Final Report
Arizona Canal Diversion
Channel Bridges
at Interstate 17
Phoenix, Arizona
for
RGA Consulting Engineers
Job No. 2125J066

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Arizona Canal Diversion Channel Bridges at Interstate 17 Phoenix, Arizona for RGA Consulting Engineers

Job No. 2125J066

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Phoenix, Arizona 85013

October 1, 1985

Attn: Mr. Harold Ditzler

Re: Final Report
Arizona Canal Diversion Channel Bridges
at Interstate 17
Phoenix, Arizona

Job No. 2125J066

Our final geotechnical report for the above project is attached. The work was performed according to our proposal of November 15, 1984. The scope of the field work was modified as the result of discussions with Mr. Dick Bruce of ADOT. The modified scope included drilling two borings to a depth of 100 feet and six borings to a depth of 40 feet.

Soils at the site consisted of firm to stiff sandy clays and clayey sands underlain by dense to very dense clayey sands, gravelly sands, sandy gravels, clayey sandy gravels and sandy clays. We recommend that the main bridge structure be founded on drilled shafts. The in-fill structures for the existing bridges may be founded on spread footings. Pavement design recommendations were transmitted in the Materials Design Memorandum under separate cover.

The final report completes Western Technologies Inc.'s current services. We are prepared to review your plans and specifications for consistency with the recommendations.

Sincerely,
WESTERN TECHNOLOGIES INC.
Geotechnical Services

Registered Professional Engineer
10971
KENNETH L.
RICKER
Date Signed 10-1-85
ARIZONA, U.S.A.

Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (1)
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RGA Consulting Engineers
Job No. 2125J066

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RGA Consulting Engineers
Job No. 2125J066

Geotechnical Investigation
Final Report
Arizona Canal Diversion Channel Bridges
at Interstate 17
Phoenix, Arizona
October 1, 1985

INTRODUCTION

This report contains the results of our geotechnical investigation for the proposed bridges over the Arizona Canal Diversion Canal to be located along Interstate-17 in Phoenix, Arizona. The bridges will be located along the existing I-17 right-of-way just north of the Arizona Canal. The purpose of these services is to provide information and recommendations relative to foundation design, lateral earth pressures, and approach fill grading.

PROPOSED CONSTRUCTION

Based on information provided by RGA, the proposed project will include a bridge on the east frontage road, the west frontage road, and the north and south bound freeway to be located on the north side of the existing canal. The bridges will span a 110 foot wide channel, skewed 15° to the channel centerline. The clear height under the bridges will be at least 21 feet. The channel under the bridge will be concrete lined and rectangular in shape. The bridges will be supported on 30-inch diameter drilled shafts constructed 5.5 feet on center. In addition to the main bridges, the project includes in-fill structures to be constructed between the existing canal bridges along the freeway and frontage roads, a temporary frontage road bridge which will be an 80 foot long single span structure east of the exit frontage road and various detour roads. The existing canal is approximately 10 to 15 feet deep. Structural foundation loads will be on the order of:

Structure	Total Vertical Load	Moment
Main Bridges	109 kips/shaft	578 kip ft/shaft
In-fill Structure	6.8 klf/abutment	--
In-fill Structure	9.8 klf/pier	--
Temporary Bridge	12 to 18 klf/abutment	--

SITE CONDITIONS

At the time of our exploration, the site was occupied by the existing freeway, adjoining frontage roads, canal and canal bridges. The area contained landscaping and underground and overhead utilities.

SCOPE OF SERVICES

Eight borings were drilled to depths of 41 to 100 feet at the locations shown on the site plan. During exploration, subsoils were examined visually and sampled at selected intervals.

The following tests were performed on selected soil samples:

- Water content
- Dry density
- Consolidation
- Expansion
- Shear strength
- Gradation
- Plasticity
- R-Value

Test results were used in the development of foundation and earthwork recommendations.

INTERPRETATION OF SUBSURFACE CONDITIONS

Exploration: As presented on Logs of Borings, surface and subsoils to the full depth of exploration were found to be alluvial soils consisting of interbedded deposits of sandy clay, clayey sand, sandy gravel, gravelly sand, clayey sand and gravel, and silty sand. In Borings 1, 2, and 7 the upper 2 to 3 feet of the material is fill. In Borings 5, 6, and 8 these soils are overlain by 3 to 4 inches of asphalt concrete and 12 to 15 inches of aggregate base material. The soils to depths of 9 to 16 feet are medium dense (firm to stiff). Below these depths the soils are dense to very dense (very stiff to hard) except at Boring 2. In Boring 2, the soil becomes denser below a depth of 30 feet. A groundwater table was not encountered in any boring at the time of exploration.

Testing: Laboratory test results indicate that native subsoils at shallow foundation level are slightly to moderately compressible at existing water contents. Slight additional compression occurs when the water content is increased. When water is added to compacted near-surface clay soils, moderate expansion occurs. The soils at shallow foundation level have moderate shear strengths.

CONCLUSIONS AND RECOMMENDATIONS

General: The recommendations presented in this report are based on the final design concepts and on the assumption that the soil conditions do not deviate appreciably from those disclosed by the borings. If variations are encountered during construction or if

changes are made in project plans, structural loads or foundations types, we should be notified for supplemental recommendations.

Foundations: Because of variations in the nature of bearing soils, foundation types to be used, and structural loads, we considered the following foundation systems:

- shallow foundations on undisturbed subsoils for support of the in-fill structure
- deep foundations consisting of drilled shaft founded on undisturbed subsoils for support of the main structures and the temporary bridge

- Shallow - In-fill Structure: We recommend the in-fill structure be supported on spread foundations bearing upon undisturbed subsoils below the bottom of the existing canal.

  The recommended footing depth and design bearing capacity are presented in the following tabulation:

Footing Depth Below Canal Bottom Grade (ft)	Design Bearing Capacity (psf)*
4.0	3500

*Design bearing capacities assume footings founded at least 2 feet below existing footing (as per the request of ADOT).

Total or differential settlements resulting from the assumed loads are estimated to be less than 1/2 inch provided that:

- Foundations are constructed as we recommend, and
- Essentially no changes occur in water contents of foundation soils.

Additional foundation movements of less than 1/4 inch could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction.

Finished grade is the lowest adjacent canal bottom grade for abutment and pier footings. The design bearing capacity applies to dead loads plus design live load conditions. The design bearing capacity may be increased by one-third when considering total loads that include wind or seismic or toe pressures provided the resultant of all forces acts in the center one-third of the footing. Recommended minimum width of footings is 24 inches.

Foundation excavations into undisturbed soils should be inspected by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

- Drilled Shafts - Main Structure and Temporary Bridge: We understand that a drilled shaft foundation system will be used for support of the main structures and the temporary bridge. The following capacities should be used in design for straight, shaft, machine-cleaned, 2-foot and 2.5-foot diameter shafts:

Depth* (ft)	Total Capacity (kips)	
	2.0' Dia.	2.5' Dia.
10	109	175
16	165	265
17	185	280

*Depth measured from bottom of channel

Bearing capacity may be increased one-third when considering total loads including wind and seismic.

Estimated settlements for drilled shafts are 1/2 inch or less for maximum loads.

Drilling to design depths should be possible with conventional rotary or bucket augers. Shafts will probably remain open without stabilizing measures. However, caving and sloughing should be anticipated in the relatively clean granular soils. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

The bearing surface must be machine cleaned prior to concrete placement. A representative of the geotechnical engineer should inspect the bearing surface and pier configuration without entering the drilled element.

Lateral Earth Pressures: For soils above any free water surface, recommended equivalent fluid pressures and coefficients of base friction for unrestrained elements for use in preliminary design are:

- Active:
  - Undisturbed subsoil ---------- 35 psf/ft
  - Compacted granular backfill ---------- 30 psf/ft
- Passive:
  - Shallow wall footings ---------- 350 psf/ft
  - Drilled Shafts ---------- 500 psf/ft
- Coefficient of base friction ---------- 0.40*

*The coefficient of base friction should be reduced to 0.30 when used in conjunction with passive pressure.

Where the design includes restrained elements, the following equivalent fluid pressures are recommended:

- At-rest:
  Undisturbed subsoil ---------- 60 psf/ft
  Compacted granular backfill ---------- 55 psf/ft

The lateral earth pressures herein are not applicable for submerged soils. We should be consulted for additional recommendations if such conditions are to be included in the design.

Fill against footings, stem walls, abutment walls, and retaining walls should be compacted to densities specified in "Earthwork." Medium to high plasticity clay soils should not be used as backfill against retaining walls. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures which could result in wall movements.

Earthwork:

- General: The conclusions contained in this report for the proposed construction are contingent upon compliance with recommendations presented in this section.

- Excavation: We anticipate that excavations for the proposed construction can be accomplished with conventional equipment.

- Foundation Preparation: Specialized treatment of existing soils within foundation areas is not required.

- Materials:

1. On-site soils may be used as backfill against abutments or retaining walls.

2. Imported soils should conform to the following:

- Gradation (ASTM C136): percent finer by weight

6"	100
4"	70-100
No. 4 Sieve	50-100
No. 200 Sieve	60 (max)

- Maximum expansive potential(%)* 1.5

- Maximum soluble sulfates(%) 0.10

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

3. Aggregate base should conform to ADOT specifications.

- Placement and Compaction:

1. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended water contents and densities throughout the lift.

2. Uncompacted fill lifts should not exceed 6 inches.

3. Materials should be compacted to the following:

Material	Minimum Percent Compaction (ASTM D698)
On-site soils:	
Below pavement	95
Against subsurface walls	95
Imported fill:	
Below pavement	95
Against subsurface walls	95
Aggregate base	95
Miscellaneous backfill	90

4. On-site clay soils should be compacted within a water content range of 1 percent below to 4 percent above optimum. On-site granular soils and imported soils should be compacted within a moisture range of 3 percent below to 3 percent above optimum.

- Compliance: Recommendations for backfill and pavement elements supported on compacted fills or prepared subgrade depend upon compliance with "Earthwork" recommendations. To assess compliance, observation and testing should be performed under the direction of a geotechnical engineer.

Temporary Shoring Requirements: We understand that construction sequence for the main structures will include excavation of the channel after the abutment drilled shafts and the bridge super structure has been constructed. The channel excavation will be approximately 26 feet deep as measured from the bottom of the bridge super structure. The channel excavation can be expected to encounter clayey sands and sandy clays underlain by dense to very dense gravelly sands/sandy gravels underlain by dense clayey sands. During excavation the soils should bridge between drilled shafts; however, some sloughing or raveling of relatively clean and

dry granular soils may occur. This sloughing or raveling may be controlled by the installation of lagging or by guniting the exposed surfaces prior to the placement of the permanent channel wall.

CLOSURE

Our conclusions and recommendations assume observation and testing of the earthwork and foundation preparations by a representative of a registered engineer. During construction, the engineer will have the responsibility of assuring that construction complies with our recommendations. The engineer also will be responsible for decisions/recommendations should unanticipated conditions occur.

If plans, specifications, or field applications deviate from our recommendations, we shall be relieved of responsibility unless our written concurrence has been obtained.

DEFINITION OF TERMINOLOGY

ALLOWABLE SOIL BEARING CAPACITY ALLOWABLE FOUNDATION PRESSURE	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 observation 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 the absorption of moisture.
FILL	Materials deposited by the action 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 AND 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.

METHOD OF SOIL CLASSIFICATION
(ASTM D 2487)

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, etc.)

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 SILTY-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

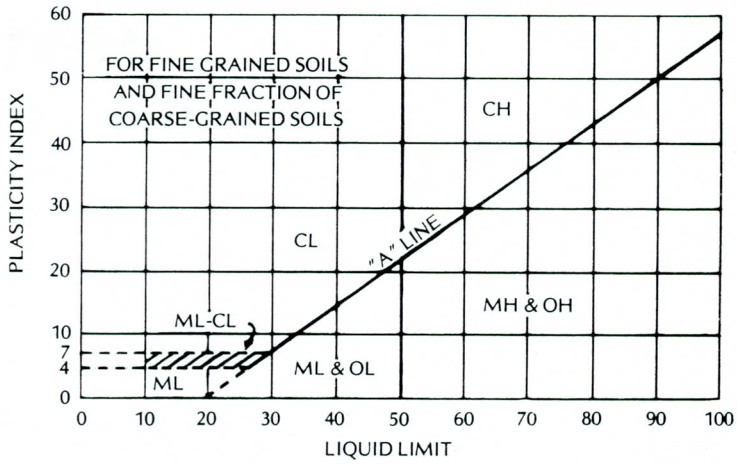
NOTE:
Fine grained soils receive dual symbols if their limits plot in the hatched zone on the Plasticity Chart (ML-CL)

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	ABOVE 12 in.
COBBLES	3 in. to 12 in.
GRAVEL	No. 4 to 3 in.
Coarse	¾ in. to 3 in.
Fine	No. 4 to ¾ in.
SAND	No. 200 to No. 4
Coarse	No. 10 to No. 4
Medium	No. 40 to No. 10
Fine	No. 200 to No. 40
*FINES (Silt or Clay)	BELOW No. 200

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

PLASTICITY CHART



SOIL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression: Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Water Soluble Matter, %: Salts	Sulfates	Shear Strength: Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	∅ Deg.	Consolidation: Initial Void Ratio	Surcharge KSF	Consol. %
1	3 - 5	SC	112.1 (1)	11.1 (4)	0.1	+2.8 (5)											
1	5 - 6	SC								UC	12.3	112.9	1.085				
1	25 - 26	SC	98.8 (1)	16.9 (4)	0.56	-0.50											
1	25 - 26	SC	98.8 (1)	16.9 (4)	1.10	-1.04											
1	25 - 26	SC	98.8 (1)	16.9 (4)	2.22	-1.52											
1	25 - 26	SC	98.8 (1)	16.9 (4)	4.42	-2.31											
1	25 - 26	SC	98.8 (1)	16.9 (4)	8.84	-3.27											
1	25 - 26	SC	98.8 (1)	16.9 (4)	17.70	-4.78											
1	25 - 26	SC	98.8 (1)	16.9 (4)	35.40	-9.32											
1	25 - 26	SC	98.8 (1)	16.9 (4)	35.40	-9.32 (5)											

Boring No.	Depth, ft.	Remarks

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
- UU Unconsolidated Undrained
- CU Consolidated Undrained w/pore press
- CU Consolidated Undrained
- CD Consolidated Drained
- CR Cyclic Consolidated Undrained w/pore press

REMARKS

1. In-situ density.
2. Compacted density (Approx. 95% of ASTM:D698 max. density at moisture content slightly below optimum).
3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

SOIL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression: Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Water Soluble Matter, %: Salts	Sulfates	Shear Strength: Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	Ø Deg.	Consolidation: Initial Void Ratio	Surcharge KSF	Consol. %
3	35 - 36	SC								DS	16.7 (4)	110.7 (1)	1.7	40			
5	25 - 26	SC								DS	17.8 (4)	98.4 (1)	1.8	40			
6	30 - 31	CL	101.9 (1)	20.2 (4)	0.56	-0.62											
6	30 - 31	CL	101.9 (1)	20.2 (4)	1.10	-1.17											
6	30 - 31	CL	101.9 (1)	20.2 (4)	2.20	-1.92											
6	30 - 31	CL	101.9 (1)	20.2 (4)	4.42	-2.96											
6	30 - 31	CL	101.9 (1)	20.2 (4)	8.84	-4.58											
6	30 - 31	CL	101.9 (1)	20.2 (4)	17.70	-7.12											
6	30 - 31	CL	101.9 (1)	20.2 (4)	35.40	-11.21											
6	30 - 31	CL	101.9 (1)	20.2 (4)	35.40	(5) -11.21											

Boring No.	Depth, ft.	Remarks

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
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REMARKS

1. In-situ density.
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3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

SOIL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression					Water Soluble Matter, %		Shear Strength					Consolidation		
			Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Salts	Sulfates	Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	∅ Deg.	Initial Void Ratio	Surcharge KSF	Consol. %
7	2 - 5	CL	118.6 (2)	16.2	0.1	+3.8 (5)											
8	30 - 31	SC								DS	22.5 (4)	100.9 (1)	2.0	42			

Boring No.	Depth, ft.	Remarks

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
- UU Unconsolidated Undrained
- CU Consolidated Undrained w/pore press
- CU Consolidated Undrained
- CD Consolidated Drained
- CR Cyclic Consolidated Undrained w/pore press

REMARKS

1. In-situ density.
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3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

PHYSICAL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Particle Size Distribution, % Passing by wt.					Atterberg Limits		Moisture - Density Rel.			Specific Gravity	Permeability		'R' Value	Remarks
			3"	#4	#10	#40	#200	LL	PI	Dry Density pcf	Optimum Moisture %	Meth.		Dry Density pcf	K Cm/Sec	Corrected 'R'	
1	0 - 3	SC/CL														20	12
1	3 - 5	SC					45	25	8								3
7	2 - 5	CL					74	38	18								3

Boring No.	Depth, ft.	Comments

REMARKS

Classification/Particle Size
1. Visual
2. Laboratory Tested
3. Minus #200 Only

Moisture Density Relationship
4. Tested ASTM D-689/AASHTO T-99
5. Tested ASTM D-1557/AASHTO T-180
6. Other_____

Specific Gravity
7. Minus #4
8. Plus #4

Permeability
9. Constant Head
10. Falling Head

'R' Value
11. Expansion Pressure_____psf
12. Exudation Pressure 300 psi

Note: NP = nonplastic

BORING LOG NOTES

The number shown in "LOG OF BORING NO." refers to the approximate location of the same number indicated on the "Site Plan" 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.

"N" in "Blows/Foot" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a two-inch-outside-diameter split-barrel sampler a distance of 1 foot, Standard Penetration Test (ASTM D1586). Refusal to penetration is defined as more than 100 blows per foot.

"R" in "Blows/Foot" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a 2.42-inch-inside-diameter ring sampler a distance of 1 foot. Refusal to penetration is considered more than 50 blows per foot.

"Sample Type" refers to the form of sample recovery, in which N = Split-barrel sample, R = Ring sample, and G = Grab sample.

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

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

"Unified Class" 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 date(s) noted. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

In general, terms and symbols on the boring logs conform with "Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics" (ASTM D653).

LOG OF BORING NO. 1

Project ACDC Bridge Job No. 2125J066

Elevation 1234.46 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 75 Date 3/19/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
			G			SC/CL	CLAYEY SAND/SANDY CLAY; some silt, fill, brown, poorly compacted, firm to stiff, near PL
5			G			SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
		10	R	113	12.3		
10			G			CL	SANDY CLAY; some silt, brown, stiff, near PL
		9	N			SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
15		50	R	128	2.2	SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
20		57	G N				
25		43	R	99	16.9	SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp Trace gravel
30							

LOG OF BORING NO. 1 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		48	N			SC	CLAYEY SAND; (Cont'd)
35							
		50	R	115	7.9	SP	GRAVELLY SAND; trace silt and cobbles, light brown, dense to very dense, damp
40						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
		36	N				
45							Stopped @ 41.5 feet
50							
55							
60							

LOG OF BORING NO. 2

Project ACDC Bridge Job No. 2125J066

Elevation 1234.84 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 75 Date 3/19/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
						GP	SANDY GRAVEL; some silt, fill, brown, poorly compacted, loose, damp
						SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
5		8	N			CL	SANDY CLAY; some silt, brown, stiff, near PL
10		28	R	107	18.1		
						SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
15		39	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
20							
		22	R	101	18.0	SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
25		20	N				More sand and gravel
30							

LOG OF BORING NO. 2 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		50/8"	R	*	3.7	SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
35		92	N				
40		50/9"	R	NR			
							Stopped @ 41 feet
45							
50							
55							
60							

LOG OF BORING NO. 3

Project ACDC Bridge Job No. 2125J066

Elevation 1231.28 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME75/CME 45 Date 3/22/85 3/27/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
5		27	R	109	19.2	CL	SANDY CLAY; some silt, brown, stiff, near PL
						SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
10		25	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
15		50/8"	R	122	7.7		
20		36	N			SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
25		44	R	115	12.9		Trace gravel, more clay, light cementation
30							

LOG OF BORING NO. 3 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		48	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
							More gravel
35						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
		50/8"	R	111	16.7		
						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
40							With cobbles
		100/1"	N	NR			
45							
		100/1"	N	NR			
		169	N			SC-GC	CLAYEY SAND AND GRAVEL; some silt, trace cobbles, brown, dense to very dense, damp
50							
55							
							Some cobbles
60							

LOG OF BORING NO. 3 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
61		100/6"	N			SC-GC	CLAYEY SAND AND GRAVEL; (Cont'd)
65							
70							
		100/6"	N			SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
75							
80							
		172/9"	N				
							More clay, trace gravel
85							
							More gravel, trace cobbles
90							

LOG OF BORING NO. 3 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
91						SC	CLAYEY SAND; (Cont'd)
		137	N			CL	SANDY CLAY; brown, hard, -PL
95							
						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
100							
							Stopped @ 100 feet
105							
110							
115							
120							

LOG OF BORING NO. 4

Project ACDC Bridge Job No. 2125J066

Elevation 1232.50 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 45/CME 75 Date 3/27/85 4/22/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
5			G			CL	SANDY CLAY; some silt, brown, stiff, near PL
10		7	N G			SC	CLAYEY SAND; with silt, light brown, loose, damp
15		46	R G	125	4.3	SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp Coarser gravel
		75	N				Trace clay
20		39	R G	98	19.8	SC	CLAYEY SAND; some silt, light brown, light cementation, dense to very dense, damp
25		36	N				More silt, slightly finer sand, slightly lower plasticity
30			G			CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL

LOG OF BORING NO. 4 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		45	R	100	22.1	CL	SANDY CLAY; (Cont'd)
35		40	N			SM	SILTY SAND; some clay, trace gravel, brown, dense to very dense, damp
40		37	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp Some cobbles
45		153	N				Trace clay
50		100/4"	N				Some clay
55							
60							

LOG OF BORING NO. 4 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
61		128	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; (Cont'd)
65							Coarser gravel and cobbles 64-67 feet
70		173	N				
75							
80		156/10"	N			CL	SANDY CLAY; brown, hard, -PL
85							Some gravel
90						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp

LOG OF BORING NO. 4 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
91		100/4"	N			SC	CLAYEY SAND; (Cont'd)
95							
100							
							Stopped @ 100 feet
105							
110							
115							
120							

LOG OF BORING NO. 5 Sta. 583+38

Project ACDC Bridge Job No. 2125J066

Elevation Datum

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/30/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
							3 inches asphaltic concrete on 15 inches of aggregate base
5		25	R	114	13.8	SC	CLAYEY SAND; with silt, trace gravel, fill, brown, moderately compacted, medium dense, damp
10						CL	SANDY CLAY; some silt, brown, stiff, near PL
		20	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
15		38	R	119	2.0		
							More coarse gravel
20		54	N				Trace clay
25		30	R	98	17.8	SC	CLAYEY SAND; some silt, light brown, light cementation, dense to very dense, damp
30						CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL

Sta. 583+38

LOG OF BORING NO. 5 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		44	N			CL	SANDY CLAY; (Cont'd)
35							
		43	R	101	20.4	SM	SILTY SAND; some clay, trace gravel, brown, dense to very dense, damp
40		100/6"	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
45							Stopped @ 41.5 feet
50							
55							
60							

LOG OF BORING NO. 6 Sta. 582+70

Project ACDC Bridge Job No. 2125J066

Elevation _____ Datum _____

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/30/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
							4 inches asphaltic concrete on 12 inches aggregate base
5		6	N			CL	SANDY CLAY; some silt, brown, stiff, near PL
10							Less moisture, coarser sand
		14	R	107	18.2	SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
15		44	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
20		50	R	114	5.6		Trace clay
25		37	N			SC/CL	CLAYEY SAND/SANDY CLAY; some silt, brown, very light cementation, hard, -PL
30						CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL

Sta. 582+70

LOG OF BORING NO. 6 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		35	R	102	20.2	CL	SANDY CLAY; (Cont'd)
35		27	N			SP	GRAVELLY SAND; some silt, brown, medium dense to dense, damp
							More gravel
40		45	R	121	2.6		
45							Stopped @ 41 feet
50							
55							
60							

LOG OF BORING NO. 7

Project ACDC Bridge Job No. 2125J066

Elevation 1235.98 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/30/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
						SC/CL	CLAYEY SAND/SANDY CLAY; some silt, fill, brown, poorly compacted, firm to stiff, near PL
						CL	SANDY CLAY; some silt, brown, stiff, near PL
			G				
5		13	R	104	15.8		
							Trace gravel, slightly less moisture
10		20	N				More sand, very stiff
15		15	R	106	6.7	SP	GRAVELLY SAND; some silt, brown, medium dense to dense, damp
						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
			G				
20		81	N				
							More gravel
25		45	R	102	23.1		With clay, less gravel
						SC	CLAYEY SAND; some silt, light brown, light cementation, dense to very dense, damp
30							

LOG OF BORING NO. 7 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		39	N			SC	CLAYEY SAND; (Cont'd)
35		50/10"	R	118	7.6	SM	SILTY SAND; some clay, trace gravel, brown, dense to very dense, damp
40						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
45							Stopped @ 40 feet
50							
55							
60							

LOG OF BORING NO. 8 Sta. 583+00

Project ACDC Bridge Job No. 2125J066

Elevation Datum

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/31/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
							3 inches asphaltic concrete on 15 inches of aggregate base
5		6	G N			CL	SANDY CLAY; some silt, brown, stiff, near PL Less moisture, -PL
10		31	R G	104	20.3	SC/CL	CLAYEY SAND/SANDY CLAY; some silt, brown, dense to very dense, damp
15		44	N G			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
20		22	R G	100	19.9	CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL
25 30		40	N			SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp

Sta. 583+00

LOG OF BORING NO. 8 CONTINUED

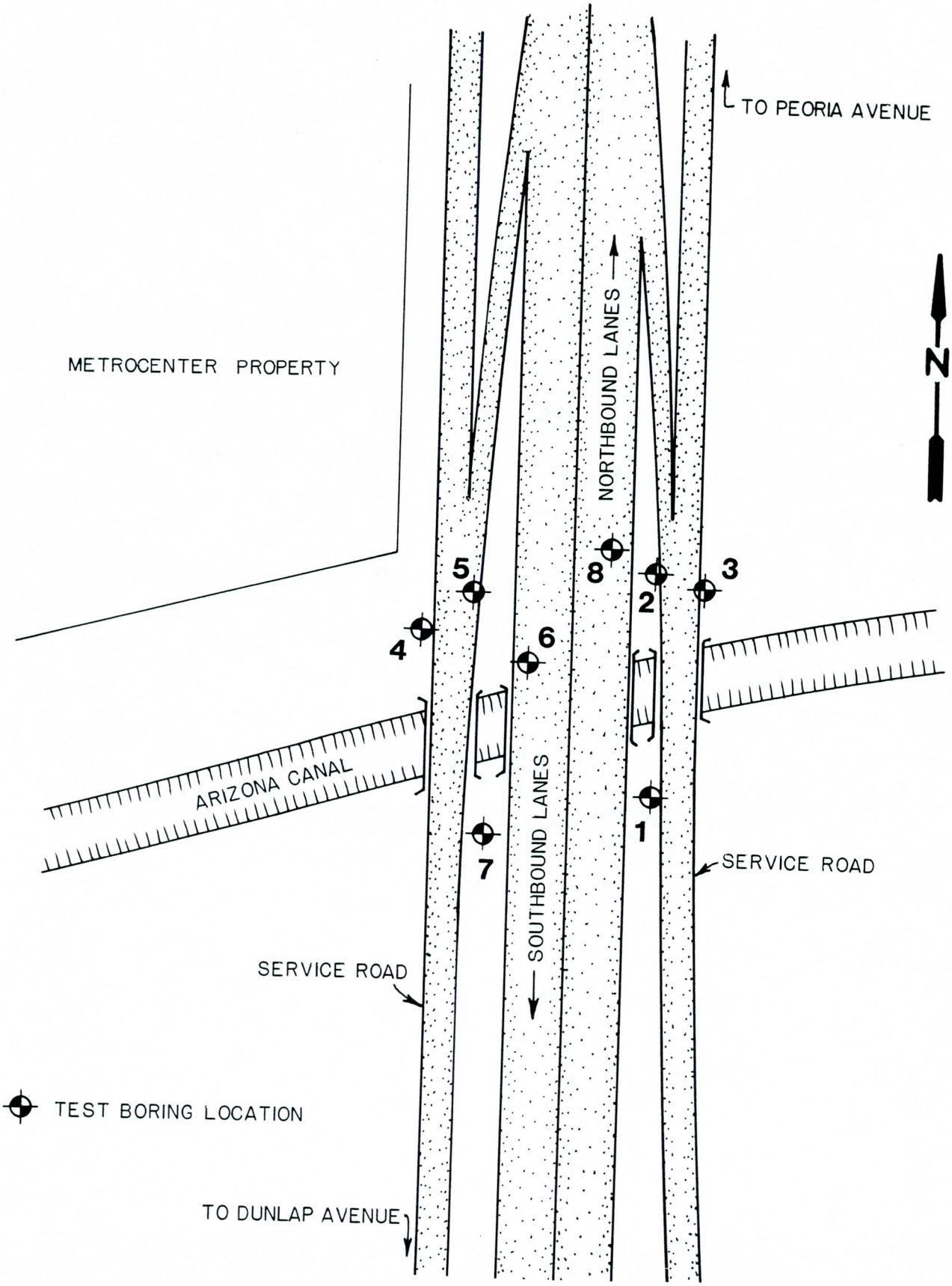
Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		50/9"	R	101	22.5	SC	CLAYEY SAND; (Cont'd)
35						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
		124	N				
40		50/9"	R	105	4.5		
							Stopped @ 41 feet
45							
50							
55							
60							

JOB NO. 2125J066

REFERENCE: AERIAL PHOTO, NOT DATED

Site Plan



Prepared By SDV Date 5/14/85 Checked By Date

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

RGA Consulting Engineers
1102 West Indian School Road
Phoenix, Arizona 85013

July 8, 1985

Attn: Mr. Harold Ditzler

Re: In-Fill Structures
Arizona Canal Diversion Channel Bridge
At Interstate 17
Phoenix, Arizona

Job No. 2125J066
Supplement No. 1

At your request this firm has reviewed the subsurface conditions, laboratory test data and the interim report for the subject project with respect to foundation support of the in-fill structures. We understand that the in-fill structures will:

- Be constructed between the existing frontage road bridges and the existing freeway bridges over the Arizona Canal.
- Match the existing adjacent structures.
- Be supported on foundations founded 2 feet below existing footings.
- Have abutment and pier loads of 6.8 and 9.8 klf, respectively.
- Have a lined channel.

The existing structures are 3-span reinforced concrete structures founded approximately 13 feet below existing highway grade and 4 to 5 feet below existing channel grade.

The soils at foundation level will vary from sandy clays to relatively clean gravelly sands. These soils are medium dense and stiff and will provide good support for relatively lightly loaded shallow footings.

Foundations: We recommend spread foundations bearing upon undisturbed subsoils for support of the in-fill structures. The footings should be founded at least 2 feet below the existing footing and should be designed using a bearing capacity of 3500 psf. Total or differential settlements resulting from the assumed loads are estimated to be less than 1/2 inch.

The design bearing capacity applies to dead plus design live load conditions. The design bearing capacity may be increased by one-third when considering total loads that include wind or seismic. Recommended minimum width of footings is 24 inches.

The lateral earth pressures presented in the interim report may be used in design.

This supplement should be attached to and made a part of the original report.

If you have any questions concerning this information, or if we may be of any additional service, please call us.

Sincerely,

WESTERN TECHNOLOGIES INC.
Geotechnical Services

Registered Professional Engineer
CERTIFICATE NO.
10971
KENNETH L.
RICKER
Date Signed
ARIZONA, U.S.A.

Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (1)
RGA Tucson (5)

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
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Phoenix, Arizona 85036
(602) 437-3737

RGA Consulting Engineers
1102 West Indian School Road
Phoenix, Arizona 85013

August 1, 1985

Attn: Mr. Harold Ditzler

Re: In-Fill Structures
Arizona Canal Diversion Channel Bridge
At Interstate 17
Phoenix, Arizona

Job No. 2125J066
Supplement No. 2

At your request, this firm has reviewed Supplement No. 1 and the available data for this project with respect to toe pressures on the continuous footings of the in-fill structure. We understand that toe pressures will be on the order of 4200 psf.

Based on our review, the design bearing capacity may be increased by one-third for toe pressure provided the resultant of the forces acts in the center one-third of the footing.

This supplement should be attached to and made a part of the original report.

If you have any questions concerning this information, or if we may be of any additional service, please call us.

Sincerely,

WESTERN TECHNOLOGIES INC.
Geotechnical Services

Registered Professional Engineer (Civil) CERTIFICATE NO. 10971 KENNETH L. RICKER Date Signed ARIZONA, U.S.A.

Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (1)
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WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

RGA Consulting Engineers
1102 West Indian School Road
Phoenix, Arizona 85013

August 14, 1985

Attn: Mr. Harold Ditzler

Re: Arizona Canal Diversion Channel Bridge
At Interstate 17
Phoenix, Arizona

Job No. 2125J066
Supplement No. 3

At your request, this firm has reviewed the interim report for the subject project dated May 15, 1985 with respect to shoring requirements between drilled piers. It is our understanding that the drilled piers will be 2 feet in diameter and will be spaced 5 feet on center. The channel will be 29 feet deep. The channel excavation will encounter clayey sands and sandy clays underlain by dense to very dense gravelly sand/sandy gravels underlain by dense clayey sands.

Based on our review, it is our opinion that the soils will bridge between drilled piers. However, some sloughing or raveling of relatively clean and dry granular soils may occur. This sloughing or raveling may be controlled by the installation of lagging or by guniting the exposed surface shortly after excavation.

This supplement should be attached to and made a part of the original report.

If you have any questions concerning this information, or if we may be of any additional service, please call us.

Sincerely,

WESTERN TECHNOLOGIES INC.
Geotechnical Services

Registered Professional Engineer
10971
KENNETH L. RICKER
Date Signed
ARIZONA, U.S.A.

Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (1)
RGA (Tucson) (5)

Interim Report
Arizona Canal Diversion
Channel Bridges
at Interstate 17
Phoenix, Arizona
for
RGA Consulting Engineers
Job No. 2125J066

WESTERN TECHNOLOGIES INC.

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WESTERN TECHNOLOGIES INC.

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Phoenix, Arizona 85036
(602) 437-3737

RGA Consulting Engineers
1102 West Indian School Road
Phoenix, Arizona 85013

May 15, 1985

Attn: Mr. Harold Ditzler

Re: Interim Report
Arizona Canal Diversion Channel Bridges
at Interstate 17
Phoenix, Arizona

Job No. 2125J066

Our interim geotechnical report for the above project is attached. The work was performed according to our proposal of November 15, 1984. The scope of the field work was modified as the result of discussions with Mr. Dick Bruce of ADOT. The modified scope included drilling 2 borings to a depth of 100 feet and 6 borings to a depth of 40 feet.

Soils at the site consisted of firm to stiff sandy clays and clayey sands underlain by dense to very dense clayey sands, gravelly sands, sandy gravels, clayey sandy gravels and sandy clays. We recommend that the facility be founded on either spread footings, drilled piers, or driven piles.

The interim report completes Western Technologies Inc.'s current services for the preliminary design phase. The final report will be prepared following finalization of the structural system to be used.

Sincerely,

WESTERN TECHNOLOGIES INC.
Geotechnical Services

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10971
KENNETH L.
RICKER
Date Signed
ARIZONA, U.S.A.

Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (1)
RGA (Tucson) (5)

RGA Consulting Engineers
Job No. 2125J066

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RGA Consulting Engineers
Job No. 2125J066

Geotechnical Investigation
Interim Report
Arizona Canal Diversion Channel Bridges
at Interstate 17
Phoenix, Arizona
May 15, 1985

INTRODUCTION

This report contains the results of our geotechnical investigation for the proposed bridges over the Arizona Canal Diversion Canal to be located along Interstate-17 in Phoenix, Arizona. The bridges will be located along the existing I-17 right-of-way just north of the Arizona Canal. The purpose of these services is to provide information and recommendations relative to foundation design, lateral earth pressures, and approach fill grading.

PROPOSED CONSTRUCTION

The proposed project will include a bridge on the east frontage road, the west frontage road, and the north and south bound freeway. The bridges will be either one or two spans with a total bridge length of 110 feet. The clear height under the bridges will be at least 21 feet. The channel under the bridge will be concrete lined and rectangular in shape. The bridges will be either supported by shallow footings or deep foundations. If shallow footings are used, foundation loads will be on the order of 26 klf. If deep foundations are used, foundations founded at five foot centers will have loads of 105 to 185 kips.

SITE CONDITIONS

At the time of our exploration, the site was occupied by the existing freeway and adjoining frontage roads. The area contained some landscape materials and underground and overhead utilities.

SCOPE OF SERVICES

Eight borings were drilled to depths of 41 to 100 feet at the locations shown on the site plan. During exploration, subsoils were examined visually and sampled at selected intervals.

The following tests were performed on selected soil samples:

- Water content
- Dry density
- Consolidation
- Expansion
- Shear strength
- Gradation
- Plasticity
- R-Value

Test results were used in the development of foundation and earthwork recommendations.

INTERPRETATION OF SUBSURFACE CONDITIONS

Exploration: As presented on Logs of Borings, surface and subsoils to the full depth of exploration were found to be alluvial soils consisting of interbedded deposits of sandy clay, clayey sand, sandy gravel, gravelly sand, clayey sand and gravel, and silty sand. In Borings 1, 2, and 7 the upper 2 to 3 feet of the material is fill. In Borings 5, 6, and 8 these soils are overlain by 3 to 4 inches of asphalt concrete and 12 to 15 inches of aggregate base material. The soils to depths of 9 to 16 feet are medium dense (firm to stiff). Below these depths the soils are dense to very dense (very stiff to hard) except at Boring 2. In Boring 2, the soil becomes denser below a depth of 30 feet. A groundwater table was not encountered in any boring at the time of exploration.

Testing: Laboratory test results indicate that native subsoils at shallow foundation level are slightly to moderately compressible at existing water contents. Slight additional compression occurs when the water content is increased. When water is added to compacted near-surface clay soils, moderate expansion occurs. The soils at shallow foundation level have moderate shear strengths.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

General: The recommendations presented in this report are based on the preliminary design concepts and on the assumption that the soil conditions do not deviate appreciably from those disclosed by the borings. The final report will be prepared upon completion of preliminary designs.

Foundations: Because of variations in the nature of bearing soils, foundation bearing levels, and structural load grades, we considered the following foundation systems:

- shallow foundations on undisturbed subsoils
- deep foundations consisting of drilled piers founded on undisturbed subsoils
- deep foundations consisting of driven piles founded in the undisturbed subsoils

- Shallow Foundations: We recommend spread foundations bearing upon undisturbed subsoils, below the bottom of the proposed channel for the anticipated loading conditions.

  Footing depth and design bearing capacity are presented in the following tabulation:

Footing Depth Below Finished Grade (ft)	Design Bearing Capacity (psf)*
2.0	8000

*Design bearing capacities assume fulfillment of "Earthwork" recommendations.

Total or differential settlements resulting from the assumed loads are estimated to be less than 1-3/8 inches provided that:

- Foundations are constructed as we recommend, and
- Essentially no changes occur in water contents of foundation soils.

Additional foundation movements of up to 1/4 inch could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction.

Finished grade is the lowest adjacent channel grade for abutment and pier footings. The design bearing capacity applies to dead loads plus design live load conditions. The design bearing capacity may be increased by one-third when considering total loads that include wind or seismic. Recommended minimum width of footings is 24 inches.

Foundation excavations into undisturbed soils should be inspected by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

- Deep Foundations - Drilled Piers: We recommend a drilled pier foundation system. The following capacities should be used in design for straight, shaft, machine-cleaned, 2-foot diameter piers:

Depth* (ft)	Total Capacity (kips)
10	109
16	165
17	185

*Depth measured from bottom of channel

Bearing capacity may be increased one-third when considering total loads including wind and seismic.

Estimated settlements for drilled piers are 1/2 inch or less for maximum loads.

Drilling to design depths should be possible with conventional rotary or bucket augers. Shafts will probably remain open without stabilizing measures. However, caving and sloughing should be anticipated in the relatively clean granular soils. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

The bearing surface must be machine cleaned prior to concrete placement. A representative of the geotechnical engineer should inspect the bearing surface and pier configuration without entering the drilled element.

- Deep Foundations - Driven Pile: We recommend low displacement H-piles driven into the alluvial soil. At present only one H-pile section has been considered because of anticipated lateral loads on the pile section. An allowable end bearing capacity for an HP 14 x 89 of 40 tons may be used in design.

The recommended minimum center to center spacing on the driven H-piles is three pile diameters in order to develop full capacity of each pile in the group. The settlement of pile groups, with the individual piles being loaded to the full design load, is expected to be on the order of 1/4 to 1/2 inch. This settlement should take place soon following load application.

Lateral Earth Pressures: For soils above any free water surface, recommended equivalent fluid pressures and coefficients of base friction for unrestrained elements for use in preliminary design are:

- Active:
  - Undisturbed subsoil ---------- 35 psf/ft
  - Compacted granular backfill ---------- 30 psf/ft
- Passive:
  - Shallow wall footings ---------- 350 psf/ft
  - Drilled Piers ---------- 500 psf/ft
- Coefficient of base friction ---------- 0.40*

*The coefficient of base friction should be reduced to 0.30 when used in conjunction with passive pressure.

Where the design includes restrained elements, the following equivalent fluid pressures are recommended:

- At-rest:
  - Undisturbed subsoil ---------- 60 psf/ft
  - Compacted granular backfill ---------- 55 psf/ft

The lateral earth pressures herein are not applicable for submerged soils. We should be consulted for additional recommendations if such conditions are to be included in the design. Once the design concept has been finalized, additional evaluations of the soil response to various lateral load conditions will be accomplished.

Fill against footings, stem walls, abutment walls, and retaining walls should be compacted to densities specified in "Earthwork." Medium to high plasticity clay soils should not be used as backfill against retaining walls. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other light-weight compactors. Overcompaction may cause excessive lateral earth pressures which could result in wall movements.

Earthwork:

- General:

  1. The conclusions contained in this report for the proposed construction are contingent upon compliance with recommendations presented in this section.

- Excavation:

  1. We anticipate that excavations for the proposed construction can be accomplished with conventional equipment.

- Foundation Preparation:

  1. Specialized treatment of existing soils within foundation areas is not required.

- Materials:

  1. On-site soils may be used as backfill against abutments or retaining walls.

  2. Imported soils should conform to the following:

- Gradation (ASTM C136): percent finer by weight

6"	100
4"	70-100
No. 4 Sieve	50-100
No. 200 Sieve	60 (max)

- Maximum expansive potential(%)* 1.5

- Maximum soluble sulfates(%) 0.10

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

3. Aggregate base should conform to ADOT specifications.

- Placement and Compaction:

1. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended water contents and densities throughout the lift.

2. Uncompacted fill lifts should not exceed 6 inches.

3. Materials should be compacted to the following:

Material	Minimum Percent Compaction (ASTM D698)
On-site soils:	
Below pavement	95
Against subsurface walls	95
Imported fill:	
Below pavement	95
Against subsurface walls	95
Aggregate base	95
Miscellaneous backfill	90

4. On-site clay soils should be compacted within a water content range of 1 percent below to 4 percent above optimum. Imported soils should be compacted within a moisture range of 3 percent below to 3 percent above optimum.

- Compliance:

1. Recommendations for backfill and pavement elements supported on compacted fills or prepared subgrade depend upon compliance with "Earthwork" recommendations. To assess compliance, observation and testing should be performed under the direction of a geotechnical engineer.

CLOSURE

Our conclusions and recommendations are based on preliminary design concepts. Additional recommendation will be present in a final report upon selection of final design alternates.

DEFINITION OF TERMINOLOGY

ALLOWABLE SOIL BEARING CAPACITY ALLOWABLE FOUNDATION PRESSURE	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 observation 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 the absorption of moisture.
FILL	Materials deposited by the action 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 AND 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.

METHOD OF SOIL CLASSIFICATION
(ASTM D 2487)

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, etc.)

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 SILTY-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

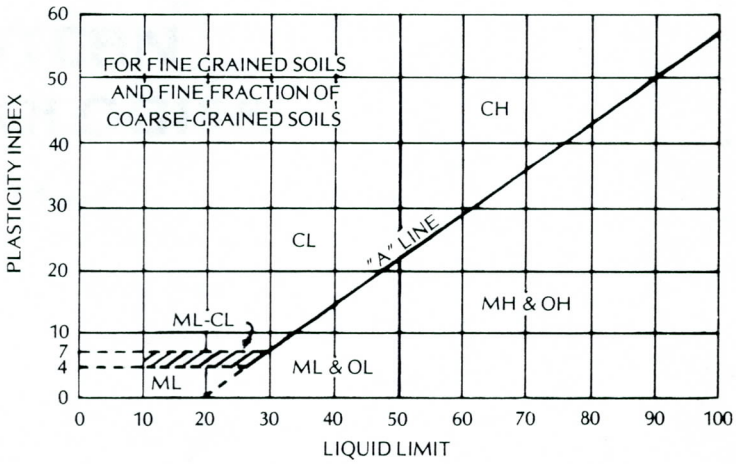
NOTE:
Fine grained soils receive dual symbols if their limits plot in the hatched zone on the Plasticity Chart (ML-CL)

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	ABOVE 12 in.
COBBLES	3 in. to 12 in.
GRAVEL	No. 4 to 3 in.
Coarse	¾ in. to 3 in.
Fine	No. 4 to ¾ in.
SAND	No. 200 to No. 4
Coarse	No. 10 to No. 4
Medium	No. 40 to No. 10
Fine	No. 200 to No. 40
*FINES (Silt or Clay)	BELOW No. 200

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

PLASTICITY CHART



SOIL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression					Water Soluble Matter, %		Shear Strength					Consolidation		
			Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Salts	Sulfates	Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	Ø Deg.	Initial Void Ratio	Surcharge KSF	Consol. %
1	3 - 5	SC	112.1 (1)	11.1 (4)	0.1	+2.8 (5)											
1	5 - 6	SC								UC	12.3	112.9	1.085				
1	25 - 26	SC	98.8 (1)	16.9 (4)	0.56	-0.50											
1	25 - 26	SC	98.8 (1)	16.9 (4)	1.10	-1.04											
1	25 - 26	SC	98.8 (1)	16.9 (4)	2.22	-1.52											
1	25 - 26	SC	98.8 (1)	16.9 (4)	4.42	-2.31											
1	25 - 26	SC	98.8 (1)	16.9 (4)	8.84	-3.27											
1	25 - 26	SC	98.8 (1)	16.9 (4)	17.70	-4.78											
1	25 - 26	SC	98.8 (1)	16.9 (4)	35.40	-9.32											
1	25 - 26	SC	98.8 (1)	16.9 (4)	35.40 (5)	-9.32											

Boring No.	Depth, ft.	Remarks

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
- UU Unconsolidated Undrained
- CU Consolidated Undrained w/pore press
- CU Consolidated Undrained
- CD Consolidated Drained
- CR Cyclic Consolidated Undrained w/pore press

REMARKS

1. In-situ density.
2. Compacted density (Approx. 95% of ASTM:D698 max. density at moisture content slightly below optimum).
3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

SOIL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression: Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Water Soluble Matter, %: Salts	Sulfates	Shear Strength: Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	∅ Deg.	Consolidation: Initial Void Ratio	Surcharge KSF	Consol. %
3	35 - 36	SC								DS	16.7 (4)	110.7 (1)	1.7	40			
5	25 - 26	SC								DS	17.8 (4)	98.4 (1)	1.8	40			
6	30 - 31	CL	101.9 (1)	20.2 (4)	0.56	-0.62											
6	30 - 31	CL	101.9 (1)	20.2 (4)	1.10	-1.17											
6	30 - 31	CL	101.9 (1)	20.2 (4)	2.20	-1.92											
6	30 - 31	CL	101.9 (1)	20.2 (4)	4.42	-2.96											
6	30 - 31	CL	101.9 (1)	20.2 (4)	8.84	-4.58											
6	30 - 31	CL	101.9 (1)	20.2 (4)	17.70	-7.12											
6	30 - 31	CL	101.9 (1)	20.2 (4)	35.40	-11.21											
6	30 - 31	CL	101.9 (1)	20.2 (4)	35.40 (5)	-11.21											

Boring No.	Depth, ft.	Remarks

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
- UU Unconsolidated Undrained
- CU Consolidated Undrained w/pore press
- CU Consolidated Undrained
- CD Consolidated Drained
- CR Cyclic Consolidated Undrained w/pore press

REMARKS

1. In-situ density.
2. Compacted density (Approx. 95% of ASTM:D698 max. density at moisture content slightly below optimum).
3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

SOIL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression					Water Soluble Matter, %		Shear Strength					Consolidation		
			Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Salts	Sulfates	Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	∅ Deg.	Initial Void Ratio	Surcharge KSF	Consol. %
7	2 - 5	CL	118.6 (2)	16.2	0.1	+3.8 (5)											
8	30 - 31	SC								DS	22.5 (4)	100.9 (1)	2.0	42			

Boring No.	Depth, ft.	Remarks

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
- UU Unconsolidated Undrained
- CU Consolidated Undrained w/pore press
- CU Consolidated Undrained
- CD Consolidated Drained
- CR Cyclic Consolidated Undrained w/pore press

REMARKS

1. In-situ density.
2. Compacted density (Approx. 95% of ASTM:D698 max. density at moisture content slightly below optimum).
3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

PHYSICAL PROPERTIES

Job No. 2125J066

Boring No.	Depth, ft.	Soil Class.	Particle Size Distribution, % Passing by wt.					Atterberg Limits		Moisture - Density Rel.			Specific Gravity	Permeability		'R' Value	Remarks
			3"	#4	#10	#40	#200	LL	PI	Dry Density pcf	Optimum Moisture %	Meth.		Dry Density pcf	K Cm/Sec	Corrected 'R'	
1	0 - 3	SC/CL														20	12
1	3 - 5	SC					45	25	8								3
7	2 - 5	CL					74	38	18								3

Boring No.	Depth, ft.	Comments

REMARKS

Classification/Particle Size
1. Visual
2. Laboratory Tested
3. Minus #200 Only

Moisture Density Relationship
4. Tested ASTM D-689/AASHTO T-99
5. Tested ASTM D-1557/AASHTO T-180
6. Other_____

Specific Gravity
7. Minus #4
8. Plus #4

Permeability
9. Constant Head
10. Falling Head

'R' Value
11. Expansion Pressure_____psf
12. Exudation Pressure 300 psi

Note: NP = nonplastic

BORING LOG NOTES

The number shown in "LOG OF BORING NO." refers to the approximate location of the same number indicated on the "Site Plan" 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.

"N" in "Blows/Foot" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a two-inch-outside-diameter split-barrel sampler a distance of 1 foot, Standard Penetration Test (ASTM D1586). Refusal to penetration is defined as more than 100 blows per foot.

"R" in "Blows/Foot" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a 2.42-inch-inside-diameter ring sampler a distance of 1 foot. Refusal to penetration is considered more than 50 blows per foot.

"Sample Type" refers to the form of sample recovery, in which N = Split-barrel sample, R = Ring sample, and G = Grab sample.

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

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

"Unified Class" 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 date(s) noted. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

In general, terms and symbols on the boring logs conform with "Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics" (ASTM D653).

LOG OF BORING NO. 1

Project ACDC Bridge Job No. 2125J066

Elevation 1234.46 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 75 Date 3/19/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
			G			SC/CL	CLAYEY SAND/SANDY CLAY; some silt, fill, brown, poorly compacted, firm to stiff, near PL
5			G			SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
		10	R	113	12.3		
			G			CL	SANDY CLAY; some silt, brown, stiff, near PL
10							
		9	N			SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
15						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
		50	R	128	2.2		
			G				
20		57	N				
25						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
		43	R	99	16.9		
30							Trace gravel

LOG OF BORING NO. 1 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		48	N			SC	CLAYEY SAND; (Cont'd)
35							
		50	R	115	7.9	SP	GRAVELLY SAND; trace silt and cobbles, light brown, dense to very dense, damp
40						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
		36	N				
45							Stopped @ 41.5 feet
50							
55							
60							

LOG OF BORING NO. 2

Project ACDC Bridge Job No. 2125J066

Elevation 1234.84 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 75 Date 3/19/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
						GP	SANDY GRAVEL; some silt, fill, brown, poorly compacted, loose, damp
						SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
5		8	N			CL	SANDY CLAY; some silt, brown, stiff, near PL
10		28	R	107	18.1		
						SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
15		39	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
20		22	R	101	18.0	SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
25		20	N				More sand and gravel
30							

LOG OF BORING NO. 2 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		50/8"	R	*	3.7	SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
35		92	N				
40		50/9"	R	NR			
							Stopped @ 41 feet
45							
50							
55							
60							

LOG OF BORING NO. 3

Project ACDC Bridge Job No. 2125J066

Elevation 1231.28 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME75/CME 45 Date 3/22/85 3/27/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
5		27	R	109	19.2	CL	SANDY CLAY; some silt, brown, stiff, near PL
						SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
10		25	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
15		50/8"	R	122	7.7		
20		36	N			SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
25		44	R	115	12.9		Trace gravel, more clay, light cementation
30							

LOG OF BORING NO. 3 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		48	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp More gravel
35		50/8"	R	111	16.7	SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
40		100/1"	N	NR		SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp With cobbles
45		100/1"	N	NR			
50		169	N			SC-GC	CLAYEY SAND AND GRAVEL; some silt, trace cobbles, brown, dense to very dense, damp
55							Some cobbles
60							

LOG OF BORING NO. 3 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
61		100/6"	N			SC-GC	CLAYEY SAND AND GRAVEL; (Cont'd)
65							
70							
		100/6"	N			SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
75							
80							
		172/9"	N				
							More clay, trace gravel
85							
							More gravel, trace cobbles
90							

LOG OF BORING NO. 3 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
91						SC	CLAYEY SAND; (Cont'd)
		137	N			CL	SANDY CLAY; brown, hard, -PL
95							
						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp
100							
							Stopped @ 100 feet
105							
110							
115							
120							

LOG OF BORING NO. 4

Project ACDC Bridge Job No. 2125J066

Elevation 1232.50 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 45/CME 75 Date 3/27/85 4/22/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
5			G			CL	SANDY CLAY; some silt, brown, stiff, near PL
10		7	N G			SC	CLAYEY SAND; with silt, light brown, loose, damp
15		46 75	R G N	125	4.3	SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp Coarser gravel Trace clay
20 25		39 36	R G N	98	19.8	SC	CLAYEY SAND; some silt, light brown, light cementation, dense to very dense, damp More silt, slightly finer sand, slightly lower plasticity
30			G			CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL

LOG OF BORING NO. 4 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		45	R	100	22.1	CL	SANDY CLAY; (Cont'd)
35		40	N			SM	SILTY SAND; some clay, trace gravel, brown, dense to very dense, damp
40		37	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp Some cobbles
45		153	N				Trace clay
50		100/4"	N				Some clay
55							
60							

LOG OF BORING NO. 4 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
61		128	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; (Cont'd)
65							Coarser gravel and cobbles 64-67 feet
70		173	N				
75							
80		156/10"	N			CL	SANDY CLAY; brown, hard, -PL
85							Some gravel
90						SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp

LOG OF BORING NO. 4 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
91		100/4"	N			SC	CLAYEY SAND; (Cont'd)
95							
100							
							Stopped @ 100 feet
105							
110							
115							
120							

LOG OF BORING NO. 5 Sta. 583+38

Project ACDC Bridge Job No. 2125J066

Elevation Datum

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/30/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
							3 inches asphaltic concrete on 15 inches of aggregate base
5		25	R	114	13.8	SC	CLAYEY SAND; with silt, trace gravel, fill, brown, moderately compacted, medium dense, damp
10						CL	SANDY CLAY; some silt, brown, stiff, near PL
15		20	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
		38	R	119	2.0		
							More coarse gravel
20		54	N				Trace clay
25		30	R	98	17.8	SC	CLAYEY SAND; some silt, light brown, light cementation, dense to very dense, damp
30						CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL

Sta. 583+38

LOG OF BORING NO. 5 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		44	N			CL	SANDY CLAY; (Cont'd)
35							
		43	R	101	20.4	SM	SILTY SAND; some clay, trace gravel, brown, dense to very dense, damp
40		100/6"	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
45							Stopped @ 41.5 feet
50							
55							
60							

LOG OF BORING NO. 6 Sta. 582+70

Project ACDC Bridge Job No. 2125J066

Elevation _____ Datum _____

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/30/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
							4 inches asphaltic concrete on 12 inches aggregate base
5		6	N			CL	SANDY CLAY; some silt, brown, stiff, near PL
10							Less moisture, coarser sand
		14	R	107	18.2	SC	CLAYEY SAND; with silt, trace gravel, brown, medium dense, damp
15		44	N			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
20		50	R	114	5.6		Trace clay
25		37	N			SC/CL	CLAYEY SAND/SANDY CLAY; some silt, brown, very light cementation, hard, -PL
30						CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL

Sta. 582+70

LOG OF BORING NO. 6 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		35	R	102	20.2	CL	SANDY CLAY; (Cont'd)
35						SP	GRAVELLY SAND; some silt, brown, medium dense to dense, damp
		27	N				
							More gravel
40							
		45	R	121	2.6		
							Stopped @ 41 feet
45							
50							
55							
60							

LOG OF BORING NO. 7

Project ACDC Bridge Job No. 2125J066

Elevation 1235.98 Datum N.G.S.

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/30/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
						SC/CL	CLAYEY SAND/SANDY CLAY; some silt, fill, brown, poorly compacted, firm to stiff, near PL
						CL	SANDY CLAY; some silt, brown, stiff, near PL
			G				
5		13	R	104	15.8		
							Trace gravel, slightly less moisture
10		20	N				More sand, very stiff
15		15	R	106	6.7	SP	GRAVELLY SAND; some silt, brown, medium dense to dense, damp
						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
			G				
20		81	N				
							More gravel
25		45	R	102	23.1		With clay, less gravel
						SC	CLAYEY SAND; some silt, light brown, light cementation, dense to very dense, damp
30							

LOG OF BORING NO. 7 CONTINUED

Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		39	N			SC	CLAYEY SAND; (Cont'd)
35		50/10"	R	118	7.6	SM	SILTY SAND; some clay, trace gravel, brown, dense to very dense, damp
40						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
45							Stopped @ 40 feet
50							
55							
60							

LOG OF BORING NO. 8 Sta. 583+00

Project ACDC Bridge Job No. 2125J066

Elevation _____ Datum _____

Type/Size Boring 7" HSA Rig Type CME 45 Date 3/31/85

Groundwater Conditions No Groundwater Encountered

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
							3 inches asphaltic concrete on 15 inches of aggregate base
5		6	G N			CL	SANDY CLAY; some silt, brown, stiff, near PL Less moisture, -PL
10		31	R G	104	20.3	SC/CL	CLAYEY SAND/SANDY CLAY; some silt, brown, dense to very dense, damp
15		44	N G			SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
20		22	R G	100	19.9	CL	SANDY CLAY; some silt, brown, very stiff to hard, -PL
25 30		40	N			SC	CLAYEY SAND; with silt and gravel, brown, dense to very dense, damp

Sta. 583+00

LOG OF BORING NO. 8 CONTINUED

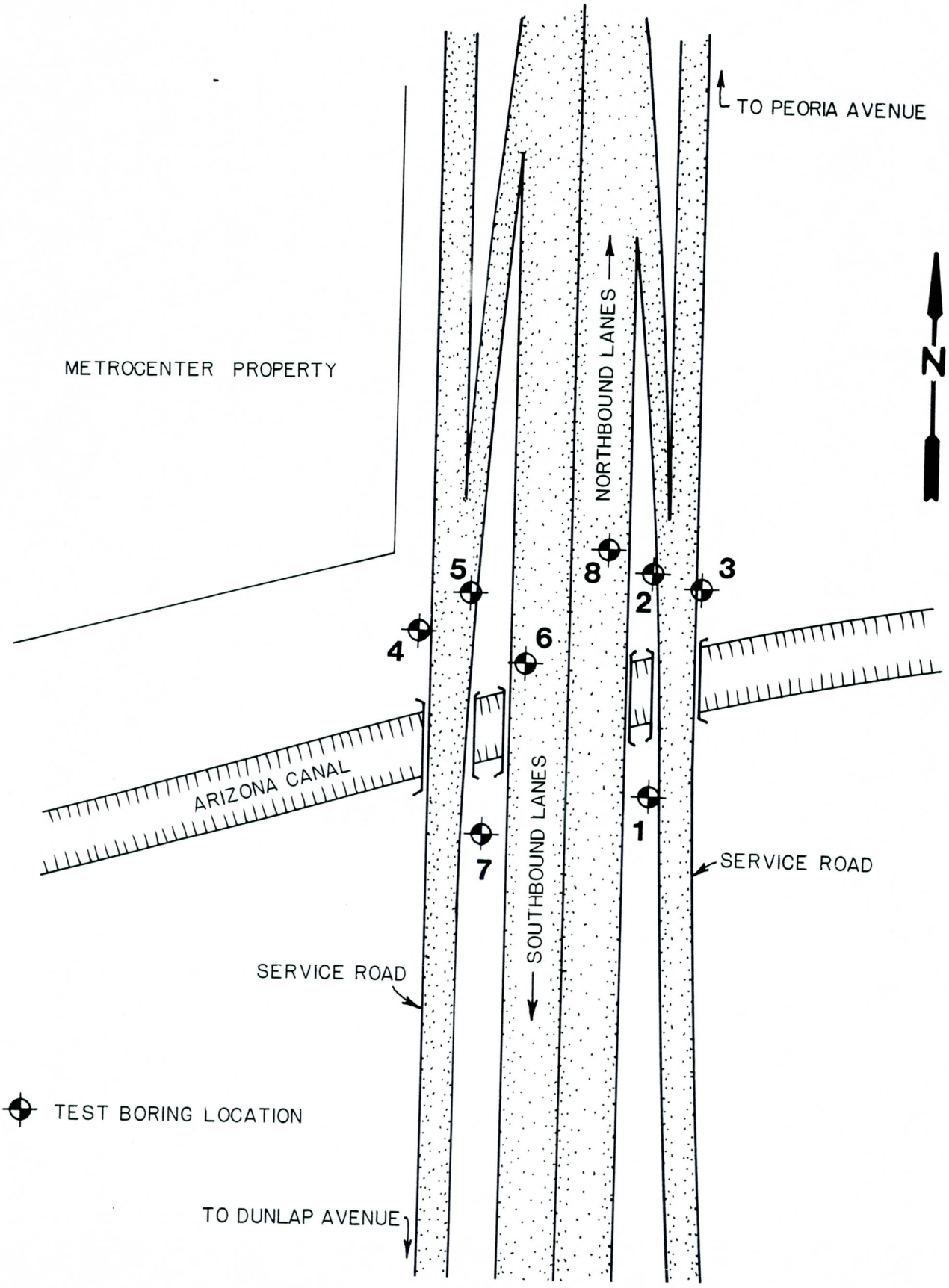
Project ACDC Bridge Job No. 2125J066

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		50/9"	R	101	22.5	SC	CLAYEY SAND; (Cont'd)
35						SP/GP	GRAVELLY SAND/SANDY GRAVEL; some silt, brown, dense to very dense, damp
		124	N				
40		50/9"	R	105	4.5		
45							Stopped @ 41 feet
50							
55							
60							

JOB NO. 2125J066

REFERENCE: AERIAL PHOTO, NOT DATED

Site Plan



Prepared By SDV Date 5/14/85 Checked By Date

WESTERN TECHNOLOGIES INC.
3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

MATERIALS DESIGN MEMORANDUM

October 3, 1985

PROJECT
PHOENIX - CORDES JUNCTION HIGHWAY
ARIZONA CANAL DIVERSION CHANNEL
I-17-3-912
STRUCTURES AND DETOURS

MEMORANDUM NO. 85-66LGR
Job No. 2125J066

MEMORANDUM TYPE:
FINAL

SECTION I - PAVEMENT STRUCTURE

ITEM 1 - Structural Design

Location	Thicknesses, in. AC(3/4)	AB	Total
Interstate Highway SB: 574+44.68 to 590+01.07 NB: 571+00.00 t 588+83.10	6	7	13
Frontage Roads SB: 575+86.28 to 588+33.88 NB: 576+03.02 to 586+29.31	4	6	10

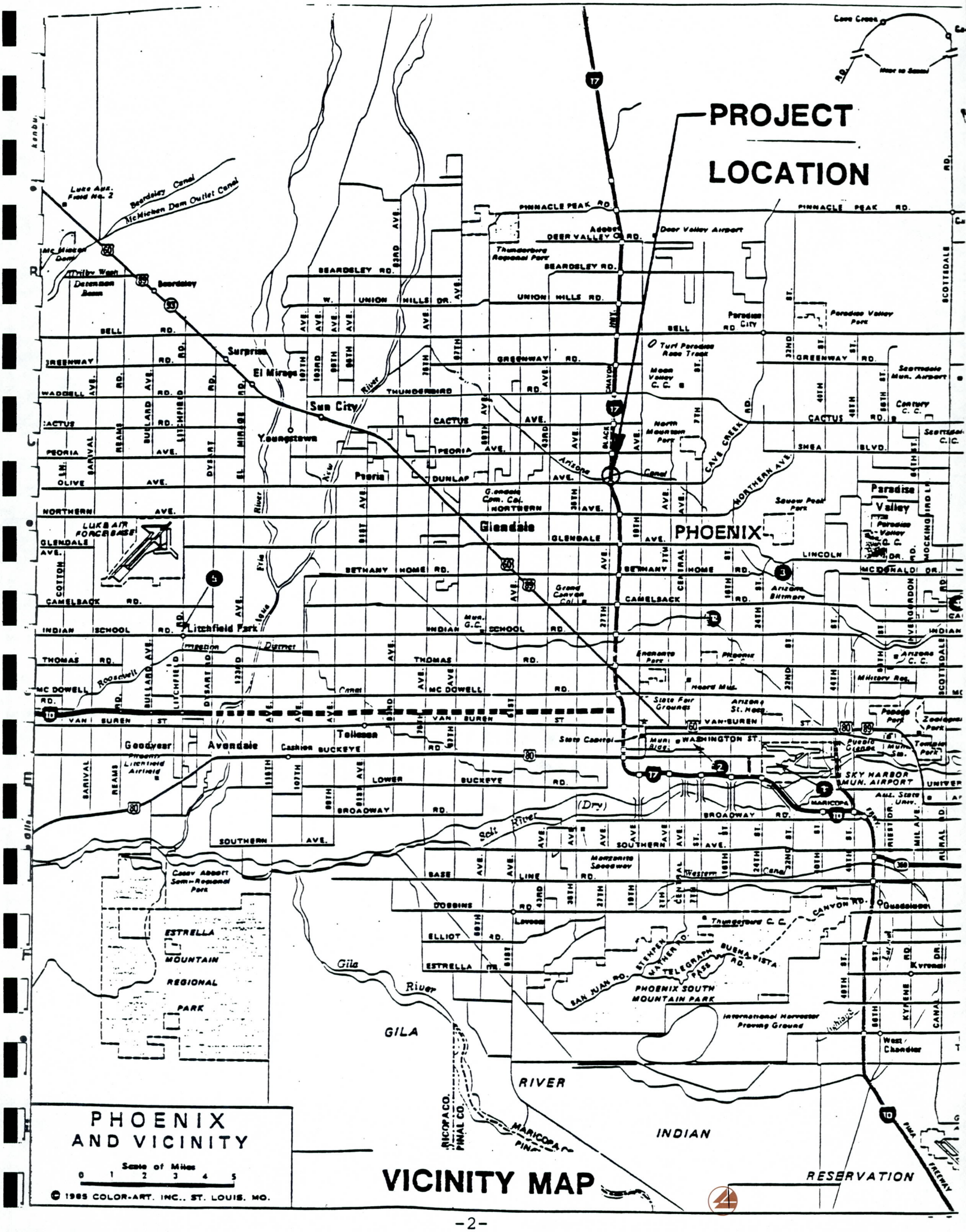
SECTION II - SUBGRADE AND BASE

ITEM 1 - Subgrade Construction Control

The attached Design Soil Support Chart should be used during construction for determining whether subgrade materials are suitable as outlined in Section 203.06 of the ADOT Construction Manual.

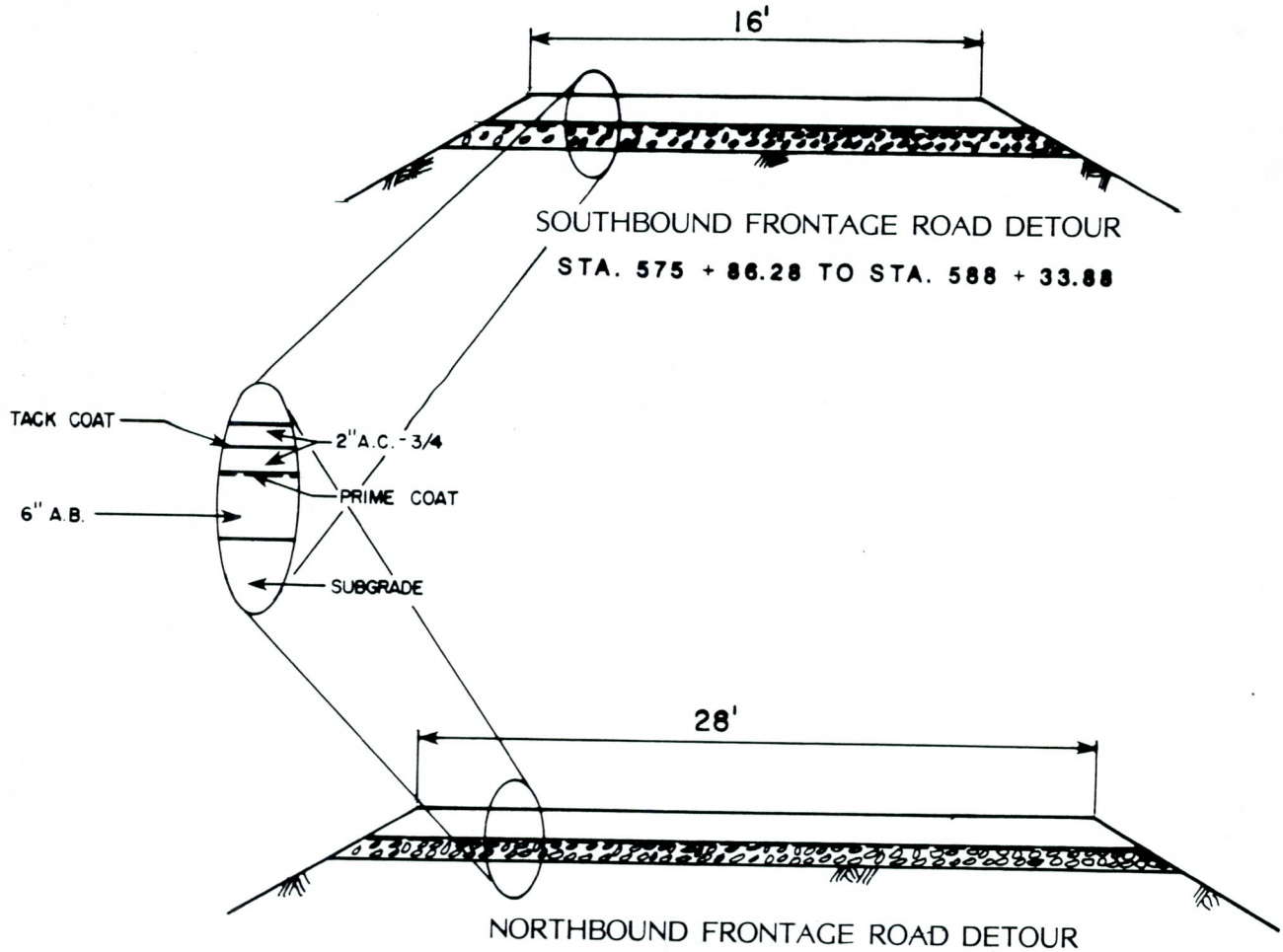
ITEM 2 - Aggregate Base

Aggregate base should be Class 2. The estimated compacted weight is 140 pounds per cubic foot. This weight does not compensate for


PROJECT LOCATION
PHOENIX AND VICINITY
Scale of Miles
0 1 2 3 4 5
© 1985 COLOR-ART, INC., ST. LOUIS, MO.
VICINITY MAP
PHOENIX
Glendale
Peoria
Sun City
Surprise
El Mirage
Youngstown
Litchfield Park
Tolleson
Goodyear
Avondale
Cashion
Paradise Valley
Scottsdale
Cave Creek
Beardsley Canal
McMicken Dam Outlet Canal
Luke Ave. Field No. 2
McMicken Dam
Trilby Wash Detention Basin
Beardsley
Luke Air Force Base
Thunderbird Regional Park
Deer Valley Airport
Turf Paradise Race Track
Moon Valley C.C.
North Mountain Park
Sevow Park
Paradise Valley Park
Scottsdale Mun. Airport
Century C.C.
Arizona Biltmore
Grand Canyon College
Encanto Park
Phoenix Mus.
Military Res.
State Fair Grounds
Arizona St. Hosp.
State Capitol
Mun. Bldg.
Pueblo Grande
Mun. Sta.
Pueblo Park
Zoological Park
Temple Park
SKY HARBOR MUN. AIRPORT
Ariz. State Univ.
Phoenix-Litchfield Airfield
Casey Abbott Sem-Regional Park
ESTRELLA MOUNTAIN REGIONAL PARK
Gila River
GILA RIVER INDIAN RESERVATION
Salt River
Arizona Canal
Western Canal
Maricopa Speedway
Thunderbird C.C.
PHOENIX SOUTH MOUNTAIN PARK
International Harvester Proving Ground
West Chandler
Guadalupe
Laveen
MARICOPA CO.
PINAL CO.
PIMA FREEWAY

TYPICAL CROSS - SECTIONS

PROJECT I-17-3-912

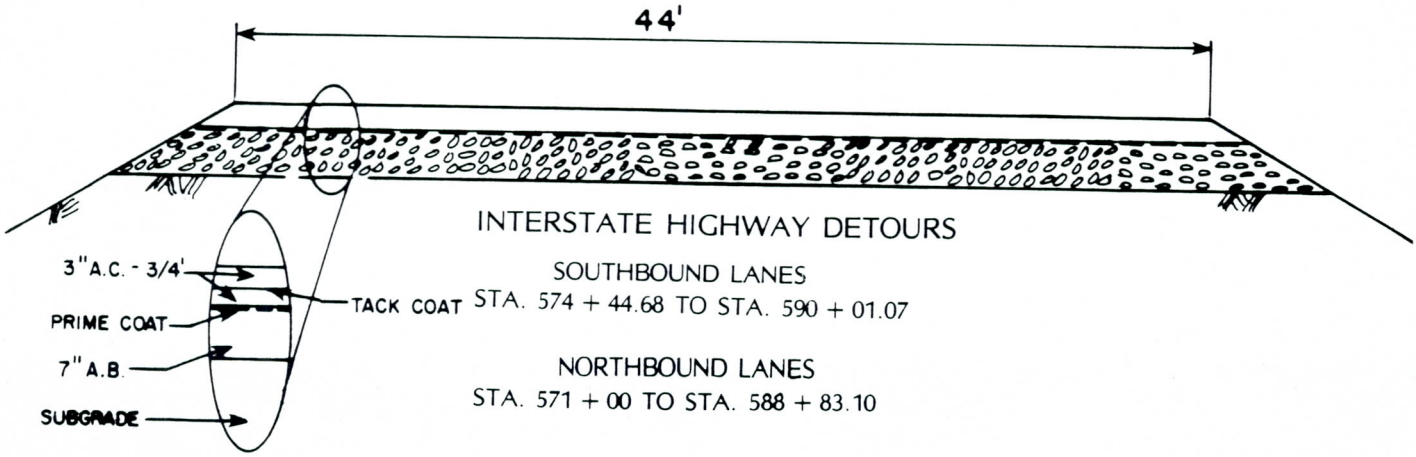


SOUTHBOUND FRONTAGE ROAD DETOUR

STA. 575 + 86.28 TO STA. 588 + 33.88

NORTHBOUND FRONTAGE ROAD DETOUR

STA. 576 + 03.02 TO STA. 586 + 29.31



INTERSTATE HIGHWAY DETOURS

SOUTHBOUND LANES

STA. 574 + 44.68 TO STA. 590 + 01.07

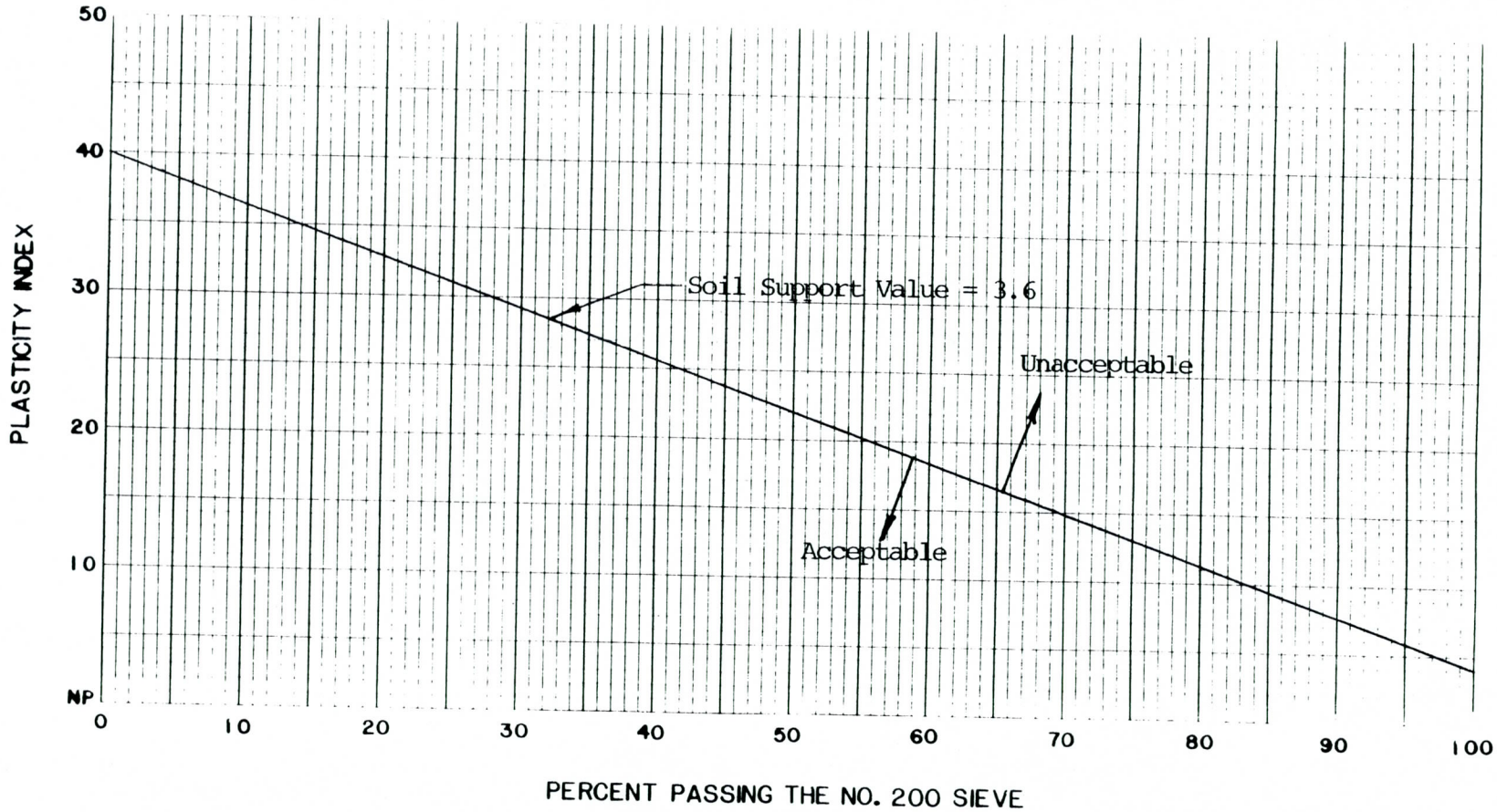
NORTHBOUND LANES

STA. 571 + 00 TO STA. 588 + 83.10

Prepared By _____ Date _____ Checked By _____ Date _____

Materials Design Soil Support Chart

Project No. I-17-3-912
Sta. 571+00 to Sta. 589+92
Arizona Canal Diversion Channel
Soil Support Value = 3.6
Job No. 2125J066



compaction in excess of requirements or waste that may be experienced during construction, however, this weight does include the natural moisture of the material (approximately 3 percent). For estimating purposes, the haul distance is 10 miles.

SECTION III - SURFACE TREATMENTS AND PAVEMENTS

ITEM 1 - Prime Coat

The prime coat shall be as specified in Section 404 of the Standard Specifications. The prime coat should be applied to the surface of the aggregate base at an approximate rate of 0.5 gallons per square yard.

ITEM 2 - Tack Coat

A tack coat should be applied as necessary to provide proper bonding prior to the placement of each lift of A.C. over an underlying bituminous surface. The tack coat shall be as specified in Section 404 of the Standard Specifications except that the use of liquid asphalts shall not be allowed.

ITEM 3 - Asphaltic Concrete (3/4)

The asphaltic concrete shall be as specified in Contracts and Specification stored Spec. "AC406". For estimating purposes the unit weight of the bituminous mix is 145 pounds per cubic foot, the asphalt is 5.2 percent and the haul distance is 10 miles. The asphalt type shall be AC-40. The minimum index of retained strength shall be 50 percent. The combined bulk specific gravity range shall be 2.35 to 2.85. The combined water absorption range shall be 0 to 2.50.

SECTION IV - MATERIALS SOURCES

No State designated material source is set-up for this project. Materials sources shall be as specified in Section 1001 of the Standard Specifications.

SECTION V - EARTHWORK

ITEM 1 - Ground Compaction

An estimated ground compaction of 0.15 ft should be compensated for in embankment sections.

ITEM 2 - Excavation Factors and Slopes

A shrinkage factor of 15 percent should be used for subgrade fill materials. Slopes should be in accordance with ADOT Standard C-2.20.

SECTION VI - MISCELLANEOUS

ITEM 1 - Removal of Asphaltic Concrete

Upon removal of asphaltic concrete, either existing or from obliteration of detours, the material may become the property of the contractor with the stipulation that it shall be salvaged for future use as recycled asphaltic concrete.

If the contractor does not elect to retain the material, it shall be hauled to the Arizona Department of Transportation Disposal Site at 35th Avenue and the Salt River. The material shall be placed in the area designated for stockpiling asphaltic concrete as specified and directed by the Engineer.

No measurement or direct payment will be made for the hauling and stockpiling of the salvaged material.

ITEM 2 - Water

Approximately 60 gallons of water per cubic yard should be estimated for the compaction of the earthwork and aggregate base. A source of water has not been arranged; however, it is expected that water would be available from City of Phoenix sources in the vicinity of the project.

Sincerely yours,
WESTERN TECHNOLOGIES INC.

W. R. Meier, Jr., Ph.D., P.E.

Kenneth L. Ricker, P.E.

clc

Attachments
Geotechnical Report
Pavement Design Summary

GEOTECHNICAL REPORT

PROJECT DESCRIPTION

This project consists of the location of temporary detours for frontage roads and Interstate Highway 17 and its crossing of the Arizona Canal Diversion Channel north of Dunlap Avenue. Temporary detours to carry both frontage road and freeway traffic for up to 1 year are planned.

FIELD INVESTIGATION AND LABORATORY TESTING

One sample of the soil subgrade at this location was sampled from 0 to 3 ft. The soil was found to be sandy clay. One laboratory test for R-value was performed and yielded a value of 20. The results for this test are attached.

RESISTANCE 'R' VALUE AND EXPANSION PRESSURE

Job No. 2155J066

Lab./Invoice No.

Date 8/23/85

Reviewed By

Project I-17 Detours

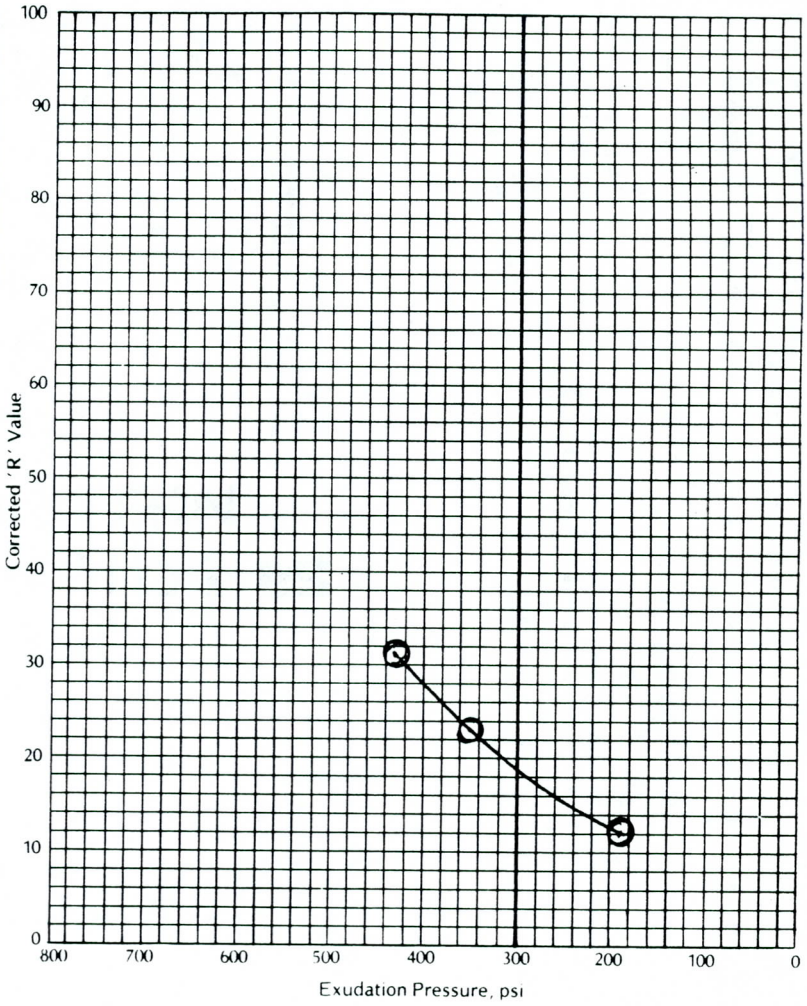
Location I-17 and ACDC — Sampled By WT/Steve Myers — Date 4/22/85

Type of Material Sandy Clay — Submitted By WT/Steve Myers — Date 4/22/85

Source of Material Subgrade, 0-3 ft — Authorized By RGA — Date 4/22/85

ASTM D2844-	Specimen A	Specimen B	Specimen C
Compactor Pressure, psi	300	125	100
Exudation Pressure, psi	426	344	182
Moisture at Compaction, %	14.2	15.1	17.0
Dry Density at Compaction, pcf	120.0	117.9	113.3
Corrected 'R' Value	31	23	12
Expansion Dial Read. × 10^{-4}			
Expansion, psf			
Plasticity Index, ASTM D424-	PL =	PI =	

Corrected 'R' Value at 300 psi 20



Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification	As Tested Grading
3''			
2 ½''			
2''			
1 ½''			
1''			
¾''			
½''			
⅜''			
¼''			
No. 4			
8			
10			
16			
30			
40			
50			
100			
Finer than 200 ASTM D1140-			

PAVEMENT DESIGN SUMMARY

Following is a summary of the information used for the pavement designs for detour sections on Interstate Highway 17 and accompanying frontage roads at their crossings of the Arizona Canal Diversion Channel north of Dunlap Avenue in Phoenix. The designs recommended in the Materials Design Memorandum were based on this information.

SCOPE OF PROJECT

The project consists of the construction of temporary detours along approximately 1900 ft of I-17. Frontage roads and six lanes of interstate highway traffic will be carried over these detours for a maximum time period of 1 year while roadway structures across the ACDC are constructed.

TEST DATA

One sample of subgrade soil from 0 to 3 ft was taken in the vicinity of the project. A laboratory R-value test yielded a value of 20. This corresponds to a soil support value of 3.6 which was used for all pavement structural designs.

DESIGN CALCULATIONS

The following parameters used during the pavement design were developed using the "Arizona Department of Transportation Materials Preliminary Engineering and Design Manual" as a basis. This publication is hereinafter referred to as the ADOT Design Manual.

Soil Support Value

On the basis of the one R-value test taken, the roadway soil is fair as a subgrade soil and was evaluated as a soil support value of 3.6.

Traffic

An Interstate highway Average Daily Traffic of 110,000 vehicles with 10 percent being commercial vehicles was provided from ADOT data. No traffic data were given for the frontage roads. The pavement structure was based upon a 1 year design period. The design lane along the interstate highway was considered to carry 40 percent of the traffic.

Vehicles	Total Number in Design Lane	Traffic Load per 1000 Vehicles	18K SAEL
Automobiles	14,454,000	0.8	11,563
Trucks	1,606,000	-	-
LT	642,400	3.1	1,991
MT	160,600	173.8	27,912
TS	321,200	704.2	226,189
TT	321,200	1042.3	334,787
TST	160,600	1365.8	219,347
	Total 18K SAEL:		821,789

Frontage roads were considered to have 10,000 vehicles per day in one direction. Commercial vehicles of 10% with 77 percent single-unit and 23 percent multiple-units were used to calculate a total of 58,765 18-kip single-axle equivalent loads for the 1 year design period.

Serviceability

Although these are temporary detours, the traffic is considered to be high enough that a terminal serviceability index of 2.5 should be used in the design equation.

Regional Factor

Phoenix is in climatological Zone 1 by Figure 203.00-2 in the ADOT Design Manual. The value of 0.1 obtained added to 0.1 for the mean sea level elevation from Figure 203.00-2a and 0.8 for the annual precipitation from Figure 203.00-2b yielded a regional factor of 1.0.

Pavement Components

Asphaltic concrete and aggregate base were considered the most appropriate pavement courses for this temporary work. Aggregate base used a structural coefficient of 0.13 and the asphaltic concrete used a structural coefficient of from 0.40 to 0.44 depending upon the depth. These coefficients were as recommended in the ADOT Design Manual.

Structural Pavement Design

By use of a soil support value of 3.6, a regional factor of 1.0, a terminal serviceability index of 2.5, SAEL's of 821,789 for interstate highway traffic and 58,765 for frontage roads and the nomograph in Figure 203.00-10 of the ADOT Design Manual, structural numbers were developed. These were 3.50 for the interstate highway

traffic and 2.28 for the frontage road traffic. Alternate designs satisfying these conditions follow.

Interstate Highway Traffic, Structural Number = 3.50

Alternate No.	Material	Thickness (in.)	Layer Coefficient	Structural Number
1	AC(3/4)	5	0.42	2.10
	AB	11	0.13	1.43
				3.53
2	AC(3/4)	6	0.43	2.58
	AB	7	0.13	0.91
				3.49
3	AC(3/4)	8	0.44	3.52

Frontage Road Traffic, Structural Number = 2.28

Alternate No.	Material	Thickness (in.)	Layer Coefficient	Structural Number
1	AC(3/4)	3	0.40	1.20
	AB	9	0.13	1.17
				2.38
2	AC(3/4)	4	0.40	1.60
	AB	6	0.13	0.78
				2.38
3	AC(3/4)	5.5	0.42	2.31

Alternate No. 2 for the interstate highway traffic and Alternate No. 2 for the frontage road traffic are recommended for use.

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LETTER OF TRANSMITTAL

To RGA Consulting Engineers
1102 West Indian School Road
Phoenix, Arizona 85013

Date 8/28/85
Job No. 2125J066
Lab./Invoice No.
Ref. No.

Attn. Mr. Harold Ditzler

Project/Subject ADOT Materials Design Memo

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By Kenneth L. Ricker, P.E.

145

WESTERN TECHNOLOGIES INC.
3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

MATERIALS DESIGN MEMORANDUM

August 23, 1985

PROJECT
PHOENIX - CORDES JUNCTION HIGHWAY
ARIZONA CANAL DIVERSION CHANNEL
I-17-3-912
STRUCTURES AND DETOURS

MEMORANDUM NO. 85-66LGR
Job No. 2125J066

MEMORANDUM TYPE:
INITIAL FOR REVIEW

SECTION I - PAVEMENT STRUCTURE

ITEM 1 - Structural Design

	Thicknesses, in.		
Location	AC(3/4)	AB	Total
Interstate Highway Sta. 571+00 to Sta. 589+92	6	7	13
Frontage Roads Sta. 575+86 to Sta. 588+34	4	6	10

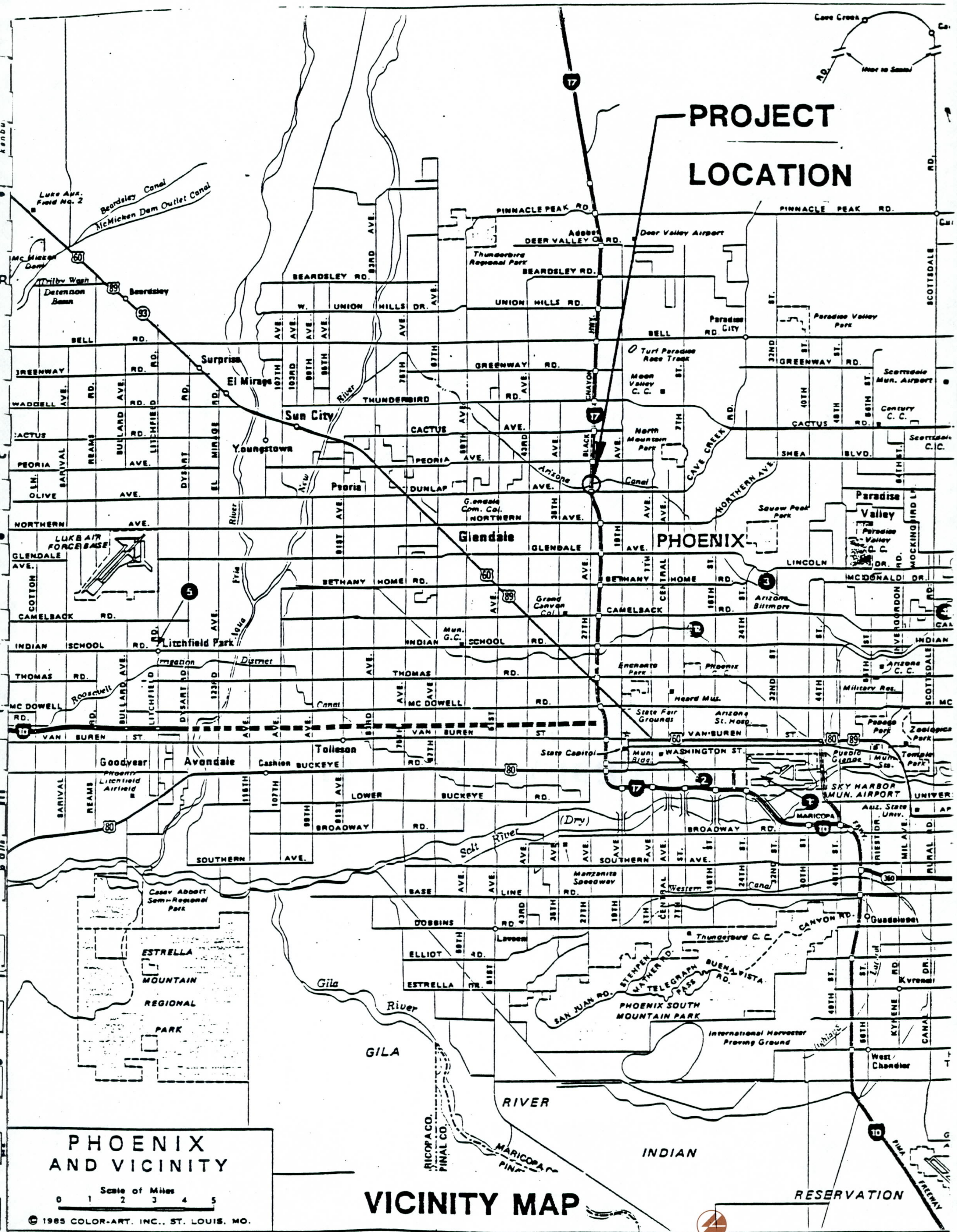
SECTION II - SUBGRADE AND BASE

ITEM 1 - Subgrade Construction Control

The attached Design Soil Support Chart should be used during construction for determining whether subgrade materials are suitable as outlined in Section 203.06 of the ADOT Construction Manual.

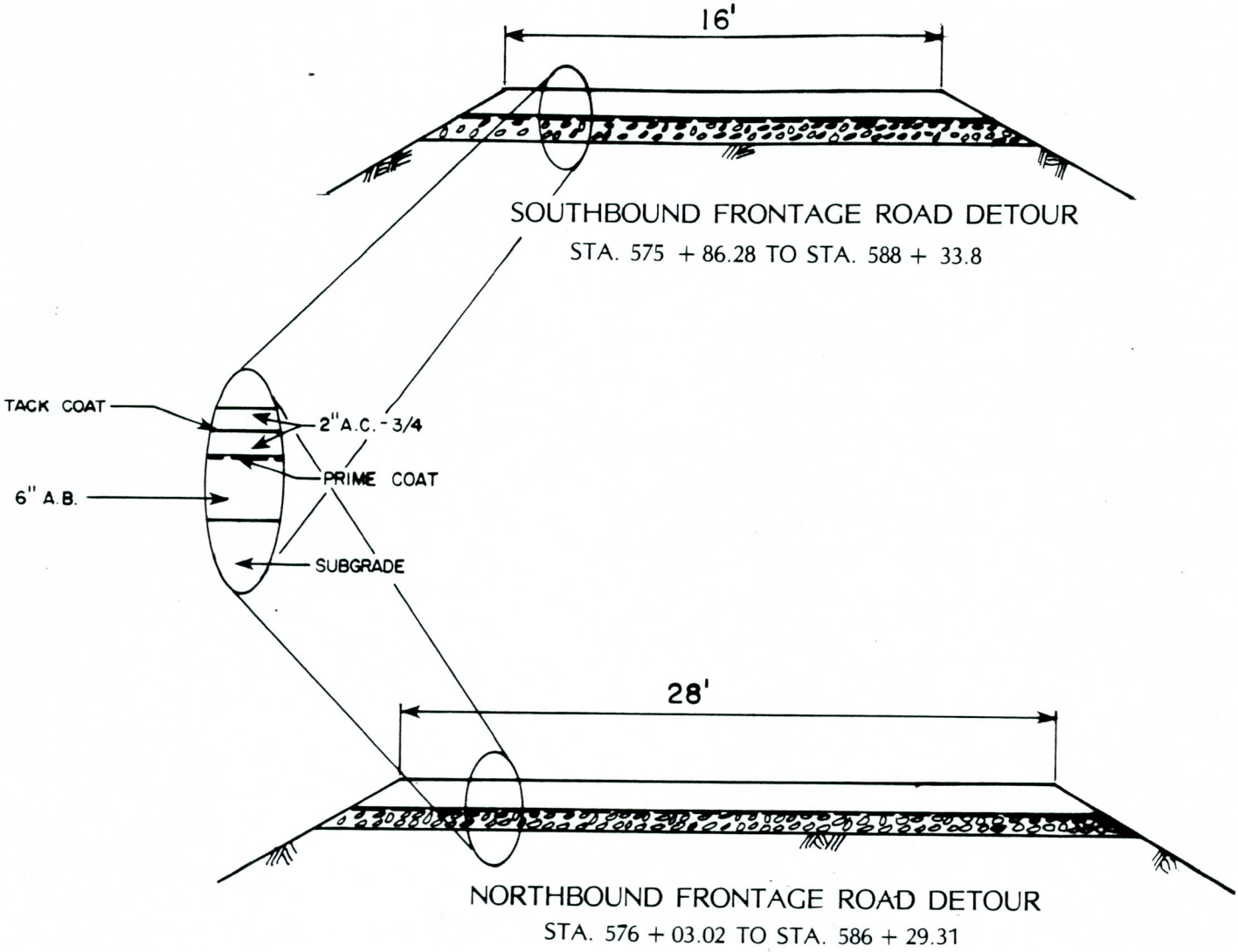
ITEM 2 - Aggregate Base

Aggregate base should be Class 2. The estimated compacted weight is 140 pounds per cubic foot. This weight does not compensate for


PROJECT LOCATION
PHOENIX
PHOENIX AND VICINITY
Scale of Miles
0 1 2 3 4 5
© 1985 COLOR-ART, INC., ST. LOUIS, MO.
VICINITY MAP
Glendale
Sun City
Youngstown
Surprise
El Mirage
Peoria
Tolleson
Goodyear
Avondale
Litchfield Park
Paradise Valley
SKY HARBOR MUN. AIRPORT
PHOENIX SOUTH MOUNTAIN PARK
ESTRELLA MOUNTAIN REGIONAL PARK
GILA RIVER INDIAN RESERVATION
PINNACLE PEAK RD.
DEER VALLEY RD.
BEARDSLEY RD.
UNION HILLS DR.
BELL RD.
GREENWAY RD.
THUNDERBIRD
CACTUS
PEORIA AVE.
DUNLAP
OLIVE AVE.
NORTHERN AVE.
GLENDALE AVE.
BETHANY HOME RD.
CAMELBACK
INDIAN SCHOOL RD.
THOMAS RD.
MC DOWELL RD.
VAN BUREN ST.
WASHINGTON ST.
BUCKEYE
LOWER BUCKEYE RD.
BROADWAY RD.
SOUTHERN AVE.
BASE LINE RD.
DOBBINS RD.
ELLIOT RD.
Salt River
Gila River
Arizona Canal
CAVE CREEK
SCOTTSDALE

TYPICAL CROSS - SECTIONS

PROJECT I - 17 - 3 - 192

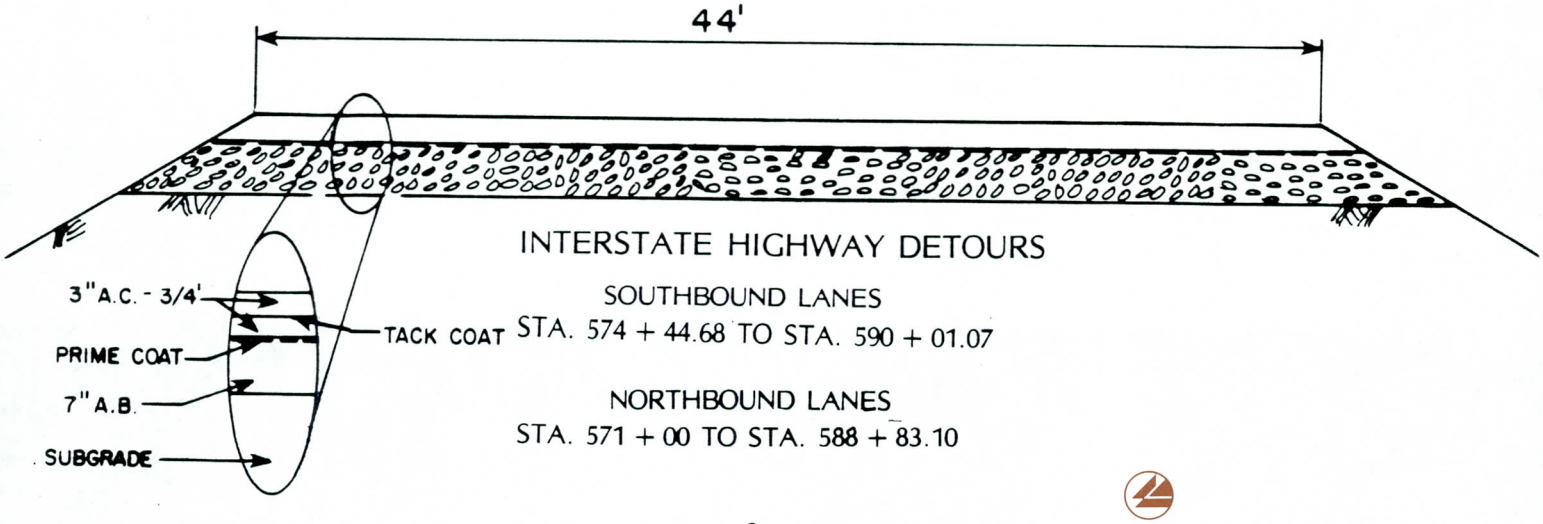


SOUTHBOUND FRONTAGE ROAD DETOUR

STA. 575 + 86.28 TO STA. 588 + 33.8

NORTHBOUND FRONTAGE ROAD DETOUR

STA. 576 + 03.02 TO STA. 586 + 29.31



INTERSTATE HIGHWAY DETOURS

SOUTHBOUND LANES

STA. 574 + 44.68 TO STA. 590 + 01.07

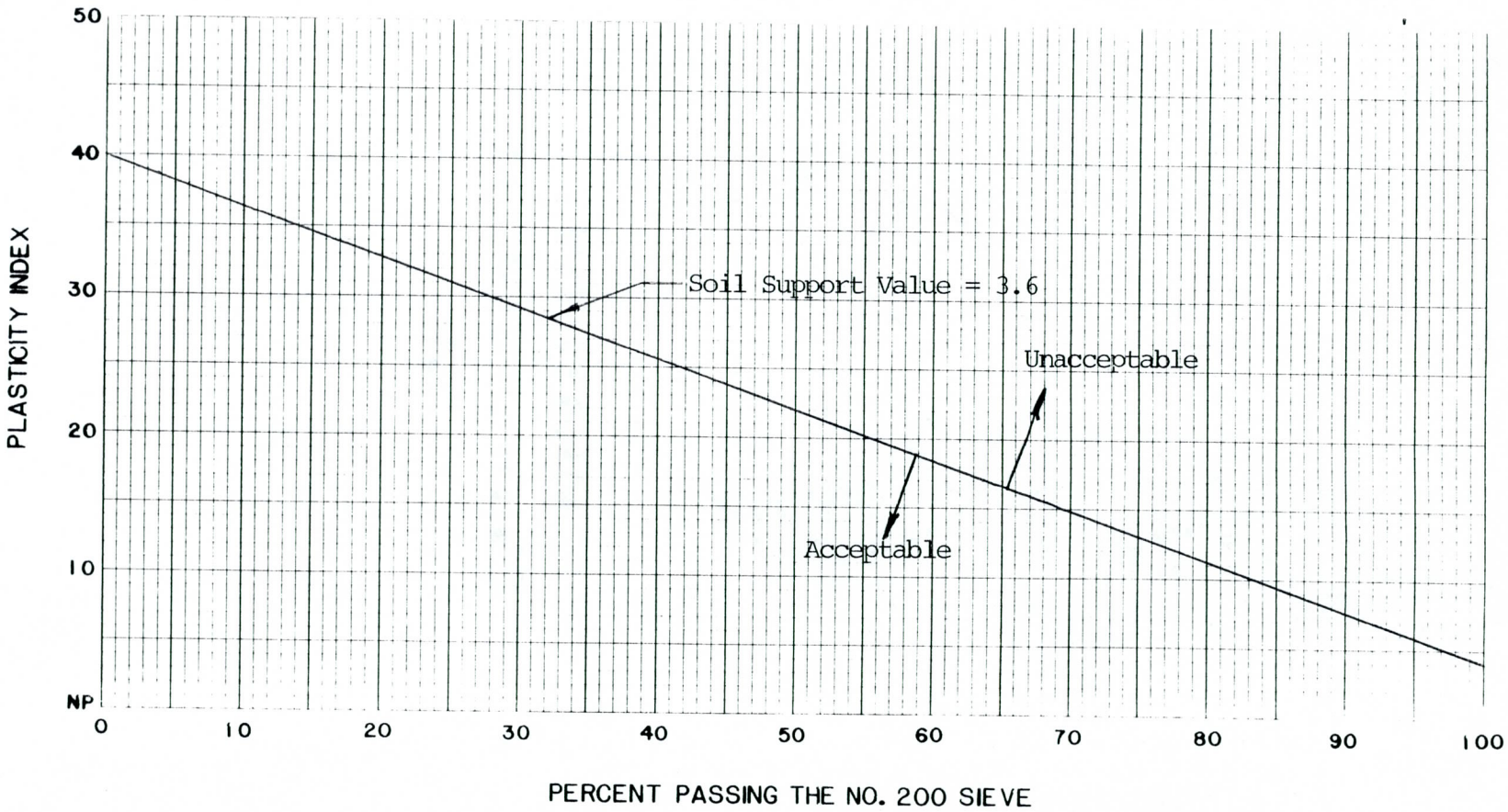
NORTHBOUND LANES

STA. 571 + 00 TO STA. 588 + 83.10

Prepared By _____ Date _____ Checked By _____ Date _____

Materials Design Soil Support Chart

Project No. I-17-3-192
Sta. 571+00 to Sta. 589+92
Arizona Canal Diversion Channel
Soil Support Value = 3.6
Job No. 2125J066



compaction in excess of requirements or waste that may be experienced during construction, however, this weight does include the natural moisture of the material (approximately 3 percent). For estimating purposes, the haul distance is 10 miles.

SECTION III - SURFACE TREATMENTS AND PAVEMENTS

ITEM 1 - Prime Coat

The prime coat shall be as specified in Section 404 of the Standard Specifications. The prime coat should be applied to the surface of the aggregate base at an approximate rate of 0.5 gallons per square yard.

ITEM 2 - Tack Coat

A tack coat should be applied as necessary to provide proper bonding prior to the placement of each lift of A.C. over an underlying bituminous surface. The tack coat shall be as specified in Section 404 of the Standard Specifications except that the use of liquid asphalts shall not be allowed.

ITEM 3 - Asphaltic Concrete (3/4)

The asphaltic concrete shall be as specified in Contracts and Specification stored Spec. "AC406". For estimating purposes the unit weight of the bituminous mix is 145 pounds per cubic foot, the asphalt is 5.2 percent and the haul distance is 10 miles. The asphalt type shall be AC-40. The minimum index of retained strength shall be 40 percent. The combined bulk specific gravity range shall be 2.35 to 2.85. The combined water absorption range shall be 0 to 2.50.

SECTION IV - MATERIALS SOURCES

No State designated material source is set-up for this project. Materials sources shall be as specified in Section 1001 of the Standard Specifications.

SECTION V - EARTHWORK

ITEM 1 - Ground Compaction

An estimated ground compaction of 0.15 ft should be compensated for in embankment sections.

ITEM 2 - Excavation Factors and Slopes

A shrinkage factor of 15 percent should be used for subgrade fill materials. Slopes should be in accordance with ADOT Standard C-2.20.

SECTION VI - MISCELLANEOUS

ITEM 1 - Removal of Asphaltic Concrete

Upon removal of asphaltic concrete, either existing or from obliteration of detours, the material may become the property of the contractor with the stipulation that it shall be salvaged for future use as recycled asphaltic concrete.

If the contractor does not elect to retain the material, it shall be hauled to the Arizona Department of Transportation Disposal Site at 35th Avenue and the Salt River. The material shall be placed in the area designated for stockpiling asphaltic concrete as specified and directed by the Engineer.

Phoenix-Cordes Junction Highway
Job No. 2125J066

No measurement or direct payment will be made for the hauling and stockpiling of the salvaged material.

ITEM 2 - Water

Approximately 60 gallons of water per cubic yard should be estimated for the compaction of the earthwork and aggregate base. A source of water has not been arranged; however, it is expected that water would be available from City of Phoenix sources in the vicinity of the project.

Sincerely
WESTERN TECHNOLOGIES INC.

Registered Professional Engineer
CERTIFICATE
15141
WELLINGTON
MEIER, JR.
Date Signed 8-28-85
ARIZONA, U.S.A.

W. R. Meier, Jr., Ph.D., P.E.

Kenneth L. Ricker, P.E.

cjc

Attachments
Geotechnical Report
Pavement Design Summary

GEOTECHNICAL REPORT

PROJECT DESCRIPTION

This project consists of the location of temporary detours for frontage roads and Interstate Highway 17 and its crossing of the Arizona Canal Diversion Channel north of Dunlap Avenue. Temporary detours to carry both frontage road and freeway traffic for up to 1 year are planned.

FIELD INVESTIGATION AND LABORATORY TESTING

One sample of the soil subgrade at this location was sampled from 0 to 3 ft. The soil was found to be sandy clay. One laboratory test for R-value was performed and yielded a value of 20. The results for this test are attached.

RESISTANCE 'R' VALUE AND EXPANSION PRESSURE

Job No. 2155J066

Lab./Invoice No.

Date 8/23/85

Reviewed By

Project I-17 Detours

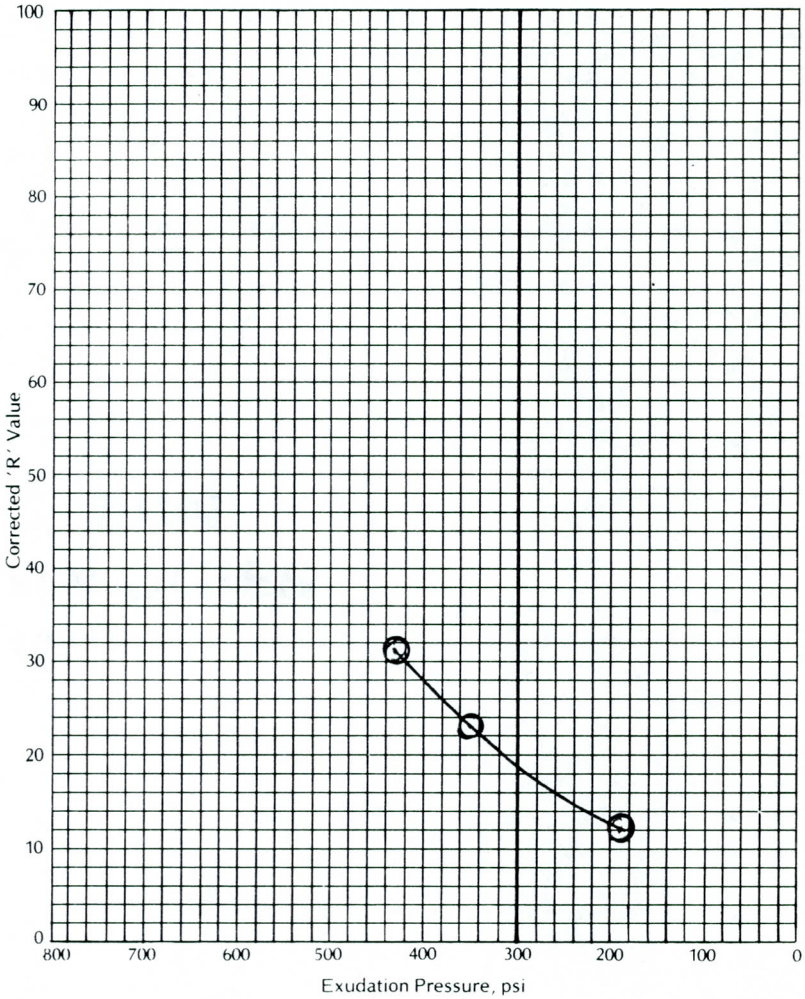
Location I-17 and ACDC — Sampled By WT/Steve Myers — Date 4/22/85

Type of Material Sandy Clay — Submitted By WT/Steve Myers — Date 4/22/85

Source of Material Subgrade, 0-3 ft — Authorized By RGA — Date 4/22/85

ASTM D2844-	Specimen A	Specimen B	Specimen C
Compactor Pressure, psi	300	125	100
Exudation Pressure, psi	426	344	182
Moisture at Compaction, %	14.2	15.1	17.0
Dry Density at Compaction, pcf	120.0	117.9	113.3
Corrected 'R' Value	31	23	12
Expansion Dial Read. × 10^{-4}			
Expansion, psf			
Plasticity Index, ASTM D424-	PL =	PI =	

Corrected 'R' Value at 300 psi 20



Sieve Analysis, ASTM D422-

Sieve Size	% Passing Accumulative	Specification	As Tested Grading
3''			
2 ½''			
2''			
1 ½''			
1''			
¾''			
½''			
⅜''			
¼''			
No. 4			
8			
10			
16			
30			
40			
50			
100			
Finer than 200 ASTM D1140-			

PAVEMENT DESIGN SUMMARY

Following is a summary of the information used for the pavement designs for detour sections on Interstate Highway 17 and accompanying frontage roads at their crossings of the Arizona Canal Diversion Channel north of Dunlap Avenue in Phoenix. The designs recommended in the Materials Design Memorandum were based on this information.

SCOPE OF PROJECT

The project consists of the construction of temporary detours along approximately 1900 ft of I-17. Frontage roads and six lanes of interstate highway traffic will be carried over these detours for a maximum time period of 1 year while roadway structures across the ACDC are constructed.

TEST DATA

One sample of subgrade soil from 0 to 3 ft was taken in the vicinity of the project. A laboratory R-value test yielded a value of 20. This corresponds to a soil support value of 3.6 which was used for all pavement structural designs.

DESIGN CALCULATIONS

The following parameters used during the pavement design were developed using the "Arizona Department of Transportation Materials Preliminary Engineering and Design Manual" as a basis. This publication is hereinafter referred to as the ADOT Design Manual.

Soil Support Value

On the basis of the one R-value test taken, the roadway soil is fair as a subgrade soil and was evaluated as a soil support value of 3.6.

Traffic

An Interstate highway Average Daily Traffic of 110,000 vehicles with 10 percent being commercial vehicles was provided from ADOT data. No traffic data were given for the frontage roads. The pavement structure was based upon a 1 year design period. The design lane along the interstate highway was considered to carry 40 percent of the traffic.

Vehicles	Total Number in Design Lane	Traffic Load per 1000 Vehicles	18K SAEL
Automobiles	14,454,000	0.8	11,563
Trucks	1,606,000	-	-
LT	642,400	3.1	1,991
MT	160,600	173.8	27,912
TS	321,200	704.2	226,189
TT	321,200	1042.3	334,787
TST	160,600	1365.8	219,347
	Total 18K SAEL:		821,789

Frontage roads were considered to have 10,000 vehicles per day in one direction. Commercial vehicles of 10% with 77 percent single-unit and 23 percent multiple-units were used to calculate a total of 58,765 18-kip single-axle equivalent loads for the 1 year design period.

Serviceability

Although these are temporary detours, the traffic is considered to be high enough that a terminal serviceability index of 2.5 should be used in the design equation.

Regional Factor

Phoenix is in climatological Zone 1 by Figure 203.00-2 in the ADOT Design Manual. The value of 0.1 obtained added to 0.1 for the mean sea level elevation from Figure 203.00-2a and 0.8 for the annual precipitation from Figure 203.00-2b yielded a regional factor of 1.0.

Pavement Components

Asphaltic concrete and aggregate base were considered the most appropriate pavement courses for this temporary work. Aggregate base used a structural coefficient of 0.13 and the asphaltic concrete used a structural coefficient of from 0.40 to 0.44 depending upon the depth. These coefficients were as recommended in the ADOT Design Manual.

Structural Pavement Design

By use of a soil support value of 3.6, a regional factor of 1.0, a terminal serviceability index of 2.5, SAEL's of 821,789 for interstate highway traffic and 58,765 for frontage roads and the nomograph in Figure 203.00-10 of the ADOT Design Manual, structural numbers were developed. These were 3.50 for the interstate highway

traffic and 2.28 for the frontage road traffic. Alternate designs satisfying these conditions follow.

Interstate Highway Traffic, Structural Number = 3.50

Alternate No.	Material	Thickness (in.)	Layer Coefficient	Structural Number
1	AC(3/4)	5	0.42	2.10
	AB	11	0.13	1.43
				3.53
2	AC(3/4)	6	0.43	2.58
	AB	7	0.13	0.91
				3.49
3	AC(3/4)	8	0.44	3.52

Frontage Road Traffic, Structural Number = 2.28

Alternate No.	Material	Thickness (in.)	Layer Coefficient	Structural Number
1	AC(3/4)	3	0.40	1.20
	AB	9	0.13	1.17
				2.38
2	AC(3/4)	4	0.40	1.60
	AB	6	0.13	0.78
				2.38
3	AC(3/4)	5.5	0.42	2.31

Alternate No. 2 for the interstate highway traffic and Alternate No. 2 for the frontage road traffic are recommended for use.