GEOTECHNICAL EVALUATION

LAKE MARY ROAD IMPROVEMENTS
COCONINO COUNTY PROJECT #09-PP-03
COCONINO COUNTY, ARIZONA
JOB NO. 2529JW068

Western Technologies Inc.
The Quality People
Since 1955

FLAGSTAFF – ARIZONA
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Prepared for:

COCONINO COUNTY PUBLIC WORKS DEPARTMENT

April 16, 2009

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April 16, 2009

Coconino County Public Works Department
5600 East Commerce
Flagstaff, Arizona 86004

Attn: Mr. Jon Ebers
Capital Projects Manager

Re: Pavement Engineering Services
Coconino County Project #09-PP-03
Lake Mary Road Improvements
Coconino County, Arizona

Job No. 2529JW068

INTRODUCTION

Western Technologies Inc. has performed geotechnical engineering and pavement design services for the Lake Mary Road Improvements in accordance with the Scope of Services dated February 5, 2009. A subsurface exploration was conducted on March 5, 2009. The results of the field work and subsequent laboratory testing of soil samples obtained during the subsurface exploration were used to develop this report.

Based on the information provided, the project will consist of asphalt cold-in-place recycling (CIR) and overlay on about 8.2 miles of Lake Mary Road, from milepost (MP) 301.8 to MP 310.0 in Coconino County. The final grade of the new road surface will be several inches higher than the existing road surface. The structural capacity of the reconditioned section will at least match the existing section. If any of this information is incorrect, the Client should notify WT immediately.

The purpose of our geotechnical services was to evaluate the existing pavement and subgrade soil conditions and to provide recommendations and/or discussion for the existing pavement sections and pavement sections recommendations for CIR and asphalt overlay thicknesses.

SUBSURFACE EXPLORATION

The subsurface exploration was performed by coring and drilling a total of six soil borings to depths ranging from 4 to 5 feet below existing site grade. Refusal to auger drilling was encountered at the location of boring No. 6 at a depth of 4 feet below existing site grade because of the presence of rock. The approximate locations of the borings are shown on the attached Boring Location Diagram. It should be mentioned that a more extensive exploration program had been anticipated (at least two to three borings per mile) but it

was reduced at the Client's request. During drilling, the strata encountered were logged and soils were visually classified. Loose samples of the soils were taken for laboratory testing. Borings were filled with native material and capped with cold patch.

Soil strata were generally a red Silty SAND with Gravel (SM) or a Gravelly SAND (SM) overlying a Clay (CL) layer. The SM layer extends to depths ranging from three to four feet below existing surface elevation; at one location (boring No. 2) this layer extended to the bottom of the exploration boring. It appears that most of this stretch of Lake Mary Road is built on embankment fills with water runoff draining toward the sides of the road. The surface course consists of an asphalt concrete layer ranging in thickness from 6 to 7 inches; it was observed on the cores (see Pictures 1 to 8) that the asphalt concrete surface was placed in several layers (two to three layers). The Silty/Gravelly SAND layer could have been considered as a sub-base/select material course by comparing its gradation results to typical gradation specification for this layer (ADOT, MAG, FP-03), but it appears that this is not the case; the gradation curve does not fulfill the requirements, especially on the finer sieves. It is possible that this layer may have become contaminated through the years by the CLAY layer underneath.

The thickness of the pavement structural sections at the boring locations is provided in the following table:

Coring No.	AC (in.)	No. of AC Layers
1	7	2
2	7	3
3	6-3/4	3
4	6	2
5	6	2
6	6	2

LABORATORY TESTING

Soil samples obtained during the subsurface exploration were tested in WT's materials laboratories in Flagstaff and Phoenix. In-situ moisture contents on two samples collected from the Silty SAND layer ranged from 14.3 to 17.8 percent.

A total of two R-value tests were performed: one of the test was performed on the sample collected on the Gravelly SAND layer and the other test on the sample collected on the CLAY layer. Both tests were performed on samples encountered at location B-3 yielding values of 82 and 21, respectively.

Selected asphalt concrete cores collected at the six coring locations were combined into

two groups and tested for the following: asphalt content, gradation of the mineral aggregate after binder extraction by the Abson method, asphalt binder absolute viscosity at 140°F and asphalt binder penetration at 77°F. Group No. 1 consisted of core samples collected at locations No. 1 and 2 and Group No. 2 consisted of core samples collected at locations No. 4 and 5. Asphalt content by total weight ranged from 6.2 to 7.1 percent. Absolute viscosity of the recovered asphalt binder at 140°F and penetration testing of the same binder at 77°F ranged from 18,970 to 43,130 poises and from 13 to 23 dmm, respectively. Test results can be seen in Appendix B.

VISUAL EXAMINATION OF PAVEMENT LANES

Visual examination of the pavement indicates the existence of significant cracks (longitudinal, transverse and alligator) throughout the entire length of the alignment. The areas exhibiting moderate to heavy alligator cracking should be treated by removal and replacement (patching) before starting the cold-in-place recycling process. These areas indicate the existence of a weak subgrade and might cause problems to the equipment train if not treated before hand, especially after the existing asphalt concrete layer has been milled and pulverized.

COLD-IN-PLACE RECYCLING (CIPR)

The content of this section is presented in the FHWA website's recycling section. The CIPR method involves a process in which the asphalt pavement is recycled in-place (cold in-place recycling (CIPR) process), where the RAP is combined without heat and with new emulsified or foamed asphalt and/or a recycling or rejuvenating agent, possibly also with virgin aggregate, and mixed at the pavement site, at either partial depth or full depth, to produce a new cold mix end product.

Performance studies indicate that CIPR retards or eliminates the occurrence of reflective cracking from environmental distress, depending on the depth of treatment and crack depth. Improper emulsion application can result in high residual asphalt content (leading to flushing) and excessive processing can result in high fines content (leading to rutting due to low stability).

CIPR requires a self-contained, continuous train operation that includes ripping or scarifying, processing (screening and sizing/crushing unit), mixing of the milled RAP, and the addition of liquid rejuvenators. Special asphalt-derived products such as cationic, anionic, and polymer modified emulsions, rejuvenators and recycling agents have been developed especially for CIPR processes. These hydrocarbon materials are sometimes, but not always, used to soften or

lower the viscosity of the residual asphalt binder in the RAP material so that it is compatible with the newly added binder.

Some of the engineering properties of RAP that are of particular interest when RAP is used in cold recycled applications include its gradation, asphalt content, and the penetration and viscosity of the asphalt binder. Test results of these properties are presented in Appendix B.

Gradation: The aggregate gradation of processed RAP is somewhat finer than virgin aggregate. This is due to mechanical degradation during asphalt pavement removal and processing. RAP aggregates usually can satisfy the requirements of ASTM D692 for coarse aggregate and ASTM D1073 for fine aggregate.

Asphalt Content: The asphalt content of most old pavements will comprise approximately 3 to 7 percent by weight and 10 to 20 percent by volume of the pavement. Due to oxidation aging, the asphalt cement has hardened and consequently is more viscous and has lower penetration values than the virgin asphalt cement. The asphalt content of the collected cores ranged from 6.2 to 7.1 percent.

Penetration and Viscosity: Depending on the amount of time the original pavement had been in service, recovered RAP binder may have penetration values from 10 to 80 and absolute viscosity values at 60°C (140°F) in a range from as low as 2,000 poises to as high 50,000 poises or greater. The penetration and absolute viscosity of the recovered asphalt binder from the collected cores ranged from 13 to 23 dmm and from 18,970 to 43,130 poises, respectively.

To satisfy the engineering requirements for use in cold recycled asphalt concrete pavements, it is usually necessary to rejuvenate or augment the asphalt binder in RAP to lower the viscosity and/or increase penetration. This is done by the addition of one or more recycling agents, consisting of either an emulsified or foamed asphalt and/or a rejuvenating agent. Some additional aggregate may also be added to adjust the mix gradation or air voids content.

The Asphalt Institute has recommended a modified Marshall mix type procedure for the design of CIPR mixes. Such a design initially involves obtaining samples of the candidate pavement to determine the gradation of the aggregate, the asphalt content, and the penetration and viscosity of the asphalt binder. Marshall specimens are prepared at various emulsion percentages, as initially determined by calculating the asphalt demand on the basis of aggregate gradation and deducting the percentage of asphalt in the RAP. The optimum asphalt content can be determined by a stability and air voids analysis, with target air voids in the 8 to 10 percent range, or the specimens may be evaluated using indirect tensile strength or resilient modulus testing.

Research has shown that the addition of virgin aggregates (20 to 25 percent) in the CIPR process results in less voids and, consequently, less flushing, and improved stability. The amount of recycling agent (either new asphalt or modifying oil) also has a significant effect on

the behavior of the mix, with the ideal range of recycling agent being somewhere between 2 and 3 percent by weight of dry RAP.

The AASHTO Design Guide is recommended for the thickness design of cold in-place recycled asphalt mixes. Since there is essentially little or no difference in the composition and structural properties of recycled cold mix and cold in-place recycled paving materials, the range of structural layer coefficients recommended for recycled cold mixes (0.25 to 0.35) are also applicable for cold in-place recycled mixes. CIPR mixes are not recommended for use as a wearing surface.

PAVEMENT DESIGN

For design purposes the existing pavement structural section can be considered to consist of 6 inches of asphalt concrete over a Silty SAND subgrade layer. Because of the contamination of this layer, it was not considered part of the existing pavement structural section but instead the supporting subgrade layer. Because of the extensive cracking (from low to high severity transverse/longitudinal/alligator cracking), a structural layer coefficient ranging from 0.20 to 0.30 (FHWA NHI -05-037 "Geotechnical Aspects of Pavements") could be assigned to the existing surface layer. For analysis purposes a value of 0.25 was assigned to the existing asphalt concrete layer. Based on these parameters the SN for the existing pavement section is **1.50** (SN = 6 * 0.25). The recommended pavement section should at least match this value.

Lake Mary Road has been classified as a major collector road by Coconino County according to information provided by Client. The types of traffic anticipated to use the roadway include passenger vehicles and small, medium and large size trucks. Average daily traffic (ADT) counts were provided by Mr. Ebers indicating a value close to 2500 vehicles per day circulate along this road as of September 25, 2008. An annual growth rate of 2 percent was assumed for this segment of Lake Mary Road. Based on this assumption, a value of 2,550 was estimated for the 2009 ADT parameter. This value was assumed as the initial value for the design period and used for calculations of the 18-kip Equivalent Single Axle Loads (ESAL). Based upon this value, an estimated annual growth rate of 2 percent during the 20 year design period, a directional distribution factor of 50 percent and a lane distribution factor of 100 percent (1 lane per direction), a total ESAL for the main roadway design lane of about 703,000 is obtained. The following table shows the calculation of the total ESALs assuming a traffic distribution of 95 percent for passenger vehicles and 5 percent for trucks.

Vehicle type	Total Vehicles Design Lane	% vehicles	ESAL factor	Design ESAL
Automobiles	11,570,500	95	0.0008	8,794
Trucks	11,570,500	5	1.2	694,230
			TOTAL ESALS	**703,024**

A resilient modulus (M_r) of 15,000 pounds per square inch was assigned to the on-site supporting layer of Silty SAND subgrade soil. Utilizing the well established correlation between the R-value and resilient modulus, $M_R = 1155 + 555 * R\_value$, yields a value well above the maximum allowed by the Arizona Department of Tranportation (ADOT) of 26,000 psi. The presence of the underlying CLAY layer and its contamination effect on the overlying layer were the main criteria on assigning the value of 15,000 psi to the supporting subgrade material.

A reliability value of 90 percent with a 0.45 standard deviation was assigned to the roadway, a value of 4.4 was assigned to the present serviceability index and 2.3 to the terminal serviceability index. A drainage coefficient factor of 0.74 was assigned based on a poor quality of drainage and a seasonal variational factor (SVF) close to 4.0 corresponding to the Happy Jack area. Based upon these parameters, the required SN value is **2.47**.

The required SN value of **2.47** is larger than the SN provided by the existing pavement section of **1.50**. Obviously, this will require the placement of an overlay on top of the CIR layer to comply with the SN requirement. This condition will also satisfy the requirement of placing an overlay on top of a CIR layer. To determine the thickness of the overlay layer it is necessary to assign a structural layer coefficient to the CIR layer and to determine the thickness to be cold-in-place recycled. The range of structural layer coefficients recommended for recycled cold mixes is from 0.25 to 0.35. A value of 0.30 will be used in our analysis.

Typical thickness of CIR recycling ranges from 2 to 4 inches; in this particular project, the thickness of the surface asphalt concrete layer ranged from 6 to 7 inches with a most prevalent value of 6 inches. It is recommended that a certain thickness of the existing asphalt concrete layer be kept in place between the new CIR layer and the underlying layer. Based on this, it is recommended that the thickness of the layer to be cold-in-place recycled be 4 inches. The thickness of the required overlay will be determined by the difference between the required SN (**2.47**) and the existing section consisting of 2 inches of existing asphalt concrete and 4 inches of CIR layer. The structural layer coefficient for the asphalt concrete overlay will be 0.44.

$$H_{ACoverlay} = \frac{2.47 - (2*0.25 + 4*0.30)}{0.44} = 1.75"$$

Because of constructability concerns, a minimum overlay thickness of 2 inches is recommended to be placed on top of the 4-inch thick CIR layer.

Bituminous surfacing for the minimum 2-inch thick asphalt concrete overlay should be constructed of dense-graded, central plant-mix, asphalt concrete. The asphalt concrete should conform to the specification requirements for asphalt concrete, type A-12.5 mm of the MAG specifications or Coconino County specifications. The asphalt concrete mix design should be performed using the Marshall method with 75 blows per specimen face. Asphalt cement should be **PG 58-16** in accordance with AASHTO MPI-93. A sample specification for cold recycling of bituminous pavements is presented in the appendices.

The "design life" of a pavement is defined as the expected life at the end of which reconstruction of the pavement will need to occur. Normal maintenance, including crack sealing, slurry sealing, and/or chip sealing, should be performed during the life of the pavement.

CLOSURE

This report concludes our scope of services for Lake Mary Road Improvements. The boring logs and related information included in this report are indicators of subsurface conditions only at the specific locations and times noted. The recommendations presented are based in part upon data derived from a limited number of samples obtained from widely spaced subsurface explorations. Variations from the field conditions represented by the borings/corings may become evident during construction. If variations appear, we should be contacted to re-evaluate our recommendations.

We prepared this report as an aid to the designers of the proposed project. The comments, statement, recommendations and conclusions set forth in this report reflect the opinions of the authors. These opinions are based upon conditions at the location of specific tests, observations and data developed to satisfy the scope of services defined by the contract documents.

Work on your project was performed in accordance with generally accepted industry standards and practices by professionals providing similar services in this locality. No other warranty, express or implied, is made.

Sincerely,
WESTERN TECHNOLOGIES INC.

Registered Professional Engineer
CERTIFICATE NO.
32310
ARMANDO DE LA ROCHA
Date Signed 4/15/09
ARIZONA U.S.A.

Armando de la Rocha
Senior Geotechnical/Pavement Engineer

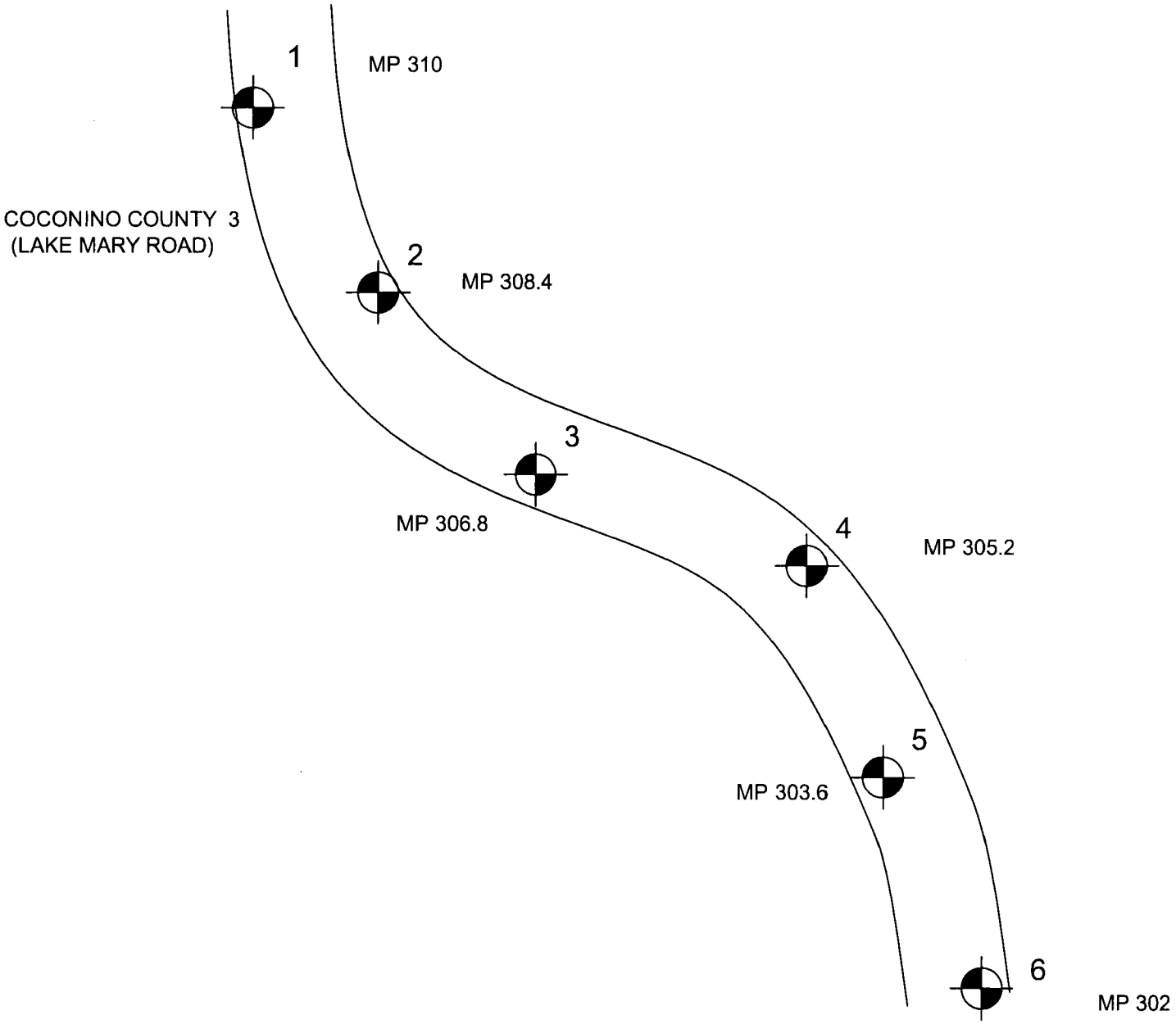
EXP 3/31/10

Craig P. Wiedeman
Craig P. Wiedeman, P.E.
Senior Geotechnical Engineer

cc

Attachments: Vicinity Map/Boring Location Diagram
Boring Log Notes and Boring Logs
Laboratory Test Results
Flexible Pavement Design Output
Photos
Cold Recycling of Bituminous Pavement – Sample Specification

Copies to: Addressee (5)



Scale: 1 Inch ≈ 1 Mile

Approximate Test Boring Location

LAKE MARY ROAD IMPROVEMENTS	
Boring Location Diagram	
Western Technologies, Inc.	
Job No.: 2529JW068	Plate: 1

Allowable Soil Bearing Capacity	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
Backfill	A specified material placed and compacted in a confined area.
Base Course	A layer of specified material placed on a subgrade or subbase.
Base Course Grade	Top of base course.
Bench	A horizontal surface in a sloped deposit.
Caisson	A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier.
Concrete Slabs-on-Grade	A concrete surface layer cast directly upon a base, subbase or subgrade.
Crushed Rock Base Course	A base course composed of crushed rock of a specified gradation.
Differential Settlement	Unequal settlement between or within foundation elements of a structure.
Engineered Fill	Specified material placed and compacted to specified density and/or moisture conditions under observations of a representative of a soil engineer.
Existing Fill	Materials deposited through the action of man prior to exploration of the site.
Existing Grade	The ground surface at the time of field exploration.
Expansive Potential	The potential of a soil to expand (increase in volume) due to absorption of moisture.
Fill	Materials deposited by the actions of man.
Finished Grade	The final grade created as a part of the project.
Gravel Base Course	A base course composed of naturally occurring gravel with a specified gradation.
Heave	Upward movement
Native Grade	The naturally occurring ground surface.
Native Soil	Naturally occurring on-site soil.
Rock	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
Sand & Gravel Base	A base course of sand and gravel of a specified gradation.
Sand Base Course	A base course composed primarily of sand of a specified gradation.
Scarify	To mechanically loosen soil or break down existing soil structure.
Settlement	Downward movement.
Soil	Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.
Strip	To remove from present location.
Subbase	A layer of specified material placed to form a layer between the subgrade and base course.
Subbase Grade	Top of subbase.
Subgrade	Prepared native soil surface.

LAKE MARY ROAD IMPROVEMENTS	
Definition of Terminology	
Western Technologies Inc.	
Job No.: 2529JW068	Plate: A-1

COARSE-GRAINED SOILS
LESS THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE
GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	
GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% FINES	
GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% FINES	
SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE
SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	
SM	SILTY SANDS, SAND-SILT MIXTURES, MORE THAN 12% FINES	
SC	CLAYEY SANDS, SAND-CLAY MIXTURES, MORE THAN 12% FINES	

NOTE: Coarse-grained soils receive dual symbols if they contain 5% to 12% fines (e.g., SW-SM, GP-GC).

FINE-GRAINED SOILS
MORE THAN 50% FINES

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
OL	ORGANIC SILTS OR ORGANIC SILT-CLAYS OF LOW PLASTICITY	
MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS	SILTS AND CLAYS LIQUID LIMIT MORE THAN 50
CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY	
PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS

NOTE: Fine-grained soils may receive dual classification based upon plasticity characteristics.

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	Above 12 in.
COBBLES	3 in. - 12 in.
GRAVEL	No. 4 - 3 in.
Coarse	3/4 in. - 3 in.
Fine	No. 4 - 3/4 in.
SAND	No. 200 - No. 4
Coarse	No. 10 - No. 4
Medium	No. 40 - No. 10
Fine	No. 200 - No. 40
*Fines (Silt or Clay)	Below No. 200

NOTE: Only sizes smaller than three inches are used to classify soils

CONSISTENCY

CLAYS & SILTS	BLOWS PER FOOT*
VERY SOFT	0 - 2
SOFT	2 - 4
FIRM	4 - 8
STIFF	8 - 16
VERY STIFF	16 - 32
HARD	Over 32

RELATIVE DENSITY

SANDS & GRAVELS	BLOWS PER FOOT*
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	Over 50

*Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1 3/8 inch ID) split spoon (ASTM D1586).

PLASTICITY OF FINE GRAINED SOILS

PLASTICITY INDEX	TERM
0	NON-PLASTIC
1 - 7	LOW
8 - 25	MEDIUM
Over 25	HIGH

DEFINITION OF WATER CONTENT

DRY
SLIGHTLY DAMP
DAMP
MOIST
WET
SATURATED

LAKE MARY ROAD IMPROVEMENTS

Method of Soil Classification

Western Technologies Inc.

Job No.: 2529JW068 | Plate: A-2

The number shown in **"BORING NO."** refers to the approximate location of the same number indicated on the "Boring Location Diagram" as positioned in the field by pacing from property lines and/or existing features.

"TYPE/SIZE BORING" refers to the exploratory equipment used in the boring wherein **HSA = hollow stem auger**

"Sample Type" refers to the form of sample recovery, in which **G = Grab Sample**

"Dry Density, pcf" refers to the laboratory-determined dry density in pounds per cubic foot. The double vertical line within the ring symbol indicates that no sample was recovered. The symbol **"DU"** indicates that determination of dry density was not possible.

"Water Content, %" refers to the laboratory-determined moisture content in percent ASTM D2216.

"Unified Classification" refers to the soil type as defined by "Method of Soil Classification". The soils were classified visually in the field and, where appropriate, classifications were modified by visual examination of samples in the laboratory and/or by appropriate tests.

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans nor as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the dates noted. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

The stratification lines shown on the boring logs represent our interpretation of the approximate boundary between soil types based upon visual field classification. The transition between materials is approximate and may be far more or less gradual than indicated.

LAKE MARY ROAD IMPROVEMENTS	
Boring Log Notes	
Western Technologies Inc.	
Job No.: 2529JW068	Plate: A-3

DATE DRILLED: **3-5-09**
LOCATION: **MP 310 - SOUTHBOUND LANE**
ELEVATION: **Not Determined**

BORING NO. 1

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **8"HSA**
FIELD ENGINEER: **M. Morris**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		C						PAVEMENT; Asphalt Concrete Overlay 0-2", Asphalt Concrete 2-7"
17.8		G				SM		Silty SAND; with gravel, red, moist (FILL)
		G				CL		CLAY; with red cinder gravel, moist (EMBANKMENT FILL)
					5			**Boring Stopped at 5 Feet**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
C- CORE: %RECOVERY/RQD
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.
2400 Huntington Drive
Flagstaff, AZ 86004-8934

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
PROJECT NO.: **2529JW068**

PLATE **A-4**

BORING LOG

DATE DRILLED: **3-5-09**
LOCATION: **MP 308.4- NORTHBOUND LANE**
ELEVATION: **Not Determined**

BORING NO. 2

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **8"HSA**
FIELD ENGINEER: **M. Morris**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		C						PAVEMENT; Asphalt Concrete; 0-7", Broken into three layers; Top 3", Middle 2.5", Bottom 2"
		G				SM		Gravelly (Cinder) SAND; with silt, red, moist (FILL)
								contains clay
					5			**Boring Stopped at 5 Feet**

N- STANDARD PENETRATION TEST
R- RING SAMPLE
C- CORE: %RECOVERY/RQD
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.
2400 Huntington Drive
Flagstaff, AZ 86004-8934

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
PROJECT NO.: **2529JW068**

PLATE **A-5**

BORING LOG

DATE DRILLED: **3-5-09**
LOCATION: **MP 306.8 - SOUTHBOUND LANE**
ELEVATION: **Not Determined**

BORING NO. 3

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **8"HSA**
FIELD ENGINEER: **M. Morris**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		C						PAVEMENT; Asphalt Concrete; 0-6.75", composed of three layers
						SM		Gravelly (Cinder) SAND; with silt, red, moist (FILL)
		G						
		G				CL		CLAY; with cinder gravel, dark brown to black, moist
					5			**Boring Stopped at 5 Feet**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
C- CORE: %RECOVERY/RQD
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.
2400 Huntington Drive
Flagstaff, AZ 86004-8934

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
PROJECT NO.: **2529JW068**

PLATE **A-6**

BORING LOG

DATE DRILLED: **3-5-09**
LOCATION: **MP 305.2- NORTHBOUND LANE**
ELEVATION: **Not Determined**

BORING NO. 4

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **8"HSA**
FIELD ENGINEER: **M. Morris**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		C						PAVEMENT; Asphalt Concrete; 0-6", composed of two layers
						SM		Gravelly (Cinder) SAND; with silt, red, moist (FILL)
		G						
		G				CL		CLAY; with red cinder gravel, moist, brown
					5			**Boring Stopped at 5Feet**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
C- CORE: %RECOVERY/RQD
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.
2400 Huntington Drive
Flagstaff, AZ 86004-8934

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
PROJECT NO.: **2529JW068**

PLATE **A-7**

BORING LOG

DATE DRILLED: **3-5-09**
LOCATION: **MP 303.6 - SOUTHBOUND LANE**
ELEVATION: **Not Determined**

BORING NO. 5

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **8"HSA**
FIELD ENGINEER: **M. Morris**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		C						PAVEMENT; Asphalt Concrete; 0-6", composed of two layers
		G						Gravelly (Cinder) SAND; with silt, red, moist (FILL)
		G				CL		CLAY; with cinder gravel, red brown, most
					5			**Boring Stopped at 5 Feet**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
C- CORE: %RECOVERY/RQD
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.
2400 Huntington Drive
Flagstaff, AZ 86004-8934

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
PROJECT NO.: **2529JW068**

PLATE **A-8**

BORING LOG

DATE DRILLED: **3-5-09**
LOCATION: **MP 302.0- NORTHBOUND LANE**
ELEVATION: **Not Determined**

BORING NO. 6

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **8"HSA**
FIELD ENGINEER: **M. Morris**

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOWS/FT.	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		C						PAVEMENT; Asphalt Concrete; 0-6", composed of two layers
						SC-SM		Silty, Clayey SAND; with gravel, white to tan, moist (FILL)
14.3		G						
		G				CL		CLAY; with gravel, tan, moist
					5			**Auger Refusal at 4 Feet**

N- STANDARD PENETRATION TEST
R- RING SAMPLE
C- CORE: %RECOVERY/RQD
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

WESTERN TECHNOLOGIES INC.
2400 Huntington Drive
Flagstaff, AZ 86004-8934

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
PROJECT NO.: **2529JW068**

PLATE **A-9**

BORING LOG

PHYSICAL PROPERTIES

BORING NO.	DEPTH (FEET)	SOIL CLASSIFICATION	PARTICLE SIZE DISTRIBUTION % PASSING BY WEIGHT					ATTERBERG LIMITS		CORROSIVITY		'R' VALUE	REMARKS
			3 IN.	NO. 4	NO. 10	NO. 40	NO. 200	LL	PI	pH	RESISTIVITY (OHM-CM)		
1	1-3	SM	100	71	51	35	17		NP				2
3	1-4	SM	100	67	48	32	16		NP			82	2
3	4-5	CL	100	99	99	99	92	44	23			21	2
6	1-3	SC-SM	100	65	50	37	25	20	5				2

REMARKS:
CLASSIFICATION / PARTICLE SIZE
1. Visual
2. Laboratory Tested
3. Minus No. 200 Only

MOISTURE-DENSITY RELATIONSHIP
4. Tested ASTM D698/AASHTO T99
5. Tested ASTM D1557/AASHTO T180

NOTE: **NP** Nonplastic

LAKE MARY ROAD IMPROVEMENTS

Physical Properties

Western Technologies Inc.

Job No.: 2529JW068 | Plate: B-1

PHYSICAL PROPERTIES OF ASPHALT CONCRETE

CLIENT: **COCONINO COUNTY PWD**

ATTN: **MR. JON EBERS**

DATE OF REPORT: **04-09-09**
JOB NO.: **2529JW068**
EVENT NO.: **2149WLF05** LAB NO.: **23501**
AUTHORIZED BY: **CCPWD/EBERS** DATE: **02-05-09**
SAMPLED BY: **WT/M. MORRIS** DATE: **03-05-09**
SUBMITTED BY: **WT/C. COOPER** DATE: **03-17-09**

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
LOCATION: **COCONINO COUNTY, AZ**
MATERIAL: **EXISTING ASPHALT CONCRETE**
SUPPLIER: --

PRODUCT CODE: --
PLANT: --

SAMPLE SOURCE/LOCATION: **COMBINED CORES NO. 4 & 5**

Gradation After Extraction (AASHTO T30)			
Sieve Size		% PASS	SPEC
US	mm		
1 1/2	37.5		
1 1/4	31.5		
1	25.0		
3/4	19.0	100	
1/2	12.5	92	
3/8	9.5	83	
1/4	6.3	67	
No. 4	4.75	59	
8	2.38	44	
10	2.00	41	
16	1.18	33	
30	0.60	27	
40	0.425	23	
50	0.300	20	
100	0.150	15	
200	0.075	11.1	

PHYSICAL PROPERTIES OF RECOVERED ASPHALT		
Absolute Viscosity (140 F), p	AASHTO T202	18,970
Penetration (77 F), dmm	AASHTO T49	13

Comments: **Asphalt cement was recovered by the Abson Method (AASHTO T170). Bitumen content has been corrected for mineral matter in extracted solvent, and moisture.**

BITUMEN CONTENT BY CENTRIFUGE METHOD AASHTO T164, METHOD A		
	RESULT	SPEC
BITUMEN CONTENT, % (BY TOTAL WEIGHT)	7.1	

Copies To: Client (1)

Reviewed By: [signature]

PHYSICAL PROPERTIES OF ASPHALT CONCRETE

CLIENT: **COCONINO COUNTY PWD**

ATTN: **MR. JON EBERS**

DATE OF REPORT: **04-09-09**
JOB NO.: **2529JW068**
EVENT NO.: **2149WLF05** LAB NO.: **23500**
AUTHORIZED BY: **CCPWD/EBERS** DATE: **02-05-09**
SAMPLED BY: **WT/M. MORRIS** DATE: **03-05-09**
SUBMITTED BY: **WT/C. COOPER** DATE: **03-17-09**

PROJECT: **LAKE MARY ROAD IMPROVEMENTS**
LOCATION: **COCONINO COUNTY, AZ**
MATERIAL: **EXISTING ASPHALT CONCRETE** PRODUCT CODE: - -
SUPPLIER - - PLANT: - -

SAMPLE SOURCE/LOCATION: **COMBINED CORES NO. 1 & 2**

Gradation After Extraction (AASHTO T30)			
Sieve Size		% PASS	SPEC
US	mm		
1 1/2	37.5		
1 1/4	31.5		
1	25.0		
3/4	19.0	100	
1/2	12.5	94	
3/8	9.5	85	
1/4	6.3	68	
No. 4	4.75	58	
8	2.38	41	
10	2.00	37	
16	1.18	30	
30	0.60	24	
40	0.425	20	
50	0.300	17	
100	0.150	13	
200	0.075	9.2	

PHYSICAL PROPERTIES OF RECOVERED ASPHALT		
Absolute Viscosity (140 F), p	AASHTO T202	43,130
Penetration (77 F), dmm	AASHTO T49	23

Comments: **Asphalt cement was recovered by the Abson Method (AASHTO T170). Bitumen content has been corrected for mineral matter in extracted solvent, and moisture.**

BITUMEN CONTENT BY CENTRIFUGE METHOD AASHTO T164, METHOD A		
	RESULT	SPEC
BITUMEN CONTENT, % (BY TOTAL WEIGHT)	6.2	

Copies To: Client (1)

Reviewed By:

AASHTO - PAVEMENT DESIGN METHOD - Flexible

Lake Mary Road Improvements, Coconino County, Arizona

This program solves for either EAL or SN

Choice	Description	Value
(0)	Number of EALs/day (5 - 9,999)	96.30
(1)	Total Number of EALs (10,000 - 99,999,999)	703,024.00
(2)	Structural Number (1.0 - 10.0)	2.47
(3)	Resilient Modulus (1,000 - 40,000 psi)	15,000.00
(4)	Present Serviceability (2.5 - 5.0)	4.40
(5)	Terminal Serviceability (1.5 - 4.1)	2.30
(6)	Design Life (1 - 30 years)	20.00
(7)	Traffic Growth Rate (%)	2.00
(8)	Overall Standard Deviation (0.2 - 0.6)	0.45
(9)	Reliability (%)	90.00

LAYER	DESCRIPTION	S.C.	D.C.	THICK.	SN
Surface	Surface Course Material #1	0.44		1.75	0.77
CIRP		0.30		4.00	1.20
Existing Asphalt Concrete		0.25		2.00	0.50
TOTAL				**7.75**	**2.47**
TARGET SN					**2.47**

DELTA SN (pos. = = > too thick, neg. = = > too thin) 0.00

COCONINO COUNTY PUBLIC WORKS DEPARTMENT
LAKE MARY ROAD IMPROVEMENTS
JOB NO. 2529JW068

Picture No. 1 - Extracted core at Location C-1.

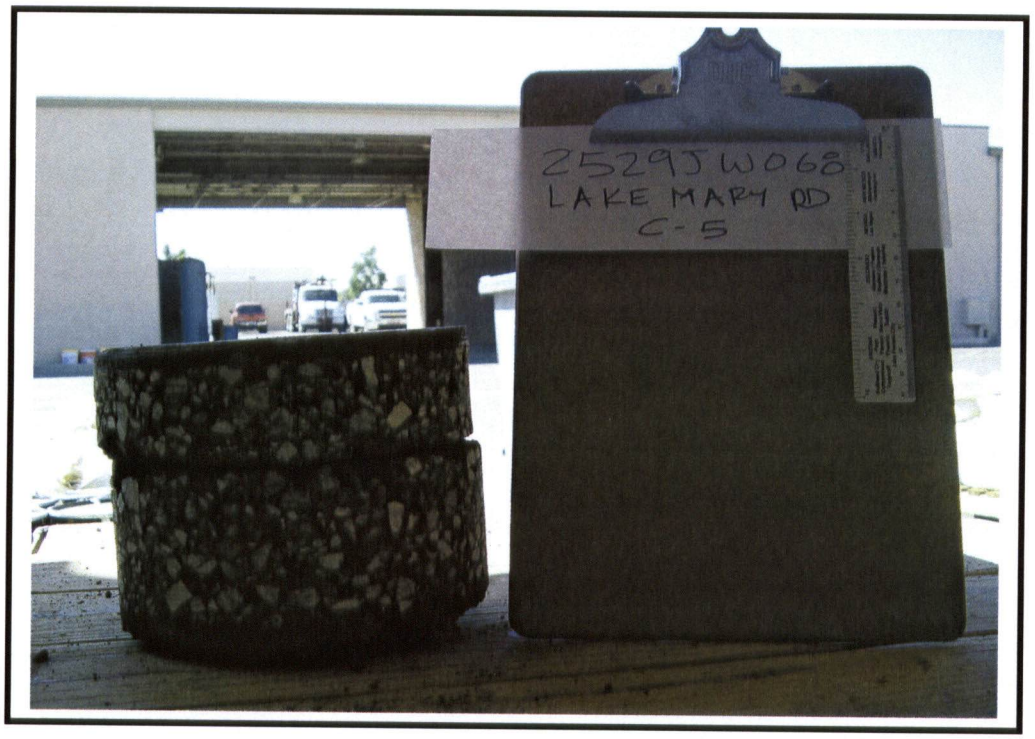
Picture No. 2 - Close-up of core extracted at Location C-1.

Picture No. 3 – Extracted core (inverted) at Location C-2. Notice core split into its three component layers.

Picture No. 4 – Close-up of core extracted at location C-2.

Picture No. 5 – Extracted core at Location C-3.

Picture No. 6 - Extracted core at Location C-4.



Picture No. 7 – Extracted core at Location C-5.

Picture No. 8 - Extracted core at Location C-6.

SECTION 325. COLD RECYCLING OF BITUMINOUS PAVEMENT

325.1 DESCRIPTION

This item shall consist of pulverizing the existing surfacing to the specified width and depth; mixing an emulsified binder agent and water, if required, with the pulverized surfacing; and spreading and compacting said mixture to the specified width and thickness. All work shall be as shown on the plans and as provided herein unless otherwise directed by the Engineer.

325.2 MATERIALS

325.2.1 Emulsified Asphalt. The emulsified binder agent shall be HFE-150P or HFE-300P meeting the requirements of Table 325-1. The grade shall be specified on the plans or in the special provisions. Other recycling agents may be used as the emulsified binder agent if it can be shown that they provide equivalent mix design results and they are approved by the Engineer.

TABLE 325-1, POLYMER MODIFIED HIGH FLOAT EMULSION REQUIREMENTS

TEST	HFE-150P	HFE-300P
Viscosity, Saybolt Furol @50° C (122° F), sec.	50+	50+
Sieve Test, retained on No. 20 Sieve, %	0.10-	0.10-
Storage Stability Test, 1 day, %	1-	1-
Residue from distillation test to 204° C (400° F), %	65+	65+
Oil Distillate by volume of emulsion, %	7-	7-
Tests on Residue from Distillation		
Penetration at 25° C (77° F), 100g, 5 sec, 0.1 mm	150-300	300+
Float test at 60° C (140° F), sec	1200+	1200+
Ductility at 25° C (77° F), 5 cm per minute, cm	100+	100+
Tensile Stress 4° C (39.2° F), 50 cm/min, 800% elongation, kg/cm^2, ASTM D412	1.0+	0.05+

325.2.2 Water. Water shall be clean, clear, and free from injurious amounts of soluble salts. A sample of the available water shall be mixed with a sample of the emulsified binder agent in the same ratio intended to be used on the project. If any adverse effect on the emulsified binder agent is indicated, a new source of water must be found.

325.2.3 RAP Gradation

The cold recycled asphalt pavement (RAP) shall meet the following gradation at the time that it is to be mixed with the binder.

Sieve Size	Percent Passing
1-1/2"	100
1"	90-100

325.2.4 Job Mix Formula: The Contractor shall be responsible for developing the job mix formula (JMF). Testing shall be in accordance with ASTM D1559 (50 blows). The laboratory performing the JMF shall be approved by the Engineer.

The mix shall be designed to meet the following criteria:

(1) Marshall Stability The stability at 77°F shall be not less than 1500 pounds.

(2) Wet/Dry Ratio The wet/dry Marshall stability ratio shall be not less than 50 percent.

(3) Liquid Content The mixing water content, emulsified binder agent content and total liquid content shall be determined by the following method.

Materials. RAP to be used for development of the mix design shall all pass a 1-inch sieve and shall be dried to constant weight in an oven at 140°F. If the sample for testing contains any material larger than 1 inch, the plus 1-inch material shall be removed and replaced with an equal weight of material passing the 1-inch sieve and retained on the 3/4-inch sieve. Emulsified binder agent shall be the product proposed for use on the project. Water shall be clean, clear and free from injurious amount of soluble salts.

Mixing Water Determination. Mix a known amount of water with 1000 grams of RAP for 30 seconds with a mechanical mixer. Add 3 percent emulsified binder agent and continue mixing for an additional 30 seconds. Place the mixed sample in a pan and dry to constant weight at 120°F. Repeat for water contents above and below the expected mixing water content. Following drying, examine the samples for distribution of the emulsified binder agent. Select the lowest water content that produces a uniform distribution of the emulsified binder agent. The selected mixing water content plus 3 percent will be the total liquid content to be used for all further testing. All liquid content percentages should be given on the basis of dry weight of RAP.

Emulsified Binder Agent Determination. Prepare specimens according to ASTM D1559 and compact at 77°F using 50 blows per specimen face. Preparation shall utilize various amounts of emulsified binder agent with prewet RAP. Vary the mixing water for different emulsified binder agent contents to maintain the same liquid content for all specimens. Mix the RAP with the appropriate amount of mixing water prior to adding and mixing with emulsified binder agent. Following compaction, place the specimens in the molds on their sides in a 120°F oven for 24 hours. After 24 hours curing in the molds, extrude the specimens and return them to the 120°F oven for an additional 24 hours of curing in an upright position on boards or glass plates. Invert the specimens at least once to allow loss of moisture for a minimum of 6 hours from either end.

Following 48 hours of oven curing, cool the specimens to 77°F in air, measure for weight and volume and test for stability. Break the specimens open and examine the distribution of the binder, being careful not to lose any material. Place the specimens in a pan, dry to constant weight at 240°F and reweigh. Compute the oven dried specimen weight, the moisture content following 48 hours of curing at 120°F and the oven dried density. On the basis of the stabilities and densities achieved and the distribution of the emulsified binder agent in the specimens, select an optimum emulsified binder agent content.

Wet/Dry Ratio. Using the mixing water and emulsified binder agent contents previously determined, compact, cure and measure the density of 6 specimens using the same procedures given for stability testing. Divide the 6 specimens into two groups of three to obtain approximately the same mean density for each group. Place one group into a water bath at 120°F. After 24 hours remove the specimens from the water bath, cool to 77°F, dry to a surface dry condition, measure weight and volume and compute the density. Compute the moisture pickup on the basis of the measured density prior to placement in the water bath.

Test both groups of specimens for Marshall stability and compute the wet/dry ratio by dividing the mean corrected stability of the wet specimens by the mean corrected stability of the dry specimens.

During production, the total liquid content of the mix shall be maintained within 1 percentage point of the optimum value established in the mix design. After the JMF is established, all mixtures shall conform thereto, other than small changes in the emulsion binder agent content as provided for in other parts of this specification. When unsatisfactory results or other conditions make it necessary, the Engineer may require the establishment of a new JMF.

325.2.5 Sampling. Prior to the start of work, the Contractor shall obtain a minimum of one sample for each 15,000 square yards of pavement and test these samples for asphalt content and aggregate gradation. These test results shall be provided to the Engineer.

EQUIPMENT

325.3.1 Cold In-Situ Machinery. The Contractor shall furnish a self-propelled machine capable of pulverizing in-situ bituminous materials to the depth shown on the plans, in one pass. The machine shall have a minimum rotor cutting width of twelve (12) feet, standard automatic depth controls and shall maintain a constant cutting depth. The machine shall also incorporate screening and crushing capabilities to reduce or remove oversize particles prior to mixing with emulsified binder agent. Oversize particles shall be reduced to size by crushing; however, the Contractor may, with concurrence of the Engineer, waste up to a maximum of two percent (2%) oversize material prior to adding emulsion. This waste shall generally be limited to that material which is flattened out rather than broken down by the crusher.

325.3.2 Mixing Equipment. The emulsified binder agent shall be applied through a mixing machine capable of mixing the pulverized material and the emulsified binder agent to a homogeneous mixture and placing the mixture in a windrow. The method of depositing the mixed material in a windrow shall be such that segregation does not occur.

A positive displacement pump, capable of accurately metering the required quantity of emulsified binder agent into the pulverized material, shall be used. The pump shall be equipped with a positive interlock system which will permit addition of the emulsified binder agent only when the pulverized material is present in the mixing chamber and will automatically shut off when the material is not in the mixing chamber.

Each mixing machine shall be equipped with a meter capable of registering the rate of flow and total delivery of the emulsified binder agent introduced into the mixture. The meter shall be calibrated by the Contractor, in the presence of the Engineer, before commencing recycling operations. Subsequent checks or calibrations of the meter shall be as directed by the Engineer.

325.3.3 Placement Equipment. Placing of the recycled bituminous course shall be accomplished with a self-propelled bituminous paver meeting the requirements of Item P-401 of these specifications, except that heating of the screed will not be permitted. This equipment shall be capable of spreading the recycled bituminous material in one continuous pass, without segregation, to the typical section shown on the plans. When a pick-up machine is used to feed the windrow into the paver hopper, the pick-up machine shall be capable of picking up the entire windrow down to the underlying materials.

325.3.4 Rollers. Rollers shall meet the requirements of Item P-401 of these specifications. The number, weight and type of rollers shall be sufficient to obtain the required compaction. All rollers shall be equipped with pads and a water system which prevent sticking of the recycled mixture to the roller wheels.

CONSTRUCTION METHODS

325.4.1 Weather Limitations. Recycling operations shall not be performed when the atmospheric temperature is below 60°F or when the weather is foggy or rainy or when weather conditions are such that in the judgment of the Engineer, proper mixing, spreading and compacting of the recycled material cannot be accomplished.

325.4.2 General. The existing surface shall be cold recycled in a manner that does not disturb the underlying material in the existing pavement structure. Prior to initiating recycling operations or other inherent work, the Contractor shall prepare the surface in accordance with the typical sections shown on the plans. Disposal of debris shall be as directed by the Engineer.

The Contractor may add water to the pulverized material for the purpose of cooling the cutting teeth on the mill or pulverizing equipment or to facilitate uniform mixing with the emulsified binder agent. Water may be added prior to or concurrently with the emulsified binder agent. A means shall be provided for accurately metering and registering the rate of flow of water into the pulverized material.

If segregation occurs either in the windrow or behind the paver, the Engineer may require the Contractor to make changes in the equipment or operations. These changes may include, but shall not be limited to, the following:

1. Reducing the forward speed of the milling operation;

2. Increasing the amount of material going through the crusher;

3. Adjusting the crusher to produce more fines;

4. Adjusting the height of free fall of material from the mixing unit;

5. Adjusting the amount of water in the mixture.

The Contractor may be required to make other changes in his equipment or operations, as necessary to obtain a satisfactory end-product. The recycled bituminous course shall be spread in one continuous pass, without segregation, to the typical section shown in the plans.

325.4.3 In-Place Mixing. When commencing recycling operations, the emulsified binder agent shall be applied to the pulverized material at the rate determined by the Engineer based on samples obtained by the Contractor for the mix design. The exact application rate of the emulsified binder agent will be determined and varied by the Engineer as required by existing pavement conditions. An allowable tolerance of plus or minus 0.2 percent of the initial design application rate or of the application rate determined by the Engineer shall be maintained at all times.

325.4.4 Compaction. Breakdown rolling shall begin immediately before or at the same time as the emulsion starts of break. At this time the mixture should be able to support the roller without undue displacement. Rolling shall be continued until the recycled pavement has achieved a density of at least 95 percent of the density obtained from specimens compacted by the Marshall procedure, 50 blows per specimen face, and cured by the procedure given for the mix design. Field density shall be the total density measured by nuclear gauge in accordance with ASTM D2950, Test Method for Density of Bituminous Concrete in Place by Nuclear Method with moisture correction in accordance with ASTM D4944, Test Method for Determination of Water Content by the Calcium Carbide Pressure Tester Method. Correlation of the nuclear gauge to the

compacted pavement as called for by ASTM D2950 may be performed by use of the existing pavement prior to recycling.

325.4.5 Curing. After the recycled material has been spread and compacted, vehicles, including the Contractor's equipment, shall not be permitted on the completed recycled bituminous course for at least one hour. The compacted mixture shall be allowed to cure such that the free moisture in the recycled material is reduced to no more than two percent (2%) when tested in accordance with ASTM D4944.

325.4.6 Surface Tolerance. The final surface of the recycled bituminous course shall not deviate in excess of 1/2 inch from the testing edge of a 10-foot straightedge resting on any two points. All deviations from this tolerance shall be corrected at no additional cost of the Owner.

All unacceptable recycled bituminous course shall be repaired by the Contractor, as directed by the Engineer prior to placing a subsequent surfacing course. The repair(s) shall be accomplished at no additional cost to the Owner.

METHOD OF MEASUREMENT

325.5.1. The quantity of in-situ cold recycling of existing surfacing to be paid for will be determined by measurement of the number of square yards actually constructed and accepted by the Engineer as complying with the plans and specifications.

325.5.2. Emulsified binder agent incorporated into the completed and accepted work shall be measured by the ton.

BASIS OF PAYMENT

325.6.1. Payment will be made at the contract unit price per square yard for in-situ cold recycling of existing bituminous pavement. This price shall be full compensation for furnishing all materials, except the emulsified binder agent; for all preparation, manipulation and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

325.6.2. Payment shall be made at the contract unit price per ton for emulsified binder agent. This price shall be full compensation for furnishing the material; for all delivery, placing and incorporation of this material; and for all labor, equipment, tools, and incidental necessary to complete the item.

Payment will be made under:

Item 325.6.1 In-Situ Cold Recycling of Existing Surfacing, per square yard

Item 325.6.2 Emulsified Binder Agent, per ton

MATERIALS AND TESTING REQUIREMENTS

ASTM D244 Standard Test Methods and Practices for Emulsified Asphalt

ASTM D412 Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension

ASTM D977 Specification for Emulsified Asphalt

ASTM D1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

ASTM D2172 Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

ASTM D3665 Random Sampling of Paving Materials

ASTM T30 Mechanical Analysis of Extracted Aggregate

Western Technologies Inc.
The Quality People
Since 1955

2400 East Huntington Drive
Flagstaff, Arizona 86004
(928) 774-8700 • fax (928) 774-6469

September 11, 2009

Coconino County Public Works Department
5600 East Commerce
Flagstaff, Arizona 86004

NOTICE
Electronic Copy of Final Document; sealed original document is with Craig P Wiedeman AZ P.E. No. 11860

Attn: Mr. Jon Ebers
Capital Projects Manager

Re: Pavement Engineering Services
Coconino County Project #-9-PP-03
Lake Mary Road Improvements
Coconino County, Arizona

Job No. 2529JW068
Addendum No. 2

The purpose of this addendum letter is to provide our opinion/recommendation regarding a request from Coconino County Public Works Department (CCPWD) submitted via e-mail on August 21, 2009. It is indicated in that e-mail that the scope of work for Lake Mary Road has changed to 1-inch scarification and 2-inch overlay to be performed between mile posts (MP) 307.5 to 310.0. It is also indicated in the e-mail that the thickness of the existing pavement layer on this particular stretch of Lake Mary Road, according to the boring exploration, is 7 inches (Boring Nos. 1 at MP 310.0 southbound lane and No. 2 at MP 308.4 northbound lane) and not 6 inches as it was considered for design purposes in our original report dated April 16, 2009 and Addendum letter No. 1 dated July 21, 2009. It is also mentioned that the design life of the rehabilitation project would be 10 years instead of 20 years as assumed initially. The Coconino County Public Works Department (CCPWD) is requesting Western Technologies, Inc. (WT) to provide an opinion as to whether this is an acceptable alternative to the CIPR and overlay approach.

The ESAL value for a design period of 10 years is estimated as follows:

- A revised initial average daily traffic (ADT) count of 1,059 was provided by Mr. Ebers in an e-mail dated July 24, 2009.
- An annual growth rate of 2 percent was assumed for this segment of Lake Mary Road.
- The revised design life of the rehabilitation project is 10 years.

Based upon these values, a directional distribution factor of 50 percent and a lane distribution factor of 100 percent (1 lane per direction), a total ESAL for the main roadway design lane of approximately 128,600 is obtained. The following table shows the calculation of the total ESALs assuming a traffic distribution of 95 percent for passenger vehicles and 5 percent for trucks.

Vehicle type	Total Vehicles Design Lane	% vehicles	ESAL factor	Design ESAL
Automobiles	2,116,280	95	0.0008	1,608
Trucks	2,116,280	5	1.2	126,977
			TOTAL ESALS	**128,585**

The required Structural Number (SN) for these design conditions (keeping the rest of the design parameters constant as in the initial report) is **1.88**.

The alternative section presented by the CCPWD yields a SN of approximately **2.38** which is greater than the required **1.88** by the analysis. The SN value of **2.38** was obtained by considering 6 inches (average thickness of 7 inches minus 1 inch that was milled) of the existing section multiplied by a layer coefficient of 0.25 plus 2 inches of the overlay multiplied by a layer coefficient of 0.44. The proposed section by the CCPWD is more than adequate to support the design traffic during the design period of 10 years. Further analysis indicates that this section may support traffic corresponding to a design period of 20 years or more. It must be taken into consideration that the SN of **2.38** was estimated based on a layer coefficient for the existing asphalt concrete layer of 0.25; the range for this type of material is typically from 0.20 to 0.30.

A concern with the alternative section suggested by the CCPWD is that of premature reflective cracking on the recently placed overlay. It is indicated in our original report that significant cracks (longitudinal, transverse and alligator) were observed throughout the entire length of the alignment. By milling just 1 inch of the existing ±7 inch thick existing pavement surface layer, the existing cracks can reflect through the newly placed asphalt concrete overlay in a very short time unless a stress absorbing membrane interlayer (SAMI) is placed between the existing layer and the overlay. The SAMI would help retard the reflection of the cracks to the overlay.

Coconino County Public Works Department
Job No. 2529JW068
Addendum No. 2

This addendum should be attached to and become part of the original report. If you have any questions concerning this information, or require additional consultation, design, observation, or testing services, please contact us. We look forward to working with you on future projects.

Sincerely,
WESTERN TECHNOLOGIES, INC.

Armando de la Rocha 11/5

Armando de la Rocha
Senior Geotechnical/Pavement Engineer

Registered Professional Engineer (Civil)
CERTIFICATE NO.
11860
CRAIG P
WIEDEMAN
Registered
Arizona
9/11/09
exp. 12/31/10

Craig P. Wiedeman, P.E.
Senior Geotechnical Engineer

Copies to: Addressee (5)