

Geotechnical Investigation

Navajo Gallup Water Supply Project
Reach 21 Regulating Tank Nos. 3A & 3B
San Juan County, New Mexico

Prepared for:
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NV5 Project No.: 444317-2360000.02

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1.0 INTRODUCTION

This report presents the results of our geotechnical analyses for Navajo Gallup Water Supply Project Reach 21 Regulating Tank Nos. 3A and 3B located in San Juan County, New Mexico.

The subsurface investigation was performed by the Bureau of Reclamation, Upper Colorado Region to determine site subsurface conditions and, based upon the conditions observed in the test holes provided in Attachment B, NV5 developed geotechnical recommendations for:

Shallow Foundation Design;
Foundation Bearing Pressures;
Site Grading; and
Drainage.

The conclusions and recommendations presented are based on information provided to us regarding the proposed development, on subsurface conditions disclosed by the test holes, on laboratory testing, and information addressed in the Navajo Gallup Water Supply Project Reach 21 Geologic Design Data Report as furnished by the Client and upon the local standards of our profession at the time this report was prepared.

This investigation was not performed to determine the presence of potentially hazardous waste or radon gas. Determination of the presence of potentially hazardous materials was beyond the scope of this investigation and requires the use of exploration techniques and analytic testing which were not appropriate for this investigation. If desired, NV5, Inc. will perform an environmental audit of the site.

2.0 PROPOSED CONSTRUCTION

We anticipate construction will consist of two water storage tanks, both 45 feet in diameter and 48 feet in height. The tanks were initially anticipated to have a height of 38 feet and to be supported on 10 feet of fill.

3.0 SITE CONDITIONS

The project site is situated on top of a mountain located north of the community of Huerfano, and south of Huerfano Mesa at elevations varying from approximately 6964 to 6970 feet. Configuration of the site is indicated on the Site Plan, Figure 1.

4.0 SITE SUBSURFACE CONDITIONS

To explore the site subsurface conditions, nine (9) drill holes were drilled within and/or near the proposed water storage tank locations by the Department of the Interior, Bureau of Reclamation, Upper Colorado Region Drill Crew using a CME 850 Track Mounted Drill Rig. Test holes were advanced with a 7.5-inch diameter hollow stem auger and 3-foot split tube sampler to refusal and

extended by means of HC3 wireline coring. Overburden soils, where encountered, consist of clayey sand (SC) described as medium toughness and medium dry strength and lean clay (CL) with sand, described as medium plasticity, medium toughness and medium dry strength. The soils are also described as Quaternary Alluvium (Qal). The alluvium was encountered in three of the nine test holes within the upper 2 to 2.5 feet.

Either below the alluvium or beginning at the present ground surface, primary materials (bedrock) identified as the Tertiary Nacimient Formation was encountered and extended to depths of approximately sixty (60) feet, the maximum depth investigated at this site. In four of the test holes, the formation was initially penetrated using hollow stem auger and split spoon sampler to depths varying from 5.7 to 25.7 feet and then advanced by wireline coring. The Tertiary Nacimient Formation consists of various primary materials (bedrock) including sandstone, siltstone, claystone and shale.

The sandstone was generally described as fine to medium grained, laminated to thinly to moderately bedded, moderately to intensely weathered and soft to hard. The siltstone was generally described as moderately to slightly weathered, soft to hard and thinly to moderately bedded.

The claystone was generally described as very soft to soft, intensely to moderately weathered, laminated to thinly bedded with varying amounts of gypsum veins and occasionally iron oxide staining. Moderately to slightly weathered, black shale was encountered in test hole DHR22RT3A-14-1 between a depth of 59.7 and 60.0 feet. The shale was described as very fine grained and moderately soft to soft.

It is our interpretation that the relative hardness of each type of primary materials as described on the log of drill holes is likely based on the rock classification system. For instance, soft generally implies that the material can be scratched with a finger nail. Moderately hard generally indicates that the material can be scratched easily with a knife, but cannot be scratched with a fingernail.

Groundwater was not encountered in any of the test holes. However, groundwater conditions may change with time due to precipitation, variations in groundwater level, seepage from ponding areas, or leaking utilities.

The test holes allow observation of a very small portion of the soils below the site. Significant variations in subsurface conditions may occur across the site, which were not disclosed by the test holes.

5.0 LABORATORY TESTING

A laboratory testing program was performed by the Bureau of Reclamation, Upper Colorado Region on samples obtained during the field investigation for the Reach 21 waterline project, which appeared representative of the soils encountered in the test holes indicated in the referenced Geologic Design Data Report. The laboratory testing program was structured to determine the physical properties of the soils encountered in the test holes necessary for development of geotechnical recommendations.

The laboratory testing program included:

- Moisture Content;
- Dry Density;
- Specific Gravity;
- Sieve Analysis;
- Atterberg Limits; and
- Compaction Tests.

6.0 FOUNDATIONS

Based on the data provided by the client and engineering studies, it is recommended that the proposed Reach 21 Regulating Tank Nos. 3A and 3B be founded on one of the following foundation systems described below. The foundation system determined to be more economical and/or more practical with respect to functional requirements should be used.

6.1 RING WALL FOOTING OPTION

If the recommendations presented in this report are implemented particularly those regarding site grading and drainage, both proposed 500,000-Gallon Water Storage Tanks (Nos. 3A and 3B) may be supported on reinforced concrete ring wall footings. The ring wall footings of the Water Storage Tanks should bear on a minimum thickness of 12 inches of structural fill. The base of the Water Storage Tanks should bear on a minimum thickness of 36 inches of structural fill. A four-inch layer of oil-treated sand should be provided below the tank base. Weep holes through the ring wall footings should be provided at frequent spacings or as recommended by the tank manufacturer. Structural fill should extend a minimum of three feet laterally beyond the edge of all footings. Foundations may be designed for an allowable bearing pressure of 3,000 pounds per square foot. This value may be increased by one-third for short-term loads due to wind and earthquakes. If it is not feasible to implement the site grading and drainage recommendations presented herein, an alternate foundation system may be required. This office should be contacted for additional recommendations.

The base of ring wall footings should be embedded a minimum of three feet below lowest adjacent grade. Ring wall footings should be a minimum of eighteen inches wide. However, local building codes may require greater dimensions.

Lateral foundation loads will be resisted by a combination of passive soil pressure against the sides of footings and friction along the base. A passive soil resistance of 300 pounds per cubic foot may be utilized for design. Frictional resistance may be determined by multiplying foundation dead load by a coefficient of friction of 0.40.

Prior to fill placement and following footing excavation, the natural soils should be scarified to a depth of eight inches and moistened to near optimum moisture content ($\pm 3\%$). The exposed soils, if any, should then be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557. All fill below structures should be placed and compacted as detailed in the attached Appendix. Prior to pouring concrete footing excavations should be cleaned of any slough, loose soil, or debris. Footing excavations should be compacted as detailed in the attached Appendix.

Foundations designed and constructed as described herein are not anticipated to settle more than one inch. Differential settlement between adjacent column footings should not exceed one-half of the above value. Foundations should be designed and constructed to tolerate the above settlement. Foundations should be designed by a qualified structural engineer.

6.2 MAT FOUNDATION OPTION

If the recommendations presented in this report are implemented particularly those regarding site grading and drainage, both proposed 500,000-Gallon Water Storage Tanks (Nos. 3A and 3B) may be supported on reinforced concrete mat foundations. Mat foundations should bear on a minimum thickness of 18 inches of structural fill. Any over-break in the bedrock should be completely filled with structural fill material. Structural fill should extend a minimum of three feet laterally beyond the edges of the mat foundations. Mat foundations may be designed for an allowable bearing pressure of 3,000 pounds per square foot. This value may be increased by one-third for short-term loads due to wind and earthquakes. If it is not feasible to implement the site grading and drainage recommendations presented herein, an alternate foundation system may be required. This office should be contacted for additional recommendations.

Lateral foundation loads will be resisted by a combination of passive soil pressure against the sides of footings and friction along the base. A passive soil resistance of 300 pounds per cubic foot may be utilized for design. Frictional resistance may be determined by multiplying foundation dead load by a coefficient of friction of 0.40.

Prior to fill placement and following footing excavation, the natural soils should be scarified to a depth of eight inches and moistened to near optimum moisture content ($\pm 3\%$). The exposed soils, if any, should then be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557. All fill below mat foundations should be placed and compacted as detailed in the attached Appendix. Prior to placing concrete to mat foundations, the structural fill surface should be cleared of any slough, loose soil, or debris. Structural fill should be compacted as detailed in the attached Appendix.

Mat foundations designed and constructed as described herein are not anticipated to settle more than one inch. Mat foundations should extend beyond the periphery of tank walls as may be required to resist overturning moment and/or minimize differential settlement. Differential settlement across the base of mat should not exceed one-half of the above value. Foundations should be designed and constructed to tolerate the above settlement. Foundations should be designed by a qualified structural engineer.

Based on our review of the Bureau of Reclamation Geologic Design Data Report, an International Building Code Site Classification of "D" may be utilized for design.

7.0 EARTHWORK

7.1 General

The settlement estimates presented in this report are based upon the assumption that site earthwork will be performed as recommended in this report and the attached Appendix. Presented below is a summary of the site earthwork recommendations. Detailed earthwork procedures are presented in the attached Appendix.

Prior to commencing earthwork the Contractor should obtain appropriate Proctor tests. Field density testing and evaluation of the suitability of the proposed materials performed prior to completion of the Proctor is "Preliminary" and may change based upon the results of the Proctor testing.

7.2 Clearing and Grubbing

Prior to placing structural fill, all borrow and fill areas should be stripped of vegetation and deleterious materials. All strippings should be hauled off-site or utilized in landscaped areas.

All existing utilities, septic tanks, leach fields, and disturbed soil should be removed from below the proposed amenities. The resulting excavations should be backfilled with compacted fill as detailed in the attached Appendix.

7.3 Excavation

We anticipate that on-site soils can be excavated with conventional earthwork equipment. Cobbles or boulders may be encountered during excavation. Cobbles and boulders should be disposed of off-site or utilized for landscaping. Cobbles and boulders should not be placed within structural fills. Cobbles and boulders as defined in ASTM D-2487.

7.4 Natural Ground Preparation

Prior to placing structural fill and subsequent to final grading in cut areas, the exposed soils should be scarified to a depth of eight inches and moisture conditioned to a near optimum ($\pm 3\%$) moisture content. The exposed soils should then be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557. If vibratory compaction poses a threat to nearby structures, static compaction should be utilized.

7.5 Fill Placement and Compaction

Structural fill should be placed in horizontal lifts a maximum of eight inches in loose thickness, moisture conditioned to near optimum moisture content, and mechanically compacted. Fill below footings and slabs should be compacted to a minimum of 95% of maximum dry density as determined by ASTM D-1557. The near surface materials at either tank location are not anticipated to satisfy

structural fill criteria. It is anticipated that import soils satisfying structural fill criteria are to be obtained from an approved outside source.

7.6 Observation and Testing

Placement and compaction of structural fill should be observed and tested by a qualified geotechnical engineer or his representative. The purpose of the observation and testing is to confirm that the recommendations presented herein are followed and to provide supplemental recommendations, if subsurface conditions differ from those anticipated.

Foundation excavations should be observed by a qualified geotechnical engineer, or his representative, prior to placement of reinforcement or concrete. The purpose of the observation is to determine if the exposed soils are similar to those anticipated.

7.7 Frequency of Testing

Earthwork should be tested periodically to confirm the fill is compacted to the criteria presented in this report. Prior to placing fill, the natural ground should be moisture conditioned, compacted, and tested to confirm it is properly compacted. Fill should be placed in maximum eight-inch thick loose lifts, but in no case thicker than can be compacted with the equipment being utilized. Fill should be moisture conditioned and compacted as detailed in this report. Fill areas should be tested at maximum one-foot vertical intervals. If fill areas are worked at different times, each individual area should be tested. Following finish grading, the final surface should be tested. Following foundation excavation, the footing excavations should be tested. Utility trench backfill should be tested as necessary.

8.0 SITE GRADING AND DRAINAGE

The settlement estimates presented in this report assume the site will be graded to drain properly. If the site does not drain properly, structure settlement substantially greater than quoted in this report will occur.

To reduce the risk of structure settlement the site should be graded to rapidly drain away from amenities. Splash blocks should be utilized below down spouts and canales.

If ponding areas are required, they should be located as far away from amenities as possible, a minimum of ten feet. If these criteria cannot be met, this office should be contacted for supplemental recommendations.

9.0 UTILITIES

The site soils and very soft claystone materials are anticipated to be compressible if allowed to increase in moisture content. If post-construction water line leaks occur, localized settlement will

occur. Following installation, all water lines should be pressure checked for leaks. Any leaks found should be repaired.

Backfill in utility line trenches below slabs, driveways, and pavement, if any, should be compacted to a minimum of 90% of maximum density as determined by ASTM D-1557 provided that the upper 12 inches of soils consist of granular materials, such as sands and gravels having a plasticity index less than or equal to twelve. Utility trenches should be as narrow as can be properly compacted. To reduce the possibility of breaking utility lines with compaction equipment, heavy compactors should not be utilized.

Utility trenches may not be compacted to the same degree as the remainder of the building pad. Therefore, wall footings, interior walls and thickened slabs should not be placed longitudinally over utility trenches. Column footings should not be placed over utility trenches.

10.0 TRENCHES AND EXCAVATIONS

All trenches greater than four feet in depth must be sloped, shored or braced or otherwise supported according to OSHA Construction and Safety Standards. Material excavated from the trench or spoil must be placed a minimum of two feet from the edge of the excavation. The spoil should be retained in an effective manner such that no loose material can fall into the excavation.

Temporary construction excavations less than eight feet deep should be sloped no steeper than 1½:1 (horizontal:vertical). If deeper excavations are required, this office should be contacted for supplemental recommendations. Limited raveling of slopes will occur particularly as the exposed soils dry out. Heavy equipment and material stockpiles should be located a minimum of five feet from the top of slope.

11.0 CLOSURE

This report was prepared for the exclusive use of our Client. The recommendations presented in this report are based upon the subsurface conditions disclosed by the test holes. Soil and groundwater conditions may vary between test holes and with time.

This report reflects our interpretation of the site subsurface conditions. We strongly recommend that prior to bidding all contractors perform their own subsurface investigation to form their own opinion of the site soil, rock, and groundwater conditions. Should contractors elect to use this report for construction, bidding or estimating purposes, they do so at their own risk.

In a southwest climate it is particularly important to protect the soils supporting the proposed structure from an increase in moisture content. If soils supporting the structure increase in moisture content due to any cause such as poor site drainage, ponding areas, or leaking utility lines, significant structural settlement and distress may occur.

If conditions are encountered during construction which differ from those presented herein, this office should be contacted for supplemental recommendations. The staff of NV5, Inc. is available for supplemental consultation as necessary.

This office would be pleased to review site grading and drainage plans to evaluate conformance with the recommendations presented herein. All site earthwork should be observed by a qualified geotechnical engineer or his representative. NV5, Inc. would be pleased to provide these services.

NV5, Inc.



Ralph L. Abeyta, P.E., M. ASCE

APPENDIX A
EARTHWORK PROCEDURES

APPENDIX EARTHWORK PROCEDURES

General

The Geotechnical Engineer shall be the Owner's representative to observe and evaluate the earthwork operations. The Contractor shall cooperate with the Geotechnical Engineer in the performance of the Engineer's duties.

Clearing and Grubbing

Prior to placing structural fill all borrow areas and areas to receive structural fill shall be stripped of vegetation and deleterious materials. Strippings shall be hauled off-site or stockpiled for subsequent use in landscaped areas or nonstructural fill areas as designated by the Owner or his representative and approved by the Geotechnical Engineer.

Site Preparation - Fill Areas

Prior to placing structural fill the areas to be filled shall be scarified to a depth of eight inches and moisture conditioned as described below. The area to be filled shall then be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-1557. If vibratory compaction techniques pose a threat to the structural integrity of nearby facilities a static compactor shall be used. Any soft or "spongy" areas shall be removed as directed by the Geotechnical Engineer and replaced with structural fill as described herein.

Site Preparation - Cut Areas

Following excavation to rough grade, all building and pavement areas shall be scarified to a depth of eight inches and moisture conditioned as described below. All building and paved areas shall be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-1557. If vibratory compaction techniques pose a threat to the structural integrity of nearby facilities, a static compactor shall be used. Any soft or "spongy" areas shall be removed as directed by the Geotechnical Engineer and replaced with structural fill as described herein.

Foundation, Slab and Pavement Subgrade Preparation

Prior to placing reinforcement, footings, slabs, or pavement, the supporting soils shall be prepared, moisture conditioned, and compacted as described herein.

Structural Fill Material

Structural fill material shall be nonexpansive soil which may be gravel, sand, silt or clay, or a combination thereof.

Sieve Size	Percent Passing By Weight
4"	100
1"	90-100
No. 4	70-100
No. 200	10-40

Structural fill material shall exhibit a plasticity index of ten or less. No organic, frozen or

decomposable material shall be utilized. All structural fill material shall be approved by the Geotechnical Engineer.

Structural Fill Placement

Structural fill material shall be blended as necessary to produce a homogeneous material. Fill material shall be spread in horizontal lifts no greater than eight inches in uncompacted thickness, but in no case thicker than can be properly compacted with the equipment to be utilized. If structural fill is to be placed on slopes steeper than 5:1 (horizontal:vertical) the natural ground shall be benched with minimum three foot wide benches at maximum two foot vertical intervals.

Moisture Conditioning

Structural fill material shall be dried or moistened as necessary, prior to compacting, to within \pm three percent of optimum moisture content as determined by ASTM D-1557. Moisture shall be distributed uniformly throughout each lift.

Compaction

Structural fill shall be mechanically compacted to the following:

	Minimum Compaction ASTM D-1557
Foundation Support	95%
Slab Support	95%
Below Slab Utility Trenches	90%
General Site Grading	90%
Pavement Support	-
Upper 8" of Subgrade	95%
All other fill below pavement	90%

Aggregate Base Course shall be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557.

Asphaltic concrete shall be compacted to a range of 93% to 97% of the maximum Theoretical Unit Weight in accordance with ASTM D2041.

Compaction by flooding and jetting is specifically prohibited unless authorized in advance by the Owner or his representative and the Geotechnical Engineer.

Observation and Testing

The Geotechnical Engineer or his representative shall perform field density tests with a frequency and at the locations he feels appropriate. The Geotechnical Engineer or his representative will perform Proctor tests on representative samples of all structural fill material for compliance to structural fill requirements on page A-1. To minimize delays, the Earthwork Contractor is encouraged to submit soil samples prior to use for proctor testing.

ATTACHMENT A
SITE PLAN

ATTACHMENT B
GEOLOGIC LOGS OF DRILL HOLES

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3A-14-1

SHEET 1 OF 1

FEATURE: REACH 22B

LOCATION: REGULATING TANK TANK 3A

BEGUN: 12/3/14 FINISHED: 12/5/14

DEPTH OF WATER LEVEL:

DATE MEASURED:

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

COORDINATES: N 1,997,529.5 E 2,721,598.4

TOTAL DEPTH: 80.0

DEPTH TO BEDROCK: 0.0

STATE: NEW MEXICO

GROUND ELEVATION: 6984.9

ANGLE FROM HORIZONTAL: 90

HOLE LOGGED BY: J. GILBERT

REVIEWED BY:

NOTES	DEPTH	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
		% CORE RECOVERY	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSSAL, HELPERS: KYLE KILLEBREW, BRIAN HART.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 650 TRACK MOUNTED DRILL RIG</p> <p>DRILL METHOD: 0.0 - 60.0 FT HCS WIRELINE CORING SYSTEM WITH A 3" SPLIT TUBE SAMPLER AND DIAMOND SURFACE-SET BIT.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 60.0 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL CUTTINGS</p>	76												0.0 - 60.0 FT TERTIARY NACIMIENTO FORMATION (Tn)
	5												0.0 - 27.5 FT CLAYSTONE: DARK GREY IN COLOR, FINE GRAINED, VERY INTENSELY WEATHERED TO DECOMPOSED (W9-W9), VERY SOFT (H7); NO REACTION WITH HCL.
	100												JOINT MEASUREMENTS: DEPTH INCL R M T HL INFILLING 13.3 90 4 2 1 5 CL 18.0 80 4 2 1 5 CL 18.7 55 4 2 1 5 CL
	100										CLSTNE		27.5 - 31.4 FT SANDSTONE: LIGHT GREY IN COLOR, FINE TO MEDIUM GRAINED, LAMINATED TO THINLY BEDDED, MODERATELY WEATHERED (W4), MODERATELY HARD (H4); NO REACTION WITH HCL.
	15												31.4 - 48.1 FT CLAYSTONE: DARK GREY IN COLOR, FINE GRAINED, MODERATELY TO SLIGHTLY WEATHERED (W4), MODERATELY HARD (H4); NO REACTION WITH HCL.
	100												JOINT MEASUREMENTS: DEPTH INCL R M T HL INFILLING 38.8 80 4 2 1 5 CL
	25											6977.4	48.1 - 48.0 FT SANDSTONE: LIGHT GREY IN COLOR, FINE TO MEDIUM GRAINED, LAMINATED TO THINLY BEDDED, MODERATELY WEATHERED (W4), MODERATELY HARD (H4); NO REACTION WITH HCL.
	30									Tn	SS	6933.5	48.0 - 50.0 FT CLAYSTONE: DARK GREY IN COLOR, FINE GRAINED, MODERATELY TO SLIGHTLY WEATHERED (W4), MODERATELY HARD (H4); NO REACTION WITH HCL.
	100												50.0 - 59.7 FT SILTSTONE: GREY TO DARK GREY IN COLOR, FINE GRAINED, MODERATELY TO SLIGHTLY WEATHERED (W4), MODERATELY HARD (H5); NO REACTION WITH HCL.
	100										CLSTNE		59.7 - 60.0 FT SHALE: BLACK IN COLOR, VERY FINE GRAINED, MODERATELY TO SLIGHTLY WEATHERED (W4), MODERATELY SOFT TO SOFT (H5-H6); NO REACTION WITH HCL.
	35											6918.8	STRATIGRAPHY: 0.0 - 60.0 FT: TERTIARY NACIMIENTO FORMATION (Tn)
	100										SS	6916.9	ABBREVIATIONS: WLNE = WATER LEVEL NOT ENCOUNTERED I.D. = INSIDE DIAMETER BNE = BEDROCK NOT ENCOUNTERED.
	100										CLSTNE	6914.9	
	50												
	100												
	55										SILTSTN		
	100											6905.2	
	60											6904.4	

BOTTOM OF HOLE

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6499, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3A-14-4

SHEET 1 OF 1

FEATURE: REACH 22B

LOCATION: REGULATING TANK 3A

BEGUN: 12/6/14 FINISHED: 12/6/14

DEPTH OF WATER LEVEL:

DATE MEASURED:

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

COORDINATES: N 1,967,552.3 E 2,721,608.8

TOTAL DEPTH: 40.0

DEPTH TO BEDROCK: 0.0

STATE: NEW MEXICO

GROUND ELEVATION: 6964.8

ANGLE FROM HORIZONTAL: 90

HOLE LOGGED BY: J. GILBERT

REVIEWED BY:

NOTES	DEPTH	% CORE RECOVERY	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
			% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSSAL, HELPERS: KYLE KILLEBREW, BRIAN HART.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 850 TRACK MOUNTED DRILL RIG</p> <p>DRILL METHOD: 0.0 - 40.0 FT HQ3 WIRELINE CORING SYSTEM WITH A 3" SPLIT TUBE SAMPLER AND DIAMOND SURFACE-SET BIT.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 40.0 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL CUTTINGS</p> <p>OBSERVATION WELL INSTALLED BGS: NONE USED</p>														0.0 - 40.0 FT TERTIARY NACIMIENTO FORMATION (Tn)
	100											CLSTN		0.0 - 8.6 FT CLAYSTONE: DARK GREY IN COLOR, FINE GRAINED, VERY INTENSELY WEATHERED TO DECOMPOSED (W8-W9), VERY SOFT (H7); NO REACTION WITH HCl.
	5													8.6 - 9.2 FT SILTSTONE: GREY TO DARK GREY IN COLOR, FINE GRAINED, MODERATELY TO SLIGHTLY WEATHERED (W4), MODERATELY HARD TO HARD (H3-H4); NO REACTION WITH HCl.
	100											SLTS 8966.2		
	10													9.2 - 29.8 FT CLAYSTONE: DARK GREY IN COLOR, FINE GRAINED, VERY INTENSELY WEATHERED TO DECOMPOSED (W8-W9), VERY SOFT (H7); NO REACTION WITH HCl.
	18													29.8 - 30.9 FT SANDSTONE: LIGHT GREY IN COLOR, FINE TO MEDIUM GRAINED, LAMINATED TO THINLY BEDDED, MODERATELY WEATHERED (W4), MODERATELY HARD (H4); NO REACTION WITH HCl.
	15													30.9 - 40.0 FT CLAYSTONE: DARK GREY IN COLOR, FINE GRAINED, MODERATELY WEATHERED (W4), MODERATELY HARD (H4); NO REACTION WITH HCl.
	20										Tn	CLSTN		JOINT MEASUREMENTS: DEPTH INCL R M T HL INFILLING 34.8 80 4 2 1 5 CALCITE
	100													STRATIGRAPHY: 0.0 - 40.0 FT: TERTIARY NACIMIENTO FORMATION (Tn)
	25													ABBREVIATIONS: WLNE = WATER LEVEL NOT ENCOUNTERED I.D. = INSIDE DIAMETER BNE = BEDROCK NOT ENCOUNTERED.
	100													
	30											SS 6935.0		
	100											6933.8		
	35													
	100											CLSTN		
	40												6924.8	

BOTTOM OF HOLE

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS- DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6499, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3A-15-1B

SHEET 1 OF 1

FEATURE: REACH 22B

LOCATION: REGULATING TANK 3A

BEGUN: 3/12/15 FINISHED: 3/12/15

DEPTH OF WATER LEVEL:

DATE MEASURED:

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

COORDINATES: N 1,967,415.2 E 2,721,512.8

TOTAL DEPTH: 60.8

DEPTH TO BEDROCK: 2.5

STATE: NEW MEXICO

GROUND ELEVATION: 6066.4

ANGLE FROM HORIZONTAL: 90

HOLE LOGGED BY: J. GILBERT

REVIEWED BY:

NOTES	DEPTH	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VELOC. CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
		% CORE RECOVERY	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSDAL, HELPERS; KYLE KILLEBREW, STEVE COCHRAN.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 850 TRACK MOUNTED DRILL RIG</p> <p>DRILL METHOD: 0.0-7.5 4 1/4 INCH HOLLOW STEM AUGER WITH CALIFORNIA SAMPLER, REACHED AUGER REFUSAL AT 7.5 FT, SWITCHED TO CORING SETUP. 7.5 - 60.8 FT HQ3 WIRELINE CORING SYSTEM WITH A 3' SPLIT TUBE SAMPLER AND DIAMOND SURFACE- SET BIT.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 7.5 FT NONE USED 7.5 - 60.8 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL BENTONITE.</p> <p>OBSERVATION WELL INSTALLED BGS: NONE USED</p>													0.0 - 2.5 QUATERNARY ALLUVIUM (Qal):
										Cal	SC	6063.9	0.0 TO 2.5 FT, CLAYEY SAND (SC): ABOUT 60% FINE SAND; ABOUT 20% FINES WITH MEDIUM TO HIGH PLASTICITY, MEDIUM TOUGHNESS AND MEDIUM DRY STRENGTH; GREY, NO REACTION WITH HCL.
	5								19/31		SS	6061.4	
									10/50				2.5 TO 60.8 TERTIARY NACIMIENTO FORMATION.
	7.5												2.5 TO 5.0 FT SANDSTONE: MODERATELY WEATHERED (W5), SOFT (H6), GREY IN COLOR, FINE GRAINED, NO REACTION WITH HCL.
	10										CLSTNE		5.0 TO 25.2 FT CLAYSTONE: INTENSELY WEATHERED (W7), SOFT (H6), LIGHT GREY TO DARK GREY IN COLOR, GYPSUM VEINS AND NODULES, IRON OXIDE STAINING THROUGHOUT. 1 GALLON BAG SAMPLE COLLECTED FROM AUGER CUTTING FROM 2.5 TO 6.0 FT FOR CORROSION TESTING
	15												JOINT MEASUREMENTS: DEPTH INCL R W O T HL INFILLING 13.1 80 4 1 1 6 FeOx 13.4 40 4 1 1 6 FeOx 14.9 65 4 1 1 6 FeOx
	20												
	25										SS	6041.2	25.2 TO 31.6 FT SANDSTONE: SLIGHTLY WEATHERED (W3), HARD (H3), GREY IN COLOR, FINE GRAINED, NO REACTION WITH HCL.
	30										Tit	6034.8	31.6 TO 48.0 FT CLAYSTONE: INTENSELY WEATHERED (W7), SOFT (H6), LIGHT GREY TO DARK GREY IN COLOR, GYPSUM VEINS AND NODULES, IRON OXIDE STAINING THROUGHOUT.
	35												48.0 TO 60.8 SANDSTONE: MODERATELY WEATHERED (W5), SOFT (H6), GREY IN COLOR, FINE GRAINED, NO REACTION WITH HCL.
	40										CLSTNE		
	45											6018.4	
	50												
	55										SS		
	60											6005.6	

BOTTOM OF HOLE

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6499, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3A-15-3B

SHEET 1 OF 1

FEATURE: REACH 22B

LOCATION: REGULATING TANK TANK 3A

BEGUN: 3/14/15 FINISHED: 3/14/15

DEPTH OF WATER LEVEL:

DATE MEASURED: 3/14/2015

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

COORDINATES: N 1,967,391.6 E 2,721,492.8

TOTAL DEPTH: 40.7

DEPTH TO BEDROCK: 2.0

STATE: NEW MEXICO

GROUND ELEVATION: 6565.3

ANGLE FROM HORIZONTAL: 90

HOLE LOGGED BY: C. BEYER

REVIEWED BY:

NOTES	DEPTH	% CORE RECOVERY	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
			% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSDAL, HELPERS; KYLE KILLEGREY, STEVE COCHRAN.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 850 TRACK MOUNTED DRILL RIG.</p> <p>DRILL METHOD: 0.0 - 5.7 4 1/4 INCH HOLLOW STEM AUGER WITH CALIFORNIA SAMPLER, REACHED AUGER REFUSAL AT 5.7 FT, SWITCHED TO CORING SETUP. 5.7 - 40.7 FT HQ3 WIRELINE CORING SYSTEM WITH A 3" SPLIT TUBE SAMPLER AND DIAMOND SURFACE- SET BIT.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 5.7 FT NONE USED 5.7 - 40.7 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL BENTONITE.</p> <p>OBSERVATION WELL INSTALLED BGS: NONE USED</p>														0.0 - 2.0 QUATERNARY ALLUVIUM (Qal):
											Qal	SC	6565.3	0.0 TO 2.0 FT, CLAYEY SAND (SC); ABOUT 90% FINE SAND; ABOUT 20% FINES WITH MEDIUM TO HIGH PLASTICITY, MEDIUM TOUGHNESS AND MEDIUM DRY STRENGTH; GREY, NO REACTION WITH HCL.
										16/28				2.0 TO 40.7 TERTIARY NACIMIENTO FORMATION.
										27/REFUSAL				2.0 TO 19.0 FT, CLAYSONE: SANDY, LAMINATED TO THINLY BEDDED, GREY IN COLOR, INTERMITTENT PURPLE SPOTS, DECOMPOSED (W9) AND VERY SOFT (H7) IN TOP 1.5 FEET, BECOMES INTENSELY WEATHERED (W7) AND SOFT (H6) BELOW 1.5 FEET, CORE STICKS TO SAMPLER, VERY DIFFICULT TO REMOVE, SAMPLE FALLS APART UPON REMOVAL FROM SPLIT SPOON. SILTSTONE INTERBED FROM 14.8 TO 15.0 FT MODERATELY SOFT (H6) INTENSELY TO MODERATELY WEATHERED (W6), LIGHT GREY, NO REACTION WITH HCL.
	5													19.0 TO 24.9 FT SANDSTONE: FINE GRAINED ARGILLACEOUS, TAN TO GREY IN COLOR, SOFT (H6) MODERATELY WEATHERED (W5), MICACEOUS, THINLY TO MODERATELY BEDDED, GYPSUM VEINS, NO REACTION WITH HCL. SANDSTONE WASHED AWAY BY DRILL RESULTING IN POOR RECOVERY.
	10											CLST		24.9 TO 25.7 CLAYSTONE: SANDY, LAMINATED TO THINLY BEDDED, GREY IN COLOR, INTERMITTENT PURPLE SPOTS, INTENSELY WEATHERED (W7) AND SOFT (H6) CORE STICKS TO SAMPLER, VERY DIFFICULT TO REMOVE, SAMPLE FALLS APART UPON REMOVAL FROM SPLIT SPOON.
	100													25.7 TO 29.2 FT SANDSTONE: FINE GRAINED ARGILLACEOUS, TAN TO GREY IN COLOR, MODERATELY SOFT (H5) SLIGHTLY WEATHERED (W3), THINLY TO MODERATELY BEDDED, NO REACTION WITH HCL.
	15													29.2 TO 40.7 FT CLAYSONE: LAMINATED TO THINLY BEDDED, DARK GREY TO BLACK IN COLOR, SLIGHTLY WEATHERED (W3) AND MODERATELY SOFT (H6) CORE STICKS TO SAMPLER, VERY DIFFICULT TO REMOVE, SAMPLE FALLS APART UPON REMOVAL FROM SPLIT SPOON, INTERMITTENT SILTSTONE/SANDSTONE INTERBEDS 0.3 FT THICK.
	20													STRATIGRAPHY: 0.0 - 2.0 FT QUATERNARY ALLUVIUM (Qal) 2.0 - 40.7 FT TERTIARY NACIMIENTO FORMATION
	22													

BOTTOM OF HOLE

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.
THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK. DRAWING NO. 40-D-6499, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3A-15-4B

SHEET 1 OF 1

FEATURE: REACH 22B

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

STATE: NEW MEXICO

LOCATION: REGULATING TANK TANK 3A

COORDINATES: N 1,987,394.9 E 2,721,535.2

GROUND ELEVATION: 6885.5

BEGUN: 3/11/15 FINISHED: 3/11/15

TOTAL DEPTH: 40.7

ANGLE FROM HORIZONTAL: 90

DEPTH OF WATER LEVEL:

DEPTH TO BEDROCK: 2.2

HOLE LOGGED BY: C. BEYER

DATE MEASURED: 3/11/2015

REVIEWED BY:

NOTES	DEPTH	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
		% CORE RECOVERY	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSSDAL, HELPERS: KYLE KELLEBREW, STEVE COCHRAN.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 850 TRACK MOUNTED DRILL RIG</p> <p>DRILL METHOD: 0.0 - 40.7 FT HQ3 WIRELINE CORING SYSTEM WITH A 3" SPLIT TUBE SAMPLER AND DIAMOND SURFACE-SET BIT.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 40.7 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.</p> <p>OBSERVATION WELL INSTALLED BGS: NONE USED</p>													0.0 - 2.2 QUATERNARY ALLUVIUM (Qal):
											CL	6883.3	0.0 TO 2.2 FT, LEAN CLAY WITH SAND (CL)s: ABOUT 80% FINES WITH MEDIUM TO HIGH PLASTICITY, MEDIUM TOUGHNESS AND MEDIUM DRY STRENGTH; ABOUT 20% FINE SAND; GREY, NO REACTION WITH HCL.
	100												2.2 TO 40.7 TERTIARY NACIMIENTO FORMATION.
	5												2.2 TO 19.2 FT, CLAYSTONE: SANDY, LAMINATED TO THINLY BEDDED, GREY IN COLOR, INTERMITTENT PURPLE SPOTS, DECOMPOSED (W9) AND VERY SOFT (H7) IN TOP 1.5 FEET, BECOMES VERY INTENSELY WEATHERED (W8) AND SOFT (H6) BELOW 1.5 FEET, CORE STICKS TO SAMPLER, VERY DIFFICULT TO REMOVE, SAMPLE FALLS APART UPON REMOVAL FROM SPLIT SPOON.
	98										CLST		19.2 TO 29.1 SANDSTONE: FINE GRAINED ARGILLACEOUS, TAN TO GREY IN COLOR, SOFT (H6) MODERATELY WEATHERED (W5), MICACEOUS, THINLY TO MODERATELY BEDDED, NO REACTION WITH HCL. SANDSTONE WASHED AWAY BY DRILL RESULTING IN POOR RECOVERY.
	10												29.1 TO 30.2 FT CLAYSTONE: BLACK IN COLOR, MODERATELY WEATHERED (W5), SOFT (H6), LAMINATED TO THINLY BEDDED, GYPSUM VEINS AND IRON OXIDE CONCRETIONS.
	100												30.2 TO 30.7 SANDSTONE: HARD (H3) SLIGHTLY WEATHERED TO FRESH (W2), MODERATELY BEDDED, GREY IN COLOR, NO REACTION WITH HCL.
	15												30.7 TO 40.7 CLAYSTONE: SANDY, SOFT (H6) INTENSELY TO MODERATELY WEATHERED (W6), GYPSUM VEINS, INTERMITTENT IRON OXIDE VEINS, DARK GREY TO BLACK IN COLOR, THINLY TO MODERATELY BEDDED.
	42										Tn	6848.3	STRATIGRAPHY: 0.0 - 2.2 FT QUATERNARY ALLUVIUM (Qal) 2.2 - 40.7 FT TERTIARY NACIMIENTO FORMATION
	20										SS		
	64												
	25												
	50											6930.4	
	30										CLST	6935.3	
	50										SS	6934.8	
	35												
	92										CLST		
	40											6924.8	

BOTTOM OF HOLE

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6483, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6499, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3B-14-1

SHEET 1 OF 1

FEATURE: REACH 22B

LOCATION: REGULATING TANK 3B

BEGUN: 12/17/14 FINISHED: 12/20/14

DEPTH OF WATER LEVEL:

DATE MEASURED: 12/20/2014

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

COORDINATES: N 1,987,529.4 E 2,721,508.0

TOTAL DEPTH: 60.0

DEPTH TO BEDROCK: 0.0

STATE: NEW MEXICO

GROUND ELEVATION: 6969.5

ANGLE FROM HORIZONTAL: 90

HOLE LOGGED BY: C. BEYER

REVIEWED BY:

NOTES	DEPTH	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
		% CORE RECOVERY	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSSDAL, HELPERS: KYLE KILLEBREW, JOE PROCTOR.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 85 TRACK MOUNTED DRILL RIG</p> <p>DRILL METHOD: 0.0 - 25.7 FT 1/4 INCH HOLLOW STEM AUGER WITH CALIFORNIA SAMPLER 25.7 - 60.0 FT HQ3 WIRELINE CORING SYSTEM WITH A 3" SPLIT TUBE SAMPLER AND DIAMOND SURFACE- SET BIT.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 25.7 FT, NONE USED 25.7 - 60.0 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.</p>													0.0 TO 60.0 TERTIARY NACIMIENTO FORMATION.
									17/25				0.0 TO 30.1 FT, CLAYSTONE: SANDY, LAMINATED TO THINLY BEDDED, GREY IN COLOR, DECOMPOSED (W9) AND VERY SOFT (H7) IN TOP 1.5 FEET, BECOMES INTENSELY WEATHERED (W7) TO MODERATELY TO INTENSELY WEATHERED (W6) AND SOFT (H6) INTERMITTENT IRON OXIDE STAINING, DIFFICULT AUGERING ABOVE 25.0 FT, CORE STICKS TO SAMPLER, VERY DIFFICULT TO REMOVE, SAMPLE FALLS APART UPON REMOVAL FROM SPLIT SPOON FROM 25.0 TO 30.0 FT.
	5								30/50				
									SD REFUSAL				
	10								SD REFUSAL				
									SD REFUSAL				
	15								REFUSAL		CLST		30.1 TO 39.0 SANDSTONE: FINE GRAINED, ARGILLACEOUS, LIGHT GREY IN COLOR, MODERATELY SOFT (H5) INTENSELY TO MODERATELY WEATHERED (W6), MODERATELY BEDDED, THIN CLAYSTONE INTERBEDS 0.3 FT THICK, NO REACTION WITH HCL.
									REFUSAL				
	20								REFUSAL				39.0 TO 48.2 FT CLAYSTONE: SANDY, LAMINATED TO THINLY BEDDED, DARK GREY IN COLOR, MODERATELY WEATHERED (W5), SOFT (H6), INTERMITTENT IRON OXIDE STAINING, CORE STICKS TO SAMPLER, VERY DIFFICULT TO REMOVE, SAMPLE FALLS APART UPON REMOVAL FROM SPLIT SPOON.
									SD REFUSAL				
	25												48.2 TO 55.0 FT SILTSTONE: LIGHT GREY IN COLOR, MODERATELY HARD (H5), SLIGHTLY WEATHERED (W3), MODERATELY BEDDED, THIN CLAYSTONE INTERBEDS, 0.2 FT THICK, NO REACTION WITH HCL.
	100												
	30									Tn		6939.4	55.0 TO 60.0 SANDSTONE: GREY IN COLOR, MODERATELY HARD (H4) TO MODERATELY SOFT (H5) SLIGHTLY WEATHERED (W3), MODERATELY TO THICKLY BEDDED, NO REACTION WITH HCL.
	56										SS		
	35											6930.5	
	36												
	40												
	100										CLST		
	45												
	100											6921.3	
	50										SLTS		
	100											6914.5	
	55												
	38										SS		
	60											6909.5	
BOTTOM OF HOLE													

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.

THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6499, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3B-15-2

SHEET 1 OF 1

FEATURE: REACH 22B
 LOCATION: REGULATING TANK 3B
 BEGUN: 1/29/15 FINISHED: 1/29/15
 DEPTH OF WATER LEVEL:
 DATE MEASURED: 1/29/2015

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT
 COORDINATES: N 1,967,531.2 E 2,721,532.8
 TOTAL DEPTH: 40.7
 DEPTH TO BEDROCK: 0.0

STATE: NEW MEXICO
 GROUND ELEVATION: 6968.0
 ANGLE FROM HORIZONTAL: 90
 HOLE LOGGED BY: C. BEYER
 REVIEWED BY:

NOTES	DEPTH	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
		% CORE RECOVERY	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSSDAL, HELPERS: KYLE KILLEBREW, JOE PROCTOR.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 85 TRACK MOUNTED DRILL RIG</p> <p>DRILL METHOD: 0.0 - 40.7 FT HQ3 WIRELINE CORING SYSTEM WITH A 3" SPLIT TUBE SAMPLER AND DIAMOND SURFACE-SET BIT.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 40.7 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.</p>													0.0 TO 40.7 TERTIARY NACIMIENTO FORMATION.
	75												0.0 TO 28.1 FT CLAYSTONE: GREY IN COLOR, DECOMPOSED (W9) AND VERY SOFT (H7) FROM 0.0 TO 1.4 FT, INTENSELY WEATHERED (W7) AND SOFT (H6) BELOW 1.4 FT. INTERMITTENT GYPSUM VEINS, ROOTS AND IRON OXIDE STAINING. MODERATELY BEDDED, NO REACTION WITH HCL. CORE WASHED BY DRILLING. CORE DIFFICULT TO RECOVER FROM 20.7 TO 25.7 FT. CORE DIFFICULT TO REMOVE FROM SPLIT SPOON. CLAYSTONE BECOMES DARK GREY TO BLACK FROM 25.7 TO 28.1 FT.
	5												28.1 TO 28.8 FT SILTSTONE: GREY IN COLOR, MODERATELY WEATHERED (W5) SOFT (H6) THINLY BEDDED, NO REACTION WITH HCL.
	100												28.8 TO 36.9 FT SANDSTONE: GREY IN COLOR, MODERATELY WEATHERED (W5) SOFT (H6) GREY IN COLOR, FINE GRAINED, AND THINLY BEDDED. BECOMES HARD (H3) SLIGHTLY WEATHERED (W3) LIGHT GREY, AND MODERATELY BEDDED, WITH GYPSUM VEINS AND ROUNDED MUDSTONE GRAVEL 20MM IN DIAMETER BELOW 29.4 FT.
	10												36.9 TO 40.7 FT CLAYSTONE: MODERATELY WEATHERED (W5) AND SOFT (H6) DARK GREY TO BLACK IN COLOR, INTERMITTENT GYPSUM VEINS, AND IRON OXIDE STAINING. MODERATELY BEDDED, NO REACTION WITH HCL. CORE DIFFICULT TO REMOVE FROM SPLIT SPOON.
	80												STRATIGRAPHY: 0.0 - 40.7 FT TERTIARY NACIMIENTO FORMATION
	15												
	100												
	20												
	62												
	25												
	100												
	30												
	100												
	35												
	100												
	40												

BOTTOM OF HOLE

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.
 THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS-DRAWING NO. 40-D-6493. STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6499. STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

SHEET 1 OF 1

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT
COORDINATES: N 1,967,549.0 E 2,721,527.8
TOTAL DEPTH: 7.3
DEPTH TO BEDROCK: 0.0

STATE: NEW MEXICO
GROUND ELEVATION: 6967.8
ANGLE FROM HORIZONTAL: 90
HOLE LOGGED BY: C. BEYER
REVIEWED BY:

NOTES	DEPTH	% CORE RECOVERY	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 10.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
			% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT					
ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER. ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED. DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSSDAL, HELPERS: KYLE KILLESBREW, STEVE COCHRAN. PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS. DRILL EQUIPMENT: CME 85 TRACK MOUNTED DRILL RIG DRILL METHOD: 0.0 - 7.3 4 1/4 INCH HOLLOW STEM AUGER WITH CALIFORNIA SAMPLER, REACHED AUGER REFUSAL AT 7.3 FT. DID NOT CONTINUE WITH CORING SETUP BECAUSE OF CULTURAL RESOURCE COMPLIANCE. CASING RECORD: NONE USED DRILLING MEDIUM: 0.0 - 7.3 FT NONE USED HOLE COMPLETION: BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.	5								12/24		Tn Clst	0.0 TO 7.3 FT TERTIARY NACIMIENTO FORMATION. 0.0 TO 7.3 FT CLAYSTONE: GREY IN COLOR, DECOMPOSED (W9) AND VERY SOFT (H7) FROM 0.0 TO 1.5 FT, BECOMING INTENSELY WEATHERED (W7) AND SOFT (H6) BELOW, NO REACTION WITH HCL. DIFFICULT AUGERING BELOW 5.0 FT, REACHED AUGER REFUSAL AT 7.3 FT. DID NOT CORE FOR CULTURAL RESOURCE COMPLIANCE. DISCONTINUED HOLE. STRATIGRAPHY: 0.0 - 7.3 FT TERTIARY NACIMIENTO FORMATION	
									27/40				
									50/REFUSAL				
BOTTOM OF HOLE													

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.
THE DATA FOR THE CENTER COLUMN AND "CLASSIFICATION AND PHYSICAL CONDITIONS" COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL
AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS: DRAWING NO. 40-D-6493, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK,
DRAWING NO. 40-D-6499, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

GEOLOGIC LOG OF DRILL HOLE NO. DHR22RT3B-15-4

SHEET 1 OF 1

FEATURE: REACH 22B
 LOCATION: REGULATING TANK 3B
 BEGUN: 1/29/15 FINISHED: 3/11/15
 DEPTH OF WATER LEVEL:
 DATE MEASURED: 1/29/2015

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT
 COORDINATES: N 1,987,514.7 E 2,721,526.9
 TOTAL DEPTH: 40.3
 DEPTH TO BEDROCK: 0.0

STATE: NEW MEXICO
 GROUND ELEVATION: 6987.7
 ANGLE FROM HORIZONTAL: 90
 HOLE LOGGED BY: C. BEYER
 REVIEWED BY:

NOTES	DEPTH	LABORATORY DATA						LABORATORY CLASSIFICATION	BLOWS / 0.5 FT	GEOLOGIC UNIT SYMBOL	VISUAL CLASSIFICATION	ELEVATION	CLASSIFICATION AND PHYSICAL CONDITION
		% CORE RECOVERY	% FINES	% SAND	% GRAVEL	LIQUID LIMIT	PLASTICITY INDEX						
<p>ALL MEASUREMENTS ARE FROM GROUND SURFACE AND ARE THE SAME AS THOSE USED BY THE DRILLER.</p> <p>ALL MEASUREMENTS ARE REPORTED IN FEET EXCEPT WHERE NOTED.</p> <p>DRILLED BY: U.C. REGION DRILL CREW; DRILLER: JEFF VAN AUSSDAL, HELPERS: KYLE KILLEBREW, JOE PROCTOR.</p> <p>PURPOSE: PRECONSTRUCTION SOIL AND BEDROCK FOUNDATION INVESTIGATIONS.</p> <p>DRILL EQUIPMENT: CME 85 TRACK MOUNTED DRILL RIG</p> <p>DRILL METHOD: 0.0 - 40.3 FT HQ3 WIRELINE CORING SYSTEM WITH A 3" SPLIT TUBE SAMPLER AND DIAMOND SURFACE-SET BIT.</p> <p>NOTES: DISCONTINUED DRILLING AT 20.3 FT AT END OF DAY. SNOW/STORM MOVED IN OVER NIGHT, SNOWED 1.5 FT CREATING DIFFICULT ACCESS TO SITE. CAME BACK ON 3/11/2015 AND FINISHED HOLE.</p> <p>CASING RECORD: NONE USED</p> <p>DRILLING MEDIUM: 0.0 - 40.3 FT, WATER</p> <p>HOLE COMPLETION: BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.</p>	77												0.0 TO 40.3 FT TERTIARY NACIMENTO FORMATION.
	94												0.0 TO 29.4 FT CLAYSTONE: GREY IN COLOR, DECOMPOSED (W9) AND VERY SOFT (H7) FROM 0.0 TO 1.5 FT, INTENSELY WEATHERED (W7) AND SOFT (H6) BELOW 1.4 FT. INTERMITTENT GYPSUM VEINS, ROOTS AND IRON OXIDE STAINING, THINLY TO MODERATELY BEDDED, NO REACTION WITH HCL. CORE WASHED BY DRILLING, CORE DIFFICULT TO REMOVE FROM SPLIT SPOON.
	100												JOINT MEASUREMENTS: DEPTH INCL R M T HL INFILLING 17.2 20 5 1 3 IRON OXIDE 19.5 20 5 1 3 IRON OXIDE 20.0 60 5 1 3 IRON OXIDE 20.6 30 5 1 3 IRON OXIDE 21.1 30 5 1 3 IRON OXIDE 22.3 30 5 1 3 IRON OXIDE
	150												29.4 TO 29.7 SILTSTONE: GREY, MODERATELY SOFT (H5), MODERATELY TO SLIGHTLY WEATHERED (W4), NO REACTION WITH HCL.
	200												29.7 TO 33.5 SANDSTONE: GREY TO TAN IN COLOR SOFT (H8) MODERATELY TO SLIGHTLY WEATHERED (W4), FINE GRAINED, THINLY BEDDED, NO REACTION WITH HCL. CORE WASHED BY DRILL.
	250												33.5 TO 34.2 FT CLAYSTONE: GREY IN COLOR, INTENSELY WEATHERED (W7), SOFT (H6) INTERMITTENT GYPSUM VEINS, AND IRON OXIDE STAINING, THINLY TO MODERATELY BEDDED, NO REACTION WITH HCL. CORE WASHED BY DRILLING, CORE DIFFICULT TO REMOVE FROM SPLIT SPOON.
	300												34.2 TO 34.6 SANDSTONE: GREY TO TAN IN COLOR SOFT (H8) MODERATELY TO SLIGHTLY WEATHERED (W4), FINE GRAINED, THINLY BEDDED, NO REACTION WITH HCL.
	350												34.6 TO 36.3 SILTSTONE: MODERATELY HARD (H4), SLIGHTLY WEATHERED TO FRESH (W2), GREY IN COLOR, NO REACTION WITH HCL.
	400												36.3 TO 40.3 FT CLAYSTONE: GREY IN COLOR, MODERATELY WEATHERED (W5), SOFT (H6) INTERMITTENT AND IRON OXIDE STAINING, THINLY BEDDED, NO REACTION WITH HCL. CORE DIFFICULT TO REMOVE FROM SPLIT SPOON.
	40.3												STRATIGRAPHY: 0.0 - 40.3 FT TERTIARY NACIMENTO FORMATION

COMMENTS:

ALL ANGLES MEASURED FROM CORE AXIS AT ZERO DEGREES, UNLESS OTHERWISE NOTED.
 THE DATA FOR THE CENTER COLUMN AND CLASSIFICATION AND PHYSICAL CONDITIONS COLUMN ARE BASED ON BUREAU OF RECLAMATION GEOLOGY FIELD MANUAL AND DRAWINGS TITLED FOR DESIGNS AND SPECIFICATIONS AS FOLLOWS- DRAWING NO. 40-D-6403, STANDARD DESCRIPTIONS AND DESCRIPTIVE CRITERIA FOR ROCK, DRAWING NO. 40-D-6409, STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES.

ATTACHMENT C
GEOLOGIC DESIGN DATA REPORT
(PREPARED BY THE BUREAU OF RECLAMATION REGION DATED AUGUST 2015)

RECLAMATION

Managing Water in the West

NAVAJO GALLUP WATER SUPPLY PROJECT

REACH 21

GEOLOGIC DESIGN DATA REPORT



Department of the Interior
Bureau of Reclamation
Upper Colorado Region
Four Corners Construction Office
Farmington, New Mexico

August 2015

Report Written By: Justin Gilbert, Geologist

Reviewed in the Farmington Construction Office, Farmington, NM by:

Christopher Beyer, Geologist

Casey Hall, Geologist

James Gates, Geologist

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APPENDICES

APPENDIX 1

LOGS OF EXPLORATION

Drill Holes:

DHR21-14-A, DHR21-14-B, DHR21-14-C, DHR21-14-D, DHR21-14-E, DHR21-14-F, DHR21-14-G, DHR22B-14-129, DHR22B-14-133, DHR22B-14-137, DHR22RT3A-14-1, DHR22RT3A-14-4, DHR22RT3A-15-1B, DHR22RT3A-15-3B, DHR22RT3A-15-4B, DHR22RT3B-14-1, DHR22RT3B-15-2, DHR22RT3B-15-3 and DHR22RT3B-15-4

Backhoe Test Pits:

TPR21-14-A, TPR21-14-B, TPR21-14-C, TPR21-14-D, TPR21-14-E, TPR21-14-F, TPR21-14-G, TPR22B-14-130, TPR22B-14-131, TPR22B-14-132, TPR22B-14-134, TPR22B-14-135, TPR22B-14-136, TPR22B-14-138, TPR22B-14-139

Cone Penetration Test Holes:

CPTR21-14-A, CPTR21-14-B, CPTR21-14-C, CPTR21-14-D, CPTR21-14-E, CPTR21-14-F, CPTR21-14-G, CPT22B-14-38, CPT22B-14-39, CPT22B-14-40, CPT22B-14-41, CPT22B-14-43, CPT22B-14-44, CPT22B-14-46

APPENDIX 2

LABORATORY SUMMARY SHEETS

APPENDIX 3

DRAWINGS

Dwg No. 1695-529-910 Reach 21 General Location Map 1/1

Dwg No. 1695-529-853 Location of Exploration

Dwg No. 1695-941 Reach 21 General Geologic Legend, Explanation, and Notes 1/1

Dwg No 1695-529-770 through -772 Reach 21 Surface Geology Maps 1": 200'

Dwg No. 1695-529-710 Reach 21 Surface Geology and Location of Exploration

Dwg No. 1695-529-932 Section A – A'

Dwg No 1695-529-933 Section B – B'

Dwg No. 1695-529-938 Regulating Tanks No. 3A & 3B - Surface geology and Location of Section A-A' and C-C'

Dwg No. 1695-529-946 Storage Tanks (Regulating Tanks 3A & 3B) – Geologic Section A-A', B-B', and C-C'

APPENDIX 4

CORE PHOTOGRAPHS

TEST PIT PHOTOGRAPHS

1.0 INTRODUCTION

The Reach 21 is located to the north of the community of Huerfano, and just to the south of Huerfano Mesa. Reach 21 includes 3 miles of approximately 20-inch HDPE pipe and includes a water treatment plant and two regulating tanks.

2.0 SUMMARY OF INVESTIGATIONS

In the Summer and Fall of 2014 the Upper Colorado Drill Crew and Four Corners Construction Office Geologists performed investigations within the water treatment plant footprint, three miles of Reach 21 pipeline alignment and regulating tanks 3A and 3B footprint to determine subsurface conditions. Investigations included seventeen drill holes, fourteen test pits, and fourteen cone penetration test (CPT's) holes. Drill holes (DHR21-14-A, DHR21-14-B, DHR21-14-C, DHR21-14-D, DHR21-14-E, DHR21-14-F, DHR21-14-G, DHR22B-14-129, DHR22B-14-133, DHR22B-14-137, DHRT3A-15-1B, DHRT3A-15-3B, DHRT3A-15-4B, DHRT3B-14-1, DHRT3B-14-2, DHRT3B-14-3 and DHRT3B-14-4) were drilled using either a truck mounted Central Mining Equipment (CME) 85 drill rig or a track mounted CME 850 with a hollow stem auger with SPT sampler that drilled to depths ranging from 25.0 feet to 60.0 feet below ground surface.

Test pits (TPR21-14-A through TPR21-14-G, TPR22B-14-131, TPR22B-14-132, TPR22B-14-134, TPR22B-14-135, TPR22B-14-136, TPR22B-14-138 and TPR22B-14-139) were performed using a Case 580N Rubber Tire Backhoe, with a 2-foot wide bucket with teeth. Four Corners Construction Office Materials Lab performed one in-place density at six feet below ground surface in each test pit.

Cone penetration tests (CPTR21-14-A, CPTR21-14-B, CPTR21-14-C, CPTR21-14-D, CPTR21-14-E, CPTR21-14-F, CPTR21-14-G, CPT22B-14-38, CPT22B-14-39, CPT22B-14-40, CPT22B-14-41, CPT22B-14-43, CPT22B-14-44 and CPT22B-14-46) were conducted by Pacific

Northwest Drill Crew personnel. CPT's refusal ranged from 22.3 to 53.3 feet below ground surface. Logs of exploration for drill holes, test pits and CPT's can be found in Appendix 1.

3.0 SITE GEOLOGY

Reach 21 lies entirely within the Navajo section of the San Juan Basin, a section characterized by young plateaus, mesas, and dry-wash canyons presently being eroded in an arid climate.

Quaternary Alluvium exists on the surface throughout most of Reach 21. Alluvium ranges from about 28.3 to 49.3 feet below ground surface within the Reach 21 Water Treatment Plant.

Claystone bedrock is located on the surface or within three feet of the surface at the Regulating Tanks 3A and 3B footprint. The Nacimiento Formation is typically about 1,400 feet in thickness in this area of the San Juan Basin. Vegetation at the site is sparse, consisting of grasses, occasional sage and rabbit brush.

3.1 Quaternary Alluvium (Qal)

Quaternary age alluvium deposits (Qal) overlie bedrock throughout most of Reach 21. The alluvium is derived from a variety of sources including eolian and alluvial deposition.

Quaternary age alluvium is used to describe all unconsolidated surficial deposits along the alignment regardless of origin. Alluvial soils range from predominantly silty sand (SM), to clayey sand (SC), and occasionally lean clay with sand (CL)s. Within the sand washes, the alluvium generally is classified as a poorly graded sand with silt (SP-SM) and silty sand (SM). These deposits occasionally contain a component of fine gravel. For more detail, see specific geologic logs in Appendix 1.

3.2 Tertiary Nacimiento Formation (Tn)

The Nacimiento Formation (Tn) underlies the alluvium and was encountered in drill holes at depths ranging from 0.0 to 49.3 feet within the Reach 21 Water Treatment Plant footprint and pipeline alignment and encountered within two feet of the surface within the footprint of

Regulating Tank 3A and 3B. It consists predominately of sandstone with interbedded siltstone and claystone. Sandstone is fine to coarse grained soft (H6), intensely weathered (W7) and color transitions between brown, orange, grey, and yellow. Sandstone can contain occasional conglomeratic zones with subrounded to subangular fine gravel, and mud rip up clasts. Siltstone is grey to brown in color, very soft (H7) to moderately hard (H4), slightly weathered (W3) to intensely to moderately weathered (W6). Claystone is dark grey to brown in color, very soft (H7) to soft (H6), decomposed (W9) to intensely weathered (W7). Siltstone, claystone and sandstone are typically laminated to thinly bedded and can contain occasional carbon inclusions, gypsum and calcite veins with iron or manganese oxide staining.

4.0 STATION TO STATION GEOLOGY

Reach 21 Water Treatment Plant Investigations

Stations 23151+10 to 23158+20 Qal

Drill hole DHR21-14-A encountered alluvium to a depth of 39.8 feet below ground surface. Alluvium consisted of silty sand (SM), poorly graded sand (SP), clayey sand (SC), and lean clay (CL). Standard penetration tests (SPT's) were conducted and recorded blows per half foot in depth. Blows ranged from 3 to 23 blows per half foot. Bedrock was encountered at 39.8 feet and consisted of interbedded claystone and sandstone. The claystone is unfractured (FD0), very intensely weathered to decomposed (W8-W9), very soft to soft (H6-H7). Sandstone encountered is moderately to intensely weathered (W5-W6), moderately hard to moderately soft (H4-H5).

Drill hole DHR21-14-B encountered alluvium to a depth of 49.2 feet below ground surface. Alluvium consisted of poorly graded sand with silt (SP-SM), poorly graded sand with gravel (SP-SM)g, poorly graded sand (SP), clayey sand (SC), poorly graded sand with gravel (SP)g, sandy lean clay s(CL) and poorly graded sand with silty clay and gravel (SP-SC)g. Bedrock encountered consisted of claystone. Claystone is very intensely weathered (W8) and very soft (H7).

Drill hole DHR21-14-C encountered alluvium to a depth of 49.3 feet below ground surface. Alluvial material encountered consisted of silty sand (SM), clayey sand (SC), lean clay (CL), and

poorly graded sand (SP). SPT's ranged from 4 to 26 blows per half foot. Bedrock encountered at 49.3 feet consisted of conglomeratic sandstone. The sandstone is moderately to intensely weathered (W5-W7), moderately soft to soft (H5-H6). Bedrock contains very hard (H2) subrounded to subangular gravel-sized clasts with a maximum size of 70 mm.

Drill hole DHR21-14-D encountered alluvium to a depth of 46.7 feet below ground surface. Surficial materials encountered include silty sand (SM), poorly graded sand (SP) and clayey sand (SC). SPT's ranged from 4 to 39 blows per half foot. Bedrock was encountered at 46.7 feet in depth. Bedrock consisted of a fine to medium grained sandstone. Sandstone is moderately to intensely weathered (W5-W7), and moderately soft to soft (H5-H6).

Drill hole DHR21-14-E encountered alluvium to a depth of 49.2 feet in depth below ground surface. Materials encountered within alluvium include silty sand (SM), clayey sand (SC), poorly graded sand (SP) and lean clay (CL). SPT's ranged from 2 to 32 blows per half foot. Bedrock encountered at 49.2 feet in depth consisted of sandstone. Bedrock is moderately to intensely weathered (W5-W7), and moderately soft to moderately hard (H4-H5). Sandstone contains a trace of very hard (H2) subrounded to subangular quartzite and granite gravel-sized clasts with a maximum size 40 mm.

Drill hole DHR21-14-F encountered alluvium to a depth of 43.8 feet below ground surface. Alluvial material consisted of silty sand (SM), poorly graded sand with silt (SP-SM), poorly graded sand with silt and gravel (SP-SM)g, and clayey sand (SC). SPT's ranged from 3 blows per half foot to 50 blows (refusal). Bedrock consisted of a fine to medium grained sandstone with clay rip up clasts. The sandstone is moderately to intensely weathered (W5-W7), and moderately soft to soft (H5-H6).

Drill hole DHR21-14-G encountered alluvium to a depth of 28.3 feet below ground surface. Surficial materials included silty sand (SM), clayey sand (SC), lean clay (CL), and poorly graded sand with silt (SP-SM). SPT's ranged from 5 to 50 blows (refusal) per half foot. Bedrock encountered at 28.3 feet and consisted of a fine to medium grained sandstone. Sandstone is moderately to intensely weathered (W5-W7), moderately soft (H5), and thinly bedded to laminated.

A total of seven test pits (TPR21-14-A, TPR21-14-B, TPR21-14-C, TPR21-14-D, TPR21-14-E, TPR21-14-F and TPR21-14-G) were excavated within Reach 21 footprint in the Summer and Fall of 2014, using a Case 580 N rubber tire backhoe. The backhoe used a 2-foot wide bucket, with teeth. In place density tests were conducted in each pit at approximately 6.0 feet in depth. Corrosion samples were collected at about 10.0 feet and were sent to Denver's Technical Services Center (TSC) for analysis. Test pit TPR21-14-A encountered clayey sand (SC), silty sand (SM), and lean clay (CL) down to 12.1 feet and was discontinued due to limit of equipment. Test pit TPR21-14-B encountered clayey sand (SC) and silty sand (SM) down to 14.8 feet. Test pit TPR21-14-C encountered silty sand (SM) down to 14.0 feet and was discontinued due to limit of equipment. Test pit TPR21-14-D encountered silty sand (SM) and poorly graded sand with silt (SP-SM) down to 14.2 feet. Test pit TPR21-14-E silty sand (SM) down to 13.0 feet. Test pit TPR21-14-F encountered alluvium consisting of silty sand (SM) and poorly graded sands with silt (SP-SM) down to 14.9 feet. Test pit TPR21-14-G encountered silty sand (SM) down to limit of equipment at 14.9 feet. The in place unit weight in all test pits ranged from 77.8 to 112.2 lbs. / cu ft. Test pit TPR21-14-D had a low dry in place unit weight of 77.8%. Further information regarding specific test pit laboratory results can be found in Appendix 2 and specific logs in Appendix 1.



Photo of Four Corners Construction Office Lab Technician Taking an In-Place Density In TPR21-14-B.

Reference Image Only.

Photo Taken By C. Beyer on 10/14/2014.

Seven cone penetration test (CPT's) holes were performed within the Water Treatment Plant footprint (CPTR21-14-A.1, CPTR21-14-B, CPTR21-14-C.1, CPTR21-14-D, CPTR21-14-E, CPTR21-14-F and CPTR21-14-G). Depth to refusal ranged from 35.0 to 53.3 feet below ground surface. CPT holes CPTR21-14-A and CPTR21-14-C conducted resistivity surveys. The table below indicates depth to refusal for each CPT hole. Included in Appendix 1 are detailed logs of each CPT hole.

REACH 21 CPT HOLE	DEPTH TO REFUSAL (FEET)
CPTR21-14-A.1	53.3
CPTR21-14-B	50.7
CPTR21-14-C.1	50.0
CPTR21-14-D	46.4

CPTR21-14-E	41.0
CPTR21-14-F	48.4
CPTR21-14-G	46.3
CPTR22B-14-38	35.0

The remaining three miles of Reach 21 and regulating tank 3a and 3b included an additional 10 drill holes (DHR22B-14-129, -133, -137, DHRT3A-15-1B, DHRT3A-15-3B, DHRT3A-15-4B, DHRT3B-14-1, DHRT3B-14-2, DHRT3B-14-3, DHRT3B-14-4), 7 test pits (TPR22B-14-131, -132, -134, -135, -136, -138, -139) and 6 cone penetration tests (CPT22B-14-39, -40, -41, -43, -44, -46).

Reach 21 Pipeline Investigations

Stations 23158+20 - 23282+00 Qal

Drill Hole DHR22B-14-129 was drilled to a depth of 25.0 feet entirely through alluvium. Alluvium consisted of silty sand (SM), poorly graded sand with silt (SP-SM) and clayey sand (SC). Standard penetration tests ranged from 3 to 22 blows per half foot. Drill hole DHR22B-14-133 encountered alluvium from ground surface to a depth of 24.5 feet. Alluvium encountered in DHR22B-14-133 consisted of silty sand (SM) and clayey sand (SC). Standard penetration tests in DHR22B-14-133 ranged from 4 to 26 blows per half foot. Drill hole DHR22B-14-137 was drilled to a depth of 25.0 feet. Alluvium was encountered in DHR22B-14-137 from 0.0 to 4.5 feet and consisted of silty sand (SM). Standard penetration tests in DHR22B-14-137 ranged from 6 to 50 blows per half foot. Interbedded claystone and sandstone bedrock was encountered from 4.5 to 25.0 feet in DHR22B-14-137. Bedrock consisted of claystone from 4.5 to 14.1 feet and was intensely weathered to decomposed (W8-W9) and moderately soft to soft (H5-H6). Sandstone was encountered from 14.1 to 16.6 feet in DHR22B-14-137 and was intensely weathered (W7) and moderately soft to soft (H5-H6). Claystone was encountered from 16.6 to 25.0 feet and was intensely weathered to decomposed (W7-W9) and moderately soft to soft (H5-H6).

Test pit TPR22B-14-131 was excavated entirely within alluvium and encountered sandy lean clay s(CL) and silty sand (SM) down to 14.0 feet. Test pit TPR22B-14-132 encountered alluvial materials such as poorly graded sand with silt (SP-SM) from ground surface to 16.0 feet in depth. Test pit TPR22B-14-134 encountered silty sand (SM) and clayey sand (SC) to a depth of 10.0 feet. Test pit TPR22B-14-135 encountered alluvium from 0.0 to 14.2 feet, and encountered silty sand (SM) and sandy lean clay s(CL) to a depth of 14.2 feet. Test pit TPR22B-14-136 encountered silty sand (SM) to 14.3 feet. Test pit TPR22B-14-138 was excavated from 0.0 to 14.0 feet. Materials encountered include silty sand (SM) down to 14.0 feet.

Cone penetrometer test holes (CPT22B-14-39, CPT22B-14-40, CPT22B-14-41, CPT22B-14-43, CPT22B-14-44 and CPT22B-14-46) varied in depth to refusal from 7.5 to 35.0 feet below ground surface.

Regulating Tank 3A and 3B Investigations

Stations 23282+00 to 23300+00 Qal/Tn

Regulating Tank No. 3A

Geological conditions at Regulating Tank 3A consist of claystone and sandstone outcrops of the Nacimiento Formation on the surface, with areas of thin alluvial cover. Interbedded sequences of sandstone, siltstone and claystone of variable thickness were encountered during drilling investigations. Foundation investigations at the Regulating Tank 3A site included one test pit (TPR22B-14-139) and three drill holes (DHR22RT3A-15-1B, DHR22RT3A-15-3B, and DHR22RT3A-15-4B). Intact claystone core samples of eight inches or more were wrapped with plastic and duct tape to preserve moisture, and packed in bubble wrap to be shipped for compressive strength testing. California samples were collected in select drill holes for and for expansion testing. Soil and decomposed bedrock samples were collected in select drill holes for corrosion testing. All samples were shipped to the Materials Engineering Research Laboratory (MERL) in Denver for analysis.

Test Pit TPR22B-14-139 was excavated near the Regulating Tank 3A site and encountered 2.9 feet of silty sand (SM) atop claystone bedrock. The claystone is dark grey in color, very soft

(H7) and very intensely weathered to decomposed (W8). The test pit was excavated to a total depth of 8.6 feet into claystone before reaching refusal.

Drill hole DHR22RT3A-15-1B was drilled to a total depth of 60.8 feet and encountered 2.5 feet of clayey sand (SC) atop Nacimiento Formation bedrock. Sandstone was encountered from 2.5 to 5.0 feet. The sandstone is fine grained, moderately weathered (W5), soft (H6), grey in color and had no reaction with HCl. Claystone was encountered from 5.0 to 25.2 feet. The claystone is intensely weathered (W7), soft (H6), light to dark grey in color, with gypsum veins and iron oxide staining. Sandstone was encountered from 25.2 to 31.6 feet. The sandstone is fine grained, slightly weathered (W3), hard (H3), grey in color, and had no reaction with HCl. Claystone was encountered from 31.6 to 48.0 feet. The claystone is intensely weathered (W7), soft (H6), light to dark grey in color, with gypsum veins and iron oxide staining. Sandstone was encountered from 48.0 to 60.8 feet. The sandstone is fine grained, moderately weathered (W5), soft (H6), grey in color and had no reaction with HCl.

Drill hole DHR22RT3A-15-3B was drilled to a total depth of 40.7 feet and encountered 2.0 feet of clayey sand (SC) atop Nacimiento Formation bedrock. Claystone was encountered from 2.0 to 19.0 feet. The claystone is sandy, laminated to thinly bedded, grey in color, with intermittent purple spots, decomposed (W9) and very soft (H7) in top 1.5 feet, intensely weathered (W7) and soft (H6) below the top 1.5 feet. Sandstone was encountered from 19.0 to 34.9 feet. The sandstone is fine grained argillaceous, tan to grey in color, soft (H6) moderately weathered (W5), micaceous, thinly to moderately bedded with gypsum veins, and no reaction with HCl. Claystone was encountered from 24.9 to 25.7 feet. The claystone is sandy, laminated to thinly bedded, grey in color, intensely weathered (W7) and soft (H6). Sandstone was encountered from 25.7 to 29.2 feet. The sandstone is fine grained argillaceous, tan to grey in color, moderately soft (H5) slightly weathered (W3), thinly to moderately bedded, no reaction with HCl. Claystone was encountered from 29.2 to 40.7 feet. The claystone is laminated to thinly bedded, dark grey to black in color, slightly weathered (W3) and moderately soft (H5) with intermittent siltstone and sandstone interbeds 0.3 feet thick.

Drill Hole DHR22RT3A-15-4B was drilled to a total depth of 40.7 feet. 2.2 feet of lean clay with sand (CL)s was encountered atop Nacimiento Formation bedrock. Claystone was encountered from 2.2 to 19.2 feet. The claystone is sandy, laminated to thinly bedded, grey in color with

intermittent purple spots, decomposed (W9) and very soft (H7) in top 1.5 feet, intensely weathered (W7) and soft (H6) below the top 1.5 feet. Sandstone was encountered from 19.1 to 29.1 feet. The sandstone is fine grained argillaceous, tan to grey in color, soft (H6) moderately weathered (W5), micaceous, thinly to moderately bedded, and had no reaction with HCl. Claystone was encountered from 29.1 to 30.2 feet. The claystone is black in color, moderately weathered (W5), soft (H6), laminated to thinly bedded, and contained gypsum veins and iron rich concretions. Sandstone was encountered from 30.2 to 31.7 feet. The sandstone is hard (H3) slightly weathered to fresh (W2), moderately bedded, grey in color, and had no reaction with HCl. Claystone was encountered from 31.7 to 40.7 feet. The claystone is sandy, soft (H6) intensely to moderately weathered (W6), dark grey to black in color, thinly to moderately bedded with, intermittent gypsum and iron oxide veins.

Regulating Tank No. 3B

Geological conditions at Regulating Tank B consist of claystone and sandstone outcrops of the Naciminto Formation on the surface with areas of thin alluvial cover. Interbedded sequences of sandstone, siltstone and claystone of variable thickness were encountered during drilling investigations. Foundation investigations at the Regulating Tank 3B site included four drill holes (DHR22RT3B-14-1, DHR22RT3B-14-2, DHR22RT3B-14-3, and DHR22RT3B-15-4). Intact claystone core samples of eight inches or more were wrapped with plastic and duct tape to preserve moisture, and packed in bubble wrap to be shipped for compressive strength testing. California samples were collected in select drill holes for and for expansion testing. Soil and decomposed bedrock samples were collected in select drill holes for corrosion testing. All samples were shipped to the Materials Engineering Research Laboratory (MERL) in Denver for analysis.

Drill Hole DHR22RT3B-14-1 was drilled to a total depth of 60.0 feet. Claystone was encountered from 0.0 to 30.1 feet. The Claystone is sandy, laminated to thinly bedded, grey in color, decomposed (W9) and very soft (H7) in top 1.5 feet, becoming intensely weathered (W7) to moderately to intensely weathered (W6) and soft (H6) below, with intermittent iron oxide staining and no reaction with HCl. Sandstone was encountered from 30.1 to 39.0 feet. The sandstone is fine grained, argillaceous, light grey in color, moderately soft (H5) intensely to moderately weathered (W6), moderately bedded, thin claystone interbeds 0.3 feet thick, no

reaction with HCl. Claystone was encountered from 39.0 to 48.2 feet. The claystone is sandy, laminated to thinly bedded, grey in color, moderately to intensely weathered (W6) and soft (H6) with intermittent iron oxide staining and no reaction with HCl. Siltstone was encountered from 48.2 to 55.0 feet. The siltstone is light grey in color, moderately hard (H5), slightly weathered (W3), moderately bedded. It had no reaction with HCl and thin claystone interbed, 0.2 feet thick. Sandstone was encountered from 55.0 to 60.0 feet. The sandstone is grey in color, moderately hard (H4) to moderately soft (H5) slightly weathered (W3), moderately to thickly bedded, and had no reaction with HCl.

Drill Hole DHR22RT3B-14-2 was drilled to a total depth of 40.7 feet. Claystone was encountered from 0.0 to 28.1 feet. The claystone is decomposed (W9) and very soft (H7) from 0.0 to 1.4 feet and intensely weathered (W7) and soft (H6) below 1.4 ft. It is grey in color, moderately bedded with intermittent gypsum veins, roots, iron oxide staining and no reaction with HCl. Siltstone was encountered from 28.1 to 28.6 feet. The siltstone is grey in color, moderately weathered (W5), soft (H6), thinly bedded, and had no reaction with HCl. Sandstone was encountered from 28.6 to 36.9 feet. The sandstone is grey in color, moderately weathered (W5) soft (H6) grey in color, fine grained, and thinly bedded. It became hard (H3) slightly weathered (W3) light grey, and moderately bedded, with gypsum veins and rounded mudstone clasts 20mm in diameter below 29.4 ft. Claystone was encountered from 36.9 feet to 40.7 feet. The claystone is moderately weathered (W5) and soft (H6) dark grey to black in color, moderately bedded and had intermittent gypsum veins, iron oxide staining and no reaction with HCl.

Drill Hole DHR22RT3B-14-3 was drilled to a total depth of 60.0 feet, and encountered claystone from 0.0 to 30.1 feet. The claystone is sandy, laminated to thinly bedded, grey in color, decomposed (W9) and very soft (H7) in top 1.5 feet, becoming to moderately to intensely weathered (W6) and soft (H6) below, with intermittent iron oxide staining and no reaction with HCl. Sandstone was encountered from 30.1 to 39.0 feet. The sandstone is fine grained, argillaceous, light grey in color, moderately soft (H5) intensely to moderately weathered (W6), moderately bedded, thin claystone interbeds 0.3 feet thick, and no reaction with HCl. Claystone was encountered from 39.0 to 48.2 feet. The claystone is sandy, laminated to thinly bedded, dark grey in color, moderately weathered (W5) soft (H6), with intermittent iron oxide staining.

Siltstone was encountered from 48.2 to 55.0 feet. The siltstone is light grey in color, moderately hard (H5) slightly weathered (W3), and moderately bedded, with thin claystone interbeds 0.3 feet thick and no reaction with HCl. Sandstone was encountered from 55.0 to 60.0 feet. The sandstone is grey in color, moderately hard (H4) to moderately soft (H5), slightly weathered (W3), moderately to thickly bedded, and had no reaction with HCl.

Drill Hole DHR22RT3B-15-4 was drilled to a total depth of 40.3 feet, and encountered claystone from 0.0 to 29.4 feet. The claystone is sandy, laminated to thinly bedded, grey in color, decomposed (W9) and very soft (H7) in top 1.5 feet, becoming to moderately to intensely weathered (W6) and soft (H6) below, with intermittent iron oxide staining and no reaction with HCl. Siltstone was encountered from 29.4 to 29.7 feet. The siltstone is grey, moderately soft (H5), moderately to slightly weathered (W4), and had no reaction with HCl. Sandstone was encountered from 29.7 to 33.5 feet. The sandstone is grey to tan in color, fine grained, soft (H6) moderately to slightly weathered (W4), thinly bedded, and had no reaction with HCl. Claystone was encountered from 33.5 to 34.2 feet. The claystone is grey in color intensely weathered (W7), soft (H6), and moderately bedded with intermittent gypsum veins and iron oxide staining. Sandstone was encountered from 34.2 to 34.6 feet. The sandstone is grey to tan in color, fine grained, soft (H6) moderately to slightly weathered (W4), thinly bedded, and had no reaction with HCl. Siltstone was encountered from 34.6 to 36.3 feet. The siltstone is moderately hard (H4), slightly weathered to fresh (W2), grey in color, and had no reaction with HCl. Claystone was encountered from 36.3 to 40.3 feet. The claystone is grey in color, moderately weathered (W5), soft (H6), and thinly bedded, with intermittent iron oxide staining and no reaction with HCl.

Additional drill holes were done at the original Regulating Tank 3A location. These holes were drilled east of the current Regulating Tank B site and include Drill Holes DHR22RT3A-14-1 and DHR22RT3A-14-4. Drill Hole DHR22RT3A-14-1 was drilled to a total depth of 60.0 feet. Claystone was encountered from 0.0 to 27.5 feet. The claystone is dark grey in color, and very intensely weathered to decomposed (W8-W9), and very soft (H7) near the surface and became moderately weathered (W5) and moderately soft (H5) with depth. Sandstone was encountered from 27.5 to 31.4 feet. The sandstone is light grey in color, fine to medium grained, laminated to thinly bedded, moderately weathered (W5), moderately hard (H4) and had no reaction with HCl.

Claystone was encountered from 31.4 to 50.0 feet. The claystone is dark grey in color, moderately to slightly weathered (W4) and moderately hard (H4). Siltstone was encountered from 50.0 to 59.7 feet. The siltstone is grey to dark grey in color, moderately to slightly weathered (W4), moderately hard to hard (H4-H3), and had no reaction with HCl.

Drill hole DHR22RT3A-14-4 was drilled to a total depth of 40.0 feet, and encountered claystone from 0.0 to 8.6 feet. The claystone is dark grey in color, very intensely weathered to decomposed (W8-W9), very soft (H7) and had no reaction with HCl. Siltstone was encountered from 8.6 to 9.2 feet. The siltstone is grey to dark grey in color, moderately to slightly weathered (W4), moderately hard (H4), and had no reaction with HCl. Claystone was encountered from 9.2 to 29.8 feet. The claystone is dark grey in color, very intensely weathered to decomposed (W8-W9), very soft (H7) and had no reaction with HCl. Sandstone was encountered from 29.8 to 30.9 feet. The sandstone is light grey in color, fine to medium grained, laminated to thinly bedded, moderately weathered (W4), moderately hard (H4) and had no reaction with HCl. Claystone was encountered from 30.9 to 40.0 feet. The claystone is dark grey, moderately weathered (W5), moderately hard (H4), and had no reaction with HCl. For further information see geologic logs in Appendix 1.

5.0 GROUNDWATER OCCURRENCE

In general, groundwater in the Reach 21 area was typically encountered at the base of the alluvium near the top of bedrock surface. It also may occur sporadically in the Nacimiento Formation sandstone under perched conditions at fairly shallow depths. Groundwater was encountered in drill holes DHR21-14-A, DHR21-14-B, DHR21-14-C, DHR21-14-D, DHR21-14-E and DHR21-14-F. Water ranged from 38.1 to 43.5 feet below ground surface in these drill holes. Groundwater was not encountered in drill hole DHR21-14-G when drilled to a depth of 53.5 feet. All water levels were measured at the time of drilling. Groundwater was not encountered in any Regulating Tank 3A and 3B subsurface investigations at the tail end of Reach 21.

6.0 GEOLOGIC CONSIDERATIONS

Unconsolidated soils and intensely weathered to decomposed bedrock can be excavated using common methods. Construction in low density soils will require excavations to be sloped sufficiently, to allow access. Claystone of the Nacimiento Formation are often weathered and soft and will likely be excavated by ripper-equipped dozers and/or large excavators with adequate pullout force and appropriate teeth. Rock weathering transitions out of decomposed (W9), and becomes less weathered within three feet from the top of the unit in sandstone and siltstone of the Nacimiento Formation.

APPENDIX 2

Drill Hole Number: DHR22B-14-129[illegible]

Drill Hole Number: DHR22B-14-133[illegible]

Drill Hole Number: DHR22B-14-137[illegible]

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

FEATURE: REACH 22B

Page 1 of 1

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (.074mm) to #4 (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - PCF	FILL WATER CONTENT - %	SPECIFIC GRAVITY PLUS NO. 4	SPECIFIC GRAVITY MINUS NO. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM WATER CONTENT - %	PENETRATION RESISTANCE psi	D-Value %
			SMALLER THAN 0.005 mm	0.005 to 0.074 mm															
TPR22B-14-131	6.0	SM	11.0	6.2	82.8	0	0	0	NA	NP	-	100.7	3.0	-	2.67	110.3	13.4	-	91.3
TPR22B-14-132	6.0	SM	8.0	11.2	80.8	0	0	0	NA	NP	-	96.2	3.0	-	2.64	113.8	11.8	600	84.5
TPR22B-14-134	6.0	SC	26.7	12.3	61.0	0	0	0	25.0	9.7	-	108.1	6.5	-	2.66	115.7	12.8	520	93.4
TPR22B-14-135	6.0	SM	17.4	21.7	60.8	0.1	0	0	NA	NP	-	93.0	4.1	2.55	2.63	118.5	11.5	-	78.5
TPR22B-14-136	6.0	SM	8.0	6.5	85.5	0	0	0	NA	NP	-	97.7	2.4	-	2.64	107.1	13.1	433	91.2
TPR22B-14-138	6.0	SP-SM	6.5	2.6	90.9	0	0	0	NA	NP	-	100.7	2.4	-	2.65	107.2	12.0	-	93.9

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.

*Denotes In-place density and 5-point curve.

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

**FEATURE: REACH 21WTP
TPR21-14-A,B,C,D,E,F,G**

Page 1 of 1

[illegible]

SUMMARY OF PHYSICAL PROPERTIES TEST RESULTS

PROJECT: NAVAJO GALLUP WATER SUPPLY PROJECT

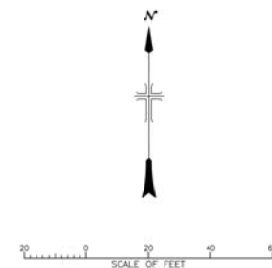
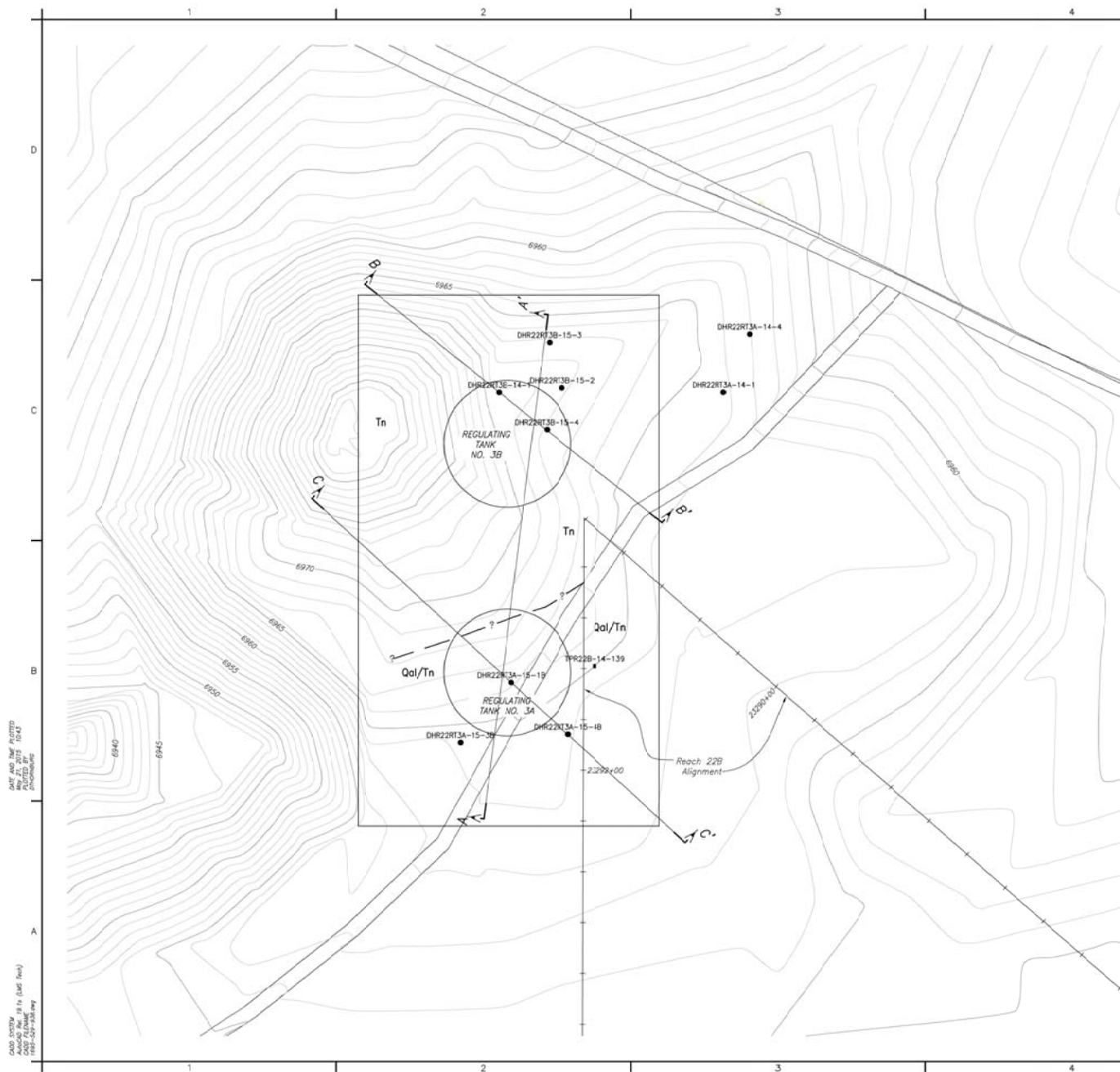
FEATURE: REACH 22B

Page 1 of 1

IDENTIFICATION			PARTICLE SIZE FRACTIONS IN PERCENT						CONSISTENCY LIMITS			IN-PLACE DENSITY				COMPACTION TESTS			
TEST PIT NUMBER	DEPTH - feet	CLASSIFICATION SYMBOL	FINES		SAND #200 (.074mm) to #4 (4.76mm)	GRAVEL #4 (4.76mm) to 3" (76.2mm)	COBBLES 3" (76.2mm) to 5" (127mm)	OVERSIZE Larger than 5" (127mm)	LIQUID LIMIT - %	PLASTICITY INDEX - %	SHRINKAGE LIMIT - %	DRY DENSITY - PCF	FILL WATER CONTENT - %	SPECIFIC GRAVITY PLUS NO. 4	SPECIFIC GRAVITY MINUS NO. 4	MAXIMUM DRY DENSITY - pcf	OPTIMUM WATER CONTENT - %	PENETRATION RESISTANCE psi	D-Value %
			SMALLER THAN 0.005 mm	0.005 to 0.074 mm															
TPR22B-14-131	6.0	SM	11.0	6.2	82.8	0	0	0	NA	NP	-	100.7	3.0	-	2.67	110.3	13.4	-	91.3
TPR22B-14-132	6.0	SM	8.0	11.2	80.8	0	0	0	NA	NP	-	96.2	3.0	-	2.64	113.8	11.8	600	84.5
TPR22B-14-134	6.0	SC	26.7	12.3	61.0	0	0	0	25.0	9.7	-	108.1	6.5	-	2.66	115.7	12.8	520	93.4
TPR22B-14-135	6.0	SM	17.4	21.7	60.8	0.1	0	0	NA	NP	-	93.0	4.1	2.55	2.63	118.5	11.5	-	78.5
TPR22B-14-136	6.0	SM	8.0	6.5	85.5	0	0	0	NA	NP	-	97.7	2.4	-	2.64	107.1	13.1	433	91.2
TPR22B-14-138	6.0	SP-SM	6.5	2.6	90.9	0	0	0	NA	NP	-	100.7	2.4	-	2.65	107.2	12.0	-	93.9

NOTE: Numbers in parentheses are metric equivalents of numbers directly above.

*Denotes In-place density and 5-point curve.

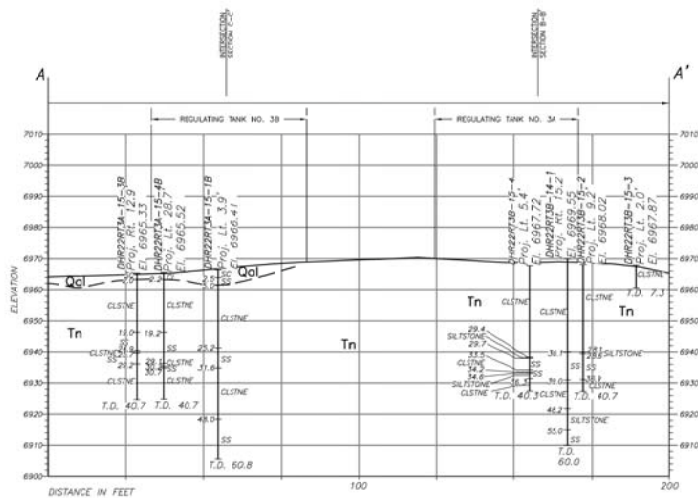


For Sections B-B' and C-C' see drawing number 1695-529-948.

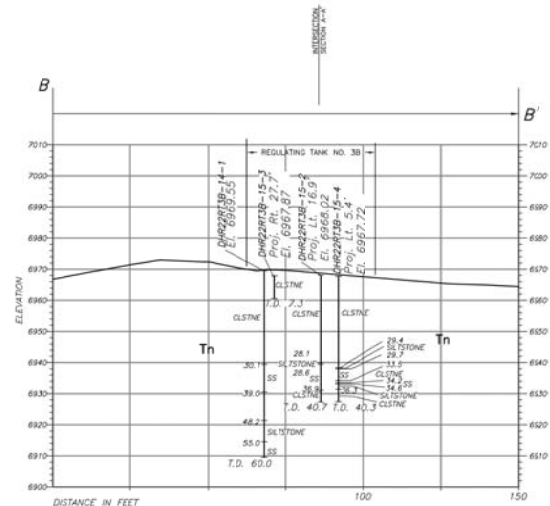
Sheet 1 of 1

DATE AND TIME PLOTTED
PLOTTER'S NAME
PLOTTER'S PHONE

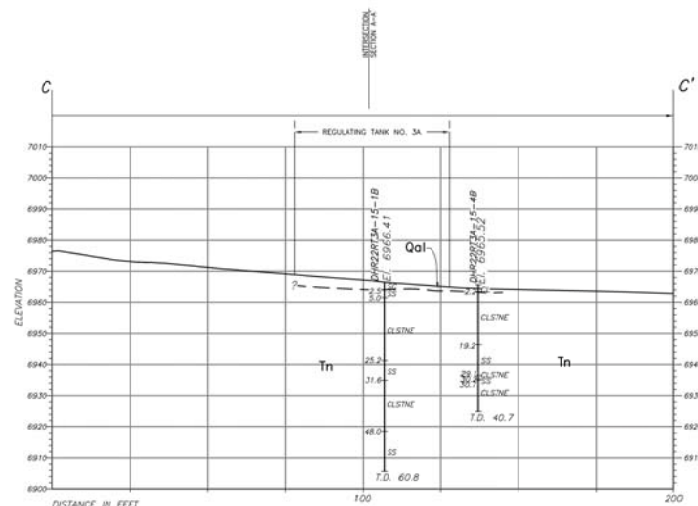
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CAD PLOTTER
CAD PLOTTER



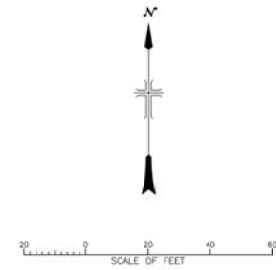
GEOLOGIC SECTION A-A'



GEOLOGIC SECTION B-B'



GEOLOGIC SECTION C-C'



NOTES

Coordinates are in NAD83 state plane, New Mexico West Zone
For General Geologic Legend Explanation and Notes Drawing see 1695-529-942.
For location of Section A-A', B-B' AND C-C' see drawing number 1695-529-938.

DESIGNED
DRAWN
CHECKED
BY
APPROVED
DATE
2015-04-09

REGULATING TANKS NO. 3A AND 3B

GEOLOGIC SECTIONS
A-A', B-B' AND C-C'

1695-529-946

SHEET 1