FINAL
PAVEMENT DESIGN REPORT
Alamogordo-Elk NM PFH 35-1(1)
NM SR 82

LINCOLN NATIONAL FOREST
OTERO COUNTY, NEW MEXICO

July 2, 2012
YA Project No. 212-034

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1.0 PURPOSE AND SCOPE OF STUDY

Yeh and Associates, Inc., as a subconsultant to PB Americas, Inc., Denver, Colorado, was retained by the Federal Highway Administration (FHWA), Central Federal Lands Highway Division (CFLHD) to provide pavement design recommendations for the 100% PS&E package for 3R improvements on New Mexico State Route 82/Forest Highway 35 in the Lincoln National Forest, New Mexico. The project is located about 35 miles east of Alamogordo, New Mexico along a winding road, in mountainous terrain. The proposed improvements will begin at approximate MP 35.1 and end at approximate MP 43.5 (from Mayhill, NM to the USFS boundary/Otero County Line). The project location is shown on Figure 1.1.

The project is programmed as 3R (resurfacing, restoration, and rehabilitation) roadway improvements on 8.5 miles of FH 35, including placement of an engineered pavement section. The project is expected to have very minor impacts outside the limits of the existing pavement and will avoid rock cuts and steep embankments; therefore, shoulder widening will be limited. The new pavement section is to be designed so that construction will not require widening of the existing bench.

The improvements will be designed and implemented in accordance with CFLHD, and American Association of State Highway and Transportation Officials (AASHTO) Highway Design Standards, in cooperation with the United States Forest Service, NMDOT and the CFLHD Denver Service Center.

The purpose of the geotechnical investigation is to evaluate geologic and subsurface conditions in the project area and provide recommendations for design of pavement improvements within the scope of a 3R project. This report presents the results of the geotechnical investigation along FH 35. The design recommendations include pavements, surface and subsurface drainage, grading and corrosivity of soil materials. This report also addresses potential geotechnical constraints for the proposed improvements, existing pavement conditions along the FH 35, and includes recommendations for pavement section thickness designs.

Figure 1.1: Project Location Map

2.0 GEOLOGIC SETTING

East of Mayhill, FH 35 follows the north side of the relatively narrow valley of the Rio Penasco. Bedrock exposed on the north side of the road from Mayhill to approximate MP 38 consists of the Permian Yeso Formation, a heterogeneous unit of mudstone, limestone, dolomite, and evaporates. The evaporate zones in the Yeso Formation can dissolve in the presence of groundwater. The result is a solution cavity in the bedrock that can eventually become a sinkhole or cave. The Yeso formation is overlain by the Rio Bonito member of the San Andres Formation, a gray to brownish gray locally fossiliferous micritic (microcrystalline calcite) limestone and dolomite, which is the exposed bedrock in the eastern section of the project. The Rio Bonito limestone is highly fractured and where it is exposed, gravel to boulder size fragments are easily dislodged from the rock face.

The road crosses terrace and alluvial fan deposits that occur mainly at the mouths of smaller side canyons where they run into the Rio Penasco Valley. These deposits consist of fine to coarse subrounded carbonate pebbles, most with calcic rinds, in a reddish silty sand matrix. Alluvial fan deposits have been mapped at McGee Canyon, Cherry Canyon, Carr Canyon and east of Browning Canyon. Holocene and older stream alluvium and minor terrace deposits fill the Rio Penasco valley floor. This material is characterized as sandy gravel composed of mainly carbonate clasts and minor quartz sandstone.

3.0 SITE CONDITIONS

3.1 Terrain

The site is located along the north side of the alluvial valley of the Rio Penasco in mountainous terrain. Vegetation consists of small deciduous trees, grasses and shrubs in the valley floor and evergreen trees on the slopes above the road. Prickly Pear Cactus grows in low moisture areas along the faces and brows of the rock cuts. Vegetation is sparse on the slopes north of the highway where recent wildfires have burned most of the trees. FH 35 is winding and has slight grades, generally down toward the east, as it traverses a bench above the valley floor. The elevation at Mayhill is approximately 6,500 feet and the elevation at the east end of the project is approximately 6,000 feet. The slopes above the Rio Penasco slope steeply up to elevations ranging from about 6,700 feet to about 7,200 feet.

3.2 Climate

Climate data is based on records for Cloudcroft, NM, the nearest population center with climate records. The area has a cool climate typical of mountainous semi-arid regions in southern New Mexico. The average annual precipitation is 29.81 inches, about half of which occurs in July and August as monsoonal thunderstorms. Average annual snowfall totals about 70 inches and occurs primarily between December and April. The average annual high temperature is 73.5^{o} F and average annual low temperature is 18.5^{o} F. The annual high temperatures occur in June and July and the annual low temperatures occur in December and January.

4.0 PAVEMENT CONDITIONS

Within the project limits, FH 35 is a winding two-lane road with an asphalt pavement surface. A pavement design report from the NMDOT dated September 26, 2006 states that this section of the highway had been chip-sealed and crack-sealed in the past. Evidence of the NMDOT subsurface investigation, consisting of patched core holes in the pavement, was visible at the time of our field work. Because the patched core holes were not covered by the chip-seal, it is assumed that the chip-seal was in place prior to September 2006, before the NMDOT study and that no subsequent surface treatment has been performed.

The ride is very rough when travelling the segment in a vehicle at the posted speed. The rough ride may be due to closely-spaced transverse cracks that are obscured by the chip seal, but still create a rough pavement surface. The observed transverse cracks are spaced at about 5 to 25 feet. Longitudinal cracks were observed at the outside edges of the lanes. Most of the cracks appear to have been recently sealed. Photo 1 shows crack patterns in the road.

Photo 1: Typical crack pattern.

The pavement is broken at the road shoulders in many locations. The resulting drop off is 1 to 3 inches with the greater drops in areas where pull-outs and approach roads are located. Photos 2 and 3 show shoulder damage.

Photo 2: Typical shoulder damage.

Photo 3: Shoulder damage at approach road.

Asphalt binder appears to have “bled-through” at several locations. This appearance of binder at the pavement surface may be due to the loss of the chip surface at these locations. Photo 4 shows an area of binder bleed-through.

Photo 4: Areas of binder bleed-through.

Patches were observed in both lanes and generally have individual areas of less than 100 square feet. Alligator (fatigue) cracks were observed in the eastbound lane near MP 40.5. Potholes are widely scattered within the project limits and are generally less than 1 square foot in area and 1 to 2 inches deep. The road surface cross section appears to have intermediate crowns in the centers of the driving lanes due to rutting in the wheel tracks. Snowplows have damaged the

pavement surface in the middle of the lanes where the plow rides on the high point between the wheel tracks.

Minor settlement of the pavement surface has occurred at several culvert locations. The settlements appear as short dips in the pavement surface, about 1 to 3 inches deep. An area of more severe settlement was observed near MP 36.5, west of Carr Canyon, where the road crosses a small drainage. The large settlement area is about 200 feet long and about 2 to 2.5 feet deep across the full width of the road. The settlement may be the result of long-term consolidation of the embankment fill and native soils or may indicate the presence of a solution cavity and sinkhole in the bedrock under the road. Photo 5 shows the depression near MP 36.5.

Photo 5: Settlement near MP 36.5

5.0 SUBSURFACE INVESTIGATION

Yeh and Associates contracted with Enviro-Drill, Inc. of Albuquerque, New Mexico to drill exploratory borings for the pavement design investigation along FH 35. Traffic control during drilling was provided by Las Cruces Barricades, Inc. of Las Cruces, New Mexico. The borings were drilled on March 12 and 13, 2012.

5.1 Exploratory Borings

Nine exploratory borings P-1 through P-9 were drilled at approximately 1-mile intervals near the center of the westbound travel lane of the road. The borings were drilled to a maximum depth of 7 feet to evaluate subgrade conditions for pavement design and corrosivity of the soils. The locations of the borings are shown on Sheet A-1 in Appendix A.

The borings were drilled with a truck-mounted CME 75 drilling rig using 8-inch O.D. hollow stem auger. Samples were obtained at selected intervals using a 1.5-inch I.D. split-spoon sampler. The split-spoon sampler was driven into the subsoils with a 140-pound hammer falling 30 inches. The number of blows needed to drive the sampler 12 inches constitutes the blow count, N, reported

on the Boring Logs (Appendix B). The blow count can be used as a relative measure of the material stiffness or density. Bulk samples of auger cuttings were also obtained from the borings at selected intervals. Upon completion, the borings were backfilled with auger cuttings. The pavement was patched with cold asphalt patch mix.

The asphalt pavement was cored at 12 locations in the eastbound lane at approximately ½-mile intervals. Samples of the asphalt pavement and base course were obtained from the core locations and the existing pavement section thicknesses were measured. The locations of the cores were different than the locations of the exploratory borings. The data obtained from the core locations is shown on Table 5.1.1.

Table 5.1.1: Existing Pavement Section Thicknesses at Core Locations

Yeh Core No.	Approximate Location	Thickness of Asphalt (in)	Thickness of Base Course (in)
C-1	MP 37.75	4.5	7
C-2	MP 38.25	3.0	5
C-3	MP 38.75	3.5	4
C-4	MP 39.25	2.75	5
C-5	MP 39.75	2.25	6
C-6	MP 41.25	4.0	5
C-7	MP 41.75	2.75	5
C-8	MP 42.25	4.0	5
C-9	MP 42.50	3.5	5
C-10	MP 42.75	3.0	4
C-11	MP 43.05	3.0	6
C-12	MP 43.75	5.5	6

5.2 Laboratory Testing

Samples retrieved during the field exploration were returned to our laboratory for observation by the project geotechnical engineer. An applicable program of laboratory testing was developed to determine engineering properties of the subsurface materials. Following the completion of the laboratory testing, the field descriptions were confirmed or modified as necessary and boring logs were prepared.

Laboratory tests performed included gradation (ASTM D 421, C 136 and AASHTO T 27), Atterberg limits (AASHTO T 89/T 90), moisture content (AASHTO T 265), R-value (ASTM D 2844), sulfate content (AASHTO T290), pH (ASTM D 4972/AASHTO T 289), chloride ion content (ASTM D 4327) and soil resistivity (AASHTO T 288). Gradation and Atterberg limits test results were used to classify the soils in accordance with the AASHTO classification system and the Unified Soil Classification System (USCS). Moisture content provides an estimate of the moisture conditions of

the subgrade and underlying materials. Soil R-value is a measure of soil subgrade strength used for pavement design. Tests for soluble sulfate content, pH, chloride content and resistivity are used to evaluate the potential of the soil to be aggressive to concrete and to corrode buried metal. The laboratory test results are presented in Appendix C and on the boring logs in Appendix B. Photos of the pavement conditions and boring locations along the project are presented in Appendix D.

6.0 SUBSURFACE CONDITIONS

6.1 Pavement Borings

The thickness of asphalt pavement encountered in the exploratory borings ranged from 1.5 to 5.5 inches. The measured asphalt thickness includes the Hot Asphalt Concrete Pavement (HACP) and chip seal applications that occurred before and after the HACP was placed. Accurately distinguishing individual layers of the pavement surface was not possible due to the destructive nature of the drilling process. The asphalt surface course thicknesses and brief descriptions of the underlying fill and native subgrade materials are summarized in Table 6.1.1. Results of laboratory tests performed on samples of the subgrade soils and bedrock are presented in Appendix C.

Native subgrade materials encountered near the western end of the project where sandstone bedrock of the Yeso Formation is found (Borings P-1 and P-2) consist of reddish brown sandy clay and clayey sand. The native soils encountered in Borings P-4 through P-9 consist of gravelly clayey sand and clayey to silty sandy gravel that were likely derived from the Rio Bonito Limestone. Embankment fill encountered in Borings P-3 and P-5 consists of gravelly clayey sand. Fill encountered in Boring P-6 consists of clayey gravel with cobbles.

The subgrade materials have 13 to 68 percent fines consisting of clay and silt and plasticity indices that range from non-plastic to 17. The natural moisture contents of the samples were generally low with a maximum of 3.9 percent. Results of R-value tests performed on the bulk samples of the subgrade soils range from 18 to 44. The clayey sand and sandy clay subgrade soils have AASHTO classifications of A-6 and A-2-4. The clayey and silty gravel soils have AASHTO classifications of A-2-6, A-4, A-1-a and A-1-b.

The bulk sample from Boring P-1 had pH of 7.9, 0.016 percent water soluble sulfates, 0.024 percent chlorides and resistivity of 807 Ohm-cm. The bulk sample from Boring P-6 had pH of 8.6, 0.001 percent water soluble sulfates, 0.006 percent chlorides and resistivity of 2,964 Ohms-cm.

Table 6.1.1: Summary of Conditions Encountered (Yeh and Associates)

Yeh Boring No.	Approximate Location	Thickness of Asphalt (in)	Thickness of Base Course (in)	Subgrade Soil Description	R Value
P-1	MP 35	3	13	sandy CLAY, gravelly	18
P-2	MP 35.75	1.5	9.5	sandy CLAY, gravelly	25
P-3	MP 36.5	5.5	5	clayey GRAVEL (Fill)	30
P-4	MP 37.5	3	7	clayey GRAVEL	31
P-5	MP 38.75	4	4	gravelly CLAY (Fill)	18
P-6	MP 40	2	6	silty GRAVEL, sandy	24
P-7	MP 41	3	5	clayey GRAVEL	29
P-8	MP 42	2.5	5	clayey SAND, gravelly	23
P-9	MP 43	3	6	clayey GRAVEL (Fill)	44

6.2 Previous Investigations

The NMDOT previously performed a subsurface investigation for pavement design along US 82 within the project limits in 2006. The exploration included borings through the pavement and into the subgrade to collect samples for laboratory testing. The NMDOT borings were drilled at approximately ¼-mile intervals in the eastbound lane. The subsurface conditions in the east bound lanes that correspond to the locations drilled by Yeh and Associates in the west bound lanes are summarized on the table below. The data include test hole locations, asphalt pavement thickness, base course thickness, subgrade soil classification and R-value.

Summary of Conditions (NMDOT Data)

NM DATA	Approximate Location	Thickness of Asphalt (in)	Thickness of Base Course (in)	Subgrade Soil Classification	R-Value
EBL	MP 35.00	3	5.5	A-6	29
EBL	MP 35.75	3	5	A-4	29
EBL	MP 36.5	3	7	A-4	25
EBL	MP 37.53	2	5	A-6	6
EBL	MP 38.76	3	8	A-1-b	56
EBL	MP 40.00	4	7	A-1-b	80
EBL	MP 41.00	3.5	2.5	A-2-6	27
EBL	MP 41.99	3.5	3.5	A-2-6	38
EBL	MP 43.00	3	2	A-2-6	68

The complete data and pavement design report provided by NMDOT have been included in Appendix E for reference. The variations in asphalt by location are likely due to previous HACP overlays during maintenance operations. Base course thickness may have been increased in areas of poor subgrade during previous construction.

NMDOT prepared 20-year pavement thickness design recommendations based on a subgrade R-value of 54 and traffic load consisting of 1,725,665 18-kip Equivalent Single Axle Loads (EASLs). The recommended design for the mainline pavement was to remove 2 inches of the existing pavement by cold-milling and place 4 inches of new Hot Asphalt Concrete Pavement (HACP). Shoulder widening recommendations were 7.5 inches of base course and a 4-inch HACP surface course. An Open Graded Friction Course (OGFC) was recommended for both mainline and shoulders.

7.0 PAVEMENT RECOMMENDATIONS

7.1 Subgrade Strength

The equations shown below from NCHRP Study 128, and the AASHTO 1993 Pavement Design Guide were used to convert the R-value measured in the laboratory to a subgrade Resilient Modulus.

$$S_1 = [(R-5)/11.29] + 3 \qquad \text{(Eq. 2.1)}$$

$$M_R = 10^{[S_1 + 18.72)/6.24]} \qquad \text{(Eq. 2.2)}$$

Where: M_R = resilient modulus (psi)
S_1 = the soil support value
R = the R-value obtained from the Hveem Stabilometer (AASHTO T190)

R-values measured by Yeh and Associates in accordance with AASHTO T190 on the soils from the project ranged from 18 to 44. Using these equations, and based on the results of our investigation, an R-value of 29 was used to calculate a resilient modulus of 6,629 psi. This resilient modulus value was used as one of the inputs for the DARWin Pavement Design computer program to determine recommended pavement thickness for FH 35. The DARWin pavement design computer program generally follows the AASHTO 1993 Pavement Design Manual. Other structural layer coefficients used in design were found in the “FHWA CFL Project Development and Design Manual (PDDM)”, March 2008.

7.2 Traffic Loading

NMDOT provided an Average Annual Daily Traffic (AADT) volume of 682 vehicles. This traffic volume appears to be consistent with our observations of the traffic during our field investigation. Yeh and Associates calculated ESALs based on the provided AADT, using a

percentage of heavy vehicles typical for a rural minor arterial and a range of design lives with a 20-year growth factor of 1.2. The calculated traffic loads in 18-kip ESALs are shown below in Table 7.1. The NMDOT vehicle traffic mix for a Minor Rural Arterial was used to calculate 18-kip ESALs. Vehicle ESAL Factors used in the calculation are from Chapter 11of the CFL Project Development and Design manual (PDDM).

Table 7.1: Design ESALs Based on Years in Service

No. of Years	Design ESALs
5-Years	209,935
10-Years	429,704
15-Years	659,982
20-Years	901,488

7.3 Pavement Design

Data from the previous NMDOT study and the recent Yeh and Associates study indicate the existing pavement typically consists of 3.5 inches of asphalt over 5.3 inches of aggregate base course (ABC). The combined thickness of existing asphalt and ABC between MP 40.0 and MP 43.5 is less than the typical thickness. However, because the subgrade soils in this segment generally have very good pavement support characteristics, the design parameters shown below should be adequate and an additional pavement design was not evaluated for this area. The rehabilitation methods that were evaluated utilize the existing pavement in combination with new materials. The design parameters used to evaluate alternate pavement rehabilitation methods and pavement layer thicknesses are shown below in Table 7.2.

Table 7.2: Pavement Design Parameters

Existing Conditions

Sub grade R-value	29
M_R (psi)	6,629
Existing Pavement Thickness (in.)	3.5
Existing Aggregate Base Thickness (in.)	5.3
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability	75%
Overall Standard Deviation	0.49

Structural Layer Coefficients

Material	Coefficient	Source
Existing Pavement	0.30	Assumed based on experience.
Existing ABC	0.12	CFL
New HACP	0.44	CFL & NMDOT
Cold Recycle	0.25	CFL & NMDOT
Hot In-place Recycle	0.30	NMDOT
Pulverized Material	0.12	CFL

Yeh and Associates evaluated five alternate pavement designs for the main line rehabilitation using this data. The alternates for a 20-year design life are summarized in Table 7.3. The Design Structural Number for a 20-year pavement life is 3.26.

Table 7.3: 20-year Pavement Design Alternates

Treatment	HACP (in)
Overlay	3.6
Mill 2" and Overlay	5.1
Cold Recycle 4"	3.5
Hot In-place 2"	3.6
Pulverize 6 & remove 1" for shoulder ABC	5.5

New pavement placed in shoulder widening areas for a 20-year design should consist of 12.5 inches of aggregate base course and 4 inches of HACP surface course.

The narrow existing bench width will not accommodate a significant increase in roadway surface elevation that will result from construction of a thick pavement structural section. A maximum practical profile increase of 3 inches will still allow for construction of a safety edge within the existing disturbed limits and bench width. Three pavement design alternatives were evaluated to determine the years of service life that could be achieved for designs that limit the rise in grade to 3 inches above the existing pavement grade. The estimated costs for each alternative were evaluated using the unit costs for each component shown in Table 7.4. The pavement width for the alternates was assumed to be 28 feet including shoulders. These cost estimates are intended for comparison purposes only to assist with preliminary design decisions.

Table 7.4: Estimated Material Unit Costs

Material	Estimated Unit Cost	Cost Data Source
HACP	$95/TON	VE Report*
2" Cold Mill	$1/SY	NMDOT 2011 Cost Data
6" Pulverization	$4/SY	VE Report*
Base Course	$60/TON	VE Report*

*Value Engineering Study NM PFH 35-1(1), Alamogordo-Elk, March 19-23, 2012

Recommended pavement section thicknesses for each rehabilitation that result in a 3-inch rise in grade are shown below in Table 7.5 alternate. The end of the pavement service life results from a decline of the pavement quality to the terminal serviceability of 2.5. Design years of service were calculated for each alternate using the ratio of 3" rise ESALs to 20-Year ESALs multiplied by 20 Years; for example 555,709/901,488 X 20 = 12.3 years. The design years of service calculated

by this method are approximate and the anticipated pavement life is reported as a range of years in the table. A 5/8-inch friction course is assumed for each alternate and the cost of the friction course was not included in the comparative cost estimates.

Table 7.5: Thicknesses, Number of Service Years and Estimated Cost (3-inch rise above existing pavement grade)

Alternate	Treatment	HACP Thickness	Structural Number	ESALs	Years of Service	Estimated Cost (millions)
1	Overlay	3.5"*	3.23	850,846	15-20	$3.05
2	Mill 2" and Overlay	5"	3.21	819,462	15-20	$3.97
3	Pulverize 6" & remove 1" for shoulder ABC	4"	2.64	252,235	5-10	$3.64

*Leveling course and 3" overlay.

7.4 Discussion of Alternates

Alternate 1(overlay) includes a leveling course to fill existing ruts in the wheel tracks. The leveling course is expected to result in an average 0.5-inch thickness of HACP over the width of the roadway. Alternate 1 has an advantage that construction can be relatively rapid with the least impact to traffic of the three alternates. The placement of two courses of HACP allows a limited opportunity to improve ride and correct crown or super-elevation deficiencies. This alternate has the lowest estimated cost and an anticipated service life that is typical for HACP design. The estimated cost includes 6 inches of ABC for the shoulder widening.

Disadvantages of Alternate 1 include less opportunity to correct ride, crown and super-elevation defects than the alternates that require partial or complete removal of the existing asphalt surface. The potential is high for reflection cracking from the existing pavement with the overlay alternative. Reflection cracking can significantly shorten the theoretical 20-year maximum service life of Alternate 1.

Alternate 2 includes partial re-use of the existing pavement materials. Alternate 2 (milling 2 inches) will generate approximately 13,000 tons of asphalt millings for shoulder ABC (6,500 Tons) and as Recycled Asphalt Product (RAP) that can be added to the new HACP mix. Correction of inadequate cross-slope, crown and super-elevation should be possible with this alternate. Opportunities for grade modification occur during the milling process and with each of the two lifts of HACP that will make up the surface course. This alternate is expected to have a typical HACP pavement service life.

Alternate 2 has the disadvantage of the highest cost of the three alternates. Construction time will be greater than Alternate 1 and traffic will travel on an intermediate surface (milled asphalt) that could become hazardous if paving is delayed and the surface degrades. This is of particular

concern between MP 40.0 and MP 43.5. Patching with HACP will be necessary where the milled asphalt surface is very thin or fails under traffic. There is potential for reflective cracks to propagate from the underlying un-milled surface with this option.

Alternate 3 has the most complete re-utilization of the existing pavement materials. Pulverizing to 6 inches depth and removal of 1 inch of pulverized material for use as shoulder ABC will allow placement of 4 inches of new HACP for a total 3-inch rise of the grade. Although the cost for this alternate is not the lowest, the pulverization and re-grading processes provide the best opportunities to re-shape the roadway and correct grades or super-elevation. Full-depth reclamation will eliminate the potential for reflection cracking in the new HACP. During construction, maintenance of the pulverized surface can be performed under traffic using conventional equipment and existing materials.

Alternate 3 has the disadvantage of the lowest expected service life of the three rehabilitation options. The intermediate surface for the pulverization alternate will be compacted aggregate consisting of the pulverized material. Wet weather during construction could damage the intermediate driving surface of the pulverized materials and could significantly slow production. Dry conditions will increase the potential for blowing dust during construction of the pulverized base course and dust palliative may be required.

Adding emulsion to treat the upper 2 to 4 inches of base course or pulverized material will increase the structure coefficient for the ABC layer from 0.12 to 0.25. The increased layer strength translates to an increase in the maximum theoretical design life. Four inches of emulsion treatment could increase the service life of Alternate 3 to a range of 10 to15 years. The cost for four inches of emulsion treated ABC is expected to be similar to that for cold recycle, approximately $12 per square yard.

NMDOT often specifies an open graded friction course (OGFC) as a surface treatment. This treatment improves the friction of the driving surface and reduces raveling of the underlying HACP. The OGFC is not given a structure layer coefficient and does not contribute to the structural number or the theoretical pavement service life. The 2011 Statewide Average Cost for rubberized OGFC in New Mexico was $83.23/TON.

7.5 Binder and Mix Recommendations

Using the Long Term Pavement Performance binder selection program LTPPBind, the 98% reliability binder recommended for the closest weather station in Mayhill, NM is PG 58-22. Figure 7.5 shows the print-out from the program based on historic weather information from the Mayhill Weather Station. PG 58-22 was also listed as the 98% reliability binder at the weather station near Elk, NM.

Figure 7.5: Recommended Mix Binder

State/Province	NM
Weather Station	MAYHILL RS
Depth from Pavement Surface to Top of Layer, mm	0

Station ID	0295502	Latitude	32.92
County / District	OTERO	Longitude	105.47
Last Year Data Avail.	1975	Elevation, m	2001

Air Temperature	Mean	Std Dev	Min	Max	Years
High 7-day Air Temp., Deg. C	31.8	1.3	30.2	34.5	21
Low Air Temperature, Deg. C	-20.2	3.4	-26.1	-15.6	16
Low Air Temp. Drop, Deg. C	20.9	4.2	9.4	27.8	16
Degree Days over 30 Deg. C	43	38	7	164	21

Pavement Temperature and PG	HIGH	LOW	High Rel	Low Rel
50% Reliability Pvt Temp., C	51.4	-11.7	50	50
>50% Reliability PG	52	-16	57	90
	58	-16	98	90
	58	-22	98	98

The new HACP overlay should be a nominal ½-inch or 3/4" mix with the above recommended binder. Grading Designation C or E mix is recommended (as per FP-03). A Superpave mix design using a ½-inch or ¾-inch nominal gradation in accordance with Section 401 of FP-03 is recommended. The quantity of binder can be estimated at 6% by weight of the mix and the unit weight can be estimated at 145 lbs/ft^3.

This project is in a relatively remote location and we understand the asphalt plant may be several miles from the construction site. Loss of temperature and segregation of the hot asphalt mix can occur during long distance transport. We recommend the project specifications require the use of a material transfer device at the point of placement to insure uniform temperatures and prevent segregation of the mix during placement. Use of a material transfer device is especially important if the mix is placed in cool weather.

The application of tack coat (at 0.10 gallons/ yd^2) is required on pulverized base material prior to paving. The tack coat material should be CSS-1, CSS-1h, SS-1, or SS-1h. A tack coat at the above rate should be included between each lift of HACP.

Pulverized material or aggregate base course should receive a prime coat of an emulsion blended as a penetrating prime at a rate of 0.33 gallons/yd^2.

7.6 Drainage

The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of the pavement structure. Proper design of drainage should include prevention of ponding of water on or immediately adjacent to pavement areas.

Slopes and other stripped areas should be protected against erosion by re-vegetation or other methods.

7.7 Earthwork

The soils encountered in the exploratory borings are suitable for use as embankment fill under roadways. Embankment materials should be placed and compacted in accordance with the Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects. Cut and fill slopes should be graded at 3 horizontal to 1 vertical or flatter. Slopes should be protected from erosion by re-vegetation or other means.

If soft soils are encountered or become unstable during construction when subjected to traffic loads following removal or pulverization of the existing pavement the upper 1.5 feet or greater depth of the soft material should be removed and replaced with compacted Subbase Fill, Grading A or B or ABC. The required depth of removal and replacement can be reduced if a geosynthetic reinforcement or separator fabric is used below the Subbase Fill.

Sources for aggregate for bases are available near Cloudcroft, NM. Aggregate for HACP mixes may need to be supplied by producers near Alamogordo, NM.

8.0 SOIL CORROSIVITY

Samples from Borings P-1 and P-6 had water soluble sulfate concentrations of 0.016 and 0.001 percent respectively. The low percentage of water soluble sulfates in these soils is not likely to be aggressive toward buried concrete.

The pH of the sample from Boring P-1 was 7.9 and the pH of the sample from Boring P-6 was 8.6. Chloride content of the samples from Borings P-1 and P-6 were very low. The soil pH and chlorides are not expected to contribute to soil corrosivity.

Resistivity measurements of 807 ohm-cm for the sample from Boring P-1 and 2,064 ohm-cm for the sample from Boring P-6 indicate the soils could be aggressive to buried metal. Metal culvert pipes should be corrosion protected. We recommend a corrosion engineer review the requirements for correction protection for any buried metal.

9.0 POTENTIAL GEOLOGIC HAZARDS

The vegetation on the slopes above and north of the highway has recently been thinned by wildfire and prescribed burns. These conditions may contribute to geologic hazards that affect FH 35 including debris flows and rockfall. Heavy seasonal rains can cause erosion in poorly vegetated areas and eroded debris may be channeled down side canyons as a debris flows that reach the highway. Rockfall from the natural limestone cliffs and man-made rock cut slopes adjacent the highway has a potential to reach the travel lanes. The incidence of rockfall may increase due to

sparse vegetation on the rock slopes. Boulder and cobble size rock fragments were observed in the ditch and on the shoulder of the westbound lane. Photo 6 shows an area of potential rockfall hazard.

Photo 6: Potential rockfall hazard.

Methods of mitigation likely to be effective for this project include re-vegetation to reduce erosion, rock slope scaling to remove loose materials and re-grading ditches to improve rockfall catchment.

Compressible soils under the embankment near MP 36.5 may be the cause of the observed settlement in this area. The settlement can be accelerated by saturated subsurface conditions resulting from poor surface drainage and infiltration of runoff. Improving drainage by cleaning, replacing and extending existing culverts will reduce the potential for embankment settlement caused by subsurface moisture. The Yeso Formation includes evaporate zones that could dissolve in the presence of groundwater. The result is a solution cavity in the bedrock that can eventually become a sinkhole and cause settlement of the roadway, similar to that observed near MP 36.5. Improving surface drainage to prevent runoff from ponding near the road can mitigate the effects of sinkholes that may form near the alignment.

10.0 REFERENCES

Federal Highway Administration (FHWA), 2003, *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects*, FP-03.

Google Earth, 2012

AASHTO 1993 Pavement Design Guide

The Weather Channel, LLC weather.com

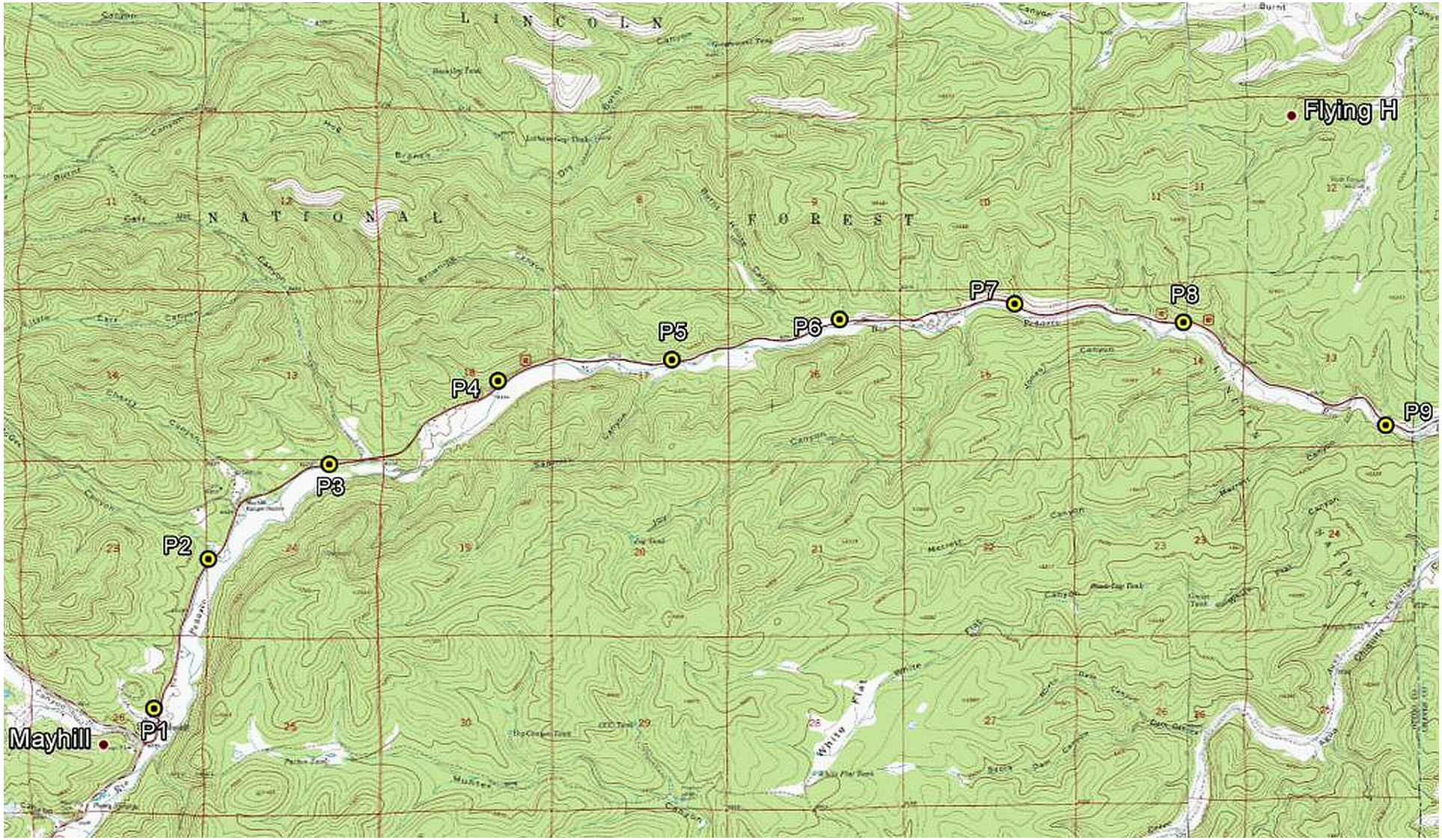
Benjamin Hallett, 2007, Preliminary Geologic Map of the Mayhill Quadrangle, Otero County, New Mexico, New Mexico Bureau of Geology and Mineral Resources.

P. S. & E. Bureau/Bid Analysis Construction Section, New Mexico Department of Transportation, Average Unit Bid Prices (Awarded Contractors), January 2011 - December 2011

11.0 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering practices in this area for use by the client for design and construction purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from exploratory borings and field review and the proposed type of construction. Subsurface variations across the site are likely and may not become evident until excavation is performed. If during construction, pavement, fill, soil, rock or water conditions appear to be different from those described herein, this office should be advised at once so reevaluation of the recommendations may be made. We recommend on-site observation of excavations and pavement subgrade conditions by a representative of the geotechnical engineer.

Appendix A – Site Map



Print Date:	ALAMOGORDO TO ELK NM PFH 35-1(1)	PAVEMENT BORING LOCATIONS	Project Information
File Name: Yeh Letter-Sized Border Landscape.dgn			
Horiz. Scale: 1:1 Vert. Scale: As Noted		Designer: XXX Detailer: XXX Checked by: XXX	Yeh & Associates Project No. 212-034
Yeh and Associates, Inc. Consulting Engineers & Scientists			Sheet Number A-1

Appendix B – Exploratory Boring Logs

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-1**
Sheet 1 of 1

Boring Began: 3/13/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/13/2012
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. 3" Asphalt.	
								0.3 - 1.6 ft. 13" Base Course.	
								1.6 - 5.0 ft. sandy CLAY, reddish brown, low plasticity, moist, stiff.	
					12/10/10	20			+#4= 8% -#200= 68% LL= 32 PL= 15 PI= 7 pH= 7.9 S= .016% Cl= 0.024% R-Value= 18 Re= 807ohms-cm AASHTO: A-6 (9) USCS: SC
	5							Bottom of Hole at 5.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-2**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.1 ft. 1.5 Inches Asphalt.	
								0.1 - 1.0 ft. 9 Inches Base course.	
								1.0 - 5.0 ft. clayey SAND gravelly, SC, reddish brown, medium plasticity, moist, medium dense to very loose.	
					1/3/4	4			+#4= 21% -#200= 40% LL= 27 PL= 14 PI= 13 R-Value= 25 AASHTO: A-6 (1) USCS: SC
	5							Bottom of Hole at 5.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-3**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.5 ft. 5.5 Inches Asphalt.	
								0.5 - 1.0 ft. 5 Inches Base Course.	
								1.0 - 5.0 ft. clayey SAND gravelly (Fill), SC, dark brown, medium plasticity, moist, medium dense.	
					5/6/7	11			+#4= 37% -#200= 39% LL= 29 PL= 17 PI= 12 R-Value= 30 AASHTO: A-6 (1) USCS: SC
	5							Bottom of Hole at 5.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-4**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. 3 Inches Asphalt.	
								0.3 - 0.8 ft. 6 Inches Base Course.	
								0.8 - 5.0 ft. clayey GRAVEL sandy, GC, tan and gray, medium plasticity, moist, very dense.	
					24/35/24	59			+#4= 37% -#200= 32% LL= 28 PL= 15 PI= 12 R-Value= 31 AASHTO: A-2-6 (0) USCS: GC
	5							Bottom of Hole at 5.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-5**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 4.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. 4 Inches Asphalt.	
								0.3 - 0.8 ft. 6 Inches Base Course.	
								0.8 - 2.0 ft. clayey SAND gravelly (Fill), SC, dark brown, medium plasticity, moist, dense.	
					15/26/24	41		**2.0 - 4.0 ft. clayey GRAVEL** and Cobbles, tan and black, medium plasticity, damp to moist, dense.	+#4= 30% -#200= 40% LL= 24 PL= 14 PI= 10 R-Value= 18 AASHTO: A-2-4 (0) USCS: SC
								Bottom of Hole at 4.0 ft.	Auger refusal In cobbles at 4 feet

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-6**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.2 ft. 2 Inches Asphalt.	
								0.2 - 0.9 ft. 9 Inches Base Course.	
								0.9 - 2.0 ft. clayey GRAVEL and Cobbles (Fill), tan and gray, low plasticity, dry, dense.	
					4/7/10	11		**2.0 - 5.0 ft. clayey GRAVEL** sandy, brown, low plasticity, moist, medium dense to dense.	+#4= 29% -#200= 43% LL= 21 PL= 17 PI= 4 pH= 8.6 S= 0.001% Cl= 0.006% R-Value= 24 Re= 2964ohms-cm AASHTO: A-4 (0) USCS: GM-GC
	5							Bottom of Hole at 5.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-7**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 5.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.2 ft. 2 Inches Asphalt.	
								0.2 - 1.0 ft. 9 Inches Base Course.	
								1.0 - 3.0 ft. clayey GRAVEL and Cobbles, brown, low plasticity, damp, very dense.	
					9/30/3"	30/3"			+#4= 43% -#200= 21% LL= 19 PL= 13 PI= 6 R-Value= 29 AASHTO: A-1-b (0) USCS: GM-GC
								3.0 - 5.0 ft. clayey SAND gravelly, gray - brown, medium plasticity, damp, medium dense to dense.	
	5							Bottom of Hole at 5.0 ft.	

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-8**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 4.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.2 ft. 2.5 Inches Asphalt.	
								0.2 - 0.8 ft. 7 Inches Base Course.	
								0.8 - 4.0 ft. clayey GRAVEL sandy, tan, medium plasticity, dry, medium dense to dense.	
					11/12/6	23			+#4= 35% -#200= 33% LL= 28 PL= 15 PI= 13 R-Value= 23 AASHTO: A-2-6 (0) USCS: GC
								Bottom of Hole at 4.0 ft.	Auger refusal on bedrock at 4 feet

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Alamogordo to Elk: US HWY 82
Project Number: 212-034 Date: 3/13/12

Boring: **P-9**
Sheet 1 of 1

Boring Began: 3/12/2012
Drilling Method: Hollow-Stem Auger
Drill: CME 75
Driller: Enviro-Drill
Logged By: B. Bunker
Final By: T. Allen
Inclination: Vertical

Completed: 3/12/2012
Drill Bit:
Casing:
Weather:

Total Depth: 7.0 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.3 ft. 3 Inches Asphalt.	
								0.3 - 1.0 ft. 8 Inches Base Course.	
								1.0 - 7.0 ft. silty GRAVEL and Cobbles, tan and gray, no plasticity, dry, medium dense.	
					10/14/7	24			
	5								+#4= 68% -#200= 13% PI= NP R-Value= 44 AASHTO: A-1-a (0) USCS: GM
								Bottom of Hole at 7.0 ft.	

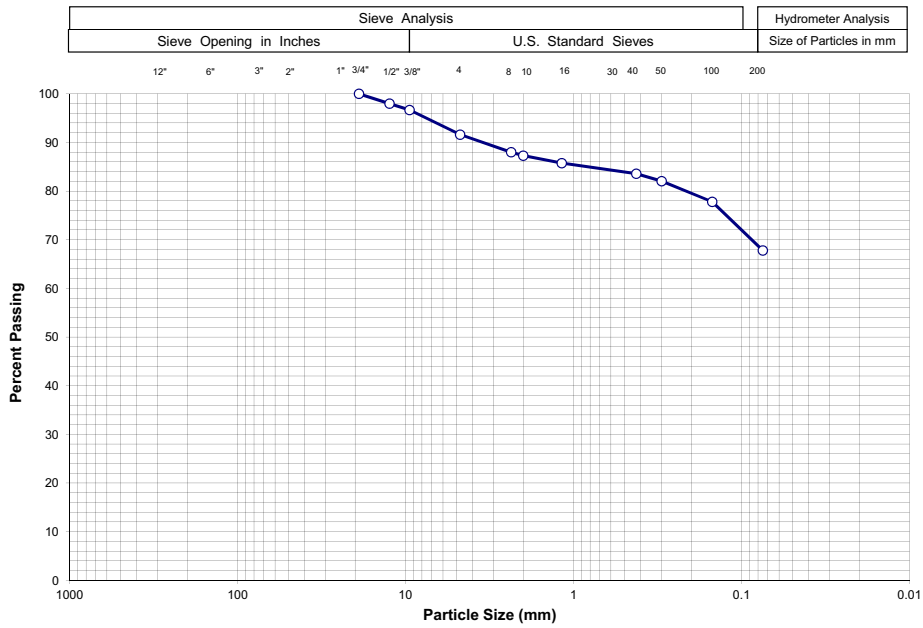
Appendix C – Laboratory Test Results

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 212-034 Project Name: Alamogordo to Elk: NM SR 82/FH 35 Date: 4/16/2012

Sample Information			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	Chloride %	Resistivity (Ohms - cm)	R Value	CLASSIFICATION	
Boring	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI						AASHTO	USCS
P-1	1.6-5.0	BULK	3.9		8	24	68	32	15	17	7.9	0.016	0.024	807	18	A-6 (9)	CL
P-2	1.0-2.0	BULK	0.7		21	40	39	27	14	13					25	A-6 (1)	SC
P-3	1.0-5.0	BULK	2.0		37	34	39	29	17	12					30	A-6 (1)	SC
P-4	0.75-5.0	BULK	0.8		37	31	32	28	15	12					31	A-2-6 (0)	GC
P-5	1.3-5.0	BULK	1.2		30	40	30	24	14	10					18	A-2-4 (0)	SC
P-6	2.0-5.0	BULK	1.1		29	28	43	21	17	4	8.6	0.001	0.006	2,964	24	A-4 (0)	GM-GC
P-7	1.0-3.0	BULK	0.2		43	36	21	19	13	6					29	A-1-b (0)	GM-GC
P-8	1.0-5.0	BULK	0.6		35	33	32	28	15	13					23	A-2-6 (0)	GC
P-9	1.0-7.0	BULK	0.2		68	20	13	NV	NP	NP					44	A-1-a (0)	GM



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	98
⅜"	97
#4	92
#10	87
#40	84
#200	67.8

Gravel (%)	8	LL	32	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	24	PL	15	Boring:	P-1
Fines (%)	68	PI	17	Sample Depth (ft.):	1.6-5.0'
Sample Description:	0	CL	A-6	(9)	

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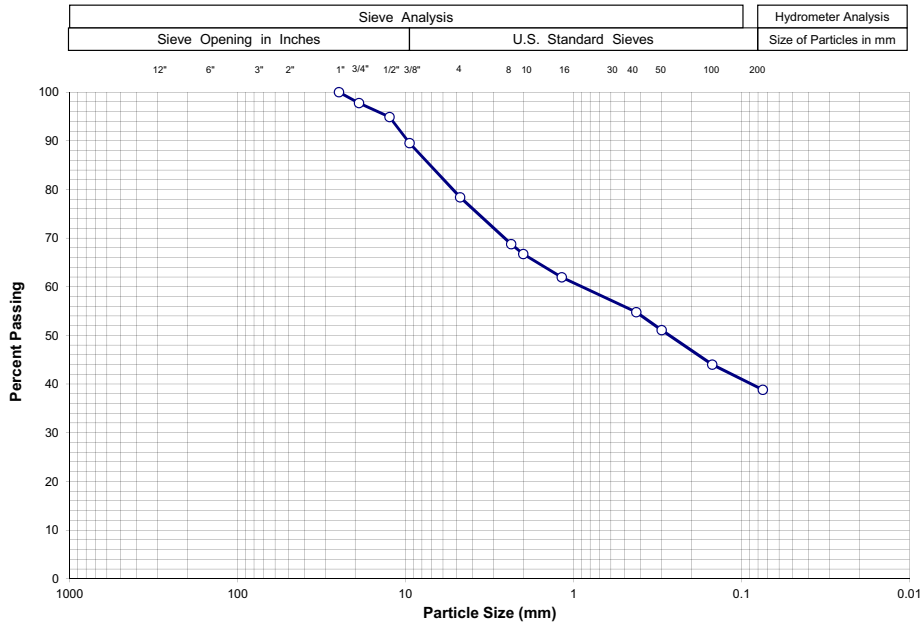
SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	100
¾ "	98
½"	95
⅜"	90
#4	78
#10	67
#40	55
#200	38.8

Gravel (%)	22	LL	27	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	39	PL	14	Boring:	P-2
Fines (%)	39	PI	13	Sample Depth (ft.):	1.0-2.0'
Sample Description:	0	SC	A-6	(1)	

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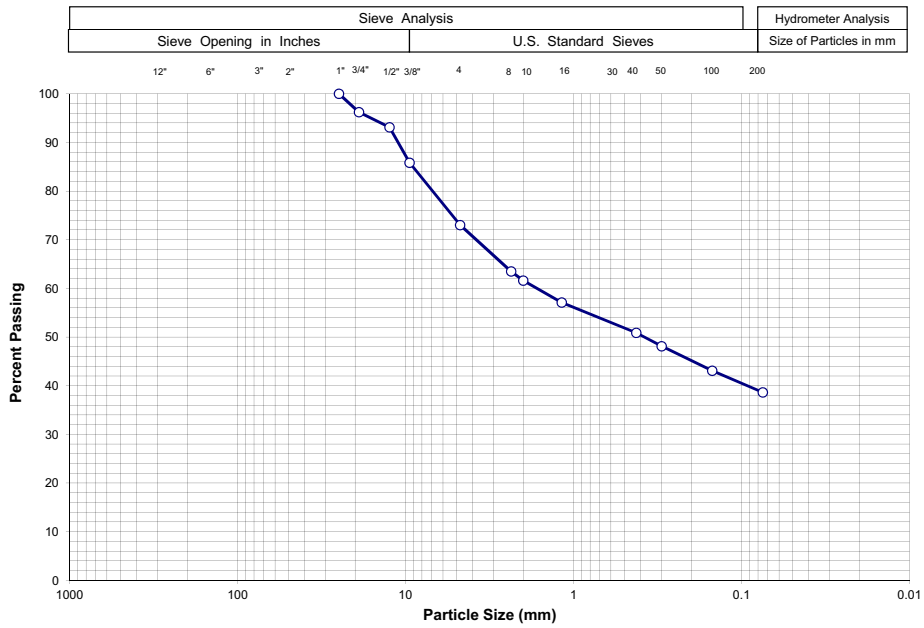
SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	100
¾ "	96
½"	93
⅜"	86
#4	73
#10	62
#40	51
#200	38.6

Gravel (%)	27	LL	29	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	34	PL	17	Boring:	P-3
Fines (%)	39	PI	12	Sample Depth (ft.):	1.0-5.0'
Sample Description:	0	SC	A-6	(1)	

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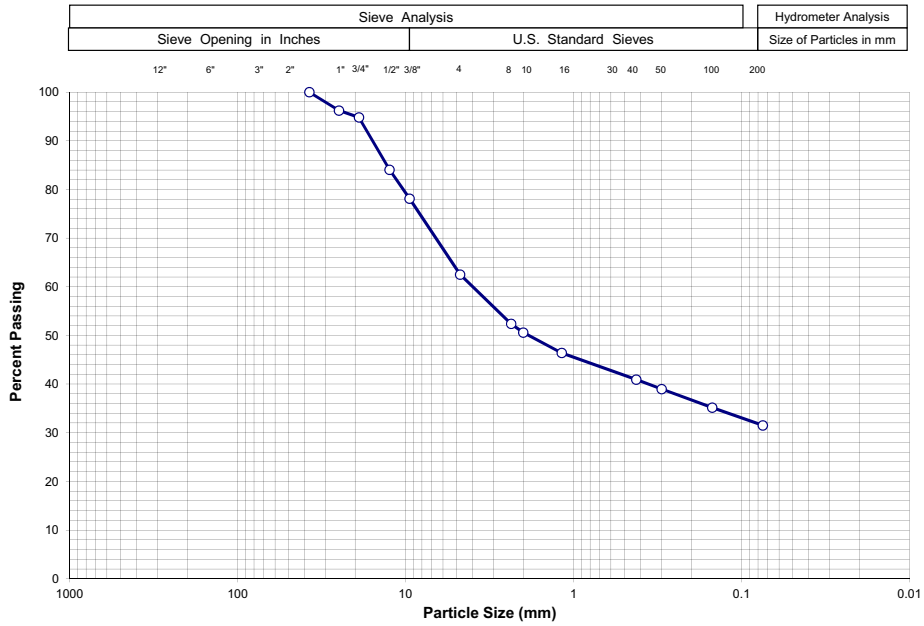
SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	96
¾ "	95
½"	84
⅜"	78
#4	63
#10	51
#40	41
#200	31.5

Gravel (%)	37	LL	27	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	31	PL	15	Boring:	P-4
Fines (%)	32	PI	12	Sample Depth (ft.):	.75-5.0
Sample Description:	0	GC	A-2-6	(0)	

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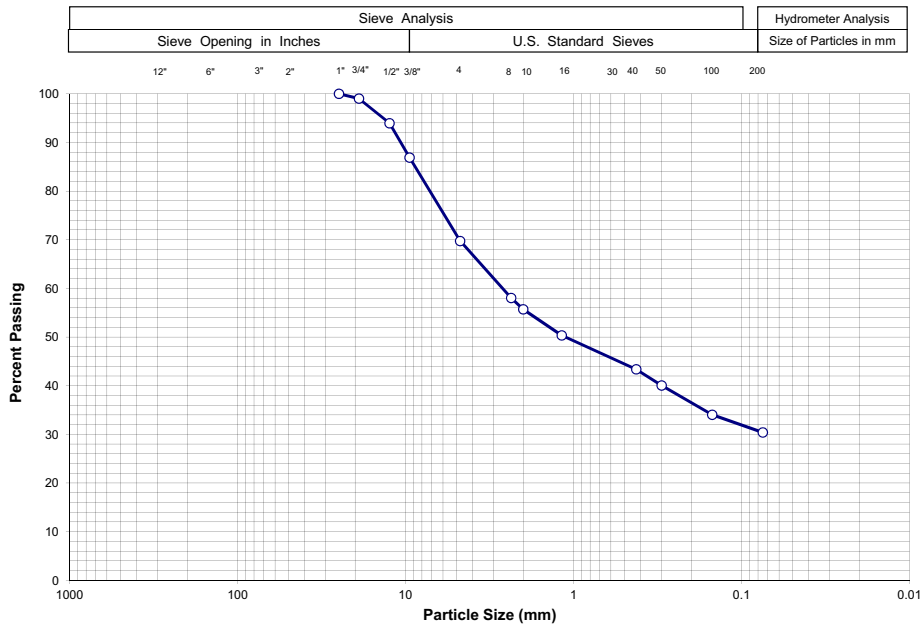
SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



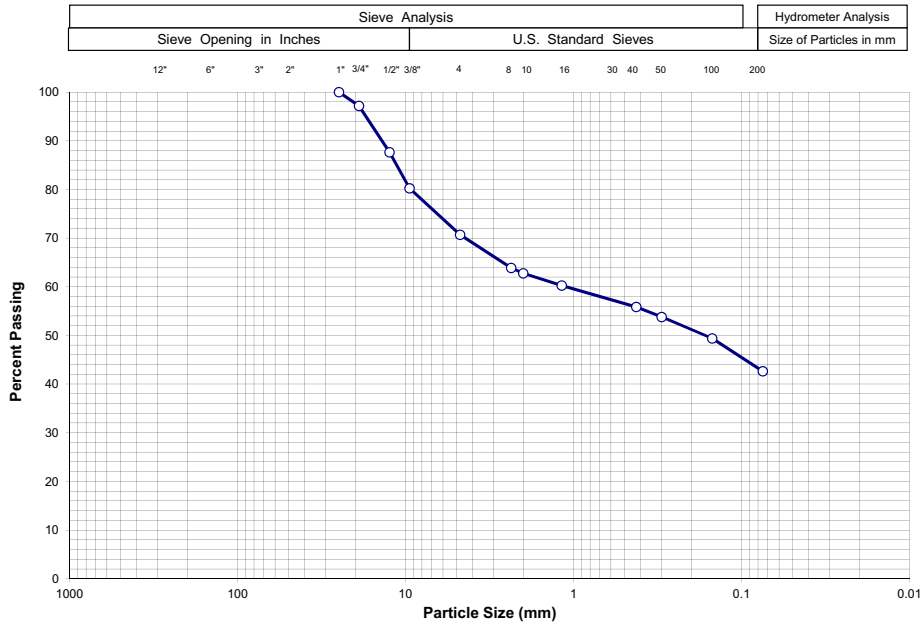
Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	100
¾ "	99
½"	94
⅜"	87
#4	70
#10	56
#40	43
#200	30.4

Gravel (%)	30	LL	24	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	40	PL	14	Boring:	P-5
Fines (%)	30	PI	10	Sample Depth (ft.):	1.2-4.0'
Sample Description:	0	SC	A-2-4	(0)	

Yeh & Associates, Inc.
Geotechnical Engineering Consultants

SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



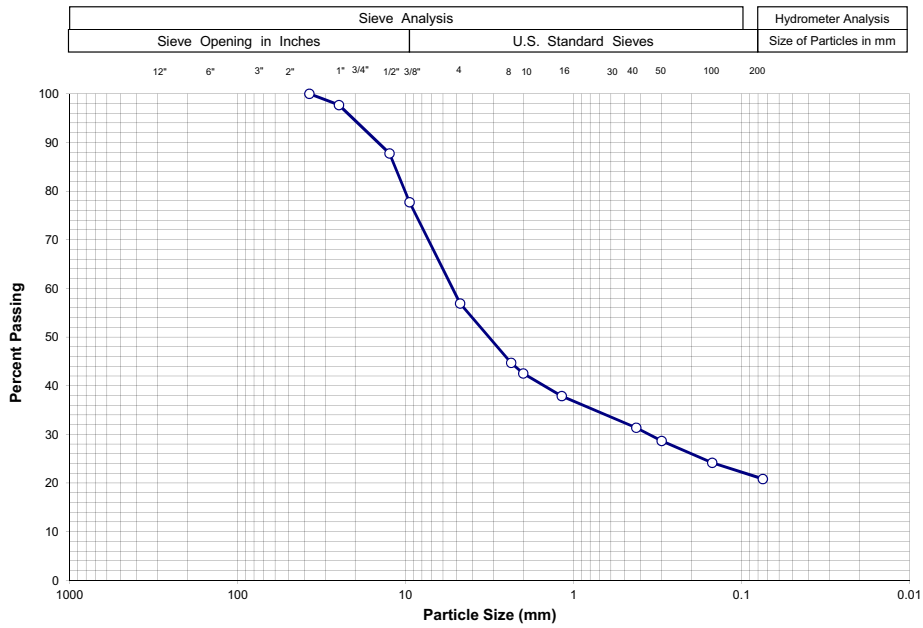
Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	100
¾ "	97
½"	88
⅜"	80
#4	71
#10	63
#40	56
#200	42.6

Gravel (%)	29	LL	21	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	28	PL	17	Boring:	P-6
Fines (%)	43	PI	4	Sample Depth (ft.):	2.0-5.0
Sample Description:	0	GM-GC	A-4	(0)	

Yeh & Associates, Inc.
Geotechnical Engineering Consultants

SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



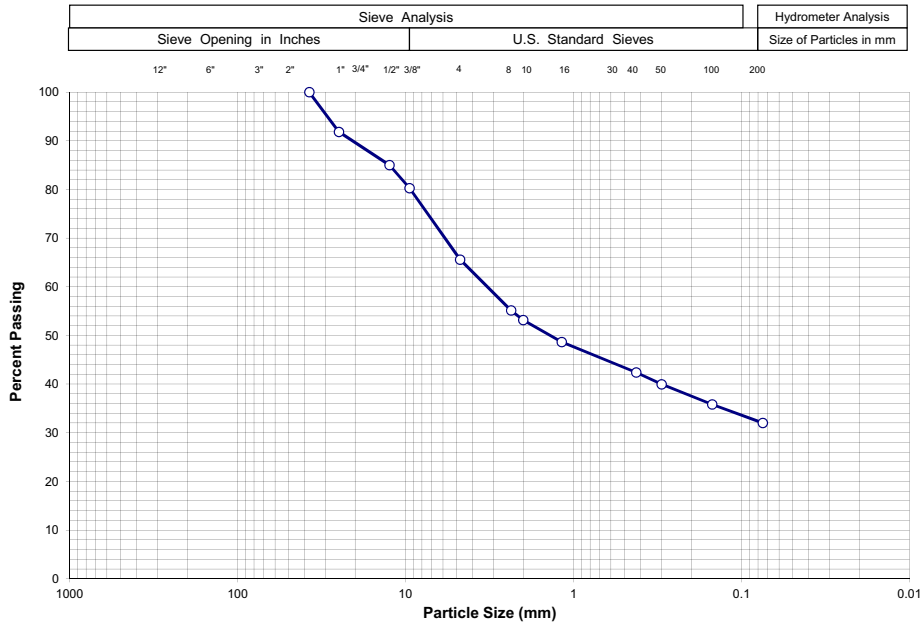
Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	98
¾ "	-
½"	88
⅜"	78
#4	57
#10	43
#40	31
#200	20.8

Gravel (%)	43	LL	19	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	36	PL	13	Boring:	P-7
Fines (%)	21	PI	6	Sample Depth (ft.):	1.0-3.0'
Sample Description:	0	GM-GC	A-1-b	(0)	

Yeh & Associates, Inc.
Geotechnical Engineering Consultants

SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



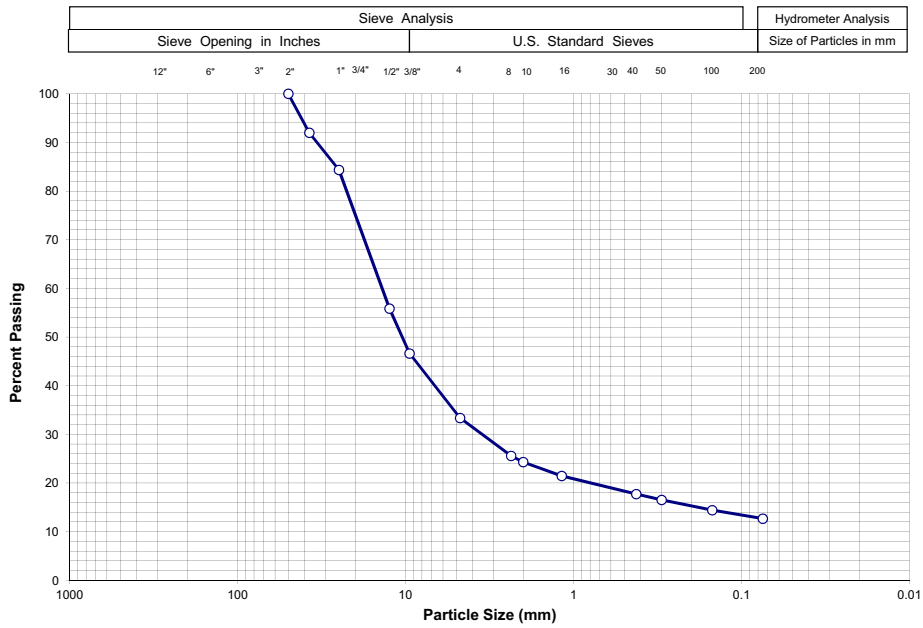
Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	92
¾ "	90
½"	85
⅜"	80
#4	66
#10	53
#40	42
#200	32.0

Gravel (%)	34	LL	28	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	34	PL	15	Boring:	P-8
Fines (%)	32	PI	13	Sample Depth (ft.):	1.0-5.0'
Sample Description:	0	GC	A-2-6	(0)	

Yeh & Associates, Inc.
Geotechnical Engineering Consultants

SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		



Sieve Size	% Passing
3"	-
2 ½"	-
2"	100
1 ½"	92
1"	84
¾ "	70
½"	56
⅜"	47
#4	33
#10	24
#40	18
#200	12.7

Gravel (%)	67	LL	NV	Project Name:	Alamogordo to Elk: US HWY 82
Sand (%)	20	PL	NP	Boring:	P-9
Fines (%)	13	PI	NP	Sample Depth (ft.):	1.0-7.0'
Sample Description:	0	GM	A-1-a	(0)	

Yeh & Associates, Inc.
Geotechnical Engineering Consultants

SIEVE ANALYSIS

Drawn By:	TLA	Project No.:	212-034
Checked By:	TLA	Figure No.:	-
Date:	03/19/12		

YEH AND ASSOCIATES, INC

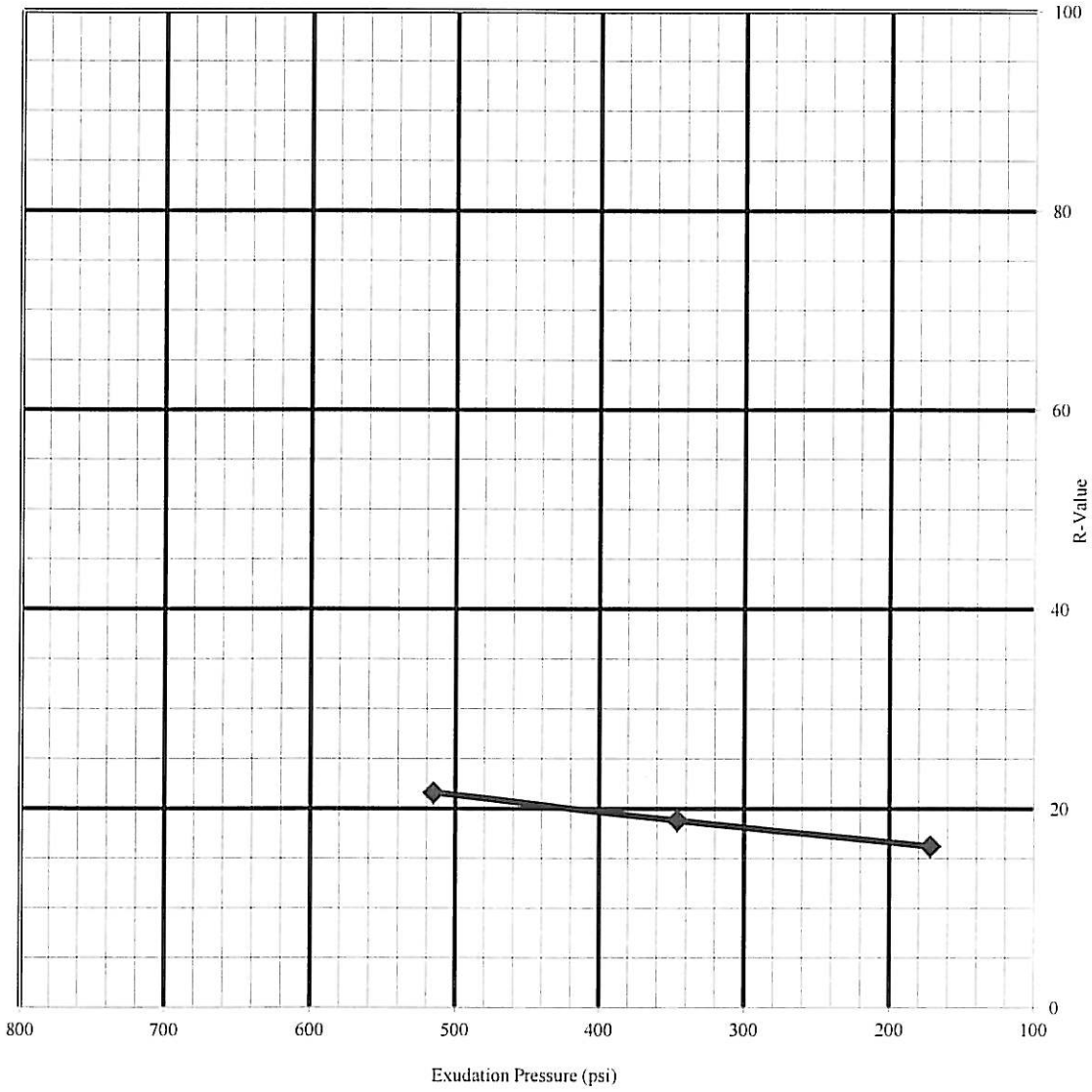
R-Value Test Report

Project Number: 212-034 Project Name: CFL PB Alamogordo

Sample Id: P-1 Depth (ft):

Soil Description: Classification:

R-Value at 300 psi exudation pressure = 18



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	119.8	15	116	2.48	515	23	22
2	300	118.4	16	124	2.56	346	17	19
3	300	118.0	17	126	2.66	172	14	16

Tested by: Lev Bekker Checked by: Mustapha Aichiouene

Rev.2-2/2011

YEH AND ASSOCIATES, INC

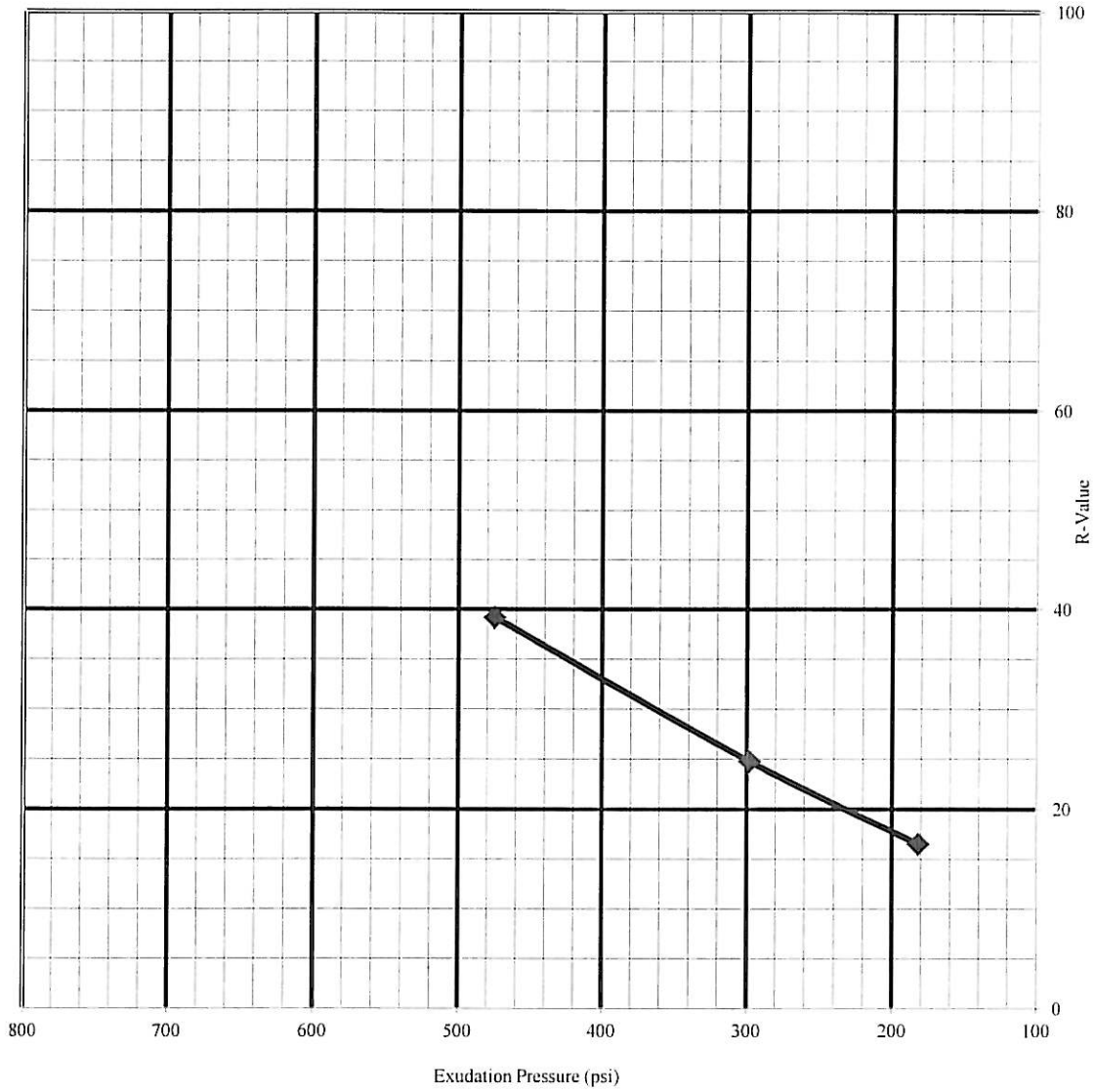
R-Value Test Report

Project Number: 212-034 Project Name: CFL PB Alamogordo- ELK

Sample Id: P-2 Depth (ft): 1-3

Soil Description: Classification:

R-Value at 300 psi exudation pressure = **25**



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	131.3	8	80	2.48	475	41	39
2	300	131.3	10	108	2.60	298	23	25
3	300	131.0	11	122	2.52	182	15	17

Tested by: Mustapha Aichiouene Checked by: RFL

Rev.2-2/2011

YEH AND ASSOCIATES, INC

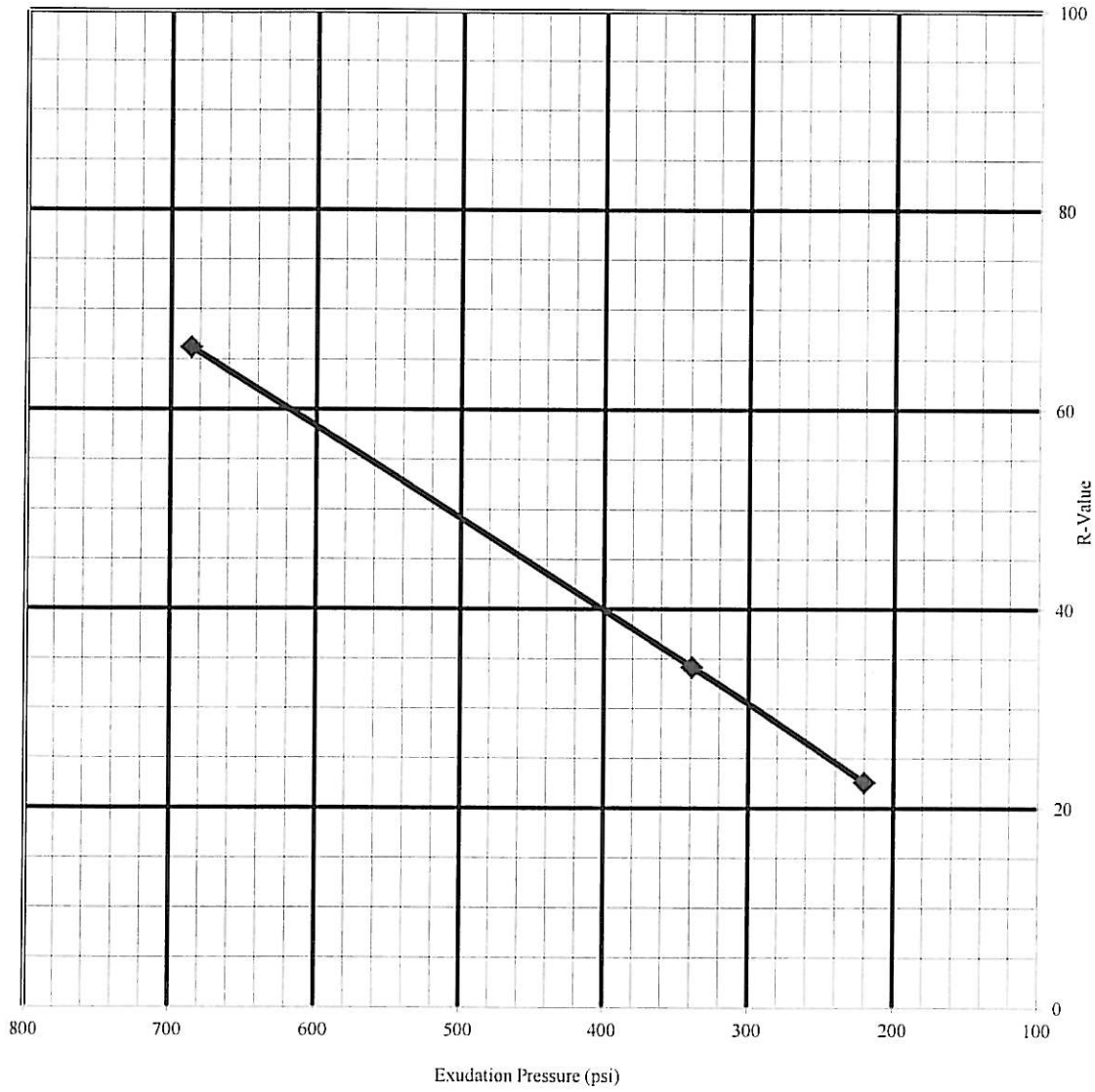
R-Value Test Report

Project Number: 212-034 Project Name: CFL PB Alamogordo-ELK

Sample Id: P-3 Depth (ft):

Soil Description: Classification:

R-Value at 300 psi exudation pressure = **30**



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	123.9	12	111	2.60	220	22	23
2	300	125.7	11	96	2.51	339	30	34
3	300	125.1	10	54	2.55	686	61	66

Tested by: Mustapha Aichiouene Checked by: RFL

Rev.2-2/2011

YEH AND ASSOCIATES, INC

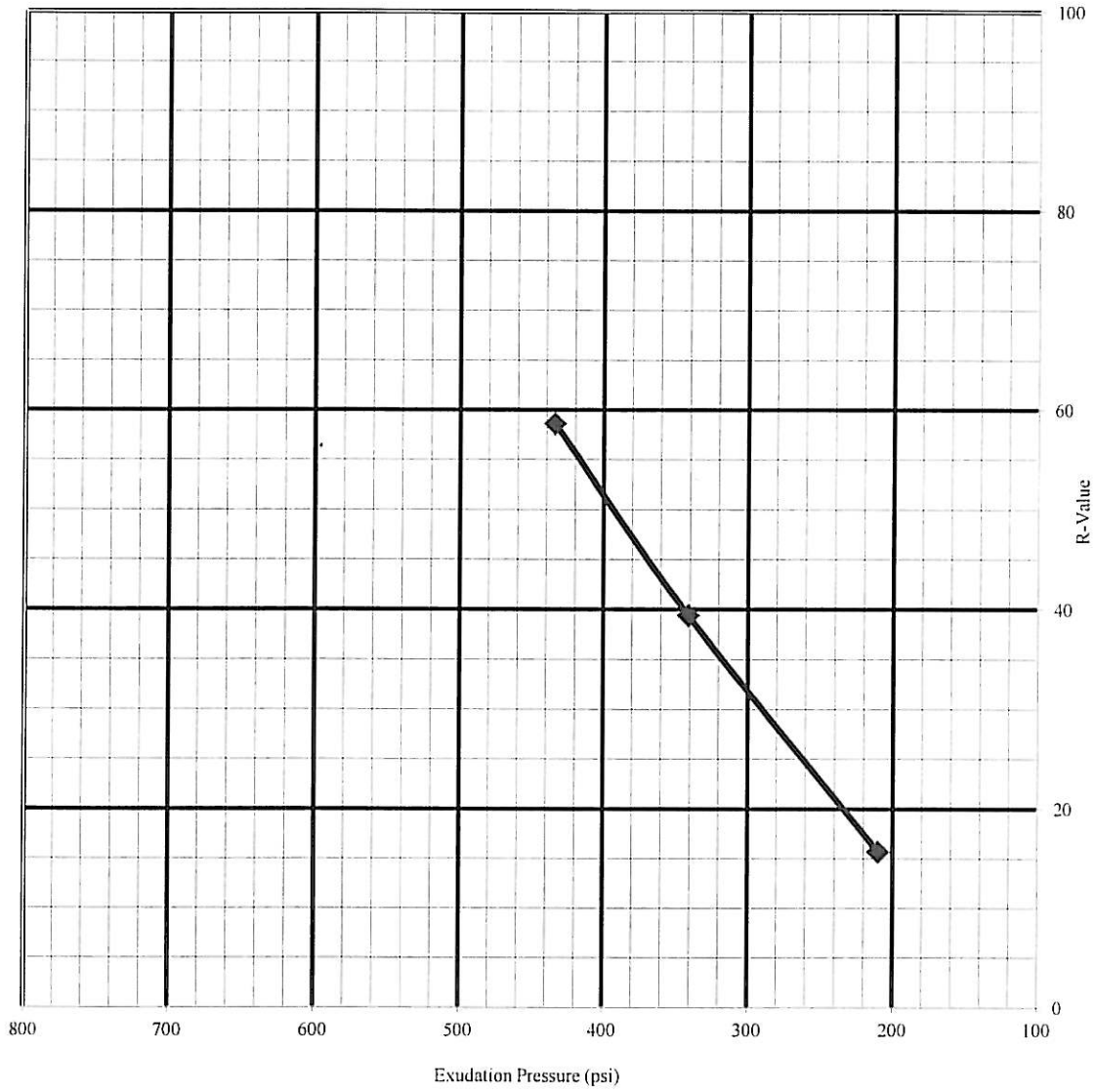
R-Value Test Report

Project Number: 212-034 Project Name: CFL PB Alamogordo-ELK

Sample Id: P-4 Depth (ft): 0.2-5

Soil Description: Classification:

R-Value at 300 psi exudation pressure = 31



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	129.1	10	126	2.65	210	14	16
2	300	130.4	9	81	2.60	341	37	39
3	300	130.9	8	60	2.54	434	54	59

Tested by: Lev Bekker Checked by: RFL

Rev.2-2/2011

YEH AND ASSOCIATES, INC

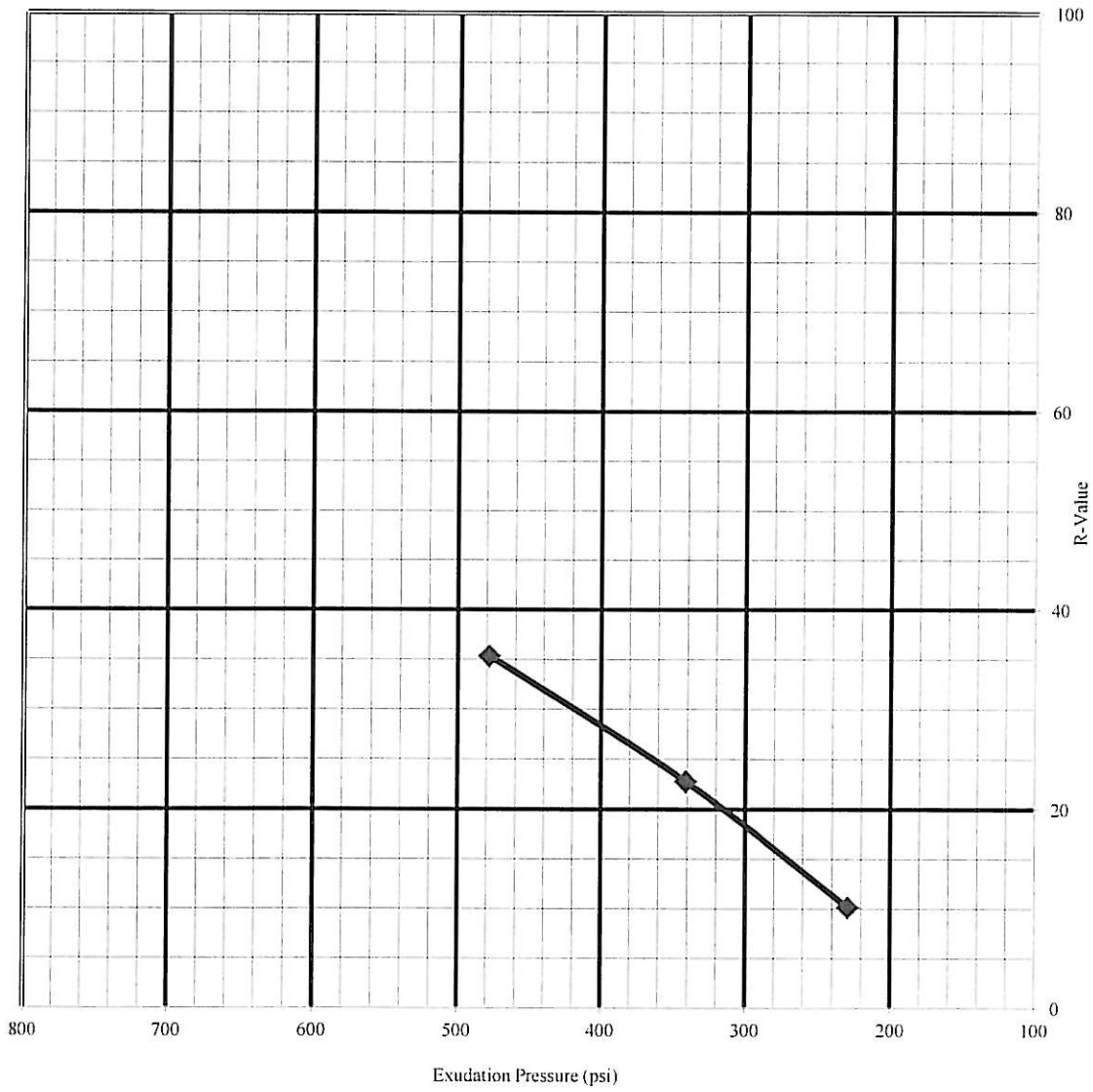
R-Value Test Report

Project Number:212-034 Project Name: CFL PB Alamogordo-ELK

Sample Id:P-5 Depth (ft): 1.2-5

Soil Description: Classification:

R-Value at 300 psi exudation pressure = **18**



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	130.9	11	137	2.62	229	9	10
2	300	130.7	10	112	2.60	341	22	23
3	300	130.5	9	88	2.46	478	37	35

Tested by: Lev Bekker Checked by: Mustapha Aichiouene

Rev.2-2/2011

YEH AND ASSOCIATES, INC

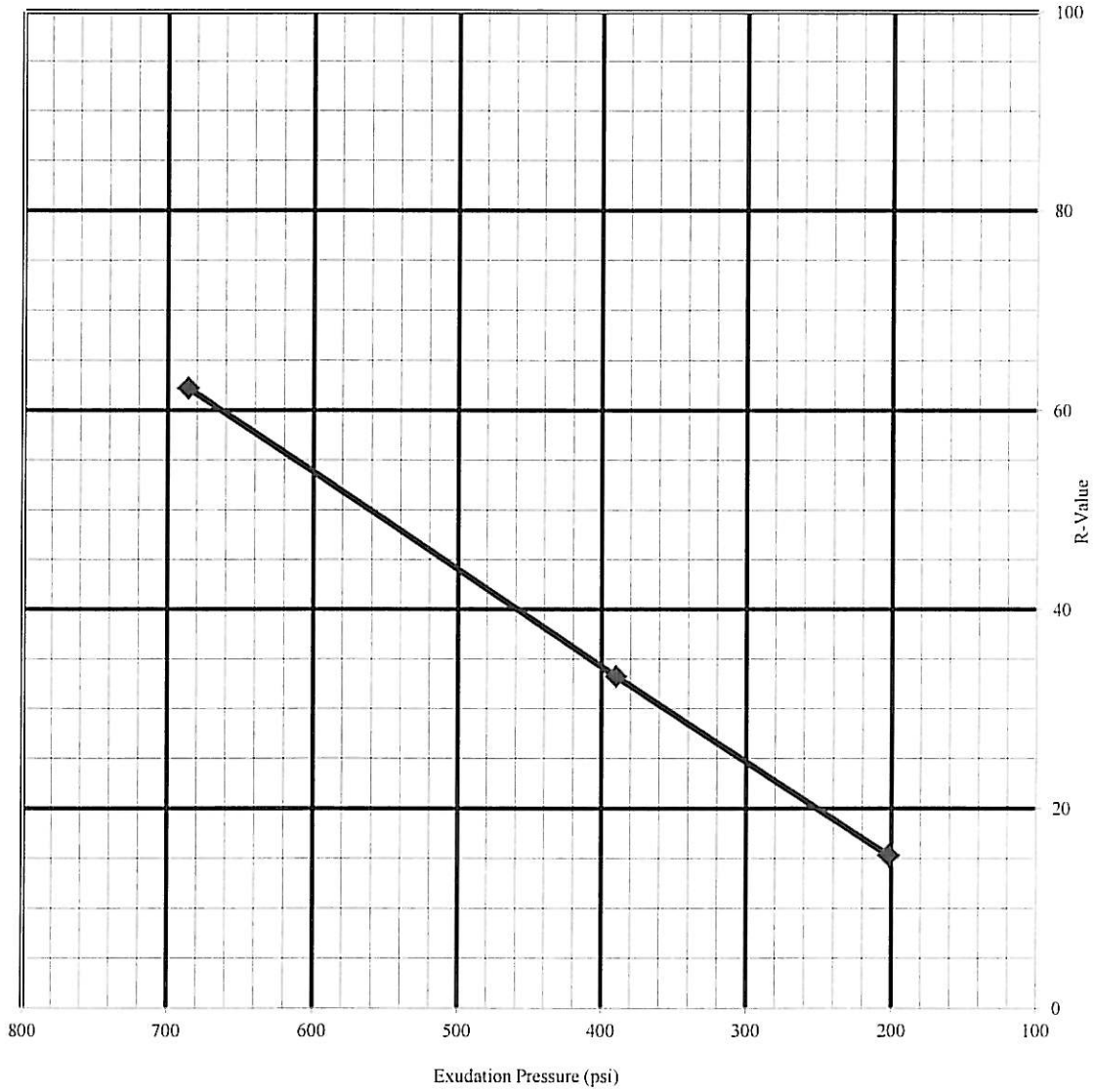
R-Value Test Report

Project Number: 212-034 Project Name: CFL PB Alamogordo-ELK

Sample Id: P-6 Depth (ft): '2-5

Soil Description: Classification:

R-Value at 300 psi exudation pressure = **24**



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	133.5	11	124	2.50	202	15	15
2	300	133.3	10	99	2.51	390	29	33
3	300	133.2	9	48	2.48	686	64	62

Tested by: Lev Bekker Checked by: Mustapha Aichiouene

Rev.2-2/2011

YEH AND ASSOCIATES, INC

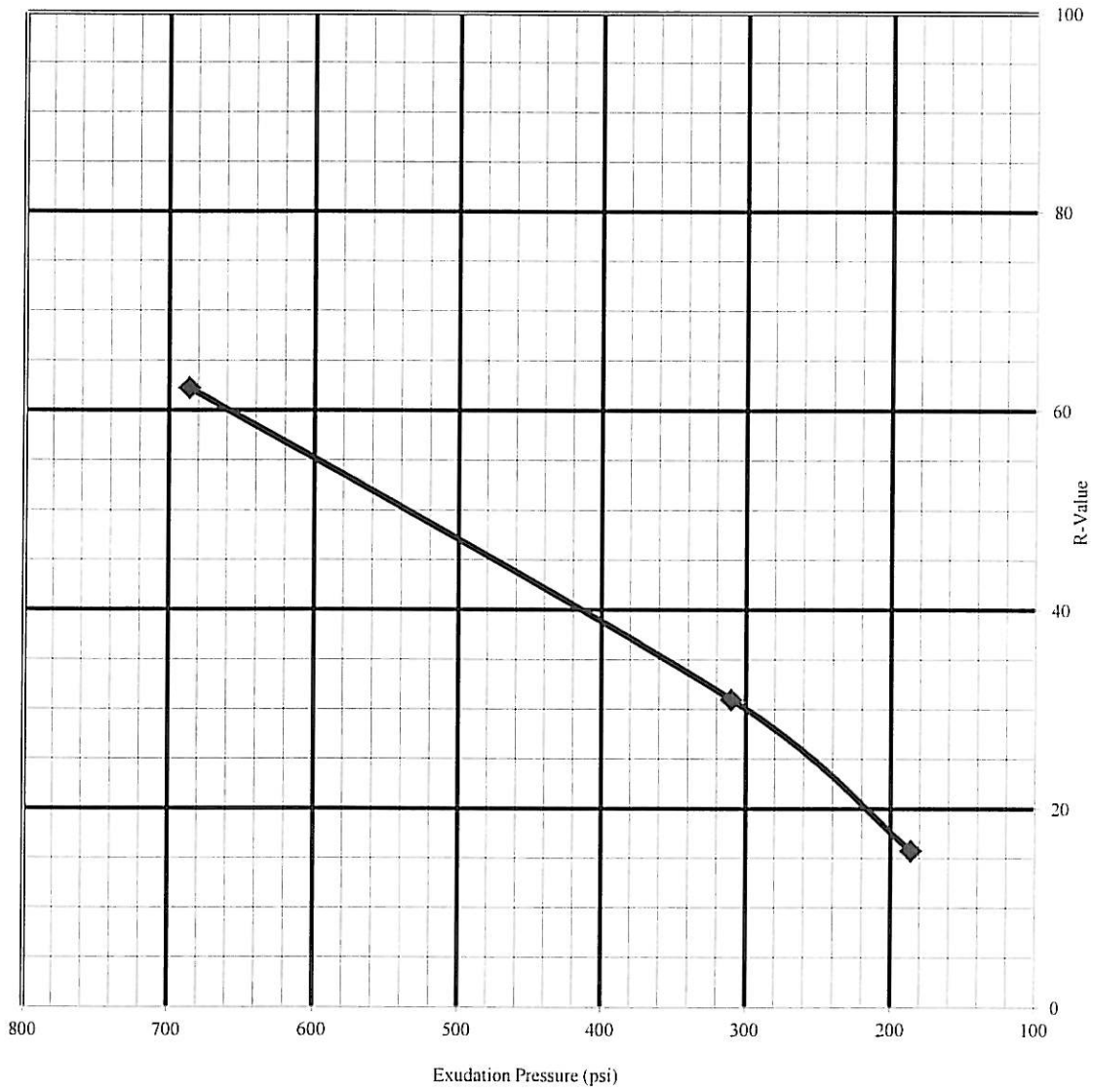
R-Value Test Report

Project Number: 212-034 Project Name: CFL PB Alamogordo-ELK

Sample Id: P-7 Depth (ft): '1-3

Soil Description: Classification:

R-Value at 300 psi exudation pressure = **29**



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	140.3	8	124	2.50	186	16	16
2	300	140.3	7	98	2.50	310	31	31
3	300	139.0	6	48	2.41	686	64	62

Tested by: Mustapha Aichiouene Checked by: RFL

Rev.2-2/2011

YEH AND ASSOCIATES, INC

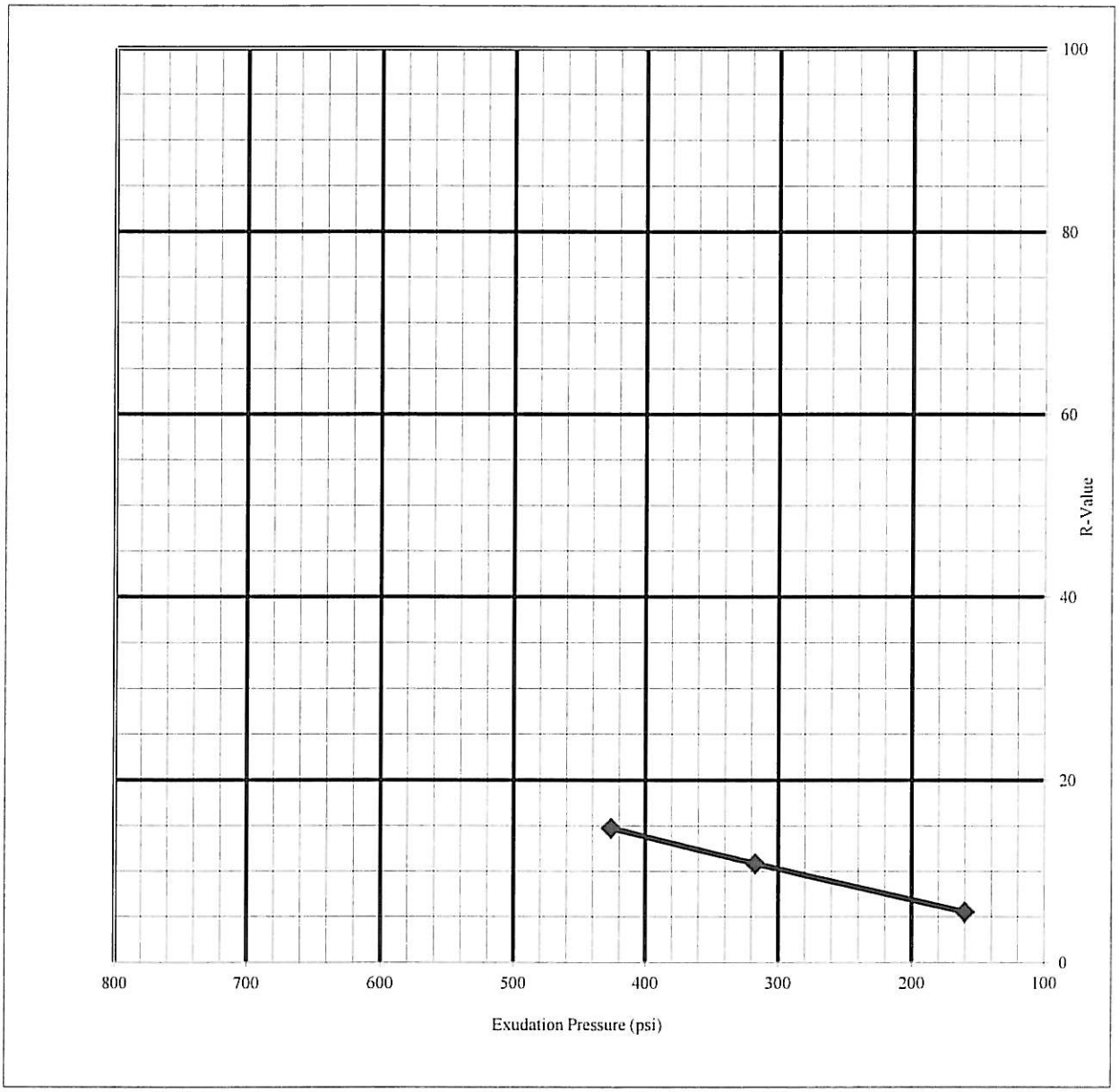
R-Value Test Report

Project Number: 212-034 Project Name: CFL PB Alamogordo-ELK

Sample Id: P-8 Depth (ft): '1-4

Soil Description: Classification:

R-Value at 300 psi exudation pressure = **10**



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	133.5	10	126	2.44	426	16	15
2	300	133.7	11	131	2.49	317	12	11
3	300	131.1	12	143	2.49	160	7	6

Tested by: Lev Bekker Checked by: Mustapha Aichiouene

Rev.2-2/2011

YEH AND ASSOCIATES, INC

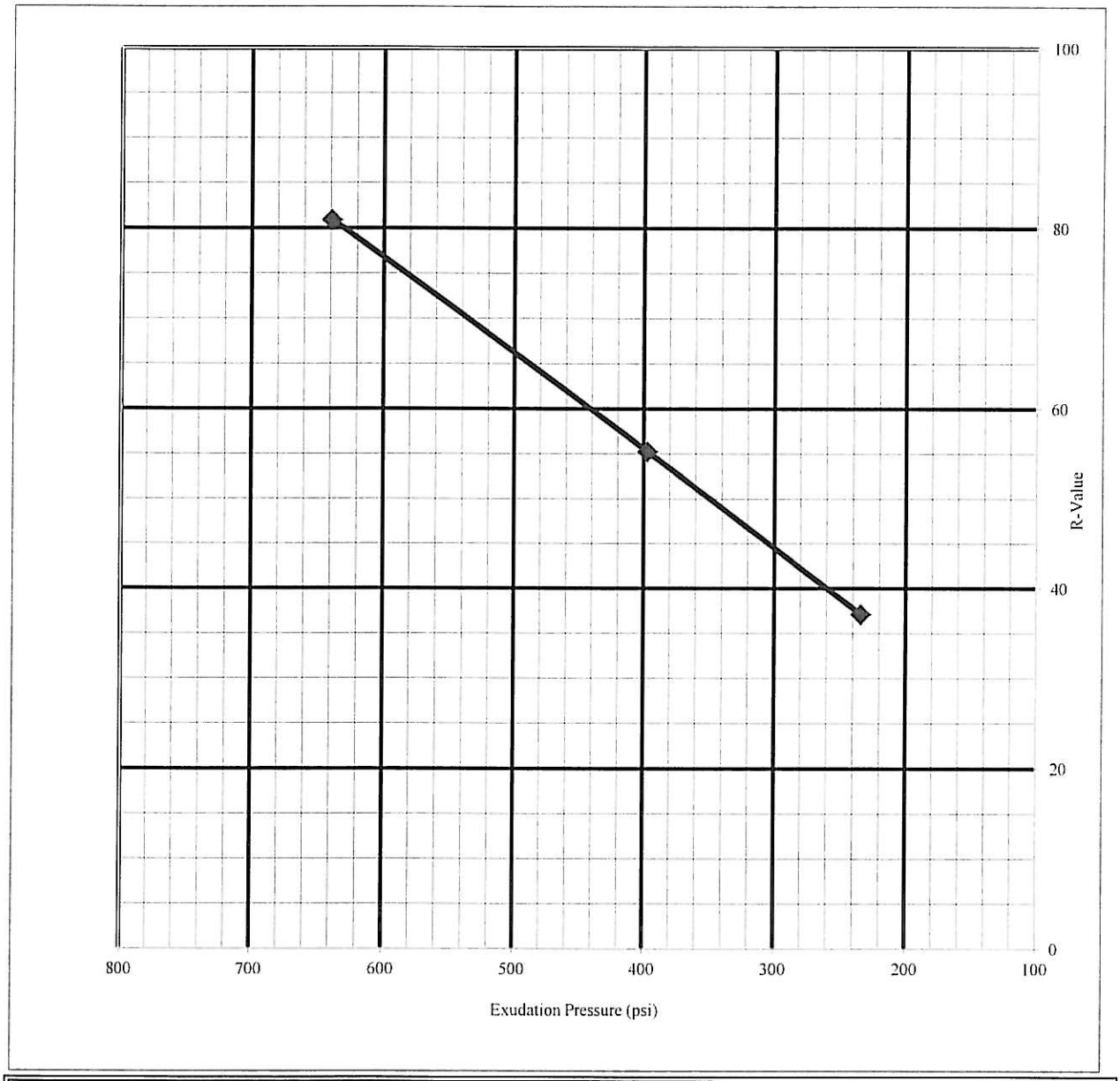
R-Value Test Report

Project Number:212-034 Project Name: CFL PB Alamogordo-ELK

Sample Id:P-9 Depth (ft): '1-7

Soil Description: Classification:

R-Value at 300 psi exudation pressure = 44



Test No.	Compact. Press. (psi)	Density (pcf)	Moist. (%)	Horizont. Pressure (psi)'@ 160 psi	Sample Height (in).	Exud. Pressure (psi)	R Value	R Value Correct.
1	300	148.9	6	83	2.37	234	39	37
2	300	148.1	6	65	2.51	397	50	55
3	300	147.9	5	21	2.43	639	82	81

Tested by: Mustapha Aichiouene Checked by: RFL

Rev.2-2/2011

Appendix D – Drilling Photographs

Boring P-1 3/12/12

Boring P-2 3/12/12

Boring P-3 3/12/12

Boring P-4 3/12/12

Boring P-5 3/12/12

Boring P-6 3/12/12

Boring P-7 3/12/12

Boring P-8 3/12/12

Boring P-9 3/12/12

Appendix E – Previous Reports

Context Sensitive Solutions Bureau

Pavement Design Solutions

SUMMARY OF MATERIALS INVESTIGATION

Control No.	1492	**Date:**	9/26/06
Project No.	TPM-082-1(5)35	**District:**	Two
Length:	10.0 Miles	**County:**	Otero
Location:	US 82, Mayhill East, MP 34.67 to MP 44.67	**ESAL-20 year:**	1,725,665
Type:	Reconstruction/Rehabilitation		

SURFACING CONSTRUCTION

Surfacing	Thickness	Binder	Remarks
Rehabilitation			
Cold Mill	2.0 inches		
PMBP SP-IV	4.0 inches	PG 64-28	Place in one 2.0 inch lift (bottom) and one 2.0 inch lift (Top)
OGFC Type I	5/8 inches	PAC-20	
Shoulder Widening			
UTBC Type I	7.5 inches		Place in two lifts
PMBP SP-IV	4.0 inches	PG 64-28	Place in two 2.0 inch lifts
OGFC Type I	5/8 inches	PAC-20	
Reconstruction			**(Isolated Areas)**
UTBC Type I	7.0 inches		Place in one lift
PMBP SP-IV*	5.0 inches	PG 64-28	Place in one 3.0 inch lift (Bottom) and one 2.0 inch lift (Top)
OGFC Type I	5/8 inches	PAC-20	
Detours/Turnouts			
UTBC Type I	7.0 inches		One lift
PMBP	2.0 inches		One lift

*** Note:** ***Last 2.0 inch lift to be placed concurrently with the rehabilitation operation.***

Subgrade Soils Investigations and Recommendations

Location	Soil Type	R-Value	M_r(psi)
BOP to EOP	A-4, A-6, A-2-6	Design R-Value = 54	13,164

MATERIAL PIT NO. Undesignated

RECOMMENDATIONS FOR BITUMINOUS SURFACING

For Estimate Use …… ……..	.45 gal/yd^2 for Prime Coat	Section 408
For Estimate Use ……	.08 gal/yd^2 for Tack Coat	Section 407

Note: For estimating purposes only, application rate shall be determined by the Project Manager.

PERCENT ASPHALT RECOMMENDED

OGFC……..……..…….	***7.1** %	**PAC-20**	By Wgt. of Total Mix
PMBP SP-IV……	****6.2**%	**PG 64-28**	By Wgt. of Total Mix

Note: *For estimating purposes only, actual % will be determined by District.
****For estimating purposes only, actual % will be determined by approved mix design.**

ADDITIVES

OGFC……..……..……	***1.0**%	**Hydrated Lime**	By Wgt. of Total Mix
Plant Mix Bituminous Pavement…….	**1.5**%	**Hydrated Lime**	By Wgt. of Total Mix

Note: *For estimating purposes only, actual % will be determined by District.
****For estimating purposes only, actual % will be determined by approved mix design.**

ESTIMATION FACTORS FOR SURFACING

Unit Weight of Open Graded Friction Course……..3650 lb/yd^3
Unit Weight of Plant Mix Bituminous Pavement…….4000 lb/yd^3
Unit Weight of Untreated Surfacing ……3950 lb/yd^3

Note: For estimating purposes only, actual weights will be determined by approved mix design.

SURFACING RECOMMENDATIONS

Scope

The scope of this project is to rehabilitate the existing mainline roadway from MP 34.7 to MP 44.7in conjunction with the construction of new shoulders: there will also be isolated areas of reconstruction due to sub-grade failure.

Existing Conditions

The roadway consists of a 2-lane highway with 2-4 foot shoulders in some areas (very poor condition). The existing mainline pavement consists of approximately 3.98 inches of asphalt material over 5.39 inches of base course. (Based off actual cores)

The existing surfacing exhibits the following distresses: low to moderate severity of transverse and thermal cracking, bleeding, along with some isolated failed areas. Roadway appears to have been "Chip-sealed" sometime in the past and is crack sealed throughout the project limits.

Design Parameters	20 Year	10 Year	1 Year
R-Value	54	54	54
Initial Serviceability Index	4.2	4.2	4.2
Terminal Serviceability Index	2.0	2.0	2.0
Regional Factor	1.8	1.8	1.8
ESAL	1,725,665	653,819	41,295
Structural Number	2.97	2.74	1.65

Recommendations

Rehabilitation

1. Cold Mill 2 inches of existing pavement, full width of roadway.
2. Place 4.0 inches PMBP SP-IV w/PG 64-28, full width of roadway and shoulders in one 2.0 inch lift (Bottom) and one 2.0 inch lift (Top)
3. Place 5/8 inch OGFC Type I, full width of roadway lapping 8.0 inches onto shoulders.

Shoulder Widening

1. Make a neat cut at edge of driving lane (Shoulder Stripe)
2. Excavate to accommodate new shoulders.
3. On a prepared subgrade place 7.5 inches of UTBC Type I, full width of roadway and shoulders in two lifts.
4. Place 4.0 inches of PMBP SP-IV w/PG 64-28, full width of roadway and shoulders in two 2.0 inch lifts.
5. Place 5/8 inch OGFC Type I, full width of roadway lapping 8.0 inches onto shoulders.

Reconstruction (Isolated Failed Areas)

1. Excavate existing roadway and shoulders to accommodate new surfacing.
2. On a prepared subgrade place 7.0 inches UTBC Type I full width of roadway and shoulders in one lift.
3. Place 5.0 inches PMBP SP-IV***** w/PG 64-28 full width of roadway and shoulders in one 3.0 inch lift (Bottom) and one 2.0 inch lift (Top).
4. Place 5/8 inch OGFC Type I, full width of roadway lapping 8.0 inches onto shoulders.

   *** Note:** ***Last 2.0 inch lift to be placed concurrently with the rehabilitation operation.***

Detours/Turnouts

1. Place 6.0 inches UTBC Type I in one lift.
2. Place 2.5 inches PMBP in one lift.

Run-Down Computation Sheet

	Control Number		1492									
	Project Number		TPM-082-1(5)35									
		County	Otero									
		District	2									
		Route	US 82									
		Unit	Inches									
	max		7.00	15.00	12.50	31.00	8.80	19.10		80.00		
	min		2.00	5.00	1.50	2.00	0.30	0.30		6.00		
	avg		3.70	9.13	5.43	15.27	2.40	8.07		36.61		
	Mile Post	Lane	Asphalt	Asphalt and Base	Base	PI	Base %M	Subgrade %M	Soil Type	R-Value	Paving Fabric Depth	Remarks
Best Fit	→		#######		#NAME?					#NAME?		
	35.00	EBL	3	8.5	5.5	22	2.3	0.6	A-6	29		
	35.25	EBL	5	11	6	16	1.4	5.9	A-2-6	40		
	35.50	EBL	3	8	5	25	2.9	14.4	A-7	24		
	35.75	EBL	3	8	5	20	1.2	8.8	A-4	29		
	36.00	EBL	5	11	6		1.2	7	A-4	70		
	36.25	EBL	2.5	8	5.5	4	2.8	8.1	A-2-4	27		
	36.50	EBL	3	10	7	8	0.6	13.1	A-4	25		
	36.75	EBL	4	9	5	23	1.3	9.4	A-7	66		
	37.00	EBL	4	9	5	8	2.2	6.7	A-4	26		
	37.25	EBL	3	5	2	12	2.1	4.5	A-2-6	52		
	37.53	EBL	2	7	5	12	1	1	A-6	6		
	37.75	EBL	2	8	6	11	3.1	5.5	A-6	36		
	38.00	EBL	3	10	7	4	0.6	10.6	A-4	50		
	38.27	EBL	3	12	9	13	7.8	5.3	A-2-6	55		
	38.50	EBL	3.5	11	7.5	21	2.2	5.7	A-2-6	45		
	38.76	EBL	3	11	8	2	2.3	3.7	a-1-b	56		
	39.00	EBL	4.5	11.5	7	20	1.8	12.1	A-6	30		
	39.25	EBL	4	12	8	20	2.6	9.8	A-6	13		
	39.50	EBL	5	14	9	18	3.3	9.7	A-6	49		
	39.75	EBL	3.5	11	7.5	6	3.2	13.4	A-2-4	30		
	40.00	EBL	4	11	7	5	2	0.3	a-1-b	80		
	40.35	EBL	4	12	8	18	2.2	6.5	A-2-6	37		
	40.50	EBL	5	7	2	8	2.3	4.4	A-4	18		
	41.00	EBL	3.5	6	2.5	15	3.5	4.6	A-2-6	27		
	41.25	EBL	4.5	6.5	2	21	0.4	10.4	A-6	31		
	41.50	EBL	5	7	2	15	2.3	5.2	A-2-6	39		
	41.75	EBL	4.5	7	2.5	10	3.1	11.7	A-2-4	9		
	41.99	EBL	3.5	7	3.5	16	1.7	5.1	A-2-6	38		
	42.25	EBL	4	7	3	14	2.1	7.8	A-2-6	45		
	42.50	EBL	3.5	7.5	4	12	3.7	9.6	A-6	28		
	42.75	EBL	3.5	5	1.5	15	3.9	8.6	A-6	45		
	43.00	EBL	3	5	2	19	3.4	7.7	A-2-6	68		
	43.24	EBL	4	6	2	31	2.7	7.4	A-2-7	53		
	43.50	EBL	7	11	4	13	0.4	6.5	A-2-6	37		
	43.75	EBL	4	11	7	27	2	19.1	A-7	15		
	44.00	EBL	3	9	6	19	8.8	6.3	A-2-6	34		
	44.25	EBL	2.5	15	12.5	22	0.6	13.8	A-6	12		
	44.50	EBL	3	12	9	20	0.3	16.4	A-6	17		
0												

Appendix F – Pavement Design Calculations

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

212-034
Alamorgordo to Elk
US Route 82 in New Mexico
R = 25
Pulverization

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,725,665
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,816 psi
Stage Construction	1
Calculated Design Structural Number	3.81 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.44	1	6.5	16	2.86
2	Pulverized HMA and AVC	0.12	1	8	16	0.96
Total	-	-	-	14.50	-	3.82

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

Alamorgordo to Elk
US Route 82 in New Mexico
Cold Recycle
R = 25

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,725,665
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Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,816 psi
Stage Construction	1
Calculated Design Structural Number	3.81 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.44	1	5.5	16	2.42
2	Cold REecycle	0.22	1	4	16	0.88
3	ABC	0.11	1	5	16	0.55
Total	-	-	-	14.50	-	3.85

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

212-034
Alamorgordo to Elk
US Route 82 in New Mexico
R = 25
Overlay with fabric

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,725,665
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,816 psi
Stage Construction	1
Calculated Design Structural Number	3.81 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.44	1	5	16	2.20
2	Old Pavement	0.33	1	3.5	16	1.16
3	ABC	0.11	1	5	16	0.55
Total	-	-	-	13.50	-	3.91

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

212-034
Alamorgordo to Elk
US Route 82 in New Mexico
R = 25
Pulverization
10-Year ESALs

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	862,833
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,816 psi
Stage Construction	1
Calculated Design Structural Number	3.40 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.44	1	5.6	16	2.46
2	Pulverized HMA and AVC	0.12	1	8	16	0.96
Total	-	-	-	13.60	-	3.42

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

Alamorgordo to Elk
US Route 82 in New Mexico
Cold Recycle
R = 25
10-Year ESALs

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	862,833
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,816 psi
Stage Construction	1
Calculated Design Structural Number	3.40 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.44	1	4.5	16	1.98
2	Cold REecycle	0.22	1	4	16	0.88
3	ABC	0.11	1	5	16	0.55
Total	-	-	-	13.50	-	3.41

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

212-034
Alamorgordo to Elk
US Route 82 in New Mexico
R = 25
Overlay with fabric
10 Year ESALs

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	862,833
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	5,816 psi
Stage Construction	1
Calculated Design Structural Number	3.40 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HACP	0.44	1	4	16	1.76
2	Old Pavement	0.33	1	3.5	16	1.16
3	ABC	0.11	1	5	16	0.55
Total	-	-	-	12.50	-	3.47