Town Range / Scientific Name	Common Name	State Status	Federal Status	State Rank	Global Rank	Group Name
Northern wet-mesic forest	Northern Wet-mesic Forest	NA		S3S4	G3?	Community~
Ophisaurus attenuatus	Slender Glass Lizard	END		S1	G5	Lizard
Opuntia fragilis	Brittle Prickly-pear	THR		S3	G4G5	Plant
Phemeranthus rugospermus	Prairie Fame-flower	SC		S3	G3G4	Plant
Poa paludigena	Bog Bluegrass	THR		S3	G3	Plant~
Poa sylvestris	Woodland Bluegrass	SC		S1	G5	Plant
Schinia indiana	Phlox Moth	END		S2S3	G2G4	Moth
Seiurus motacilla	Louisiana Waterthrush	SC/M		S3B	G5	Bird~
Sistrurus catenatus catenatus	Eastern Massasauga	END	C	S1	G3G4T3Q	Snake~
Southern dry forest	Southern Dry Forest	NA		S3	G4	Community
Stream--fast, soft, cold	Stream--Fast, Soft, Cold	NA		SU	GNR	Community~
019N003W						
Canis lupus	Gray Wolf	SC/FL	LE	S4	G4	Mammal
Emydoidea blandingii	Blanding's Turtle	THR		S3S4	G4	Turtle~
Erynnis persius	Persius Dusky Wing	SC/N		S3	G5	Butterfly
Haliaeetus leucocephalus	Bald Eagle	SC/P		S4B,S4N	G5	Bird~
Lycaeides melissa samuelis	Karner Blue	SC/FL	LE	S3	G5T2	Butterfly
Ophisaurus attenuatus	Slender Glass Lizard	END		S1	G5	Lizard
Phemeranthus rugospermus	Prairie Fame-flower	SC		S3	G3G4	Plant
Schinia indiana	Phlox Moth	END		S2S3	G2G4	Moth
019N004W						
Ammocrypta clara	Western Sand Darter	SC/N		S3	G3	Fish~
Anguilla rostrata	American Eel	SC/N		S2	G4	Fish~
Moxostoma carinatum	River Redhorse	THR		S2	G4	Fish~
Northern dry-mesic forest	Northern Dry-mesic Forest	NA		S3	G4	Community
Notropis texanus	Weed Shiner	SC/N		S3	G5	Fish~
Opsopoeodus emiliae	Pugnose Minnow	SC/N		S3	G5	Fish~
Percina evides	Gilt Darter	THR		S2S3	G4	Fish~
Pituophis catenifer	Gophersnake	SC/P		S2S3	G5	Snake
Stream--fast, soft, cold	Stream--Fast, Soft, Cold	NA		SU	GNR	Community~
Stream--slow, soft, cold	Stream--Slow, Soft, Cold	NA		SU	GNR	Community~
019N005W						
Ammocrypta clara	Western Sand Darter	SC/N		S3	G3	Fish~
Asclepias lanuginosa	Woolly Milkweed	THR		S1	G4?	Plant
Moxostoma carinatum	River Redhorse	THR		S2	G4	Fish~
Northern dry-mesic forest	Northern Dry-mesic Forest	NA		S3	G4	Community
Percina evides	Gilt Darter	THR		S2S3	G4	Fish~
Pine barrens	Pine Barrens	NA		S2	G2	Community
Pituophis catenifer	Gophersnake	SC/P		S2S3	G5	Snake
019N006W						
Ammocrypta clara	Western Sand Darter	SC/N		S3	G3	Fish~
Moxostoma carinatum	River Redhorse	THR		S2	G4	Fish~
019N007W						
Ammocrypta clara	Western Sand Darter	SC/N		S3	G3	Fish~
020N001E						
Canis lupus	Gray Wolf	SC/FL	LE	S4	G4	Mammal
Emydoidea blandingii	Blanding's Turtle	THR		S3S4	G4	Turtle~

Town Range / Scientific Name	Common Name	State Status	Federal Status	State Rank	Global Rank	Group Name
020N001W						
Canis lupus	Gray Wolf	SC/FL	LE	S4	G4	Mammal
020N002E						
Canis lupus	Gray Wolf	SC/FL	LE	S4	G4	Mammal
Emydoidea blandingii	Blanding's Turtle	THR		S3S4	G4	Turtle~
020N002W						
Canis lupus	Gray Wolf	SC/FL	LE	S4	G4	Mammal
Ophisaurus attenuatus	Slender Glass Lizard	END		S1	G5	Lizard
Pituophis catenifer	Gophersnake	SC/P		S2S3	G5	Snake
Sistrurus catenatus catenatus	Eastern Massasauga	END	C	S1	G3G4T3Q	Snake~
Southern dry forest	Southern Dry Forest	NA		S3	G4	Community
020N003W						
Lycaeides melissa samuelis	Karner Blue	SC/FL	LE	S3	G5T2	Butterfly
Ophisaurus attenuatus	Slender Glass Lizard	END		S1	G5	Lizard
Pituophis catenifer	Gophersnake	SC/P		S2S3	G5	Snake
020N004W						
Ammocrypta clara	Western Sand Darter	SC/N		S3	G3	Fish~
Moxostoma carinatum	River Redhorse	THR		S2	G4	Fish~
Percina evides	Gilt Darter	THR		S2S3	G4	Fish~
Pituophis catenifer	Gophersnake	SC/P		S2S3	G5	Snake
020N005W						
Ammocrypta clara	Western Sand Darter	SC/N		S3	G3	Fish~
Moxostoma carinatum	River Redhorse	THR		S2	G4	Fish~
Percina evides	Gilt Darter	THR		S2S3	G4	Fish~
021N004W						
Ammocrypta clara	Western Sand Darter	SC/N		S3	G3	Fish~
Percina evides	Gilt Darter	THR		S2S3	G4	Fish~
022N003W						
Percina evides	Gilt Darter	THR		S2S3	G4	Fish~
022N004W						
Percina evides	Gilt Darter	THR		S2S3	G4	Fish~

This report lists locations for all elements occurring in Monroe County, since many element occurrences cross county boundaries, it may also list townships from additional counties.

Wisconsin Natural Heritage Inventory (NHI)

Key to the County Data Printout

TOWNRANGE[1]
EO#[2] PREC[3] SCIENTIFIC NAME[4] (COMMON NAME)[5] LASTOBS[6] ST/FED[7] GROUP[8]
COUNTY[9]

1.	TownRange	Public Land Survey (PLS) Town and Range location of the endangered resource element occurrence. Please note, duplicate records may appear due to multiple locations of an element within a TownRange.
2.	EO#	Element Occurrence Number. Three digit number identifying each unique occurrence of a rare species, natural community or natural feature in Wisconsin.
3.	Prec	Precision to which the element occurrence was mapped on USGS 7.5 minute topographic map. Indicates how precisely we can locate the element. S = Seconds (~200 ft. radius), F = Forty (40-acre or quarter-quarter radius), Q = Quarter (160-acre or 1/4 mi. radius), M = Minute (1 to 1.5 mi. radius), G = General (5 mi. radius), NM = Not Mapped, U = Unmappable
4.	Scientific name	Scientific name of the endangered resource element.
5.	(Common name)	Common name of the endangered resource element, established by The Nature Conservancy.
6.	Lastobs	The last confirmed observation date of the element occurrence.
7.	St/Fed	Federal and State protection Status; **St**: Wisconsin State Status - Protection category designated by the Wisconsin DNR. END = endangered; THR = threatened; SC = Special Concern. Special Concern species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered. **Fed:** Federal protection status designated by the Office of Endangered Species, U.S. Fish and Wildlife Service indicating the status of a species in the United States. LE = listed endangered; LT = listed threatened; LE-LT = listed endangered in part of its range, threatened in another part; XN = nonessential experimental population(s) in part of its range; LT,PD = listed threatened, proposed for de-listing: C = candidate for future listing. WDNR and federal regulations regarding Special Concern species range from full protection to no protection. The current categories and their respective level of protection are as follows: SC/P = fully protected; SC/N = no laws regulating use, possession, or harvesting; SC/H = take regulated by establishment of open closed seasons; SC/FL = Federally protected as endangered or threatened, but not so designated by state WDNR; SC/M = fully protected by federal and state laws under the Migratory Bird Act.
8.	Group	Taxonomic group of the element. A "^" next to the group name indicates that the element is associated with wetlands or waterbodies.
9.	County	The first four letters of the county name. Exceptions: GRNL = Green Lake, WASB = Washburn. Please note that all counties of occurrence are listed for each element, this is a function of the data linkage within the database. Please ignore if only interested in Township information.

SOILS & ENGINEERING SERVICES, INC.
CONSULTING CIVIL ENGINEERS SINCE 1966

December 14, 2011 Project 12911 R04

Mr. Chuck Young
Smart Sand Company
7 Old Cabin Rd
Newtown, Pennsylvania 18940

Subject: Geotechnical Exploration and Supplementary Report
Revised Processing Plant Location
Smart Sand Company
Town of Oakdale
Monroe County, Wisconsin

Dear Mr. Young:

We have completed the requested geotechnical exploration consisting of eighteen standard soil borings at the subject project site. The purpose of the soil borings was to obtain information pertaining to the soil, bedrock, and groundwater conditions at the soil boring locations within the project site. The intent of this report is to convey the information obtained from the field exploration, to describe the results of the laboratory and field tests, to provide our evaluation of the soil, bedrock, and groundwater conditions which were encountered at the soil boring locations, and to present our comments and recommendations for the proposed project. Soils & Engineering Services, Inc. should be employed to make observations and perform tests at the time of excavation and construction of the proposed project to verify the soil, bedrock, and groundwater conditions encountered by this exploration, and to validate the recommendations made in this geotechnical report.

PROJECT INFORMATION

We understand that the proposed project will consist of the design and construction of a processing plant for Smart Sand Company at the subject project site which is located in the Town of Oakdale which is present in the east portion of Monroe County. The subject project site is located south of State Trunk Highway 16/U.S. Highway 12, and approximately 1 mile west of the central business district of the Town of Oakdale.

1102 STEWART ST. • MADISON, WI 53713-4648 • PHONE: 608-274-7600 • 888-866-SOIL (7645) • FAX: 608-274-7511 • EMAIL: soils@solls.ws

The proposed processing plant will be used to process and manufacture a special type of sand, referred to as "frac sand," which is used in natural gas and oil exploration and recovery processes.

The proposed frac sand processing plant will consist of multiple structures and other associated equipment which will be primarily contained within a dry plant area and a wet plant area. The project area for the dry plant will be located east of the railroad spur track, and west of the wet plant area.

The dry plant area will contain various structures such as a screen house building, storage tanks, a bag house building, dryer building, three feed bins, dryer bag building, and an EH-1 structure. The wet plant area will contain several structures such as a wash plant building, thickener tank, water tank, and an EH-2 structure. The project area for the processing plant was initially located approximately 4,600 feet south of the STH 16/USH 12 roadway.

In addition to the wet plant area and the dry plant area, the subject project will contain several large mounds of processed materials consisting of: a +70-mesh sand pile; a -70-mesh sand return to pit pile; and a +70-mesh sand winter pile.

The project also includes a rail load-out structure which will be located west of the dry plant area, and the rail load-out structure will consist of several elevated hoppers which will straddle over the top of the railroad spur tracks in order to deposit processed frac sand into rail cars.

In November 2011, we submitted to you our initial geotechnical report for the proposed processing plant to Smart Sand Company. The report provided the findings from fourteen soil borings which were performed for the proposed structures within the initial project site area, as well as our comments and preliminary recommendations for the subject project.

After submittal of our initial geotechnical report for the processing plant, we were notified that the location of the processing plant will be shifted south of the initial plant site location by approximately 500 feet. The field exploration for the soil borings described in this report were performed at the current proposed location of the processing plant, based on the project file labeled "Option5-TPS-Rev3" uploaded to the "Dropbox" site by Turn-key Processing Solutions (TPS) on November 23, 2011.

FIELD EXPLORATION

The field exploration at the current processing plant site consisted of drilling and sampling eighteen standard soil borings which were designated Borings 110 through 127. Borings 110 through 117 were located in the project area for the dry plant structures. Borings 118 and 121 through 123 were located in the project area for the wet plant structures. Borings 119, 120, 125, and 126 were located in the project areas where large stockpiles of processed materials will be accumulated. Boring 127 was located in the project area where the rail load-out structure will be constructed west of the dry

plant area. The approximate locations of Borings 110 through 127 are shown on the enclosed Drawing 12911-1d.

The depth of the soil borings varied from 18 feet 7 inches to 28 feet 7 inches below grade. Due to split-barrel sampler refusal which was caused by bedrock, the final depths of the soil borings were less than the design depths of the borings. The actual boring depths at each of the boring locations are shown in the following table:

Soil Borings	Boring Depth Below Existing Grade
115 through 118 and 125	18'-7"
110, 113, 114, 120 through 123, 126, and 127	23'-7"
111, 112, 119, and 124	28'-7"

Soil sampling was started at a depth of 1 foot below the ground surface and continued at 2½-foot intervals to a depth of 10 feet, at which depth the sampling interval was increased to 5-foot-intervals to the bottom of the borings. Soil sampling was accomplished using 2¼-inch-inside-diameter, hollow-stem augers. The hollow-stem augers serve as casing to maintain an open borehole in most soil and water conditions. The soil samples were obtained using a 2-inch-outside-diameter, split-barrel sampler. Drilling and soil sampling were performed in accordance with the ASTM Designation D 1557.

The ground surface elevations at the soil boring locations were provided to us by Lampert-Lee & Associates. The ground surface elevation at each soil boring location is shown on the respective Soil Boring Records, Drawings 12911-36 through 12911-53, which were plotted with depth and elevation scales for reference.

SOIL AND BEDROCK STRATIGRAPHY

The stratigraphy which was encountered at the boring locations can be characterized as naturally deposited (native) soil strata overlying bedrock. Fill material was not encountered at the soil boring locations.

Dry Plant Area

The soil stratigraphy for this area was determined to be similar for Borings 110 through 115 and 117. A general soil profile for the dry plant area can be characterized as topsoil overlying brown with gray mottling, or gray with brown mottling, lean clay overlying black sedimentary peat with occasional black fibrous peat seams extending to depths that varied between 4½ feet and 16 feet below grade.

The sedimentary peat stratum was encountered at Borings 110 through 115. The thickness of the sedimentary peat stratum varied between 1½ feet at Boring 115 and 10½ feet at Boring 111. Below the sedimentary peat stratum, the borings in the dry plant area primarily encountered gray to white sand overlying sandstone bedrock. The exceptions were noted at Borings 112, 114, and 117 where a stratum of dark-gray to black organic clay was encountered below the sedimentary peat stratum and above the fine sand stratum. The thickness of the organic clay stratum varied between 1 foot and 6½ feet.

Sandstone bedrock was encountered below the native soil strata at the locations of Borings 110 through 117 in the dry plant area. The ground surface elevation, depth to the surface of the sandstone bedrock, and the corresponding elevation at the surface of the sandstone bedrock are summarized as follows:

Soil Boring	Ground Surface Elevation (feet)	Surface of Sandstone Bedrock	
		Depth Below Existing Grade	Elevation (feet)
110	956.8	18'-0"	938.8
111	956.9	23'-6"	933.4
112	957.2	23'-6"	933.7
113	956.5	16'-0"	940.5
114	956.9	23'-0"	933.9
115	956.9	13'-0"	943.9
116	957.1	16'-0"	941.1
117	956.0	15'-0"	941.0

Wet Plant Area

For the wet plant area, the soil stratigraphy was determined to be similar for Borings 118 and 121 through 123. A general soil profile for the wet plant area can be characterized as topsoil overlying gray or greenish-brown or orangish-brown or greenish-gray silty fine sand overlying gray or gray to white fine sand overlying sandstone bedrock. The organic soil strata which were encountered in the dry plant area were not encountered in the wet plant area.

Sandstone bedrock was encountered below the native soil strata at the locations of Borings 118 and 121 through 123. The ground surface elevation, depth to the surface of the sandstone bedrock, and the corresponding elevation at the surface of the sandstone bedrock are summarized as follows:

Soil Boring	Ground Surface Elevation (feet)	Surface of Sandstone Bedrock	
		Depth Below Existing Grade	Elevation (feet)
118	956.9	17'-6"	939.4
121	957.2	17'-6"	939.7
122	958.0	17'-0"	941.0
123	958.9	17'-6"	941.4

Sand Pile Areas

For the three frac sand pile areas where Borings 119, 120, 125, and 126 were located, the soil stratigraphy encountered at the soil boring locations can be characterized as the same as the stratigraphy which was encountered at the wet plant project area. To re-summarize the wet plant area, a general soil profile can be characterized as topsoil overlying silty fine sand overlying fine sand overlying sandstone bedrock. The organic soil strata which were encountered in the dry plant area were not encountered in the sand pile area.

Sandstone bedrock was encountered below the native soil strata at the locations of Borings 119, 120, 125, and 126. The ground surface elevation, depth to the surface of the sandstone bedrock, and the corresponding elevation at the surface of the sandstone bedrock are summarized as follows:

Soil Boring	Ground Surface Elevation (feet)	Surface of Sandstone Bedrock	
		Depth Below Existing Grade	Elevation (feet)
119	960.0	24'-0"	936.0
120	961.9	18'-6"	943.4
125	961.0	14'-9"	946.3
126	959.8	18'-0"	941.8

Rail Load-Out

The soil stratigraphy which was encountered at Boring 127 for the rail load-out structure was determined to be similar to that encountered in the dry plant area. A general soil profile can be characterized as topsoil overlying lean clay overlying sedimentary peat with occasional black fibrous peat seams extending to a depth of 9 feet 6 inches below grade. The thickness of the sedimentary

peat stratum was 5½ feet at the location of Boring 127. Below a depth of 9 feet 6 inches, Boring 127 encountered gray to white fine sand extending to a depth of 17 feet 9 inches below existing grade.

Sandstone bedrock was encountered below the native soil strata at the locations of Boring 127. The ground surface elevation, depth to the surface of the sandstone bedrock, and the corresponding elevation at the surface of the sandstone bedrock are summarized as follows:

Soil Boring	Ground Surface Elevation (feet)	Surface of Sandstone Bedrock	
		Depth Below Existing Grade	Elevation (feet)
127	957.4	17'-9"	939.7

For a further description of the native soil strata and the sandstone bedrock which were encountered at the locations of Borings 110 through 127, please refer to the Soil Boring Records, Drawings 12911-36 through 12911-53.

GROUNDWATER

Groundwater was encountered, or estimated to be present, at relatively shallow depths below existing grade at the soil boring locations. At the completion of most but not all of the soil borings, groundwater was observed within the boreholes. However, due to caving of the sidewalls for some of the boreholes, a groundwater level reading could not be obtained at the completion of some of the borings so that we estimated the groundwater levels at eight boring locations based on the moisture condition of the soil samples. We observed that the soil samples below the groundwater level were in a wet or saturated condition.

The ground surface elevation, depth to groundwater, and the groundwater elevation at the soil boring locations are summarized as follows.

Soil Boring	Ground Surface Elevation (feet)	Depth to Groundwater Below Existing Grade	Groundwater Elevation (feet)
110	956.8	4'-9" at completion	952.1
111	956.9	6'-0" (estimated)	950.9
112	957.2	7'-1" at completion	950.1

Soil Boring	Ground Surface Elevation (feet)	Depth to Groundwater Below Existing Grade	Groundwater Elevation (feet)
113	956.5	6'-0" (estimated)	950.5
114	956.9	6'-5" at completion	950.5
115	956.9	3'-10" at completion	953.1
116	957.1	4'-6" at completion	952.6
117	956.0	4'-1" at completion	951.9
118	956.9	3'-11" at completion	953.0
119	960.0	4'-6" (estimated)	955.5
120	961.9	6'-3" (estimated)	955.7
		7'-3" at completion	954.7
121	960.0	4'-3" at completion	955.8
122	961.9	6'-8" at completion	955.2
123	957.2	6'-0" (estimated)	951.2
124	960.7	4'-6" (estimated)	956.2
		8'-8" at completion	952.0
125	961.0	7'-0" (estimated)	954.0
		8'-0" at completion	953.0
126	959.8	4'-0" (estimated)	955.8
127	957.4	6'-0" at completion	951.4

On the days that the borings were performed, the groundwater levels varied between elevation 950.5 feet and elevation 956.2 feet at the boring locations.

The groundwater levels are expected to fluctuate and reach higher or lower elevations during other seasons of the year as influenced by precipitation, surface water run-off, snowmelt, the stage of nearby bodies of water, and other hydrologic and hydrogeologic factors.

Surface water from precipitation, snowmelt, surface water runoff, or other sources should be properly conducted and diverted away from the project construction areas to minimize infiltration of surface water into excavations and the subgrade soils.

LABORATORY AND FIELD TESTS

Laboratory tests were performed on selected split-barrel soil samples. The laboratory tests consisted of moisture content, organic matter content based on the Loss on Ignition (LI) method, and approximate unconfined compressive strength (q_p) using a spring penetrometer. The field test consisted of the Standard Penetration Test (SPT) which was performed during the soil sampling procedures at the boring locations. The test result of the SPT is provided in terms of blows per foot based on driving the split-barrel sampler using a 140-pound hammer free-falling for 30 inches. The blows per foot are referred to as the "N-values" which are shown on Drawings 12911-36 through 12911-53.

Based on the field and laboratory test results, our evaluations of the native soil strata and sandstone bedrock which were encountered at the boring locations are summarized below:

Lean Clay: This cohesive stratum was encountered at Borings 110 through 117 and 127. Based on the "q_p" values from the spring penetrometer, the lean clay stratum was determined to be of soft to stiff consistency, with very low to moderately low strength.

The moisture content test and Atterberg limits test were performed on representative samples of the lean clay stratum. A summary of the laboratory test results is shown below:

Soil Boring	Approximate Sample Depth Below Existing Grade	Moisture Content (%)	Atterberg Limits Test Results		
			Liquid Limit LL	Plastic Limit PL	Plasticity Index PI
111	4'-6"	29.1	42	21	21
112	4'-6"	34.3	40	23	17
113	4'-6"	32.2	----	----	----
114	4'-6"	37.5	----	----	----

Based on the Atterberg limits test results, we classified the lean clay stratum as "CL" in accordance with the Unified Soil Classification System (USCS).

Sedimentary Peat with occasional Black Fibrous Peat Seams: This stratum was encountered at Borings 110 through 115 and 127. Based on the "N" values from the SPT, the sedimentary peat stratum was determined to be of very low to low strength. At Borings 114 and 127, for the upper portion of the sedimentary peat stratum, the "N" value was reported as "WH/18"" which means that the weight of the hammer (WH) caused a penetration of 18 inches of the split-barrel sampler without dropping the hammer. Soil with a N value of "WH/18"" are known to be of very low strength with the potential for significant compressibility if subjected to a compressive load. We classified the sedimentary peat stratum as "PT" in accordance with USCS.

A moisture content test and an organic matter content test were performed on a representative sample of the sedimentary peat stratum from Boring 113. The results of the laboratory tests are summarized as follows.

Soil Boring	Approximate Sample Depth Below Existing Grade	Moisture Content (%)	Percentage of Organic Matter (%)
110	7'-0"	174.5	23.0
111	9'-6"	63.0	7.5
112	7'-0"	63.1	8.2
113	7'-0"	177.7	31.2
114	7'-0"	128.4	16.9
127	7'-0"	339.3	42.4

The above moisture content test results which varied between 63.0 percent and 339.3 percent are representative of large to very large amounts of moisture in the sedimentary peat stratum. Also, the percentage of organic matter test results which varied between 7.5 percent and 42.4 percent are representative of moderate to large amounts of organic matter in the sedimentary peat stratum. The two factors, consisting of large amounts of moisture and organic matter, indicate that the sedimentary peat stratum has the potential for significant compressibility and volume change if it is subjected to a compressive load such as the proposed structures, equipment, and tanks for the processing plant.

Organic Clay: The dark-gray to black organic clay stratum was encountered at the locations of Borings 112, 114, and 117. Based on the "q_p" values from the spring penetrometer, this stratum was

determined to be of soft consistency, with very low strength. The organic clay stratum was classified as "OH" in accordance with USCS.

The moisture content test and the organic matter content test were performed on samples of the organic clay stratum from Boring 112 and 114. The results of the laboratory tests are shown:

Soil Boring	Approximate Sample Depth Below Existing Grade	Moisture Content (%)	Percentage of Organic Matter (%)
112	19'-6"	22.4	----
114	14'-6"	35.0	3.1

Fine Sand: This granular stratum was encountered at Borings 110 through 123, 126, and 127. Based on the "N" values from the SPT, the fine sand stratum was determined to be in a very loose to dense state of relative density, with a majority of the "N" values in the medium dense category. Based on the available information, the fine sand stratum was determined to be of very low to high strength. The very loose condition of the fine sand was encountered at Boring 113, and the upper portion of the stratum at Boring 122. The fine sand stratum was classified as "SP" in accordance with USCS.

The moisture content test and the percentage of particles passing the No. 200-mesh sieve test were performed on samples of the fine sand stratum. The laboratory test results are summarized below.

Soil Boring	Approximate Sample Depth Below Existing Grade	Moisture Content (%)	Percentage of Silt and Clay Particles, P_{200} (%)
115	7'-0"	16.7	2.1
116	9'-6"	18.4	1.5
117	4'-6"	18.8	3.2
122	14'-6"	20.0	0.6
127	14'-6"	17.1	3.8

The test results indicate a small amount of silt and clay particles in the fine sand stratum.

Silty Fine Sand: This stratum was encountered at Borings 118 through 126. Based on the "N" values from the SPT, the silty fine sand stratum was determined to be in a very loose to dense state of relative density, with a majority of the "N" values in the loose to medium dense categories. The very loose condition was encountered at Boring 119. We classified the silty fine sand stratum as "SM" in accordance with USCS.

The moisture content test and the percentage of particles passing the No. 200-mesh sieve test were performed on samples of the silty fine sand stratum. A summary of the laboratory test results is shown below:

Soil Boring	Approximate Sample Depth Below Existing Grade	Moisture Content (%)	Percentage of Silt and Clay Particles, P_{200} (%)
118	4'-6"	17.4	3.2
119	7'-0"	19.1	3.3
120	4'-6"	9.1	-----
121	2'-0"	14.0	3.9
122	2'-0"	4.8	----
123	2'-0"	5.7	----
124	2'-0"	8.3	----
124	7'-0"	19.1	24.4
125	2'-0"	3.6	----
125	4'-6"	5.0	4.9
126	2'-0"	3.4	23.0

These test results indicate a small amount of silt and clay particles in the fine sand stratum.

Weathered Sandstone Bedrock: The gray to white sandstone bedrock was encountered at each of the soil boring locations. Based on the "N" values from the SPT, the sandstone bedrock was determined to be in a dense state of relative density as evidenced by the "N" values ranging from 60 blows per 1 inch or less, to 100 blows per 10 inches.

The information from the laboratory tests and the field test was utilized in our evaluation of the native soil strata and bedrock which were encountered at the boring locations.

COMMENTS AND RECOMMENDATIONS

As described above, the soil stratigraphy encountered at the soil borings in the dry plant area differed considerably from the soil stratigraphy encountered at the soil borings in the wet plant area.

For the dry plant project area, a general soil profile can be characterized as topsoil overlying lean clay overlying sedimentary peat with occasional black fibrous peat seams extending to variable depths below grade. Below the sedimentary peat stratum, the borings primarily encountered fine sand overlying sandstone bedrock, with the exception at Borings 112, 114, and 117 where a stratum of dark-gray to black organic clay was encountered below the sedimentary peat stratum and above the fine sand stratum. Below the fine sand stratum, sandstone bedrock was encountered near the bottom of the soil borings.

For the wet plant area which will be located east of the dry plant area, the soil stratigraphy can be characterized as topsoil overlying gray or greenish-brown or orangish-brown or greenish-gray silty fine sand overlying gray or gray to white fine sand overlying sandstone bedrock. The organic soil strata which were encountered in the dry plant area were not encountered in the wet plant area.

Due to the differing soil conditions in the dry plant area and the wet plant area, our comments and recommendations for the two project areas are presented separately as follows:

Dry Plant Area

The dry plant area will be located east of the railroad spur track and west of the wet plant area. The dry plant area will contain various structures such as a screen house building, bag house building, storage tanks, dryer building, dryer bag building, four feed bins, and an EH-1 structure.

We were provided information by the project structural engineer with Turnkey Processing Solutions, LLC (TPS) regarding the structural loads which may be present for the proposed buildings and structures. In general, most of the structural loads are considered to be heavy to very heavy. The loading for the storage tanks will vary between 3,166 kips and 6,310 kips. The loading for the screen house building will be 300 kips and the loading for the feed bins will vary between 85 kips and 210 kips. The loading for the dryer bag house building will be 95 kips.

At the time of this report, we are not aware of the design grades for the lower portions of the proposed buildings and structures. We should be notified of the design grades for the lower level of the proposed buildings and structures to determine if our recommendations provided herein should be modified.

Based on the laboratory and field test results, the sedimentary peat stratum at the locations of Borings 110 through 115, and the organic clay stratum at Borings 112, 114, and 117, were determined to be of low- to very low-strength with the potential for significant consolidation if the sedimentary peat stratum and organic clay stratum will be subjected to a compressive load consisting of the weight of the proposed structures in the dry plant area. In addition, it is our opinion that the sedimentary peat stratum and the organic clay stratum are not suitable to provide stable long-term subgrade support for floor slabs, pavement areas, and other lightly-loaded areas.

1. Initial Site Preparation

Initial site preparation should include stripping and removing surface vegetation and topsoil from the dry plant area. At Borings 110 through 117, the thickness of the surficial topsoil layer varied between 9 inches and 24 inches. More or less topsoil may be encountered in unexplored areas of the dry plant.

The removal of trees and tree stumps may be required in parts of the project site.

2. Recommendation to Excavate and Remove Unsuitable Organic Soils

To provide for stable, long-term subgrade support for the structures in the dry plant project area, we recommend that the sedimentary peat stratum at Borings 110 through 115, and the organic clay stratum at Borings 112, 114, and 117 be completely excavated and removed during initial site preparation. We recommend the following depths of excavation to remove the unsuitable organic soils at the locations of Borings 110 through 117:

Soil Boring	Ground Surface Elevation (feet)	Depth to Bottom of Unsuitable Organic Soil Below Grade	Elevation at Bottom of Low-Strength Organic Soil (feet)
110	956.8	10'-0"	946.8
111	956.9	16'-0"	940.9
112	957.2	19'-6"	937.7
113	956.5	16'-0"	940.5
114	956.9	20'-0"	936.9
115	956.9	4'-6"	952.4
116	957.1	3'-0"	954.1
117	956.0	3'-1"	952.9

The depth of site excavation to remove the unsuitable organic soil strata will vary between approximately 3 feet and approximately 20 feet below grade based on the above soil borings. More or less organic soil may be encountered at unexplored project areas. The intent is to completely remove the organic soil strata from below all proposed construction areas consisting of but not limited to structures, buildings, tanks, equipment, hoppers, underground utility pipe, supports for above-ground utilities or conveyor systems, pavement, floor slabs, and any other construction areas. The excavated organic soils should be replaced with compacted fill material.

3. Groundwater Dewatering

The recommended depth of site excavation to completely remove the organic soils will extend below the groundwater levels which were encountered at the locations of Borings 110 through 115. As previously described, the groundwater level was encountered at relatively shallow depths which varied between 3 feet 10 inches and 7 feet 1 inch below grade at the locations of Borings 110 through 117.

If site excavation will extend below the groundwater level, groundwater will flow into the excavation area during site excavation activities. In order to perform site excavation, and to place compacted fill material in a relatively dry excavation, we recommend that a groundwater dewatering system be installed in the project areas where site excavation will be required to remove the organic soil strata.

Where it is needed, we recommend that a dewatering system be installed to temporarily lower the groundwater level prior to commencement of site excavation. The contractor should be at liberty to select the dewatering system to install at the project site. Dewatering equipment should remove water only, and removal of soil must be prevented. Dewatering should be a continuous operation. Starting and stopping of pumps should not be permitted. Dewatering should lower the groundwater level between 12 inches and 18 inches below the bottom of the excavation. The contractor should operate the dewatering system until the level of compacted fill material is at least 2 feet above the groundwater level.

Observation wells and/or other monitoring devices should be utilized to determine the level of the groundwater and the efficiency of the dewatering system.

Pumped water from the dewatering system should be properly disposed in accordance with the applicable regulations.

4. Site Excavation

As described in Section 2 above, the recommended depth of excavation to remove the unsuitable organic soil strata may vary between approximately 3 feet below grade and approximately 20 feet below grade. More or less site excavation may be encountered at other project areas in the vicinity of Borings 110 through 117.

The lateral extent at the bottom of the excavation should be based on a 1:1 line extending down and away from the bottom outer edge of the various structures for the dry plant area. The sidewalls of the excavation should be properly sloped or adequately shored in accordance with OSHA and the Wisconsin Department of Commerce rules and regulations regarding construction site excavations.

We expect that site excavation should be able to be accomplished using a standard hydraulic backhoe, or a dragline, or a clam-shell bucket.

The excavation should extend to the bottom of the organic soils to expose native soil consisting of gray to white fine sand at Borings 110 through 117 for the total area at the bottom of the excavation.

5. Observation and Testing of Native Soil at Bottom of Excavation

At the bottom of the excavation, we recommend that the native soil be observed and tested by Soils & Engineering Services, Inc. to verify its strength and to determine its ability to properly support the fill material to be placed for the dry plant area.

6. Treatment of Native Soil at Bottom of Excavation

Prior to the placement of compacted fill material at the bottom of the excavation, the native soil at the bottom of the excavation will be too wet or saturated to compact, even after effective dewatering. Compaction of the native soils at the bottom of the excavation is <u>not</u> recommended.

To place and effectively compact fill material at the bottom of the excavation, it may be necessary to place a geotextile upon the approved native soil followed by a minimum of 18 inches of crushed coarse stone as a means of providing "separation" between the wet to saturated native soil at the bottom of the excavation and the initial layer of fill material to be compacted. We recommend that the geotextile consist of Mirafi 600X, Contech C300, or a similar product. The stone should be similar to ASTM Designation C 33 No. 2 stone which consists of particles primarily in the 1½- to 2½-inch-size range without "fines." The intent of the geotextile and stone is to form a stable base upon which fill material can be placed and effectively compacted. We recommend that the project bid documents request unit prices for geotextile and crushed coarse stone from the contractors bidding for the subject project.

7. Placement of Compacted Fill Material

After installation of the geotextile and crushed coarse stone at the bottom of the excavation, the placement of compacted fill material may commence to raise the grade at the bottom of the excavation to the design subgrade elevation for the dry plant area. The source of the fill material for the dry plant area is not known although an on-site borrow area may be utilized as the source of the fill material. The native soil granular soil such as the stratum described

as fine sand should be suitable to utilize for the dry plant area if the moisture content of the fine sand is in the proper range to achieve the recommended degree of compaction.

We recommend that fill material be placed in maximum 12-inch-thick lifts, measured in the loose condition prior to compaction. Each lift of fill material should be thoroughly compacted to a density of at least 95 percent of the maximum dry density determined for the fill material in accordance with ASTM Designation D1557.

During cold weather conditions, fill material should not be deposited over frozen native soil or frozen previously placed fill material. Also, fill material to be placed and compacted should not be frozen or contain snow or ice.

8. Testing of Compacted Fill Material

We recommend that Soils & Engineering Services, Inc. be retained to perform compaction testing of the fill material at regular intervals to verify that the minimum density is achieved, especially during initial placement of the compacted fill material. Any compacted lift that does not meet the specified density should receive additional compactive effort and then be retested until the required density is achieved. Subsequent lifts should not be placed until the specified minimum density is achieved on the preceding lift.

9. Foundation Recommendations

Our recommendations for foundation support of the dry plant structures are provided below:

A. Shallow Footings

After complete excavation and removal of the organic soil strata and replacement using compacted fill material, shallow footings or a mat foundation may be utilized for foundation support purposes.

We recommend that the bottom of shallow footings, exterior and interior, which will be subject to freezing temperatures be placed at a minimum depth of 4½ feet below the finished exterior grade to protect the bearing soils from frost penetration. For footings below lower-level building areas which will not be subject to freezing temperatures, the bottom of the footings may be installed directly below the lower-level floor slab. Interior footings in heated building areas may be placed directly below the floor slab-on-grade.

If shallow footings will be utilized, we recommend that the shallow footings in the dry plant area be directly supported by compacted fill material overlying approved native soil.

The allowable soil bearing pressure to use for footing design purposes will depend on several factors, such as the design bottom of footing elevation, the thickness of the

compacted fill material below the bottom of the footing, and the depth to the groundwater below the design bottom of footing elevation. We should be notified of the design bottom of footing elevation to verify the actual allowable soil bearing pressure which should be used for footing design purposes. We offer the following range of preliminary allowable soil bearing pressures at each of the soil boring locations in the dry plant area, after removal of the existing organic soils:

Soil Boring	Range of Preliminary Allowable Soil Bearing Pressures (psf)
110	2,000 to 3,000
111	2,500 to 3,500
112	3,000 to 4,000
113	3,000 to 4,000
114	3,000 to 4,000
115	1,500 to 2,500
116	2,000 to 3,000
117	2,500 to 3,500

The above range of allowable soil bearing pressures are intended to reduce the potential for long-term settlement to 1½ inches, or less, for the proposed structures. If the proposed structures and/or equipment in the dry plant area cannot tolerate settlement of 1½ inches, we should be notified.

B. Deep Foundation

In lieu of standard shallow footings, foundation support for the dry plant structures may consist of a deep foundation system due to the presence of shallow high-strength sandstone bedrock. The utilization of a deep foundation system may allow the low-strength organic soil strata to remain in-place since foundation support should be derived by the H-piles extending to sound and dense sandstone bedrock. If the low-strength organic soil strata will remain in-place, then the deep foundation system will need to be installed for support of all column loads, wall loads, other structural loads, as well as floor slabs, and bottom of tank subgrade support. For floor slab areas or bottom of tank areas, piles will need to be installed at a close spacing with a pile cap

acting as the floor slab or bottom of tank. An alternative method will be to utilize a reinforced concrete structural slab to span between nearby piles.

We recommend that the deep foundation system consist of driven steel H-piles with a minimum section of HP10x42. Our comments and recommendations for steel H-piles are provided, as follows:

Driven H-piles are intended to be end-bearing piles supported by the underlying sandstone bedrock which is in a dense and sound condition. The piles should be driven through the native soil strata and through highly weathered and weathered sandstone bedrock and deep enough so that the pile tips bear upon sound and dense sandstone bedrock.

We recommend that all piles be driven to a "refusal" condition with the pile tips embedded within sound and dense sandstone bedrock. Pile refusal is reached if a set of 20 pile-hammer blows causes 1 inch or less of pile penetration and if the succeeding three sets of 20 pile-hammer blows result in 1 inch or less of pile penetration for each set of 20 pile-hammer blows. If more than 1 inch of pile penetration is caused by any set of 20 pile-hammer blows, then the test for pile refusal should be repeated until three consecutive sets of 20 pile-hammer blows result in 1 inch or less of pile penetration for each set.

The actual length of H-pile to install should be based on the driving record of the pile and will depend on the depth where sound and dense sandstone bedrock is present. Based on the information from the soil borings, we estimate that pile refusal may take place between elevation 929.9 feet and elevation 940.1 feet. The following table provides the ground surface elevation, the depth at which the sandstone bedrock was encountered, and our estimated pile tip refusal elevations at the locations of the soil borings, as follows:

Soil Boring	Ground Surface Elevation (feet)	Depth to Surface of Sandstone Bedrock Below Existing Grade	Estimated Pile Tip Refusal Elevation (feet)
110	956.8	18'-0"	936.8
111	956.9	23'-6"	929.9
112	957.2	23'-6"	930.2
113	956.5	16'-0"	934.5
114	956.9	23'-0"	933.6

Soil Boring	Ground Surface Elevation (feet)	Depth to Surface of Sandstone Bedrock Below Existing Grade	Estimated Pile Tip Refusal Elevation (feet)
115	956.9	13'-0"	939.9
116	957.1	16'-0"	940.1
117	956.0	15'-0"	939.0

Steel H-piles which are driven to a refusal condition and which bear on sound and dense sandstone bedrock may be designed based on limiting the compressive stress in the steel to 9,000 pounds per square inch (psi). The load capacity of the H-pile will be dictated by the section of H-pile selected to use for the subject project.

We recommend that the initial piles driven be those in the vicinity of the soil borings to correlate the soil boring information and the pile driving records. The actual pile length to install to achieve the design pile capacity should be based on pile driving criteria to reach a pile refusal condition.

The pile hammer used to drive the piles should have a manufacturer's rated energy of at least 30,000 foot-pounds per blow. Pile driving equipment should be in good mechanical condition and be able to drive piles without equipment malfunctions.

To protect the H-piles during potential hard driving through the weathered zone of the sandstone bedrock, we recommend that hardened steel "points" be welded to the tips of all H-piles. When hardened points are used, piling can be driven faster and in straighter alignment, as well as protecting the steel at the bottom of the pile against crushing.

We recommend that Soils & Engineering Services, Inc. be retained to observe and record blow counts during pile installation, and to document that all of the piles penetrated to the proper bearing elevation. The pile load capacity for each installed pile should be field verified by Soils & Engineering Services, Inc. personnel based on the pile driving records obtained during installation of the H-piles.

C. Vibrated Stone Columns

In lieu of, or in addition to, driven H-piles, a special type of deep foundation system, such as vibrated stone columns (e.g., Geopiers) may be installed within the project area where the processing structures will be constructed. The stone columns could be used in conjunction with standard shallow footings or a mat foundation to support the various storage tanks and processing machinery.

Vibrated stone columns are considered to be a suitable soil improvement method for the subject project. The Geopier method is a proprietary foundation improvement method which consists of drilling holes, generally between 24 inches and 36 inches in diameter, to remove low-strength soil below proposed foundation bearing areas, or slab areas. After drilling the holes to a specified depth, for this project to the sandstone bedrock, the holes are backfilled using layers of densely-compacted, open-graded aggregate such as coarse stone, gravel, or crushed concrete. The open-graded aggregate is placed in 12-inch-thick layers, and each layer is compacted using a tamper that delivers a high-energy impact ramming action. The ramming action compacts the aggregate and densifies the surrounding soil. The compacted aggregate is placed until the design bottom of foundation elevation, or design bottom of floor slab elevation, is reached.

After installation of the stone columns, standard shallow footings or a mat foundation bearing directly upon the stone columns may be utilized for foundation support of the dry plant structures. For frost protection, the bottom of the footings or mat foundation should be at least 4½ feet below finished exterior grade.

Mat foundations, footings and foundation walls should include a sufficient quantity of reinforcing steel bars to minimize the shrinkage effect of the concrete during the curing process.

The Geopier company should be contacted to determine the feasibility and economics of using their system on this project site.

Wet Plant Area

The wet plant area will be located east of the dry plant area, and the wet plant area will contain various structures such as a water tank, thickener tank, wash plant building, and an EH-2 structure.

We were provided information by the project structural engineer with TPS regarding the structural loads which may be present for the wet plant structures. In general, most of the structural loads in the wet plant area are considered to be heavy to very heavy. In the wet plant area, the loading for the wash plant building will be 2,145 kips. The loading for the thickener tank will be 1,212 kips. The loading for the water tank will be 410 kips, and the loading for the screen sump building will be 265 kips.

At the time of this report, we are not aware of the design grades for the lower portions of the proposed buildings and structures. We should be notified of the design grades for the lower levels of the proposed buildings and structures for the wet plant.

1. Initial Site Preparation

Initial site preparation should include stripping and removing surface vegetation and topsoil from the wet plant building and structure areas. At Borings 118 and 121 through 123, the thickness of the surficial topsoil layer varied between 8 inches and 18 inches, with an average thickness of approximately 12 inches. More or less topsoil may be encountered in unexplored areas of the wet plant.

The removal of trees and tree stumps may be required in parts of the project site.

2. Groundwater Dewatering

Groundwater was encountered at Borings 118 and 121 through 123 at relatively shallow depths that varied between 3 feet 11 inches and 6 feet 8 inches below grade, with an average depth of 5 feet 2 inches below grade.

We are not aware of the design bottom elevation for the various buildings and structures in the wet plant area. If the design bottom elevation for the structures or buildings in the wet plant area will extend below the groundwater levels which were encountered at the soil boring locations, a means of lowering the groundwater level will be required during the time that site excavation and building construction takes place.
Our comments and recommendations for groundwater dewatering are provided in Section 3 for the dry plant.

3. Site Excavation

For the wet plant project areas where the existing grades are higher than the design grades for the various structures and buildings, site excavation will be required to reach the design grades. Since we are not aware of the design bottom elevation for the various buildings and structures in the wet plant area, the depth of site excavation for construction of the various structures and buildings cannot be determined.

If it is necessary, we anticipate that site excavation will primarily encounter native soil which was described as silty fine sand, or possibly fine sand. We expect that site excavation should be able to be accomplished using standard earth excavation equipment such as a hydraulic backhoe, earth scrapers, bulldozers, or loaders.

4. Placement of Compacted Fill Material

For the wet plant project areas where the existing grades are lower than the design grades for the various structures and buildings, the placement of compacted fill material will be required to reach the design grades. Since we are not aware of the design bottom elevation for the various buildings and structures in the wet plant area, we cannot provide the amount of compacted fill material that will be needed for construction of the various structures and buildings in the wet plant.

Our comments and recommendations for the placement of compacted fill material are provided in Section 7 for the dry plant.

5. Observation and Testing of Native Soil at Bottom of Excavation

At the bottom of all footing or slab excavation, we recommend that the native soil be observed and tested by Soils & Engineering Services, Inc. to verify the strength of the native soil, and to determine it's ability to properly support the loading for the wet plant area.

6. Testing of Compacted Fill Material

We recommend that Soils & Engineering Services, Inc. be retained to perform compaction testing of the fill material at regular intervals to verify that the minimum density has been achieved, especially during initial placement of the compacted fill material.

7. Foundation Recommendations

For foundation support purposes, either standard shallow footings/mat foundations or a deep foundation system may be utilized for the structures and equipment in the wet plant area. Our recommendations for shallow footings/mat foundations and a deep foundation system are provided, as follows:

A. Shallow Footings/Mat Foundation

We recommend that the bottom of shallow footings or mat foundation which will be subject to freezing temperatures be placed at a minimum depth of 4½ feet below the finished exterior grade to protect the bearing soils from frost penetration. For footings below lower-level building areas which will not be subject to freezing temperatures, the bottom of the footings may be installed directly below the lower-level floor slab. Interior footings in heated building areas may be placed directly below the floor slab-on-grade.

If shallow footings will be utilized, we recommend that the shallow footings in the wet plant area be directly supported by approved native soil, or by compacted fill material overlying approved native soil.

We should be notified of the design bottom of footing elevation to verify the actual allowable soil bearing pressure which should be used for footing design purposes. We offer the following range of preliminary allowable soil bearing pressures at each of the soil boring locations in the wet plant area:

Soil Boring	Range of Preliminary Allowable Soil Bearing Pressures (psf)
118	2,000 to 3,000
121	1,250 to 1,750
122	1,500 to 2,500
123	2,000 to 3,000

The above range of allowable soil bearing pressures are intended to reduce the potential for long-term settlement to 1½ inches, or less. If the proposed structures and/or equipment in the wet plant area can tolerate a greater amount of potential settlement, we should be notified.

B. Deep Foundation

In lieu of standard shallow footings, foundation support for the wet plant structures may consist of a deep foundation system. Our comments and general recommendations for steel H-piles were provided in Section 9B for the dry plant.

Based on the information from Borings 118 and 121 through 123, we estimate that pile refusal may take place between approximate elevation 937 feet and approximate elevation 939 feet. The following table provides the ground surface elevation, the depth at which sandstone bedrock was encountered, and our estimated pile tip refusal elevations at the locations of Borings 118 and 121 through 123, as follows:

Soil Boring	Ground Surface Elevation (feet)	Depth to Surface of Sandstone Bedrock Below Existing Grade	Estimated Pile Tip Refusal Elevation (feet)
118	956.9	17'-6"	938.9
121	957.2	17'-6"	937.2
122	958.0	17'-0"	937.0
123	958.9	17'-6"	937.9

Steel H-piles which are driven to a refusal condition and which bear on sound and dense sandstone bedrock may be designed based on limiting the compressive stress

in the steel to 9,000 pounds per square inch (psi). The load capacity of the H-pile will be dictated by the section of H-pile selected to use for the subject project.

Please refer to our recommendations for steel H-piles in Section 9B for the dry plant.

C. Vibrated Stone Columns

The utilization of vibrated stone columns is also possible for the wet plant area if a higher allowable soil bearing pressure is needed for design purposes of shallow footings or a mat foundation. Please refer to our comments in Section 9C for the dry plant.

Rail Load-Out Area

We were provided information by the project structural engineer with TPS regarding the structural load which may be present for the rail load-out structure. The loading for the rail-load structure was reported as 290 kips.

Based on the laboratory and field test results, the sedimentary peat stratum at the location of Boring 127 was determined to be of very low strength with the potential for significant compressibility if the sedimentary peat stratum will be subjected to a compressive load consisting of the weight of the proposed rail-load out structure.

1. Initial Site Preparation

Initial site preparation should include stripping and removing surface vegetation and topsoil from the proposed rail load-out structure area. At Boring 127, the thickness of the surficial topsoil layer was 24 inches. More or less topsoil may be encountered in unexplored areas of the dry plant.

2. Recommendation to Excavate and Remove Unsuitable Organic Soils

To provide for stable, long-term subgrade support for the rail load-out structure, we recommend that the sedimentary peat stratum at Boring 127 be completely excavated and removed during initial site preparation. We recommend the following depth of excavation to remove the unsuitable sedimentary peat at the location of Boring 127:

Soil Boring	Ground Surface Elevation (feet)	Depth to Bottom of Sedimentary Peat Below Existing Grade	Elevation at Bottom of Sedimentary Peat (feet)
127	957.4	9'-6"	947.9

The depth of site excavation to remove the unsuitable organic soil will be approximately 9½ feet below grade. More or less organic soil may be encountered at unexplored project areas. The excavated organic soils should be replaced with compacted fill material.

3. Groundwater Dewatering

The recommended depth of site excavation to completely remove the sedimentary peat will extend below the groundwater level which was encountered at the location of Boring 127. The groundwater level was encountered at a relatively shallow depth of 6 feet 0 inch below grade at the location of Boring 127.

In order to perform site excavation, and to place compacted fill material in a relatively dry excavation, we recommend that a groundwater dewatering system be installed in the project area where site excavation will be required to remove the organic soil strata. Our comments and recommendations for groundwater dewatering were provided in Section 3 for the dry plant.

4. Site Excavation

As described in Section 2 above, the recommended depth of excavation to remove the unsuitable sedimentary peat soil from below the proposed rail load-out structure will be approximately 9½ feet below grade. More or less site excavation may be encountered at other project areas in the vicinity of Boring 127.

The lateral extent at the bottom of the excavation should be based on a 1:1 line extending down and away from the bottom outer edge of the rail load-out structure. The sidewalls of the excavation should be properly sloped or adequately shored in accordance with OSHA and the Wisconsin Department of Commerce rules and regulations regarding construction site excavations.

We expect that site excavation should be able to be accomplished using a standard hydraulic backhoe, or a dragline, or a clam-shell bucket.

The excavation should extend to the bottom of the sedimentary peat soil to expose native soil consisting of gray to white fine sand for the total area at the bottom of the excavation.

5. Observation and Testing of Native Soil at Bottom of Excavation

At the bottom of the excavation, we recommend that the native soil be observed and tested by Soils & Engineering Services, Inc. to verify the strength of the native soil, and determine its ability to properly support the fill material to be placed for the rail load-out structure.

6. Treatment of Native Soil at Bottom of Excavation

Our comments and recommendations for the treatment of the native soil at the bottom of the excavation were provided in Section 6 for the dry plant.

7. Placement of Compacted Fill Material

Our comments and recommendations for the placement of compacted fill material were provided in Section 7 for the dry plant.

8. Testing of Compacted Fill Material

We recommend that Soils & Engineering Services, Inc. be retained to perform compaction testing of the fill material at regular intervals to verify that the minimum density is achieved, especially during initial placement of the compacted fill material. Any compacted lift that does not meet the specified density should receive additional compactive effort and then be retested until the required density is achieved. Subsequent lifts should not be placed until the specified minimum density is achieved on the preceding lift.

9. Foundation Recommendations

Our recommendations for shallow footings/mat foundation and a deep foundation system are provided, as follows:

A. Shallow Footings/Mat Foundation

After complete excavation and removal of the sedimentary peat soil and replacement using compacted fill material, shallow footings or a mat foundation may be utilized for foundation support of the rail load-out structure.

We recommend that the bottom of shallow footings which will be subject to freezing temperatures be placed at a minimum depth of 4½ feet below the finished exterior grade to protect the bearing soils from frost penetration.

The allowable soil bearing pressure to use for shallow footing design purposes will be based on several factors, as previously described. We should be notified of the design bottom of footing elevation to verify the actual allowable soil bearing pressure which should be used for footing design purposes. We offer the following range of preliminary allowable soil bearing pressures the location of Boring 127:

Soil Boring	Range of **Preliminary** Allowable Soil Bearing Pressure (psf)
127	2,000 to 3,000

B. Deep Foundation

In lieu of standard shallow footings, foundation support for the rail load-out structure may consist of a deep foundation system. The utilization of a deep foundation system should allow the low-strength sedimentary peat stratum to remain in-place since foundation support should be derived by the H-piles extending to sound and dense sandstone bedrock.

Our comments and recommendations for steel H-piles were provided in Section 9B for the dry plant.

The actual length of pile to install should be based on the driving record of the H-pile and will depend on the depth where sound and dense sandstone bedrock is present. The following table provides the ground surface elevation, the depth at which sandstone bedrock was encountered, and our estimated pile tip refusal elevation at the location of Boring 127, as follows:

Soil Boring	Ground Surface Elevation (feet)	Depth to Surface of Sandstone Bedrock Below Existing Grade	Estimated Pile Tip Refusal Elevation (feet)
127	957.4	17'-10"	937.4

Please refer to our recommendations for pile load capacity and other recommendations for H-piles in Section 9B for the dry plant.

C. Vibrated Stone Columns

The utilization of vibrated stone columns is also possible for the rail load-out structure. Please refer to our comments in Section 9C for the dry plant.

Frac Sand Stockpiles

Borings 119, 120, 125, and 126 were performed in the project areas for three frac sand stockpiles consisting of a +70-mesh sand pile, a -70-mesh sand return to pit pile, and a +70-mesh sand winter pile. The soil stratigraphy encountered at the locations of Borings 119, 120, 125, and 126 consisted of topsoil overlying silty fine sand overlying fine sand overlying sandstone bedrock. The organic soil strata which were encountered in the dry plant area were not encountered in the frac sand stockpile areas.

Sandstone bedrock was encountered below the native soil strata at the locations of Borings 119, 120, 125, and 126. The depth to the sandstone bedrock varied between 14 feet 9 inches and 24 feet 0 inch below grade.

Groundwater was estimated to be present at shallow depths that varied between 4 feet and 7 feet below existing grade.

The native soil strata and underlying sandstone bedrock should be suitable for supporting the three stockpiles of frac sand. Due to the weight of the stockpiles, some compression and consolidation of the native soil strata may take place but the amount of potential subgrade settlement is not considered to be detrimental for the stockpiles.

We do not expect that groundwater should be a problem if the stockpiles of frac sand will be deposited at the existing ground surface.

CLOSING COMMENTS

This engineering report was prepared for the exclusive use of Smart Sand Company and Turnkey Processing Solutions, LLC to aid in the evaluation of the subject project site which is located in the Town of Oakdale in Monroe County, and for the uses described herein.

Soils & Engineering Services, Inc. should review any changes in the nature, design, or location of the proposed structures for the subject project after submittal of our *Geotechnical Exploration and Supplementary Report*, to revise the recommendations in this report, if necessary. Likewise, the nature and extent of soil, bedrock, or groundwater variations between the locations of the borings may not become evident until the time of excavation and construction of the subject project. If variations are evident at that time, Soils & Engineering Services, Inc. should re-evaluate the recommendations given herein, and make changes if judged to be necessary.

This supplementary report was prepared for the subject project in accordance with generally accepted geotechnical engineering practices at this time. No other warranty, expressed or implied, is made.

Soils & Engineering Services, Inc. will store the soil and bedrock samples obtained from the soil borings performed for this project for a period of 60 calendar days after the date of this report. Please advise us if this period should be extended.

We recommend that our *Geotechnical Exploration and Supplementary Report*, in its entirety, be made available to bidding contractors or subcontractors for information purposes. The Soil Boring Records should not be separated from the text of this report. This report should be considered invalid if used for purposes other than those described herein.

The project construction team should abide by all safety precautions, such as those required by OSHA and the Wisconsin Department of Commerce, throughout the entire construction of the proposed project. They include, but are not limited to, the proper sloping and/or support of excavation sidewalls.

The boreholes were backfilled with bentonite as required by the State of Wisconsin Department of Natural Resources, NR 112 Wisconsin Administrative Code. We have submitted proper documentation to the WDNR district office.

If you have any questions concerning this supplementary report, or if we can be of any further assistance to you, please contact us.

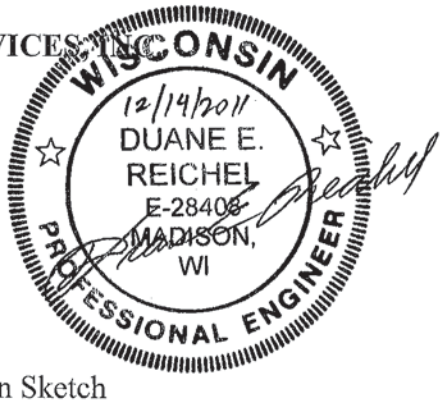
Respectfully submitted,

SOILS & ENGINEERING SERVICES, INC.

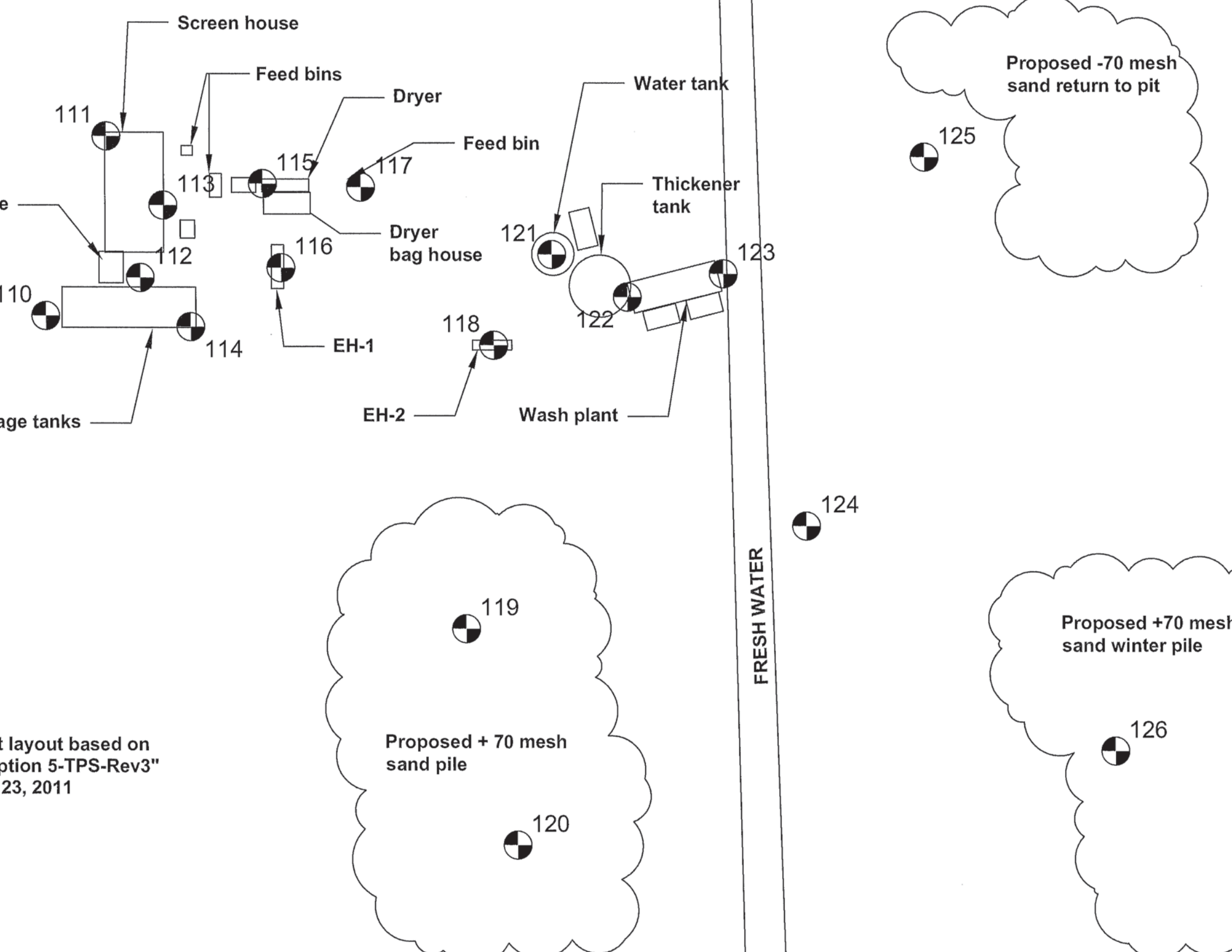
Duane E. Reichel

Duane E. Reichel, P.E.

DER:DMH:wsr



Enclosures (21):
Drawing 12911-1d, Boring Location Sketch
Drawing 12911-2, Notes and Legend for Soil Boring Records
Drawings 12911-36 through 12911-53, Soil Boring Records for Borings 110 through 127
Figure 12901-M, Particle Size Distribution Analysis Report


Screen house
Feed bins
Dryer
Feed bin
Water tank
Thickener tank
Dryer bag house
EH-1
EH-2
Wash plant
FRESH WATER
Proposed -70 mesh sand return to pit
Proposed + 70 mesh sand pile
Proposed +70 mesh sand winter pile
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
t layout based on
ption 5-TPS-Rev3"
23, 2011

NOTES

1. The drilling for the soil borings was performed using 2¼-inch-inside-diameter, continuous flight, hollow-stem augers.

2. The soil sampling for the borings was performed in accordance with ASTM Designation D 1586. The number of blows required to drive a 2-inch-outside-diameter, split-barrel sampler 12 inches, or fraction thereof when so noted, with a 140-pound hammer falling 30 inches is recorded in the "N-Value" column at the approximate middle elevation of the sample. This number of blows is the "standard penetration resistance."

3. The boreholes were backfilled with bentonite after determining the depth to water.

4. The boundary lines between different soil strata, as shown on the Soil Boring Records, are approximate and may be gradual. The recovered soils were visually identified in accordance with the Unified Soil Classification System (USCS) as defined in ASTM Designation D 2487. The drillers' field log contains a description of the soil conditions between samples based on the equipment performance and the soil cuttings. The Soil Boring Records contain the description of the soil conditions as interpreted by a geotechnical engineer and/or a geologist after review of the drillers' field logs and soil samples and/or laboratory test results.

5. The Soil Boring Records are a part of the geotechnical report. The geotechnical report should be included in the bidding or reference documents.

N-VALUE LEGEND

WH = Weight of hammer and sampling rods.
PS = Pushed Stone

TEST RESULTS LEGEND

q_p = Penetrometer reading, $^{ton}/_{ft^2}$
P_{200} = % passing the No. 200-mesh sieve
NM = Natural moisture, % moisture by weight
LI = Loss on ignition, % organic content by weight

REMARKS LEGEND

NR = No Recovery
D = Damp relative moisture condition
M = Moist relative moisture condition
W = Wet relative moisture condition
S = Saturated relative moisture condition
D-M = Damp to Moist relative moisture condition
M-W = Moist to Wet relative moisture condition
W-S = Wet to Saturated relative moisture condition
TO = Topsoil/Organic Odor

SAMPLER TYPE LEGEND

2-inch-outside-diameter, split-barrel sampler

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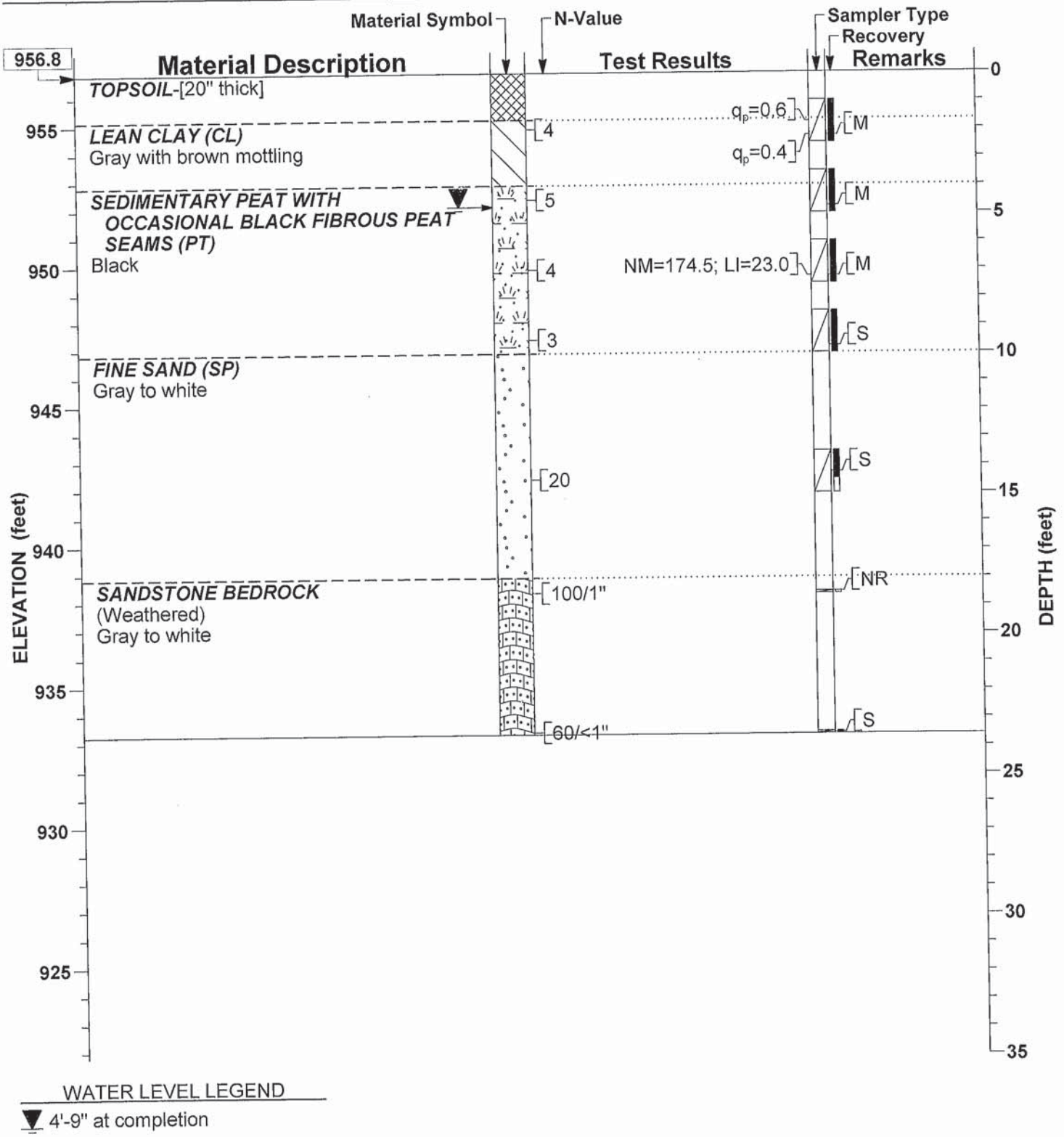
NOTES AND LEGEND
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-2

Printed on 12/5/2011

Boring **110**
Completed **November 28, 2011**
Total Depth = **23'-7"** (Page 1/1)



WATER LEVEL LEGEND
▼ 4'-9" at completion

For Notes and Legend, see Drawing 12911-2.

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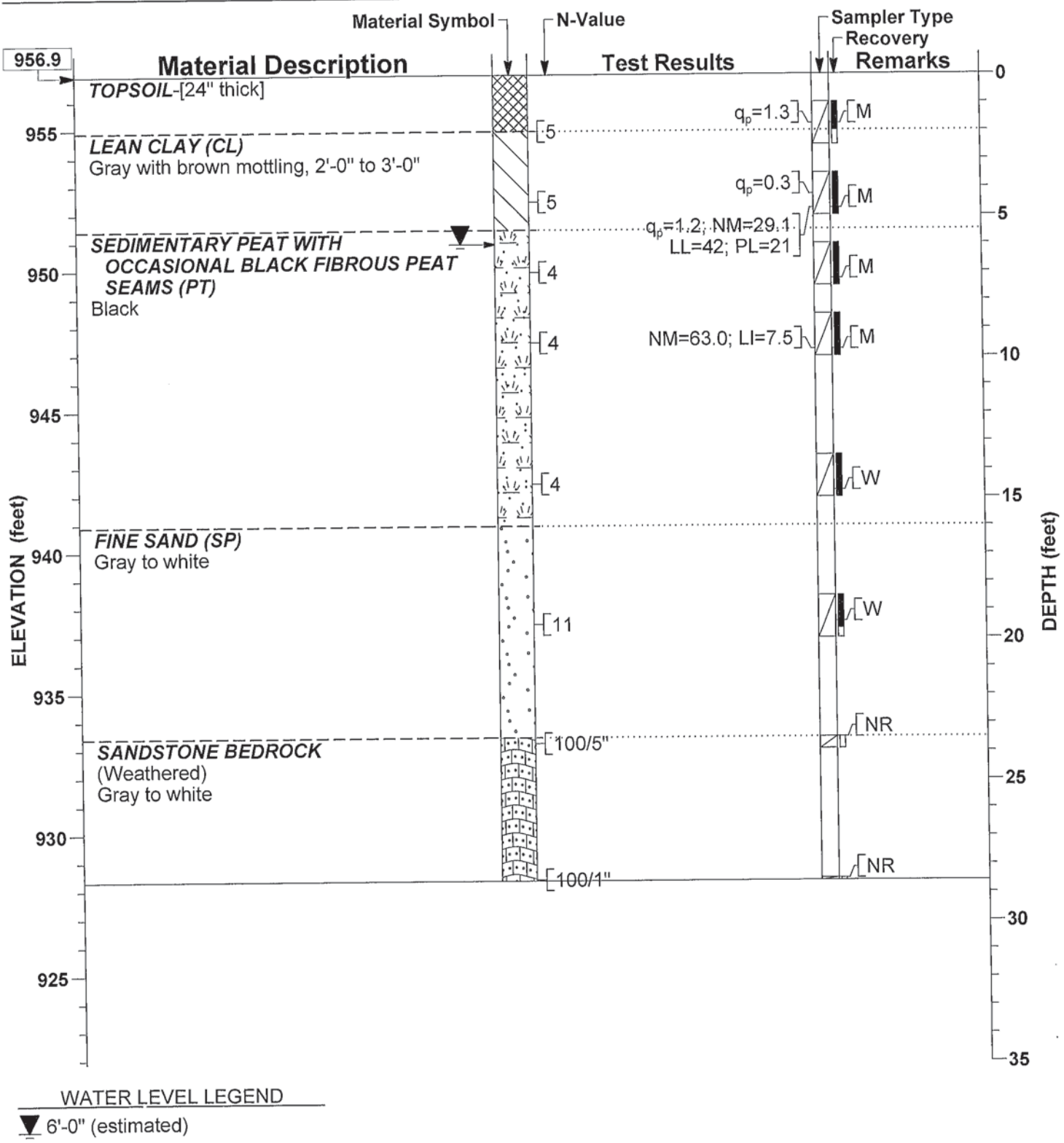
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-36

Boring **111**
Completed **November 28, 2011**
Total Depth = **28'-7"** (Page 1/1)



WATER LEVEL LEGEND
▼ 6'-0" (estimated)

For Notes and Legend, see Drawing 12911-2.

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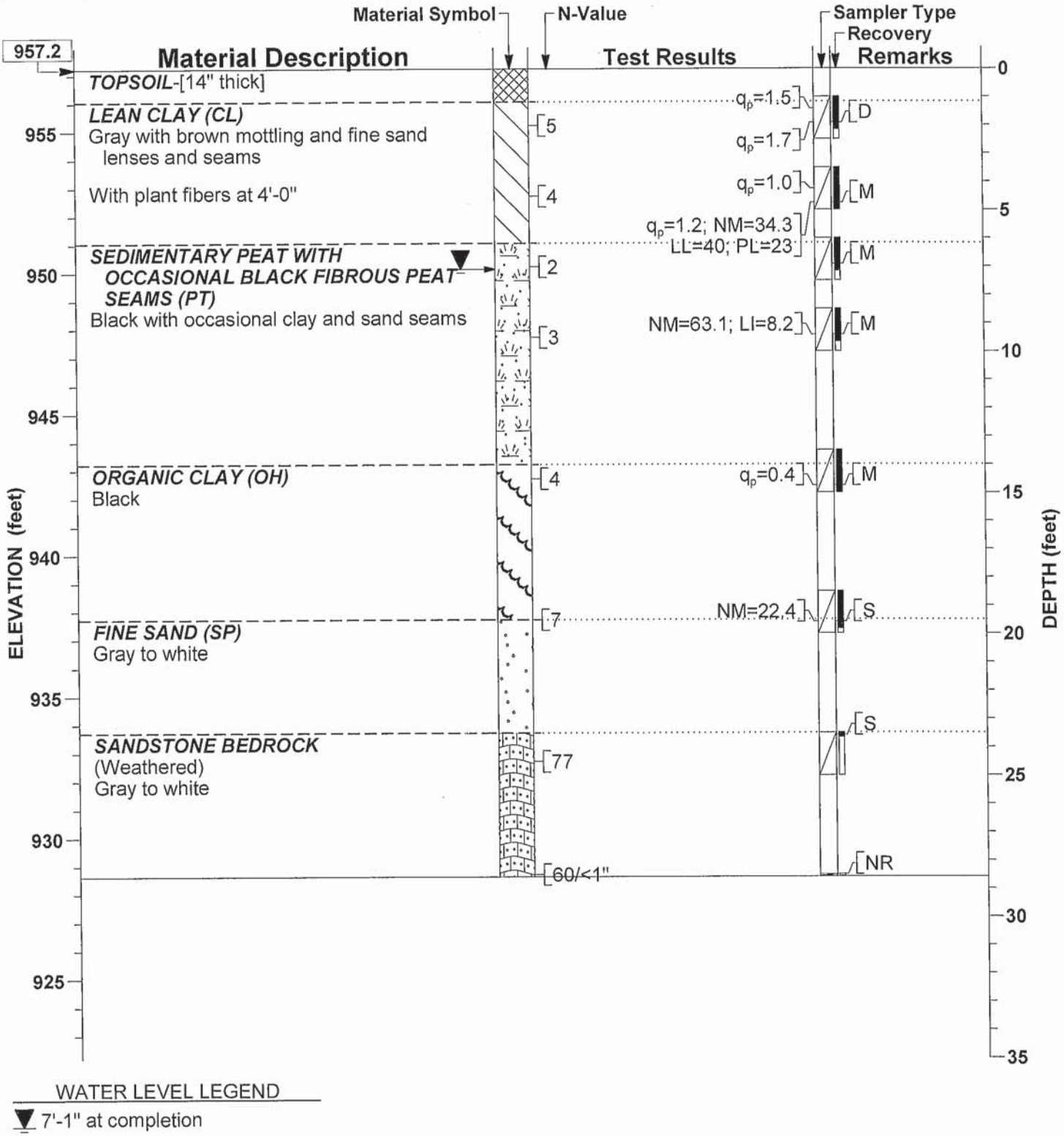
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-37

Printed on 12/12/2011

Boring **112**
Completed **November 28, 2011**
Total Depth = **28'-7"** (Page 1/1)



WATER LEVEL LEGEND

▼ 7'-1" at completion

For Notes and Legend, see Drawing 12911-2.

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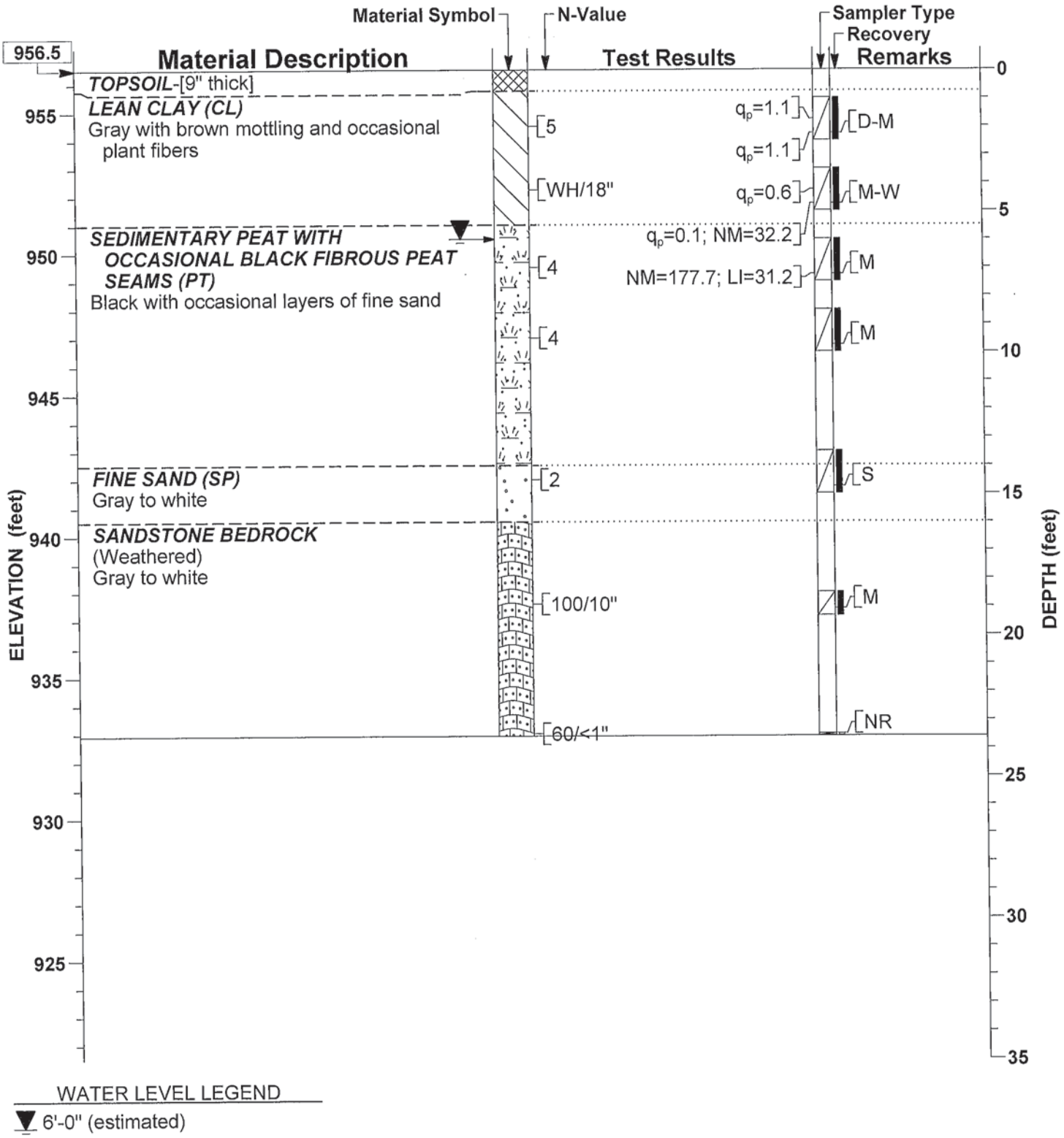
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-38

Boring **113**
Completed **November 28, 2011**
Total Depth = **23'-7"** (Page 1/1)



WATER LEVEL LEGEND
▼ 6'-0" (estimated)

For Notes and Legend, see Drawing 12911-2.

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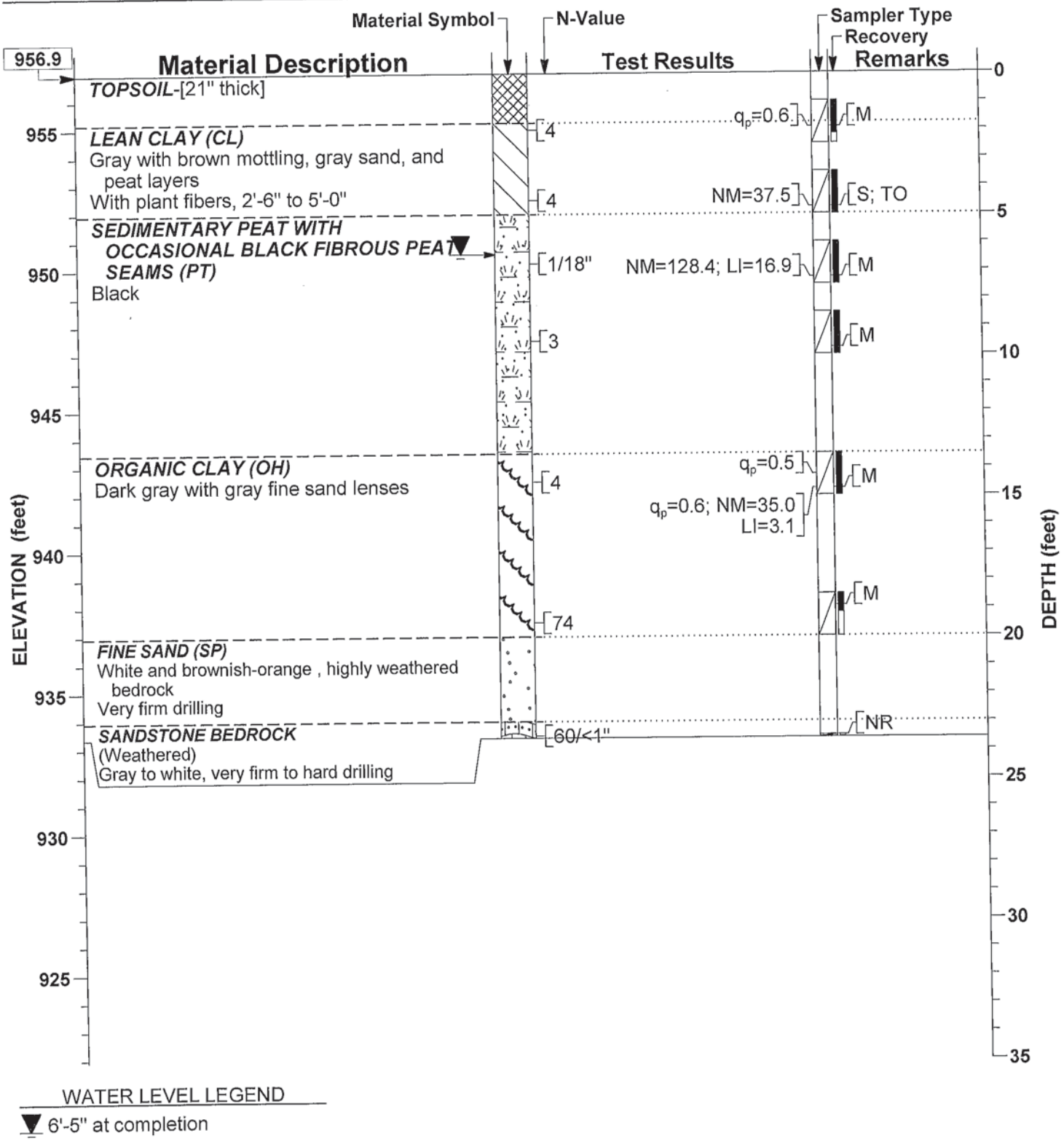
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-39

Printed on 12/12/2011

Boring **114**
Completed **November 28, 2011**
Total Depth = **23'-7"** (Page 1/1)



WATER LEVEL LEGEND

▼ 6'-5" at completion

For Notes and Legend, see Drawing 12911-2.

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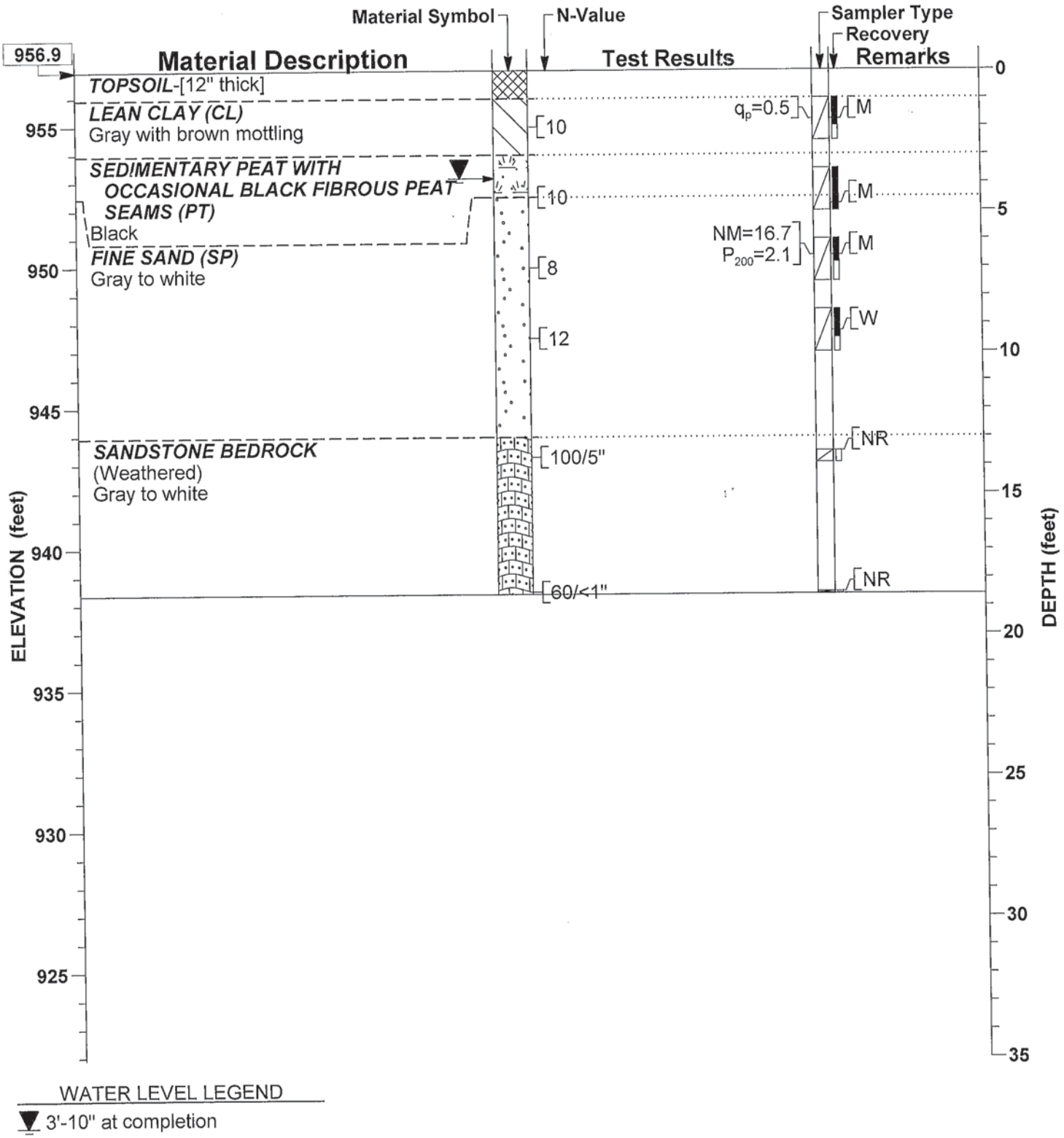
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-40

Boring **115**
Completed **November 29, 2011**
Total Depth = **18'-7"** (Page 1/1)



WATER LEVEL LEGEND
▼ 3'-10" at completion

For Notes and Legend, see Drawing 12911-2.

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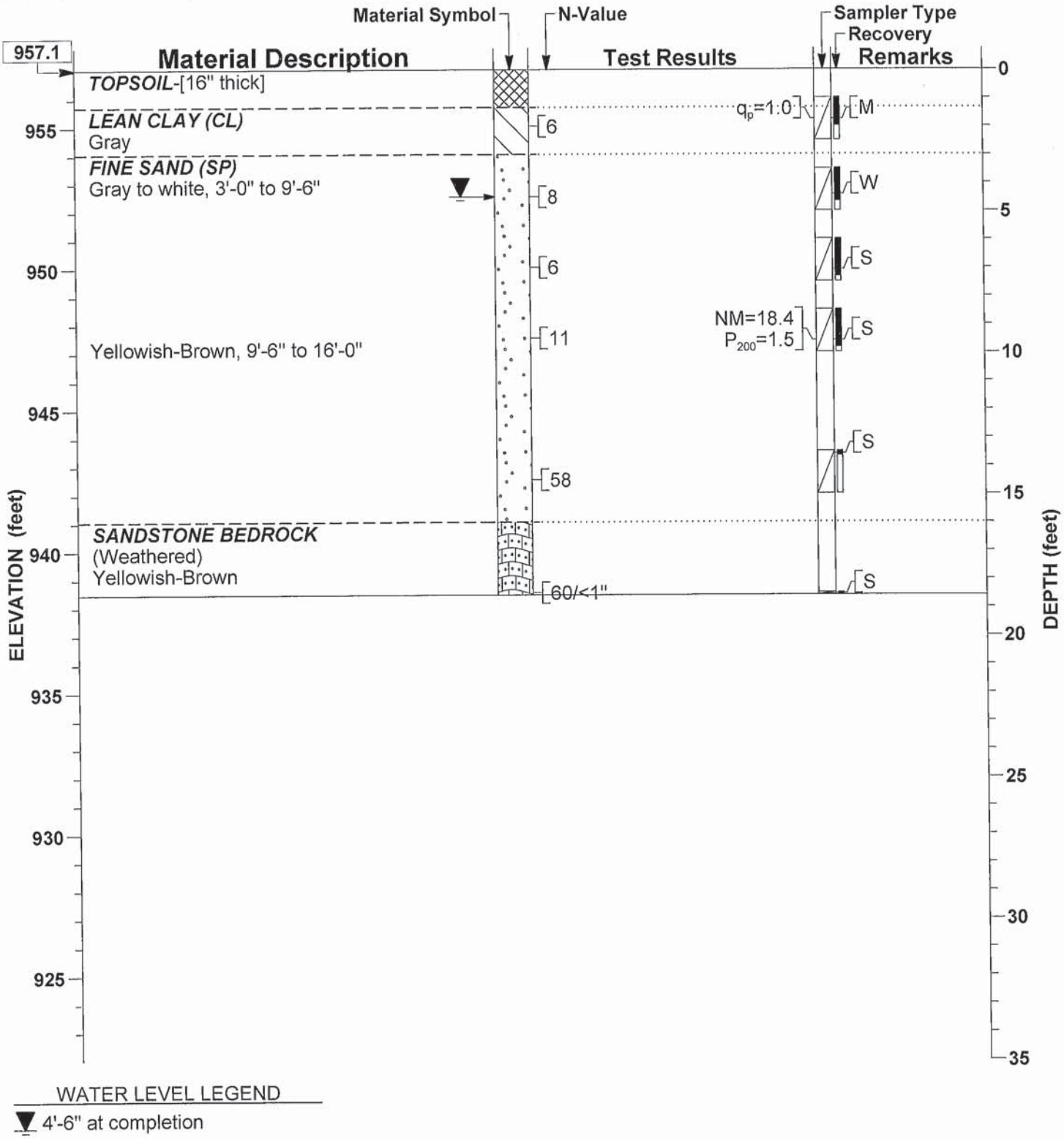
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-41

Boring **116**
Completed **November 29, 2011**
Total Depth = **18'-7"** (Page 1/1)



WATER LEVEL LEGEND

▼ 4'-6" at completion

For Notes and Legend, see Drawing 12911-2.

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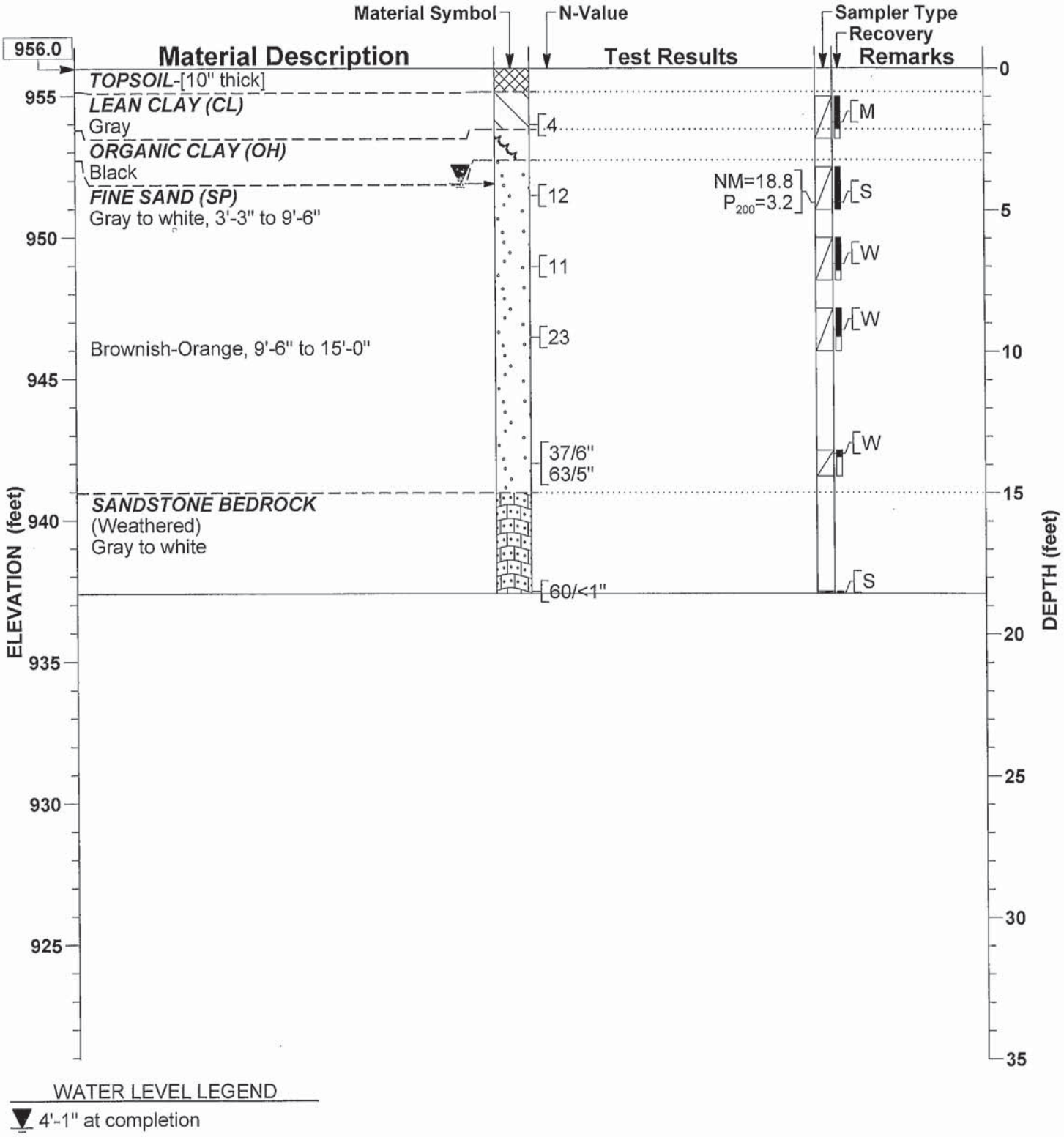
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-42

Printed on 12/12/2011

Boring **117**
Completed **November 29, 2011**
Total Depth = **18'-7"** (Page 1/1)



WATER LEVEL LEGEND
▼ 4'-1" at completion

For Notes and Legend, see Drawing 12911-2.

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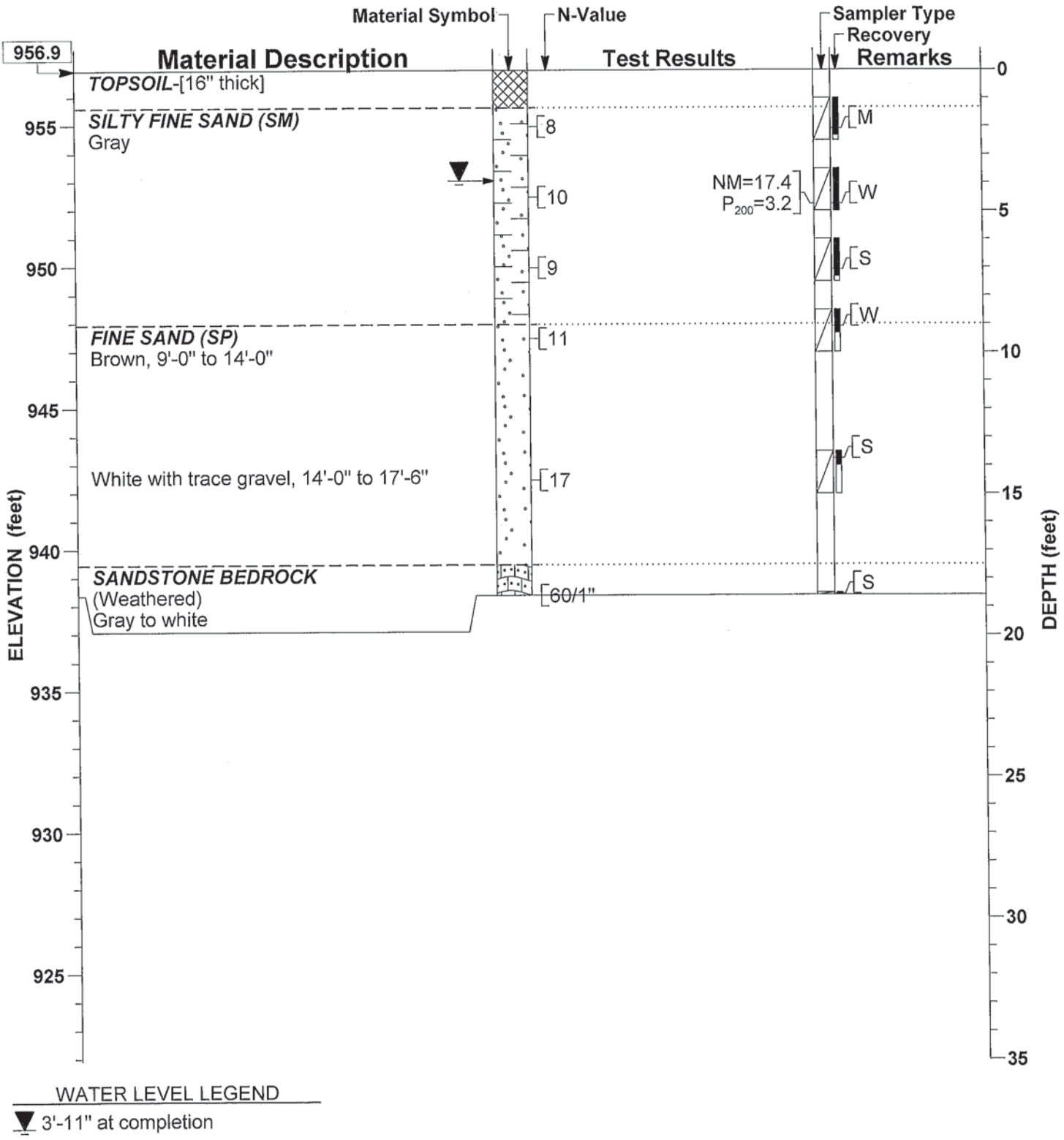
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-43

Printed on 12/12/2011

Boring **118**
Completed **November 28, 2011**
Total Depth = **18'-7"** (Page 1/1)



WATER LEVEL LEGEND
▼ 3'-11" at completion

For Notes and Legend, see Drawing 12911-2.

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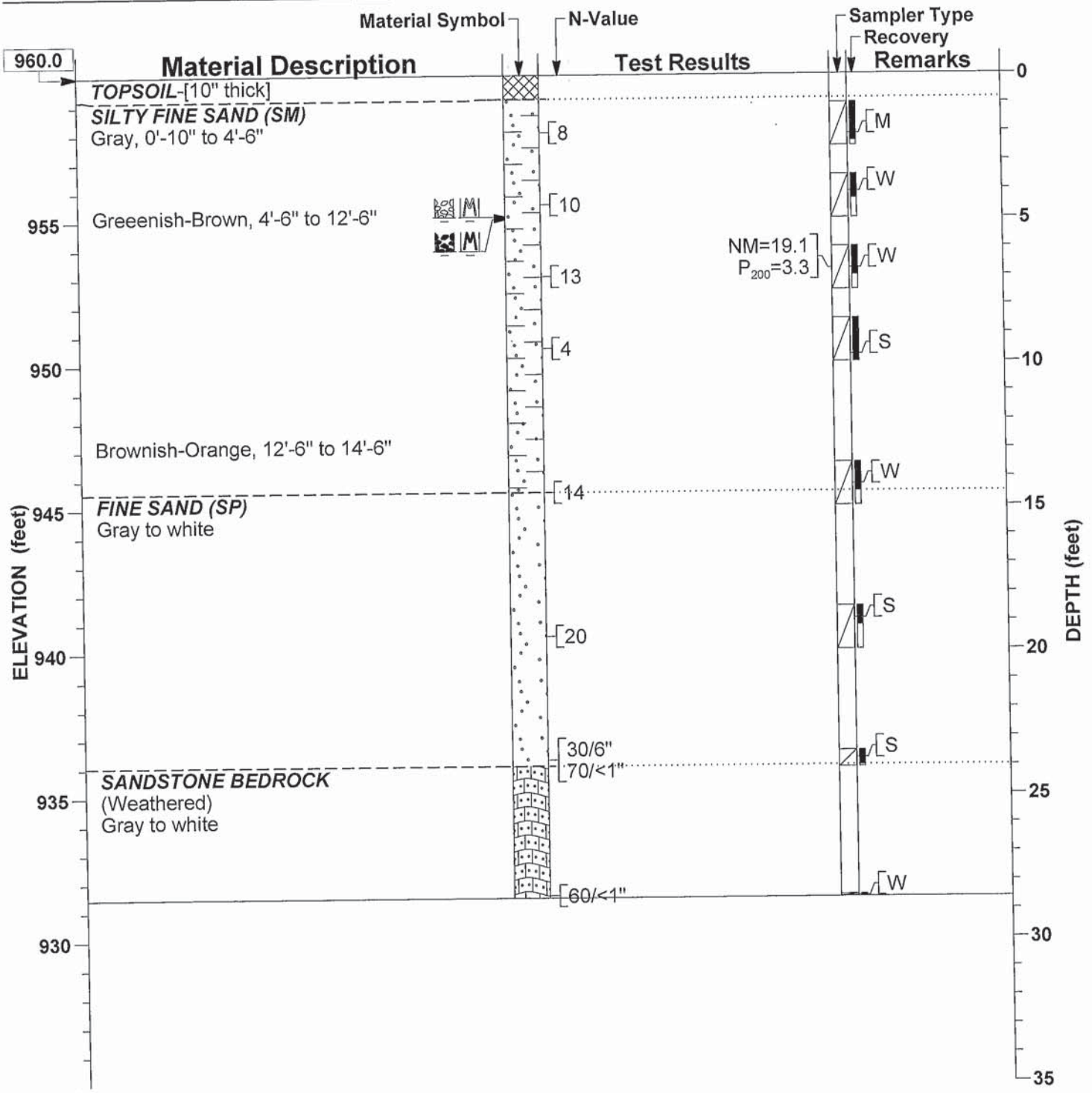
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-44

Printed on 12/12/2011

Boring **119**
Completed **November 23, 2011**
Total Depth = **28'-7"** (Page 1/1)



WATER LEVEL LEGEND
- Moist 4'-11" at 5 days
- Moist 5'-0" at completion

OTHER LEVEL LEGEND
- (caved) 4'-11" at 5 days
- (caved) 5'-0" at completion

For Notes and Legend, see Drawing 12911-2.

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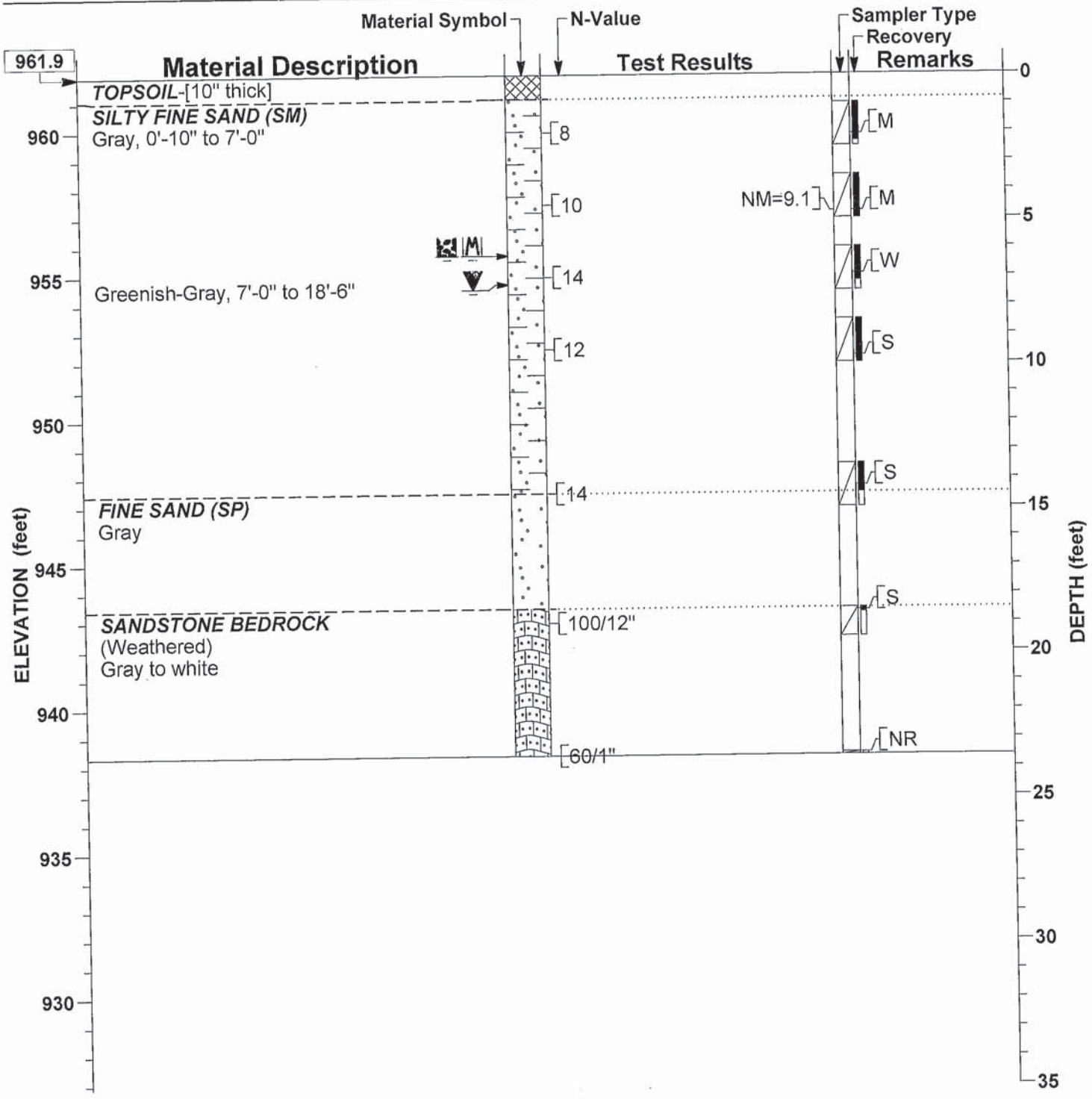
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-45

Boring **120**
Completed **November 23, 2011**
Total Depth = **23'-7"** (Page 1/1)



WATER LEVEL LEGEND
M Moist 6'-3" at 5 days
▼ 7'-3" at completion

OTHER LEVEL LEGEND
(caved) 6'-3" at 5 days

For Notes and Legend, see Drawing 12911-2.

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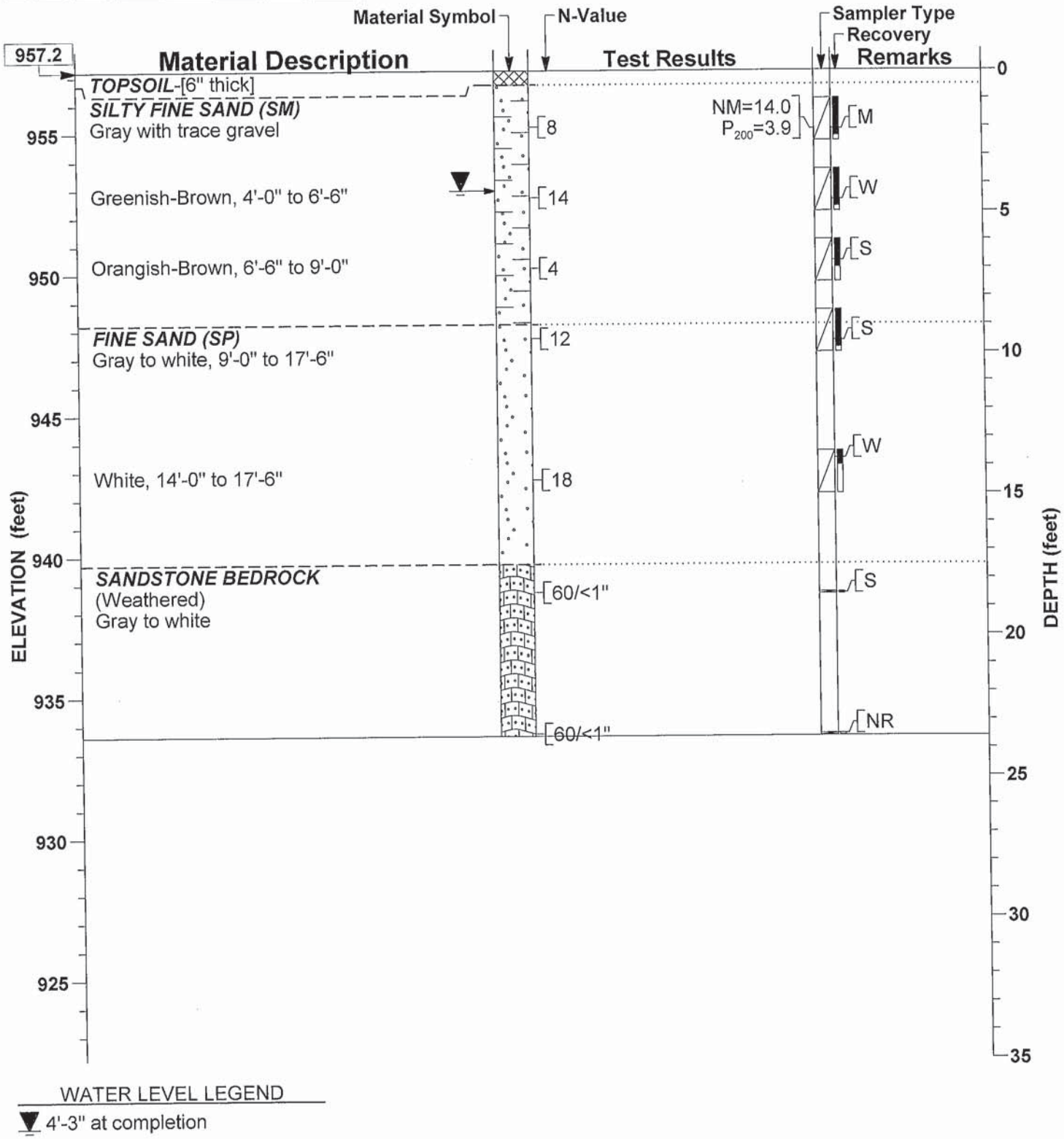
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-46

Boring **121**
Completed **November 29, 2011**
Total Depth = **23'-7"** (Page 1/1)



WATER LEVEL LEGEND

▼ 4'-3" at completion

For Notes and Legend, see Drawing 12911-2.

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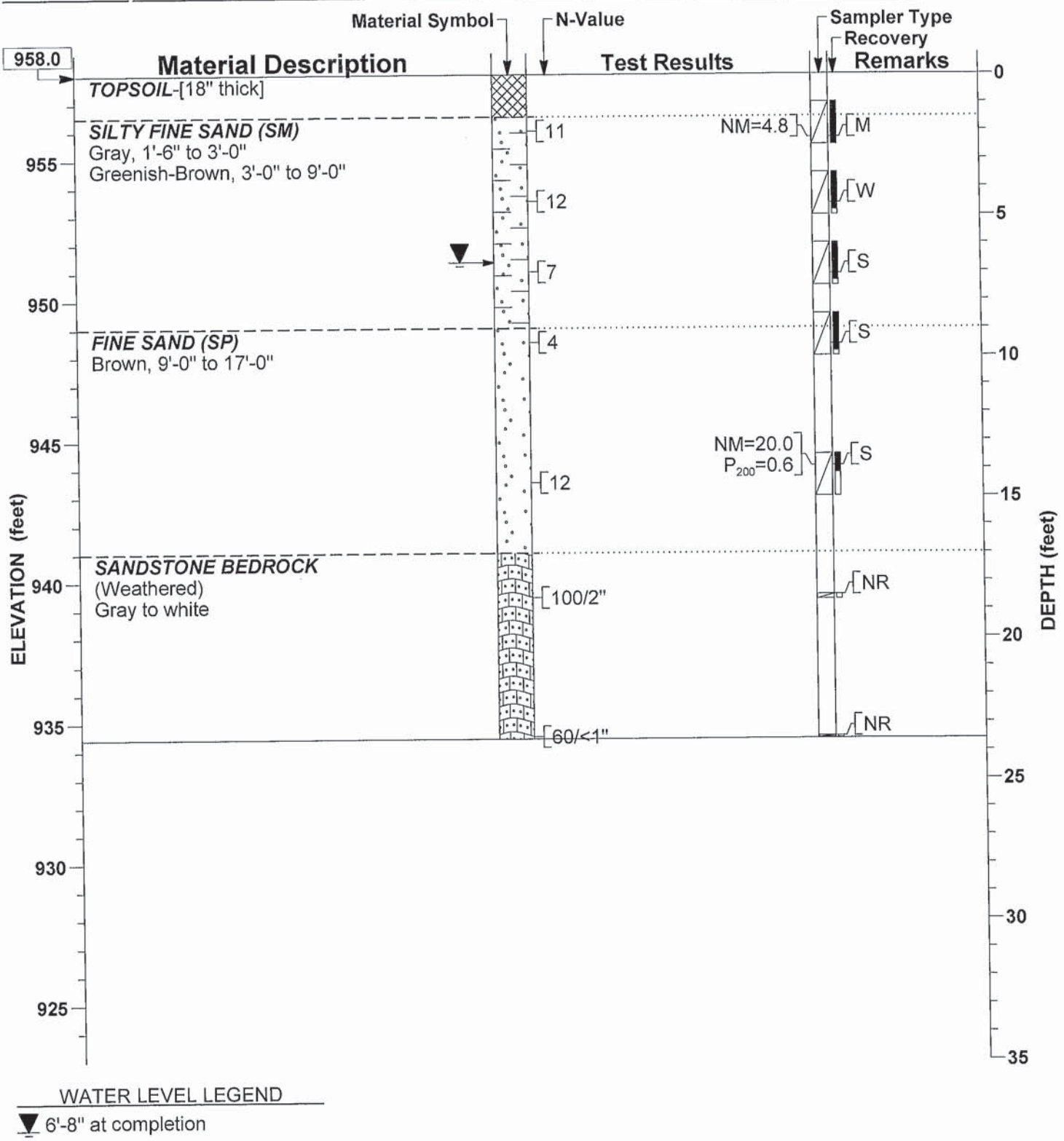
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-47

Boring **122**
Completed **November 29, 2011**
Total Depth = **23'-7"** (Page 1/1)



WATER LEVEL LEGEND

▼ 6'-8" at completion

For Notes and Legend, see Drawing 12911-2.

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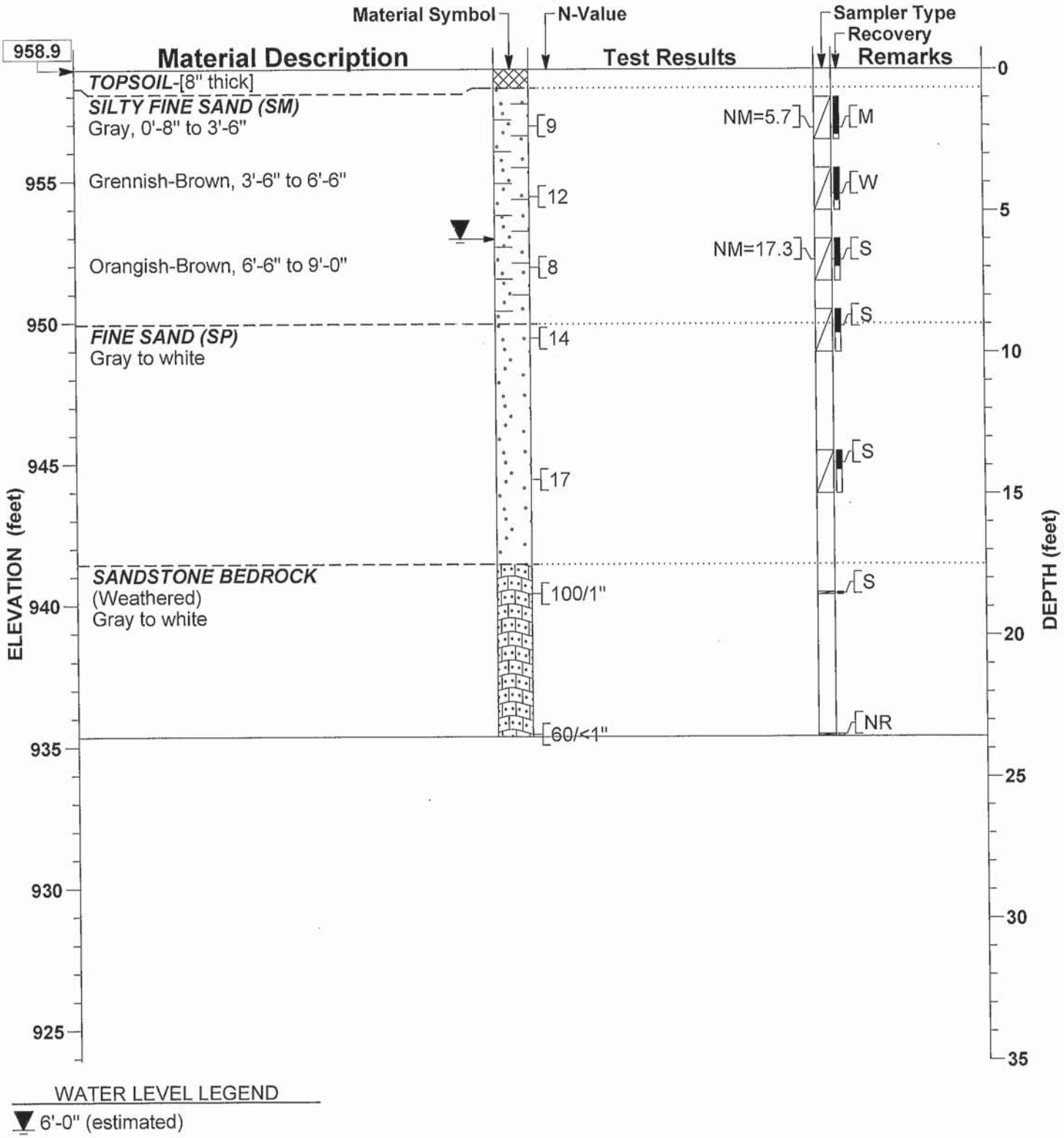
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-48

Printed on 12/12/2011

Boring **123**
Completed **November 29, 2011**
Total Depth = **23'-7"** (Page 1/1)



For Notes and Legend, see Drawing 12911-2.

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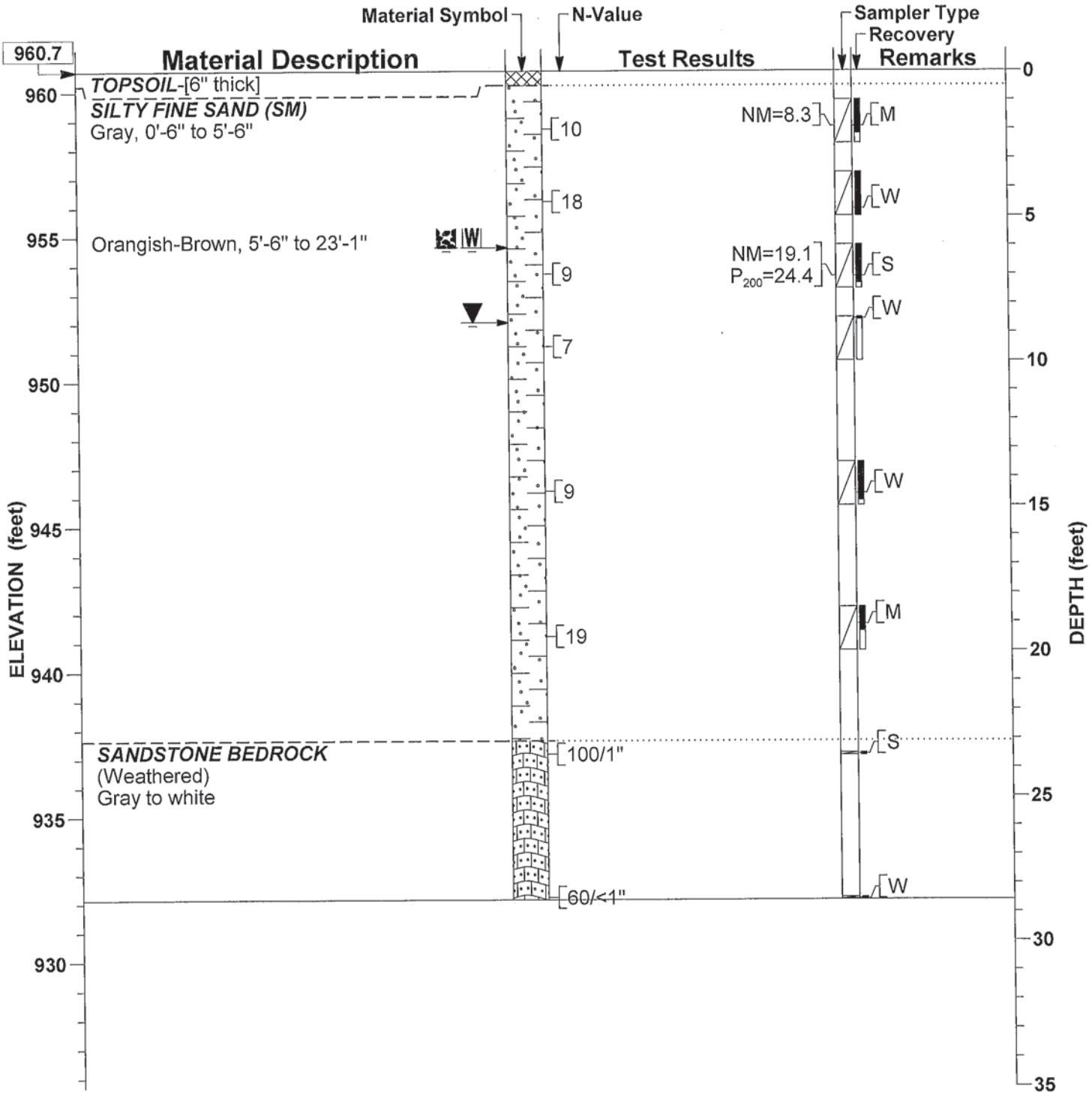
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-49

Boring **124**
Completed **November 23, 2011**
Total Depth = **28'-7"** (Page 1/1)



WATER LEVEL LEGEND
W Wet 6'-1" at 5 days
8'-8" at completion

OTHER LEVEL LEGEND
(caved) 6'-1" at 5 days

For Notes and Legend, see Drawing 12911-2.

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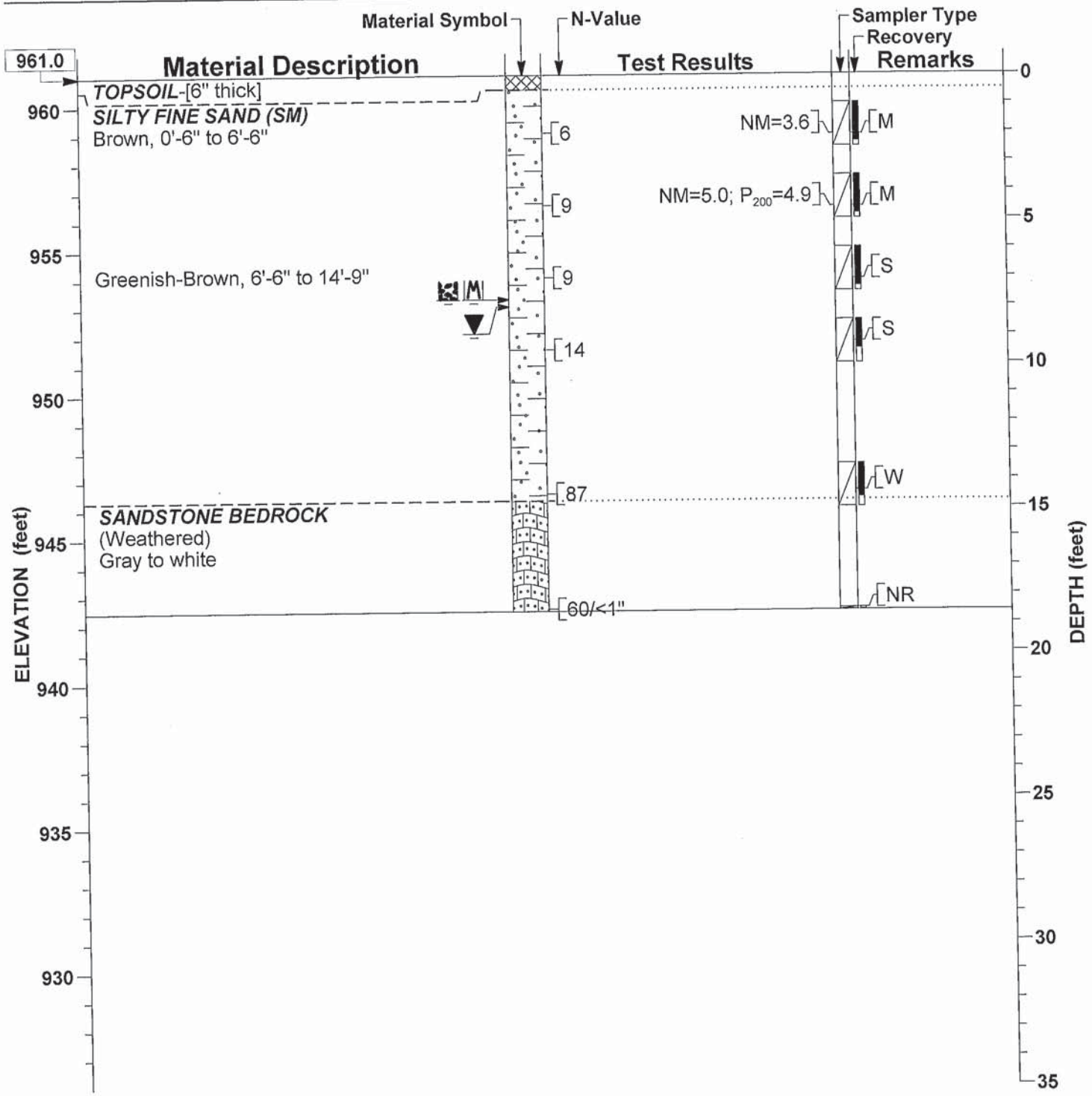
SOIL BORING RECORD
Smart Sand
Town of Oakdale
Monroe County, Wisconsin

DRAWING
12911-50

Boring **125**
Completed **November 22, 2011**
Total Depth = **18'-7"** (Page 1/1)



WATER LEVEL LEGEND
M Moist 7'-9" at 5 days
8'-0" at completion

OTHER LEVEL LEGEND
(caved) 7'-9" at 5 days

For Notes and Legend, see Drawing 12911-2.

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SOIL BORING RECORD
Smart Sand
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Monroe County, Wisconsin

DRAWING
12911-51