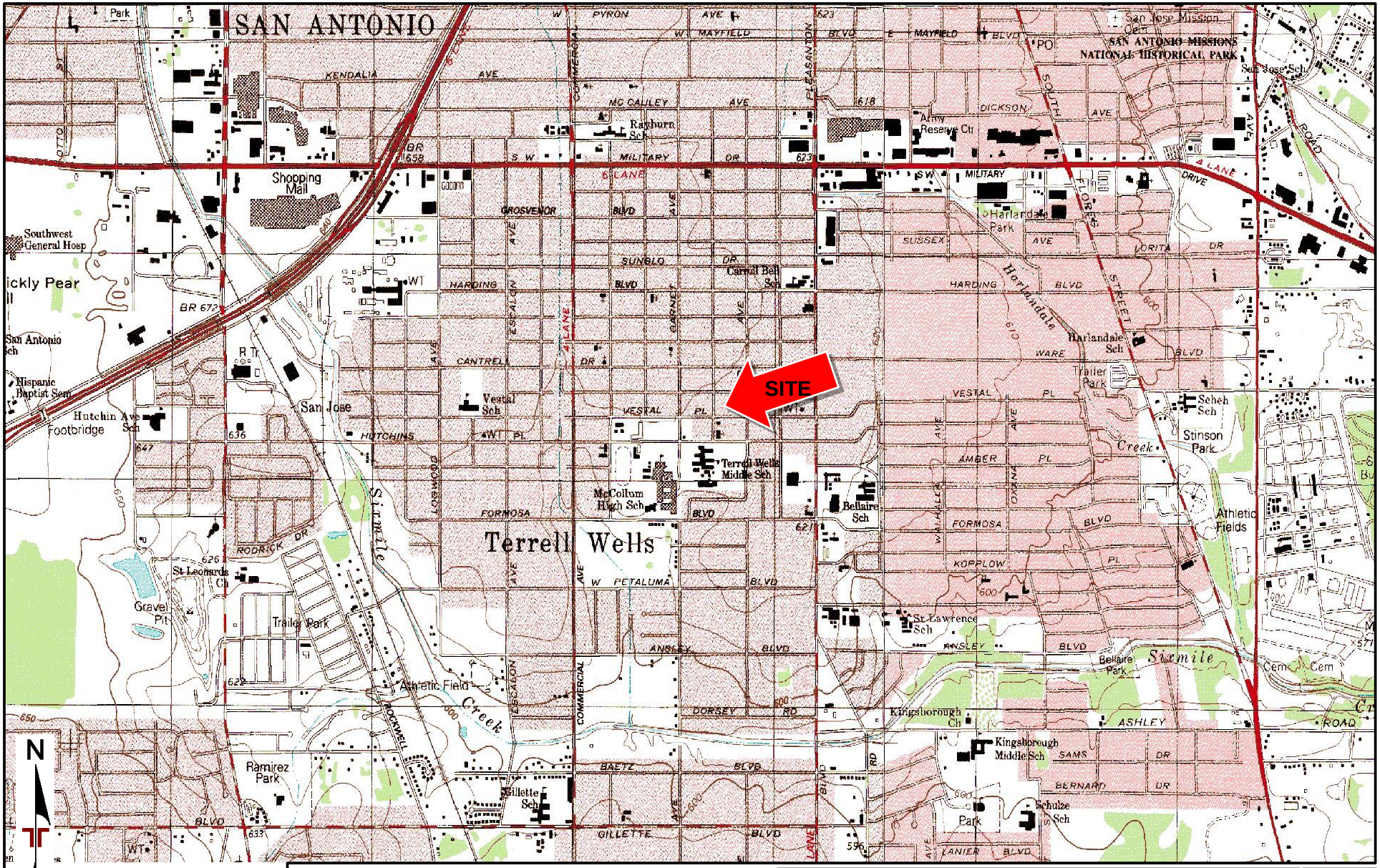
West Vestal Place Visual Observations

- Minor depression around utility alignment within pavement limits.
- New sidewalks and driveways.
- No major distress observed.
- Mature trees along the edge of the pavement.
- Smooth ride quality



No major distresses observed



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: TERRELL WELLS, TX (1/1/1992) and SOUTHTON, TX (1/1/1992).

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WEST VESTAL PLACE

City of San Antonio - Road and Sidewalk Evaluation
114 W. Commerce, 6th Floor
San Antonio, TX

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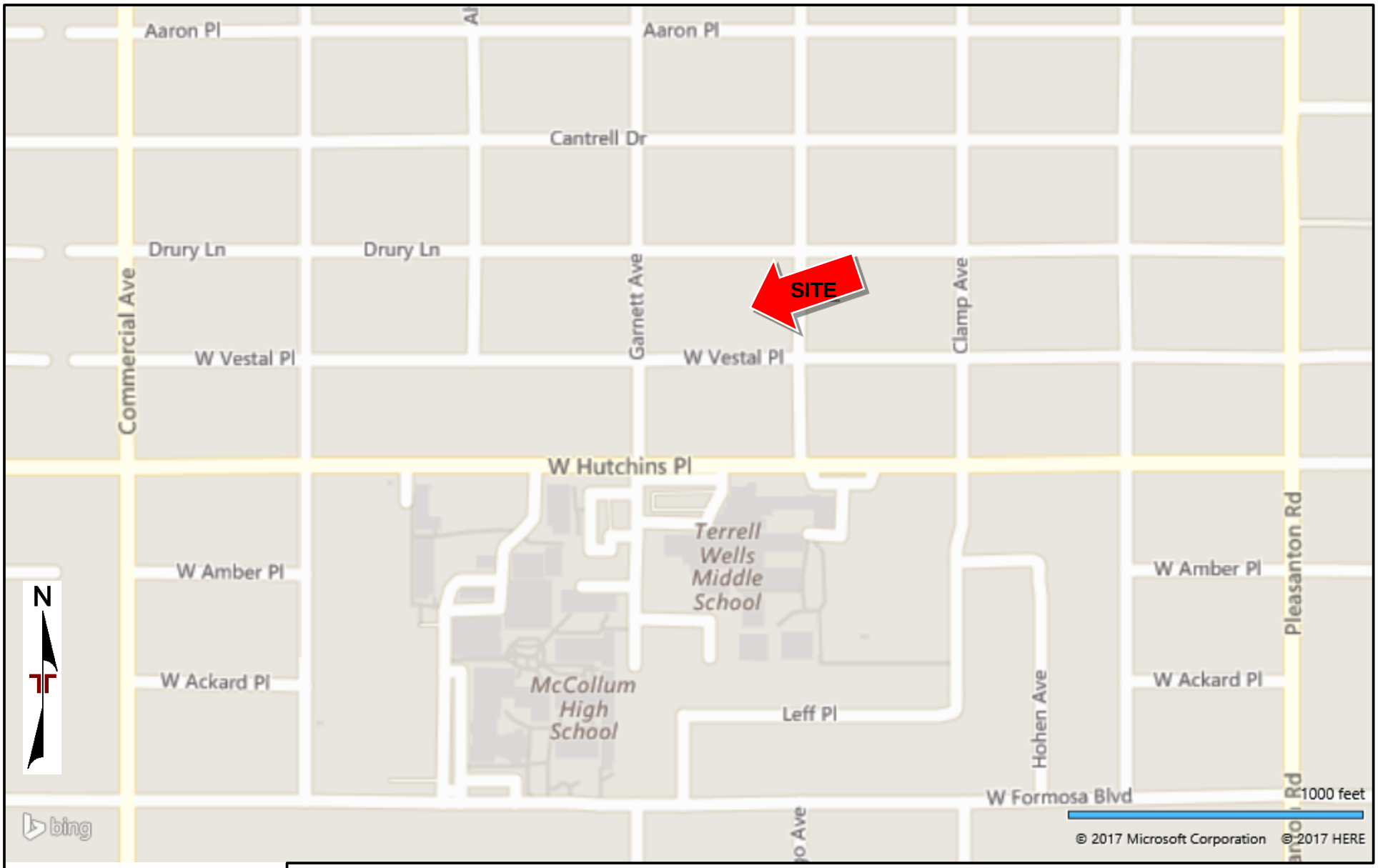

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WEST VESTAL PLACE

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PAVEMENT DESIGN GUIDANCE

PAVEMENT DESIGN GUIDANCE (ASPHALT VS. CONCRETE PAVEMENT) - EXPANSIVE CLAY SOIL SUBGRADE

- Both asphalt and concrete pavements can be successfully designed and constructed on expansive soil subgrade. Both types of pavements will be subjected to movements of the expansive clay soils. In general, asphalt pavements are more flexible and tend to bend and conform with the subgrade movements until they reach their tensile strength, then crack. Soil movements usually result in voids (loss of uniform support) beneath the more rigid concrete pavement because it does not conform with the movements of expansive soil. This unsupported section of concrete pavement will eventually crack and somewhat reposition itself on top of the subgrade.

- Layers lower in the pavement section are more difficult to address since they are buried deeper in the pavement section. This begins with implementing measures to reduce heave potential of expansive subgrade soils and preparing the subgrade and base layers to support the asphalt and concrete surface layers. Distress which begins at the surface can be more easily addressed during maintenance. Distress such as surface cracking in pavements can be addressed by crack sealing. Ride quality in asphalt pavements can be improved by milling the top portion of the pavement and using a level up course and new asphalt to provide a smoother, more waterproof asphalt surface. This “bottom up” approach is analogous to the design of a house. Making major improvements to the foundation after construction is difficult, disruptive, and costly. Repairing or replacing the roof (top protective layer) is much easier to accomplish.

- Take cost effective measures to reduce heave potential (such as modification with additives, excavate then replace with select fill, deepened curbs, edge drains).

- Perform field and lab work to adequately characterize existing conditions. As a minimum, comply with the COSA Design Guidance Manual.

- Accurately account for drainage of the pavement system (proper coefficient for untreated base and subgrades).

- Implement the short term and long term recommendations of the “Design Subcommittee” for the COSA Pavement Committee.

Factors that should be considered by the owner and design team when choosing between asphalt and concrete pavement include the following:

- Initial construction costs
- Historical maintenance costs
- Users costs
- Recycling/salvage value
- Subgrade support/measures taken to control heave potential

- Ride quality (user expectations)
- Road noise (commercial, residential, industrial area)
- Skid resistance (safety requirements)
- Heavy, stationary wheel loads (rutting at intersections and bus stops)
- Shoving of stopping/starting traffic (intersections and approaches to intersections)
- Joint maintenance/crack sealing
- Spot repairs (cost, feasibility)
- Lighting (reflectance, safety)

MAINTENANCE COST COMPARISON

Life Cycle Cost

Life cycle cost analysis (LCCA) is a tool to incorporate all of the costs associated with a project. LCCA can assist jurisdictions in determining cost effective paving solutions. LCCA combines a project's or project alternative's costs with time effects to analyze what is the total outlay of a road/pavement from initial construction through end of life. End of life for a pavement is generally considered to be when pavement is required to be fully reconstructed to restore the initial serviceability. For pavements, the costs generally considered are the initial construction, user related (time delays of the motoring public etc.), and maintenance.

For the purposes of this report initial construction costs are NOT included. We only considered the maintenance costs of asphalt and concrete pavements. The unit prices for maintenance were provided by City of San Antonio. Additional assumptions are outlined in the following exhibits. Note that we have prepared a Maintenance Cost Comparison based on a 2 percent and 5 percent Inflation Rate.

For more information, please see Life-Cycle Cost Analysis Primer by the Federal Highway Administration, US Department of Transportation (2002)

Maintenance Cost Comparison: Asphalt vs. Concrete Pavement
2% Inflation Rate
Terracon Project No. 90171081

Year of Rehab	Asphalt	2017/2018 Unit Cost per lane mile	Estimated Future Cost per lane mile
2	Crack seal/Fog Seal (includes both)	$ 17,107	$ 17,798
7	Slurry Seal/Micro-surfacing (include both)	$ 95,005	$ 109,131
14	Mill & Overlay	$ 130,662	$ 172,406
16	Crack seal/Fog Seal (includes both)	$ 17,107	$ 23,485
21	Slurry Seal/Micro-surfacing (include both)	$ 95,005	$ 143,996
28	Mill & Overlay	$ 130,662	$ 227,486
30	Crack seal/Fog Seal (includes both)	$ 17,107	$ 30,987
35	Slurry Seal/Micro-surfacing (includes both)	$ 95,005	$ 189,999
36	Reconstruction (Asphalt)	$ 976,466	$ 1,991,880
	Partial Life Cycle cost per lane mile		$ 2,907,168
	Concrete		
5	Crack seal	$ 5,421	$ 5,985
12	Diamond grind	$ 71,280	$ 90,400
17	Crack seal	$ 5,421	$ 7,590
20	Panel Replacement	$ 265,976	$ 395,226
27	Overlay	$ 130,662	$ 223,026
36	Reconstruction (Concrete)	$ 1,063,902	$ 2,170,241
	Partial Life Cycle cost per lane mile		$ 2,892,468

Given:
Maintenance schedule for Asphalt pavement provided by City of San Antonio.
2017/2018 Unit Costs for installed line items for Asphalt pavement were provided by City of San Antonio.
Analysis does not include Initial Construction Costs

Assumptions:
Inflation Rate of 2%.
Maintenance schedule is assumed for Concrete pavement based on review of industry standards.
Panel replacement is 25% of full reconstruction of concrete.
Cost for diamond grind for Concrete pavements the same cost as microsurface treatment for Asphalt pavement.
An asphalt overlay for Concrete pavements is the same cost as mill and overlay for Asphalt pavement.
Lane width is 12 feet.

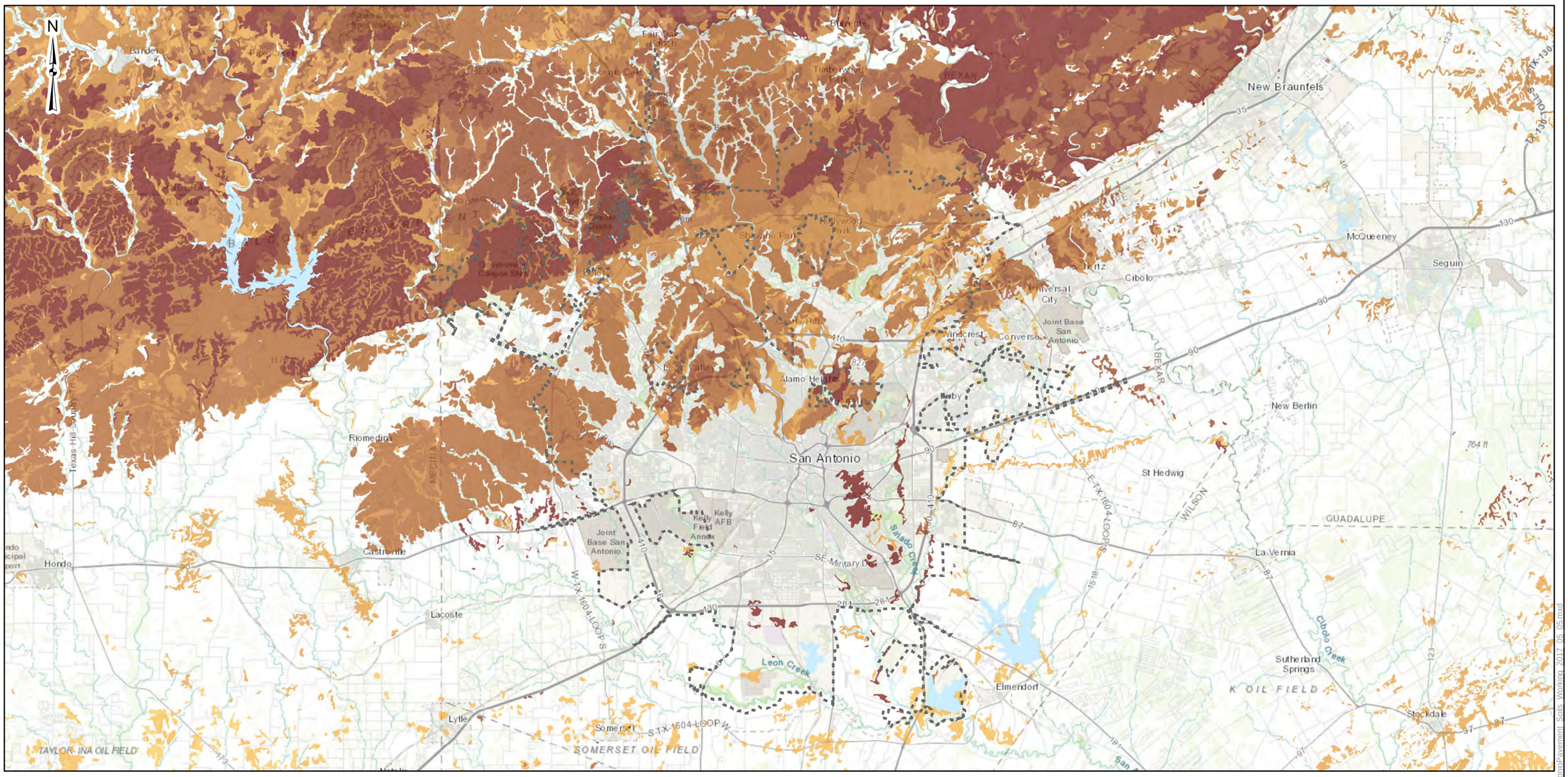
Maintenance Cost Comparison: Asphalt vs. Concrete Pavement
5% Inflation Rate
Terracon Project No. 90171081

Year of Rehab	Asphalt	2017/2018 Unit Cost per lane mile	Estimated Future Cost per lane mile
2	Crack seal/Fog Seal (includes both)	$ 17,107	$ 18,861
7	Slurry Seal/Micro-surfacing (include both)	$ 95,005	$ 133,681
14	Mill & Overlay	$ 130,662	$ 258,703
16	Crack seal/Fog Seal (includes both)	$ 17,107	$ 37,343
21	Slurry Seal/Micro-surfacing (include both)	$ 95,005	$ 264,680
28	Mill & Overlay	$ 130,662	$ 512,213
30	Crack seal/Fog Seal (includes both)	$ 17,107	$ 73,936
35	Slurry Seal/Micro-surfacing (includes both)	$ 95,005	$ 524,048
36	Reconstruction (Asphalt)	$ 976,466	$ 5,655,509
	Partial Life Cycle cost per lane mile		$ 7,478,974
	Concrete		
5	Crack seal	$ 5,421	$ 6,918
12	Diamond grind	$ 71,280	$ 128,009
17	Crack seal	$ 5,421	$ 12,425
20	Panel Replacement	$ 265,976	$ 705,712
27	Overlay	$ 130,662	$ 487,822
36	Reconstruction (Concrete)	$ 1,063,902	$ 6,161,927
	Partial Life Cycle cost per lane mile		$ 7,502,814

Given:
Maintenance schedule for Asphalt pavement provided by City of San Antonio.
2017/2018 Unit Costs for installed line items for Asphalt pavement were provided by City of San Antonio.
Analysis does not include Initial Construction Costs

Assumptions:
Inflation Rate of 5%.
Maintenance schedule is assumed for Concrete pavement based on review of industry standards.
Panel replacement is 25% of full reconstruction of concrete.
Cost for diamond grind for Concrete pavements the same cost as microsurface treatment for Asphalt pavement.
An asphalt overlay for Concrete pavements is the same cost as mill and overlay for Asphalt pavement.
Lane width is 12 feet.

MINIMUM DEPTH THROUGH SOIL TO BEDROCK



Minimum Depth Through Soil to Bedrock (by Map Unit)

- Exposed Bedrock
- Less than 1 ft (1 - 30 cm)
- 1 ft - 2 ft (31 - 60 cm)
- 2 ft - 3 ft (61 - 91 cm)
- 3 ft - 4 ft (92 - 121 cm)
- 4 ft - 5 ft (122 - 151 cm)
- 5 ft - 6 ft (152 - 182 cm)

San Antonio City Boundary

Miles
0 5 10 20

DATA SOURCES:
NRCS - gSSURGO, Muaggatt, component, copm, copmgrp
USCB - TIGER 2015 Census Boundaries
ESRI WMS - World Topography

Project No.:	90171081
Date:	May 2017
Drawn By:	IMS
Reviewed By:	JRG

Terracon
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PH. (603) 206 1190 terracon.com

Minimum Depth Through Soil to Bedrock

Desktop Soils Study
Performance Evaluation of Pavement and Sidewalks
San Antonio, Texas

Exhibit

A-1

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