ROADWAY DISTRESS ASSESSMENT

LOOP 303 MAINLINE
MP 135.7 AND MP 137.2

Prepared by:

Arizona Department of Transportation

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Subject:

Loop 303 Mainline
MP 135.7 and MP 137.2

This report presents materials and geotechnical analysis of two isolated locations on Loop 303 at MP 135.7 and MP 137.2. These locations have developed non-typical distress which was first observed in the summer of 2017. The non-typical distress consists of mid panel PCCP cracking in a longitudinal direction and development of wide gaps between the shoulder and mainline PCCP.

Should there be any questions regarding the contents of this report, please contact me.

Sincerely,

Brent M. Conner, P.E.

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1.0 INTRODUCTION/SCOPE

This report presents materials and geotechnical analysis of two isolated locations on Loop 303 at MP 135.7 and MP 137.2 that were constructed as part of H715701C. These locations have developed distress which was first observed in the summer of 2017. Current distress consists of mid panel PCCP cracking in a longitudinal direction and development of wide gaps between the shoulder and mainline PCCP.

Original construction was completed under project H7157 01C in September 2011 and included new mainline, ramps, frontage roads, and bridge structures beginning at Lake Pleasant Parkway and extending approximately 8.5 miles to tie in with Interstate 17.

Figure 1 – Project Location map

2.0 GEOLOGIC SETTING:

Geology at the distressed locations is reported by Reynolds and Grubensky [1] as consisting of alluvial deposits from the Middle Pleistocene, which dates deposition to 200,000 to 700,000 years ago. These deposits occurred at a time when the area received substantially more rainfall than today. Clasts contained within the alluvium are volcanic in origin. Deposition occurred during flooding events of Skunk Creek and New River.

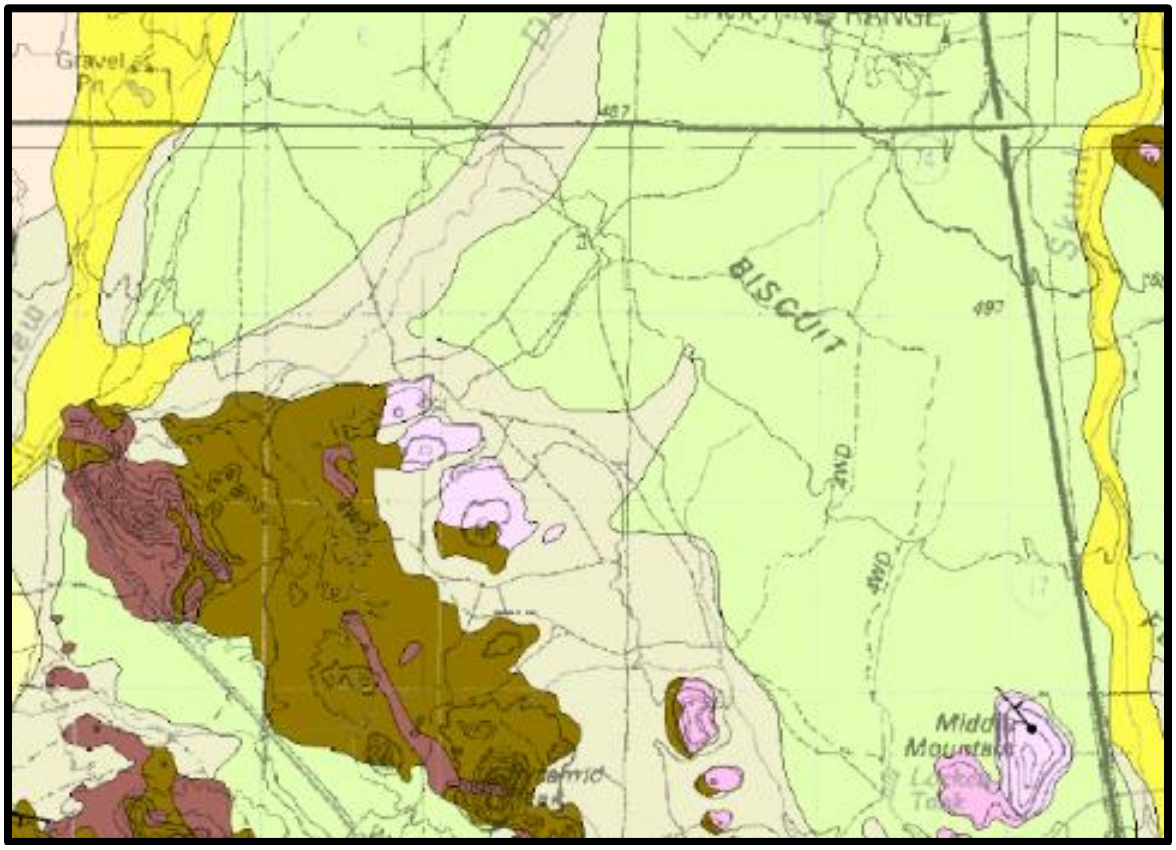


Figure 2 – Geologic Map of Phoenix North Quadrangle from Stephen J. Reynolds and Michael J. Grubensky, 1993

3.0 INVESTIGATION

3.1. Field Investigation

An investigation program consisting of 4 investigation locations was selected at the ends of the distressed locations at MP 135.7 and MP 137.2. The investigation was limited to two isolated locations which are showing distress consisting of mid panel PCCP cracking

in a longitudinal direction and development of wide gaps between the shoulder and mainline PCCP.

Cores four inches in diameter were drilled at the test locations and taken to ADOT's Structural Materials Laboratory for analysis. Secondary cores 12 inches in diameter were drilled to expose the AB and subgrade. Samples of the AB and Subgrade were collected for each test location.

ADOT's Survey Section set up a local station and measured location and elevation across each of the distressed location. The local station enables precise measurement for use in analysis of the profile changes that may have occurred following completion of construction.

3.2. Laboratory Investigation

Concrete core, Aggregate Base, and Subgrade samples obtained from the investigation were transported to ADOT's Central Materials Laboratory.

Selected samples were tested in general conformance with the procedures listed in Table 1.

Table 1: Test Methods Applied to Representative Samples

Geotechnical Test	Test Procedure
Sieve (Grain Size) Analysis	ARIZ 201c
Minus 200 Wash	ASTM D1140
Atterberg Limits (Plasticity)	AASHTO T 89 and T 90
R-Value (Subgrade Support)	AASHTO T 190
Moisture Content of Soils	AASHTO T265
Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	AASHTO T24

3.3 Records Review

The project was originally constructed with as-built drawings dated December 2011 and bid book Special Provisions dated February 13, 2009. The Final project pavement design was completed by HDR dated November 10, 2008. The Initial project pavement design was completed by HDR dated August 2008. Geotechnical investigation east of Lake Pleasant Parkway to I-17 was performed by RAMM in 2008.

Significant design changes were made to the pavement design from the Initial Design in August 2008 to Final Design in November 2008. The initial pavement design included a four inch layer of AC Base supporting the PCCP pavement. The Final pavement design

replaced the AC Base with class 2 aggregate base.

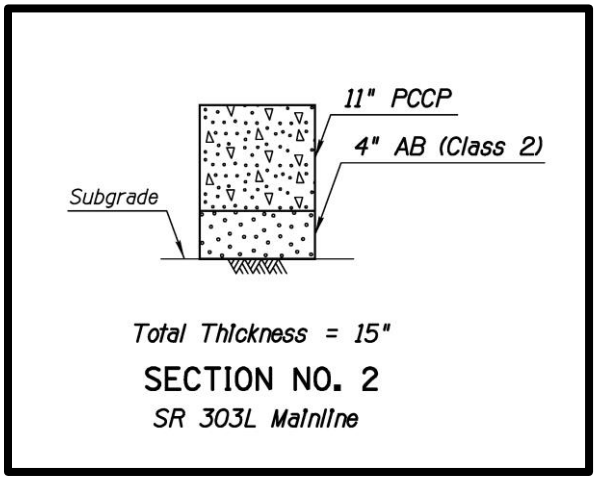


Figure 3 – Pavement Section Graphic

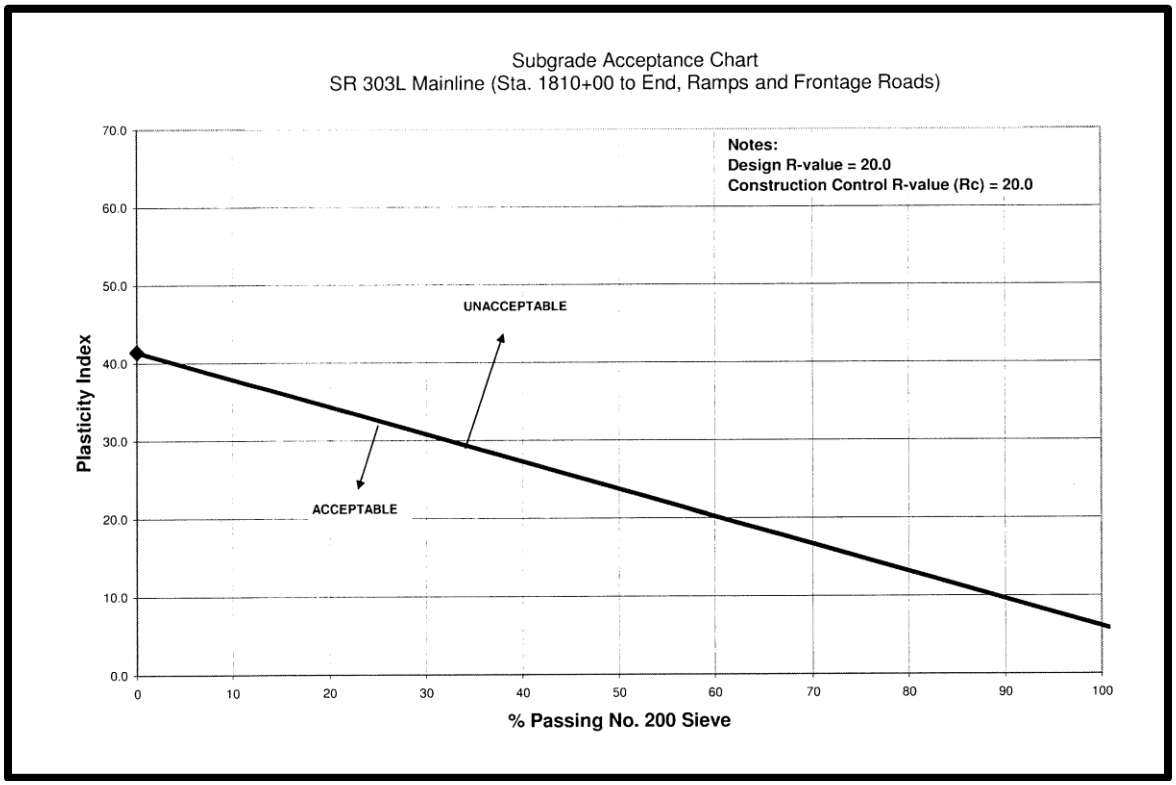


Figure 4 – Subgrade Acceptance Criteria

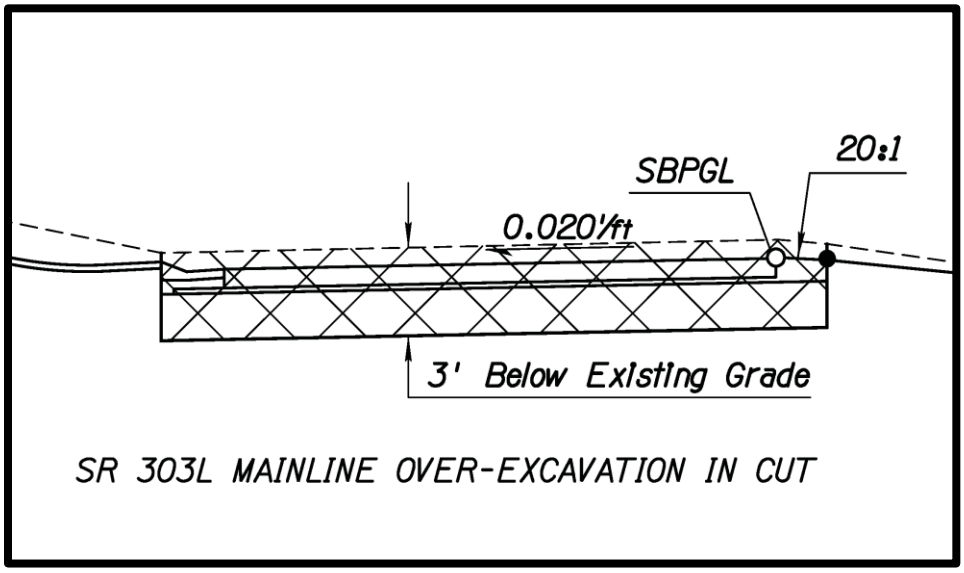


Figure 5 – Over-excavation in cut locations

OVER-EXCAVATION LIMITS				
Location	Station	to	Station	Length
SB SR 303L Med Cst CL	1812+13	to	1813+90	177
SB SR 303L Med Cst CL	1819+82	to	1821+87	205
SB SR 303L Med Cst CL	1900+14	to	1904+74	460
SB SR 303L Med Cst CL	1995+48	to	2007+21	1,173
NB SR 303L Med Cst CL	1812+31	to	1813+14	83
NB SR 303L Med Cst CL	1819+52	to	1820+35	83
NB SR 303L Med Cst CL	1992+52	to	2028+01	3,549
NB Frontage Road	15+02	to	18+52	350
NB Frontage Road	63+37	to	65+68	231
SB Frontage Road	16+59	to	18+65	206
SB Frontage Road	26+16	to	39+40	1,324
SB Frontage Road	60+63	to	64+94	431
Lone Mt Rd Ramp D	14+80	to	20+41	561
I-17 Med Cst CL	1159+49	to	1171+32	1,183

Figure 6 – Over-excavation locations

4.0 SITE CONDITIONS

4.1. Surface Conditions

4.1.1. PCCP Core Properties:

Two pavement cores were obtained for analysis at each of the distressed locations. A total of 4 cores were analyzed as detained in table 2 below:

Test Number	Location (Southbound)	Length (Inches)	Unit Weight (PCF)	Design Compressive Strength (PSI)	Compressive Strength Test Result (PSI) (See Note)*
B1	2087+27	11.75	141.6	4000	7130
B2	2086+40	11.375	141.8	4000	6930
B3	2007+93	11.625	142.7	4000	7700
B4	2005+88	11.125	143.9	4000	6910

- Note – Draft report contained erroneous compressive strength test results. Cross-sectional area was initially based on 6 inch diameter vs actual 4 inch diameter of the drilled cores.

4.1.2. PCCP Joints:

Joints were installed alternating at 13 ft, 15 ft and 17ft intervals. The longitudinal joint between the travel lane and shoulder was observed in the distressed locations to have large gaps up to ¾” in width and no tie bars. A high rate of moisture infiltration is believed to be occurring at all of the joints and is contributing to the periodic saturation in the AB and subgrade beneath the pavement.

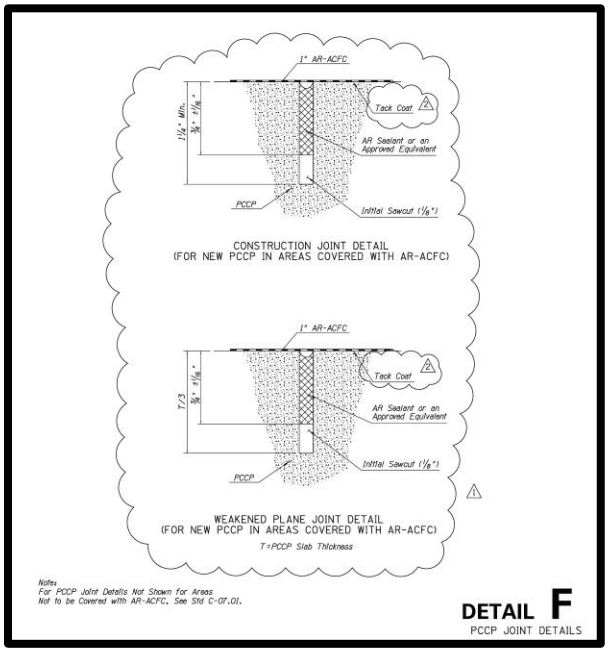


Figure 7 – Joint Sealing Detail

Figure 8 – Joint sealing and gapping

4.2. Subsurface Conditions

Project soil performance as pavement support varies greatly across the project depending on geologic origin. High quality sand and gravel deposits associated with New River and Agua Fria River flows generally compose the Western 2/3's of the project. Fine grained floodplain silts and clays generally compose the Eastern 1/3 of the project where the pavement distress has been observed. These floodplain silts and clays provide significantly lower values of pavement support than the sand and gravel deposits from New River and Agua Fria River.

4.2.1. Subgrade Earthmoving Design

Project earthmoving design placed a minimum of 3 feet of R-value 20 or greater beneath the pavement section. The geotechnical investigation confirmed that the subgrade acceptance criteria established for the project was met at the investigation locations. Fine grained silts and clays were designed for placement a minimum of 3 feet below finished subgrade or in the embankment outside the pavement section.

4.2.2. Aggregate Base and Subgrade Saturation

Investigation at the distressed locations determined that the aggregate base and subgrade are saturated or nearly saturated beneath the pavement. Figure 5 above details the placement requirements beneath the pavement section. The placement of subgrade soils with higher permeability above the silt and clay floodplain soils in a "bath tub" configuration may be contributing to the level of saturation encountered in the AB and subgrade soils directly beneath the pavement.

Table 3 – Aggregate Base Physical Properties

Test Number	Location (Southbound)	Estimated Thickness (Inches)	% Passing #200	% Retained on #4	Moisture Content (% of total sample)
B1-AB	2087+27	4	8.7	46	8.1
B2-AB	2086+40	4	10.4	46	8.2
B3-AB	2007+93	4	9.6	46	8.4
B4-AB	2005+88	4	9.3	43	8.9

Table 4 – Subgrade Physical Properties

Test Number	Location (Southbound)	Estimated Thickness (Inches)	% Passing #200	% Retained on #4	Moisture Content (% of total sample)
B1-Subg	2087+27	36	24.5	33	9.1
B2-Subg	2086+40	36	23.4	32	8.1
B3-Subg	2007+93	36	14.0	49	5.7
B4-Subg	2005+88	36	16.9	41	7.0

5.0 RECOMMENDATIONS

5.1. PCCP Quality

The investigation determined that the quality of the PCC in the distressed locations exceeds the design 28 day strength of 4000 psi. A review of the testing performed on the PCCP shows 65 lots with 5 sets of samples taken for each lot with tested conformance to design. The construction phase testing did not indicate any concrete that did not meet design strength. The testing process appears to conform to ADOT standards for scope.

5.2. Surface Drainage

Significant water is infiltrating the AB and subgrade beneath the PCCP. The joints were observed to be porous and do not provide a barrier to water infiltration. Saturation of the subgrade with loading from vehicles is likely producing lateral forces which have caused gapping of the longitudinal joint between the travel lane PCCP and shoulder.

Routing and sealing all joints based on ADOT standard 402PCCPR is recommended to decrease water infiltration into the AB and subgrade. The longitudinal joint between the travel lane PCCP and shoulder will benefit greatly with the installation of a backer rod and sealing.

6.0 REFERENCES

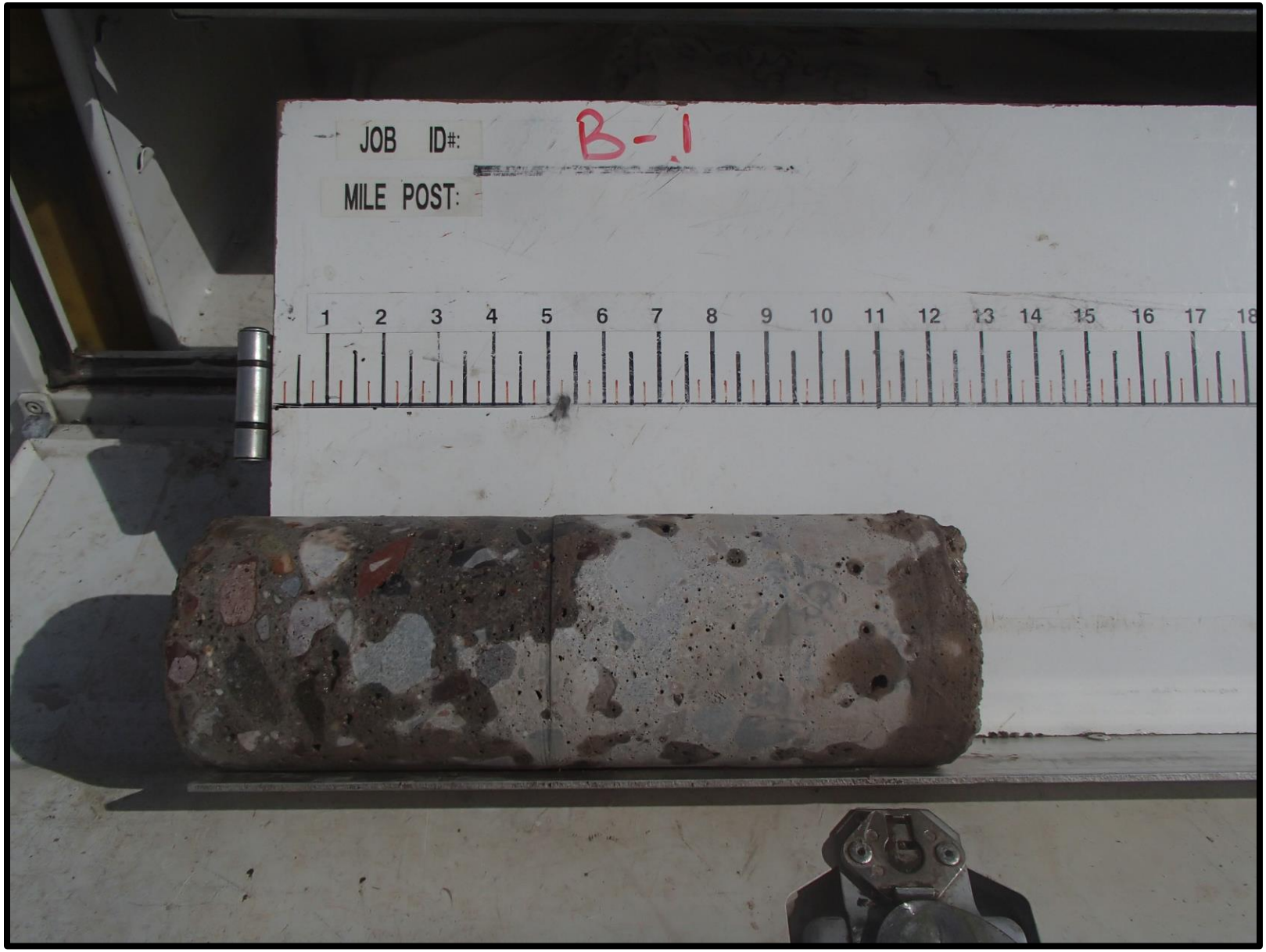
1. Geologic Map of Phoenix North Quadrangle from Stephen J. Reynolds and Michael J. Grubensky, 1993

2. American Association of State Highway and Transportation Officials (AASHTO), 2011. Standard Specifications for Transportation Materials and Methods of Sampling and Testing, 31st. Edition. Washington, D.C.

3. Arizona Department of Transportation (ADOT), 2011, Materials Testing Manual, Sampling and Testing Procedures. Phoenix, AZ. http://www.azdot.gov/Highways/Materials/QA/QA_Manuals/index.asp

4. Arizona Department of Transportation (ADOT), 2008, Standard Specifications for Road and Bridge Construction. Phoenix, AZ.

APPENDIX A
Concrete Core Photos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APPENDIX B
Longitudinal Cracking Photos

Loop 303 MP 137.2

Loop 303 MP 135.7

Loop 303 MP 137.2