

BUREAU OF INDIAN AFFAIRS MATERIALS GROUP

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November 17, 2014

MATERIALS DESIGN MEMORANDUM

REPORT #: N00370_N101(1)2&4_001
REPORT TYPE: **INITIAL**

TO: ALBERT LEE, DESIGN ENGINEER
HAROLD RILEY, PLANNING AND DESIGN CHIEF

FROM: CHRISTOPHER BECENTI
MATERIALS DESIGN SECTION ENGINEER
MATERIALS GROUP

REF: N101(1)2&4,
NEW CONSTRUCTION OF ROADWAY
STATION 0+000.000 TO 0+586.337

Project Scope

The Route N101 Priority Standing has recently been raised and is available for construction in 2015. This materials design letter presents the results of the pavement design analysis performed on BIA Route N101.

BIA route N101(1)2&4 project section is 586 m long and located in the NIIP Agency. The project is located next to Ojo Amarillo community off of N3005. This route is situated completely within Navajo Nation trust land. The road will be new construction, currently the traffic utilizes the dirt road to the north or routes through the Ojo Amarillo community. The Project Scope plans on constructing new pavement, sidewalk, and drainage items, with a spur road to the community. There are numerous existing utilities within the project limits and will require relocation or protection in place.

DESIGN ANALYSIS AND DISCUSSIONS

N101(1)2&4

In designing the roadway pavement section, the design traffic was based on the traffic counts projected to 2014 provided by the highway design section, then additionally projected for a design period of 20 years. No geotechnical and testing report was provided for the project. Information for the existing soil stratigraphy and attributes were interpolated from the USGS WEBsoil website, see attached.

Table I below shows the parameters used for the design of the structural section for the unpaved section of N101(1)2&4.

Structural Number for Future Traffic

Parameter	N101(1)2&4 Section
Design Life (years)	20
18-Kip ESALs (One Way)	23,205
Initial Serviceability (Po)	4.4
Terminal Serviceability (Pt)	2.5
Reliability Level	70%
Overall Standard Deviation (So)	0.45
RoadBed Soil Resilient Modulus	41,368.56 kPa
Required SN (per AASHTO 1993 Guide)	45mm

Future Simple ESAL Calculation

Parameter	N101(1)2&4
Performance Period(years)	20
Two-Way Traffic (ADT)	932
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100%
Percent Trucks in Design Direction	50%
Percent Heavy Trucks(of ADT) FHWA Class 5 or greater	1%
Average Initial Truck Factor (ESALs/Truck)	0.57
Annual Truck Factor Growth Rate	0%
Annual Truck Volume Growth Rate	2%
Growth	Compound
Total Calculated Cumulative ESALs	23,573

$$SN_{eff} = a_1(D_1) + a_2(D_2)(m_2) + a_3(D_3)(m_3)$$

SECTION I – STRUCTURAL THICKNESS

STATION	AB (mm)	AC (mm)	TOTAL THICKNESS (mm)
Main 0+000.00 to 0+586.337	152.4	76.2	228.6
Spur 0+000.00 to 0+082.126	152.4	76.2	228.6

SECTION II - SUBGRADE, AND BASES

The R value used for the design subgrade is 9. Soils encountered below this value shall be

removed and replaced according to subsection 303.07 of FP-03 and Supplemental.

The Base shall be as specified in subsection 301 of FP-03 and Supplemental.

SECTION III - SURFACE TREATMENTS AND PAVEMENTS

Prime Coat shall be as specified in subsection 411 of FP-03 and Supplemental.

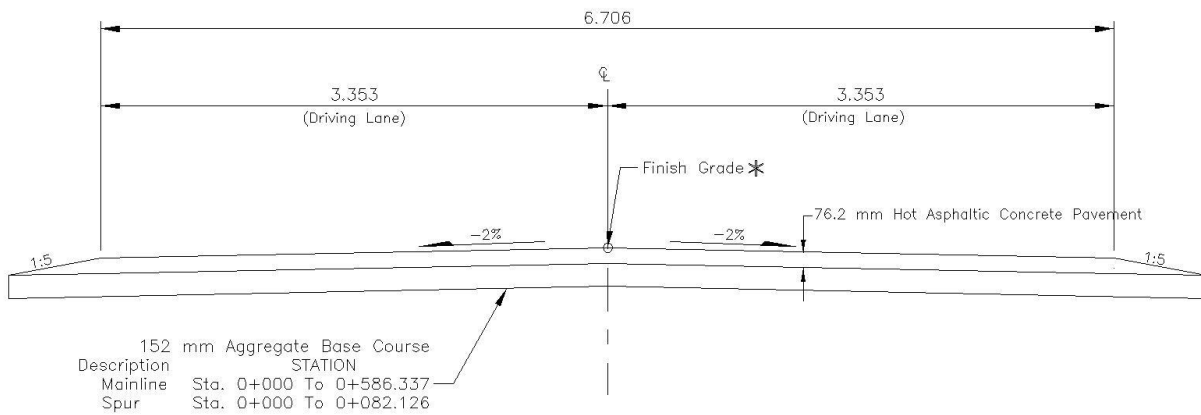
Hot Asphaltic Concrete Pavement shall be as specified in subsection 402 of FP-03 and Supplemental.

Alfred Myron
BIA NRDOT Materials Engineer

Christopher Becenti P.E.
BIA NRODT Assistant Materials Engineer

Typical Section N101(1)2&4

TYPICAL CROSS SECTION



NEW TYPICAL CROSS SECTION

B.O.P. STA. 0+000.00 - E.O.P. STA. 0+586.337

* Sidewalk and shoulders not shown.

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare Computer Software Product

Flexible Structural Design Module

N101(1)2&4 involves Drainage, Pavement, sidewalk. No geotechnical investigation has been performed. Values interpolated from USGS Websoil. A-6 soil with approximate PI of 19.

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	23,205
Initial Serviceability	4.4
Terminal Serviceability	2.5
Reliability Level	70 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	41,368.56 kPa
Stage Construction	1
Calculated Design Structural Number	45 mm

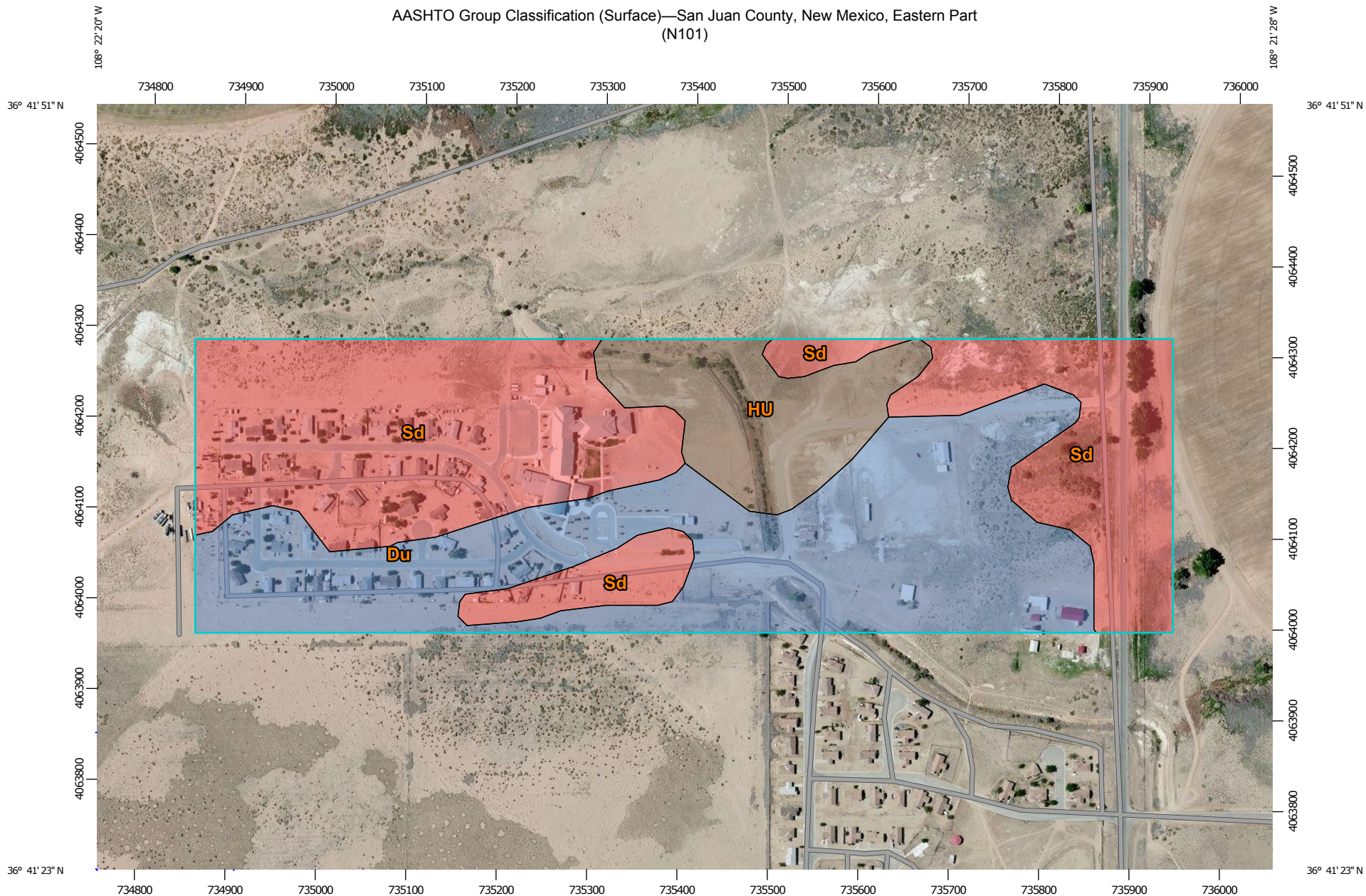
Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	932
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	50 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	1 %
Average Initial Truck Factor (ESALs/truck)	0.57
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	2 %
Growth	Compound
Total Calculated Cumulative ESALs	23,573

Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(Ai)</u>	Drain Coef. <u>(Mi)</u>	Thickness <u>(Di)(mm)</u>	Width <u>(m)</u>	Calculated <u>SN (mm)</u>
1	Aggregate Base Course	0.14	1	152.4	3.6576	21
2	Hot Asphaltic Concrete Pavement	0.44	1	76.2	3.6576	34
Total	-	-	-	229	-	55

AASHTO Group Classification (Surface)—San Juan County, New Mexico, Eastern Part
(N101)



Map Scale: 1:5,940 if printed on A landscape (11" x 8.5") sheet.

0 50 100 200 300 Meters


0 250 500 1000 1500 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84










MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

-  A-1
-  A-1-a
-  A-1-b
-  A-2
-  A-2-4
-  A-2-5
-  A-2-6
-  A-2-7
-  A-3
-  A-4
-  A-5
-  A-6
-  A-7
-  A-7-5
-  A-7-6
-  A-8
-  Not rated or not available





Soil Rating Lines

-  A-1
-  A-1-a
-  A-1-b
-  A-2


-  A-2-4
-  A-2-5
-  A-2-6
-  A-2-7
-  A-3
-  A-4
-  A-5
-  A-6
-  A-7
-  A-7-5
-  A-7-6
-  A-8
-  Not rated or not available

Soil Rating Points






-  A-1
-  A-1-a
-  A-1-b
-  A-2
-  A-2-4
-  A-2-5
-  A-2-6
-  A-2-7
-  A-3
-  A-4
-  A-5
-  A-6

-  A-7
-  A-7-5
-  A-7-6
-  A-8
-  Not rated or not available


Water Features

 Streams and Canals

Transportation

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:63,400.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Juan County, New Mexico, Eastern Part
Survey Area Data: Version 11, Dec 19, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 21, 2010—Nov 5, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

AASHTO Group Classification (Surface)

AASHTO Group Classification (Surface)— Summary by Map Unit — San Juan County, New Mexico, Eastern Part (NM618)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Du	Doak-Uffens complex, 0 to 3 percent slopes	A-6	34.9	40.3%
HU	Huerfano-Muff-Uffens complex, gently sloping	A-4	10.1	11.7%
Sd	Sheppard-Mayqueen-Shiprock complex, 0 to 8 percent slopes	A-2	41.7	48.1%
Totals for Area of Interest			86.8	100.0%

Description

AASHTO group classification is a system that classifies soils specifically for geotechnical engineering purposes that are related to highway and airfield construction. It is based on particle-size distribution and Atterberg limits, such as liquid limit and plasticity index. This classification system is covered in AASHTO Standard No. M 145-82. The classification is based on that portion of the soil that is smaller than 3 inches in diameter.

The AASHTO classification system has two general classifications: (i) granular materials having 35 percent or less, by weight, particles smaller than 0.074 mm in diameter and (ii) silt-clay materials having more than 35 percent, by weight, particles smaller than 0.074 mm in diameter. These two divisions are further subdivided into seven main group classifications, plus eight subgroups, for a total of fifteen for mineral soils. Another class for organic soils is used.

For each soil horizon in the database one or more AASHTO Group Classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Rating Options

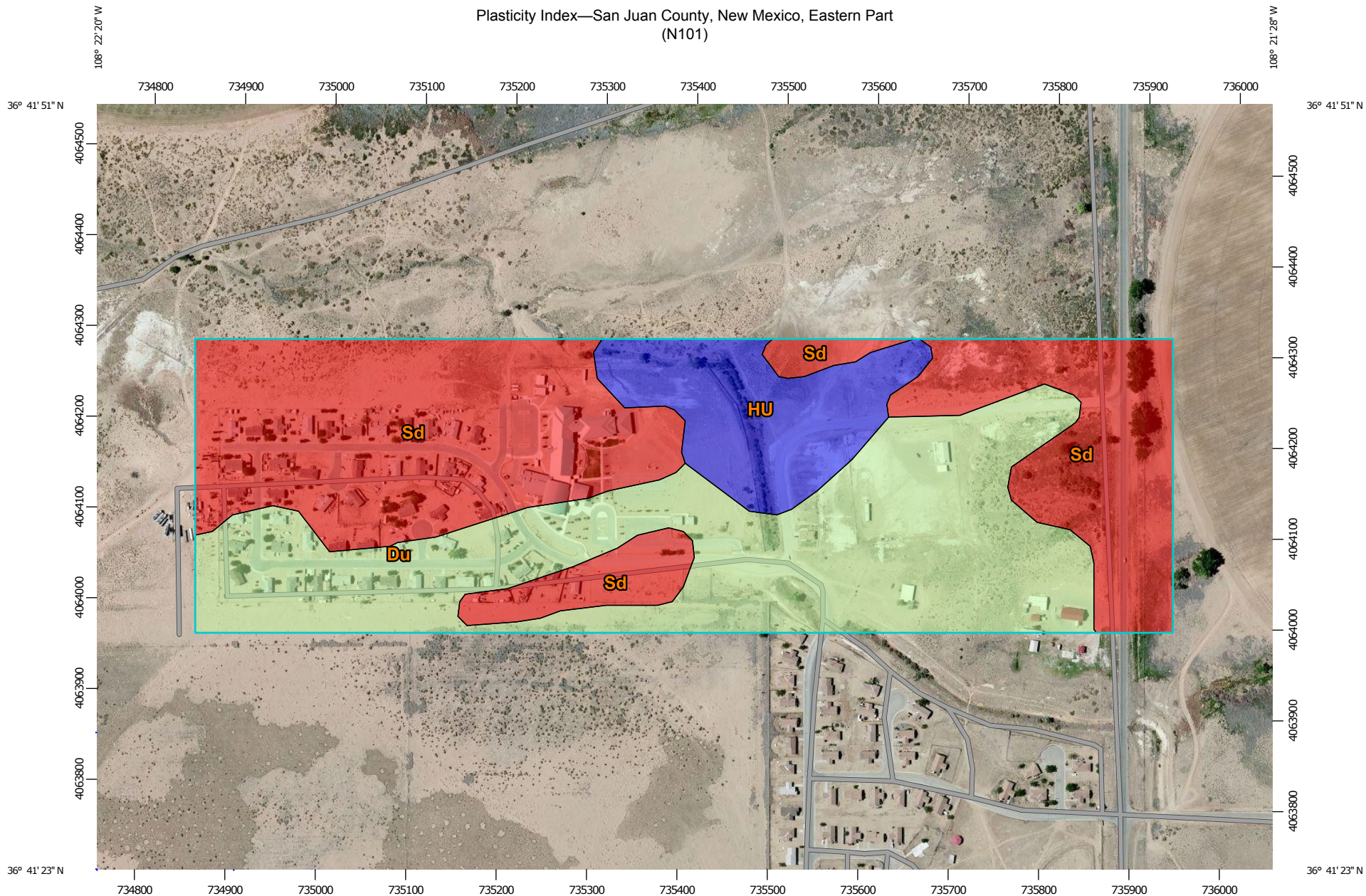
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Plasticity Index—San Juan County, New Mexico, Eastern Part
(N101)



Map Scale: 1:5,940 if printed on A landscape (11" x 8.5") sheet.

0 50 100 200 300 Meters


0 250 500 1000 1500 Feet

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MAP LEGEND

Area of Interest (AOI)





 Area of Interest (AOI)

Background





 Aerial Photography

Soils





Soil Rating Polygons

-  ≤ 4.0
-  > 4.0 and ≤ 20.2
-  > 20.2 and ≤ 20.9
-  Not rated or not available


Soil Rating Lines

-  ≤ 4.0
-  > 4.0 and ≤ 20.2
-  > 20.2 and ≤ 20.9
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




Soil Rating Points

-  ≤ 4.0
-  > 4.0 and ≤ 20.2
-  > 20.2 and ≤ 20.9
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Water Features

 Streams and Canals

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Plasticity Index

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Description

Plasticity index (PI) is one of the standard Atterberg limits used to indicate the plasticity characteristics of a soil. It is defined as the numerical difference between the liquid limit and plastic limit of the soil. It is the range of water content in which a soil exhibits the characteristics of a plastic solid.

The plastic limit is the water content that corresponds to an arbitrary limit between the plastic and semisolid states of a soil. The liquid limit is the water content, on a percent by weight basis, of the soil (passing #40 sieve) at which the soil changes from a plastic to a liquid state.

Soils that have a high plasticity index have a wide range of moisture content in which the soil performs as a plastic material. Highly and moderately plastic clays have large PI values. Plasticity index is used in classifying soils in the Unified and AASHTO classification systems.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: percent

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options (Horizon Aggregation Method): Depth Range (Weighted Average)

Top Depth: 0

Bottom Depth: 60

Units of Measure: Inches

**New Mexico Department of Transportation
Estimated R-Value Chart (60% Risk)**

Effective Date: 1/1/06

NOTE: The estimated R-Values shown on this chart have a 60% chance of being equal to or greater than the indicated estimated R-Value and a 40% chance of being equal to or less than the indicated estimated R-Value. If there is reason to believe that the actual laboratory R-Value would be higher than what this chart estimates, then a representative sample of that material should be tested using AASHTO T 190 by either the Department's State Materials Bureau or at an approved laboratory that is certified by the Department's State Materials Bureau to perform AASHTO T 190.

Plasticity Index	AASHTO Soils Classification												
	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-4	A-5	A-6	A-7-5	A-7-6	
0	72	69	55	No Correlations Presently Exists			No Correlations Presently Exists	46	46				
1	72	67	53						43	43			
2	71	65	50						41	40			
3	71	63	48						38	36			
4	71	62	45						36	33			
5	70	60	43						33	30			
6	70	58	40						31	27			
7			38						28	24			
8			35						26	21			
9			33						23	18			
10			30						20	15			
11						31		33			11	9	7
12						30		32			11	9	7
13						29		31			11	9	7
14						28		29			10	9	6
15						27		28			10	9	6
16						26		27			10	8	6
17						25		26			9	8	6
18						24		25			9	8	6
19						23		23			9	8	6
20						22		22			8	8	6
21						21		21			8	7	6
22						20		20			7	7	6
23						19		19			7	7	6
24						18		17			7	7	6
25						17		16			6	7	6
26						16		15			6	6	6
27						15		14			6	6	6
28						14		13			5	6	6
29						13		11			5	6	6
30						12		10			< 5	6	6
31						11		9			< 5	6	5
32						10		8			< 5	5	5
33						9		7			< 5	5	5
34						8		5			< 5	5	5
35						7		< 5			< 5	5	5
36						6		< 5			< 5	5	5
37						5		< 5			< 5	< 5	5
38						< 5		< 5			< 5	< 5	5
39						< 5		< 5			< 5	< 5	5
40					< 5	< 5			< 5	< 5	5		