Report on Construction and Testing of

Headwaters Monitor Well 14

Kerr County, Texas

Prepared for

Headwaters Groundwater Conservation District

LBG-GUYTON ASSOCIATES

Professional Groundwater and Environmental Engineering Services

A Division of Leggette, Brashears & Graham, Inc.

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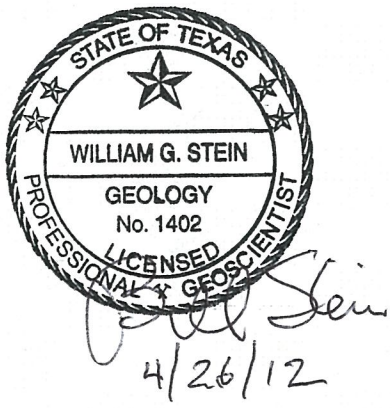
April 2012



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Professional Groundwater and Environmental Services
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Austin, Texas 78746

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INTRODUCTION

At the request of Mr. Gene Williams of the Headwaters Groundwater Conservation District (District), LBG-Guyton Associates evaluated drill cuttings and performed a pumping test on a recently constructed Monitor Well 14 located in eastern Kerr County, Texas about seven miles northeast of the City of Kerrville. The location of the well is shown on a topographic base map in Figure 1. Edwards Limestone can be found at the surface as shown in the surface geology map in Figure 2.

Edmonds Drilling of Kerrville, Texas under contract to the District constructed the new monitor well at a total depth of 740 feet as part of the District on-going program to monitor the groundwater resources in the county. The Driller's Report by Edmonds Drilling for this well is in Appendix 1. The monitor well is constructed principally into Hensell Sand of the middle Trinity Aquifer. Figure 3 shows the geologic descriptions of the sediments encountered during drilling along with the well schematic and geophysical log from the well. Coordinates of the Monitor Well 14 were measured with a Garmin 11 global positioning system (GPS) and land surface elevation is estimated from Google Earth, which are as follows:

Latitude	Longitude	Surface Elevation
30° 06' 52"	99° 02' 7.8"	2010

DRILLING AND CONSTRUCTION OF MONITOR WELL 14

Edmonds Drilling began drilling the pilot hole on November 18, 2011 using air-rotary drilling method assisted by foam injection. The shallow portion of the borehole was drilled to 12-1/4-inch diameter bit and 8-5/8-inch diameter steel casing was set to a depth of 543 feet. A roller-drilling bit of 7-7/8-inches diameter was used for the remaining hole. A total drill depth of 740 feet was reached on November 9, 2011. The lower casing segment was 6-inch diameter steel casing installed from 523 to 740 feet. The bottom portion of this linear was torch slotted. An additional 1-inch tube was installed to a depth of 231 feet to act as a monitoring tube for the overlying Edwards aquifer. The final well construction is shown in Figure 3.

Circulated drill cuttings were collected and described at intervals of approximately 10-feet or at significant drilling changes. The lithologic descriptions are summarized in Figure 3 with depths from land surface.

Geo Cam, Inc., of San Antonio, Texas initially performed geophysical logging in the pilot hole on November 15, 2011. A clay interval had swelled and the geophysical tool was not able to make it to total well depth and only got to a depth of about 680 feet. As a result, a second logging was performed on November 22, 2011 that went to 750 feet. Gamma, multiple-point resistivity and self potential (Figure 3) were log suites performed. These logs can be used to infer water quantity and quality, and to better determine depths of geologic contacts. The log shown in Figure 3 is a combined log from both runs.

PUMPING TESTS

General Information on Pumping Tests

When a well is pumped and water is withdrawn from an aquifer, water levels in the vicinity are drawn down to form an inverted cone with its apex located at the pumping well. This is referred to as a cone of depression. Groundwater flows from higher water levels to lower water levels and, therefore, in the case of a pumping well, toward the well or the center of the cone of depression. The shape and size of the cone is directly related to the aquifer parameters. When more than one well is pumped, each well superimposes its cone of water-level depression on the cones created by the pumping of neighboring wells. When the cone of one well overlaps the cone of another, interference occurs and the lowering of water levels is additive because both wells are competing for the same water in the aquifer. The amount of additional water-level decline depends on the rate of pumping from each well, the spacing between wells and the hydraulic characteristics of the aquifer.

Various hydrologic parameters are required to make a quantitative evaluation of an aquifer. The primary aquifer characteristics of concern are transmissivity (T), which is an index of the aquifer's ability to transmit water measured in gallons per day per foot (gpd/ft), and its storage coefficient (unitless), which is an index of the amount of water released from or taken into storage as water levels change. Hydraulic conductivity can be calculated by dividing the calculated T by the aquifer thickness; the unit of measurement

is gallons per day per foot squared (gpd/ft^2). Important measurements made during a pumping test are well discharge and water-level decline versus time.

One of the basic assumptions in determining these parameters from pumping-test data is that flow takes place through a homogeneous medium having the same properties in all directions. In properly applying the results, however, one must be mindful of their limitations and take into consideration the physical characteristics of the aquifer, which are usually not the same in all directions.

Monitor Well 14 Pumping Test

For the purpose of performing the pumping-test, Kerr County Pump installed a 25-horsepower submersible-pump at a depth of 651 feet in the well. A portable generator supplied the power for the pump. A picture of the well during testing is shown on the photograph on the cover of the report. A totalizing water meter was installed in the discharge line to monitor flow rate and total number of gallons discharged during testing. Static water level was at a depth of about 436 feet below land surface on March 28, 2012.

An In-Situ transducer, model 500 Level TROLL, was utilized during testing for water-level measurements. The transducer is rated for 100 pounds per square inch (psi) (2.31 feet/psi x 100 psi = 231 feet). The transducer was placed in a 1-inch diameter PVC pipe installed in the well. The unit was programmed to record water pressure every 2 minutes. The pressure data are converted to feet of water above the probe and then depth of water from the surface by comparing to sounding measurements made with a calibrated electrical tape.

The constant-rate pumping test of the Monitor Well 14 began March 28, 2012 and continued for just over 24-hours. The pump was then turned off and the well was allowed to recover with measurement being made for over 22-hours. The hydrograph for the pumping and recovery of the testing of this well is shown in Figure 4.

Data from pumping and recovery were analyzed using the Cooper-Jacob method. This method is described in detail in a number of hydrology textbooks, including Freeze and Cherry (1979) and Driscoll (1986). The graphed results and calculations from the pumping and recovery are provided in Figure 5. The following table lists the pumping rate, drawdown and specific capacity, and summarizes the results of transmissivity in gallons per day per foot (gpd/ft) calculated from the pumping tests.

Average Pumping Rate (gpm)	Total Drawdown (feet)	Specific Capacity (gpm/ft)	Calculated Transmissivity (gpd/ft)
89	25	3.6	2,060

WATER-QUALITY ANALYSES

All groundwater contains minerals that are dissolved and transported in solution. The types and concentrations of the minerals depend upon the history of the water, its source, movement and environment. Specifically, the dissolved solids depend upon the solubility of the minerals present in the rocks through which the water moves, the length of time the water is in contact with the rocks and the chemical activity of the water. In general, the concentration of dissolved minerals in groundwater increases with depth. This is especially true where circulation in the deeper sediments is restricted by low permeability. Restricted circulation retards the flushing action of water moving through the aquifer and causes the water to become more stagnant and highly mineralized.

For public supply and human consumption, the concentrations of certain constituents should not exceed the maximum levels of the Primary and Secondary Safe Drinking Water Standards mandated by the U. S. Environmental Protection Agency and the Texas Commission on Environmental Quality (TCEQ). The recommendations for maximum concentrations of some common inorganic constituents in milligrams per liter (mg/l) are as follows:

Safe Drinking Water Standards

Primary Standards	
Constituent	**mg/l**
Arsenic	0.05
Nitrate (as N)	10
Secondary Standards	
Constituent	**mg/l**
Chloride	300
Iron	0.3
Sulfate	300
Total Dissolved Solids	1,000
Fluoride	2.0

Primary Standards are concerned with dissolved constituents that are known to have adverse effects on human health. Secondary Standards are concerned with aesthetic qualities of drinking water (e.g., taste and odor). Often, water is consumed with concentrations higher than the Secondary Standards, especially when this is the only water available. Generally, water that contains more than 2,000 mg/l dissolved solids is not used for human consumption. Treatment, such as reverse osmosis, can be used to lower concentrations and remove many undesired constituents.

LBG-Guyton Associates collected a water sample from the well at 1:40 pm after extensive purging during the pumping test on March 29, 2012. The following field parameters were measured near the time of sample retrieval:

Specific Conductivity	740 µmhos
Temperature	76 ^{o}F
pH	7.26

Samples were placed in an appropriate container and left on ice until it was delivered to the lab. The samples retrieved from the well near the end of the pumping test on were analyzed for metals (calcium, magnesium, sodium, potassium, and iron), minor metals (aluminum, arsenic, copper, manganese and zinc), anions (chloride, sulfate and bicarbonate alkalinity as $CaCO_3$, nitrate, nitrite and fluoride), and total dissolved solids (TDS). LCRA Environmental Laboratory of Austin, Texas performed the inorganic analyses. LCRA subcontracted to Summit Environmental Technologies

Analytical Laboratories of Cuyahoga Falls, Ohio to analyze the radioactive chemistry consisting of gross alpha and beta, radium and uranium. The results of the chemical analyses for the sampled water are provided in Appendix 3. The full QA/QC documentation from each laboratory was in their full report, which was previously provided to the District.

Measurements for TDS, sulfate, fluoride and iron are shown in the following table along with state secondary standards:

Constituent	Water Analyses from MW 14	TCEQ Secondary Standard
Total Dissolved Solids (mg/l)	413	1,000
Sulfate (mg/l)	47.5	300
Fluoride (mg/l)	0.7	2.0
Iron (mg/l)	0.7	0.3

The analyses indicate that iron exceeds state secondary standards for public drinking water.

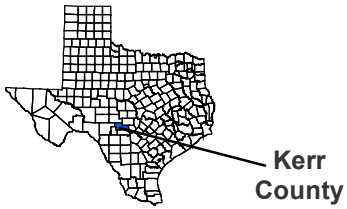
The following table summarizes the radioactive chemistry with primary standards listed:

Radioactive Primary Standards		
Constituent	**Water Analyses from MW 14**	**MCL**
Gross Alpha (pCi/l)	6.25	15
Radium-226/228 (pCi/l)	7.6	5
Gross Beta (pCi/l)	9.34	50
Uranium (ug/l)	6.3	30

The results on radioactive chemistry indicate that Radium 226/228 exceeds drinking water standards.

Figures

BASEMAP TAKEN FROM BEG GEOLOGIC ATLAS OF TEXAS



City
Elevation (ft AMSL)
Headwaters MW-14
Interstate Highway
Major Highway
Local Road

N

0 0.5 1 2 Miles

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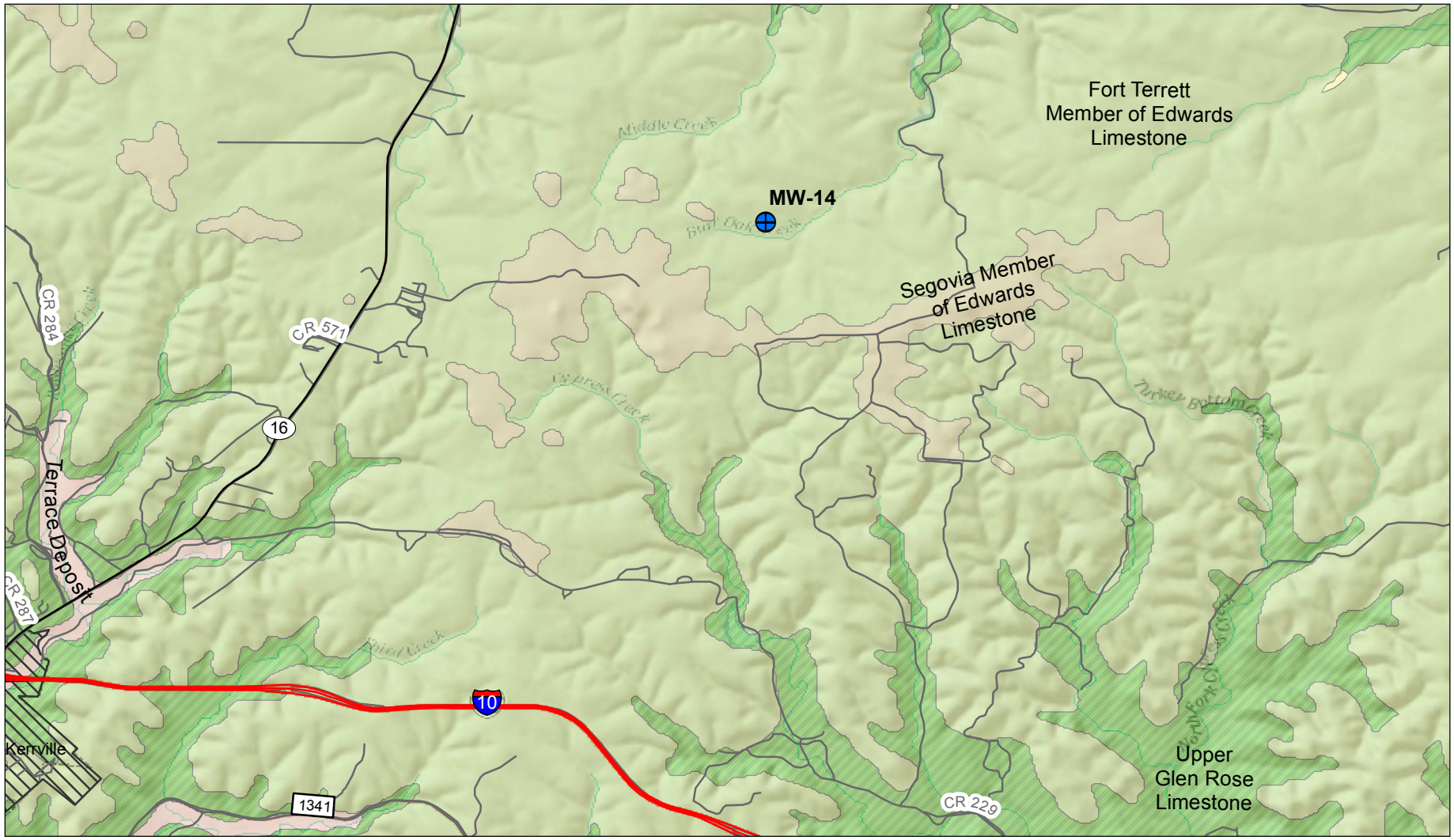
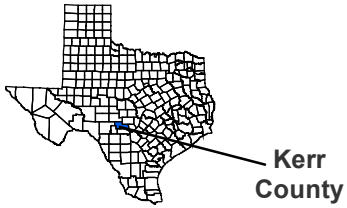
LOCATION MAP AND SURFACE TOPOGRAPHY IN VICINITY OF MONITOR WELL 14

FIGURE 1



BASEMAP TAKEN FROM BEG GEOLOGIC ATLAS OF TEXAS



City

Headwaters MW-14

Interstate Highway

Major Highway

Local Road

N

0 0.5 1 2 Miles

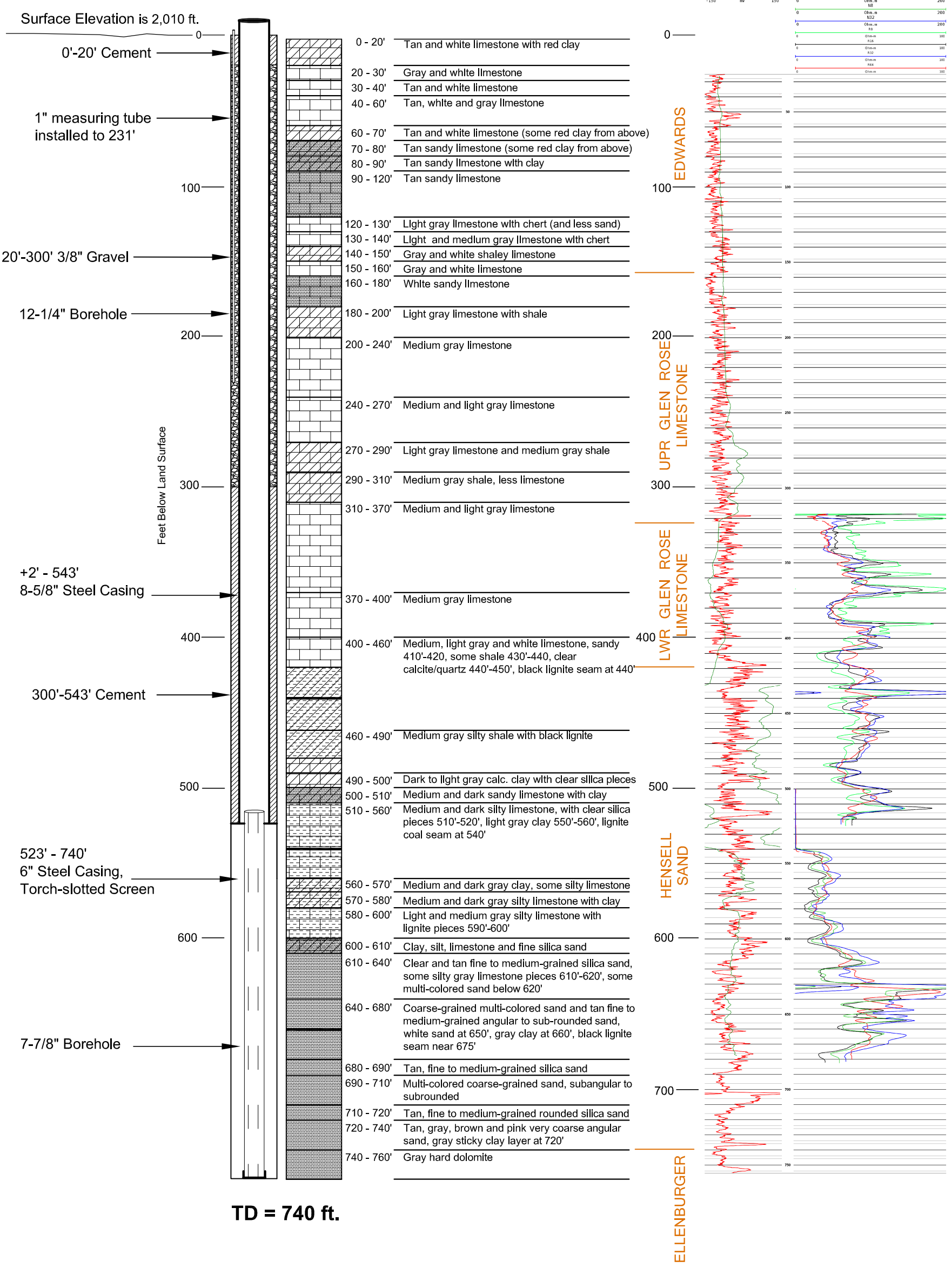
LBG-GUYTON ASSOCIATES

SURFACE GEOLOGY IN VICINITY OF MONITOR WELL 14

FIGURE 2

Headwaters Monitor Well 14

Field Descriptions
by LBG-Guyton Associates

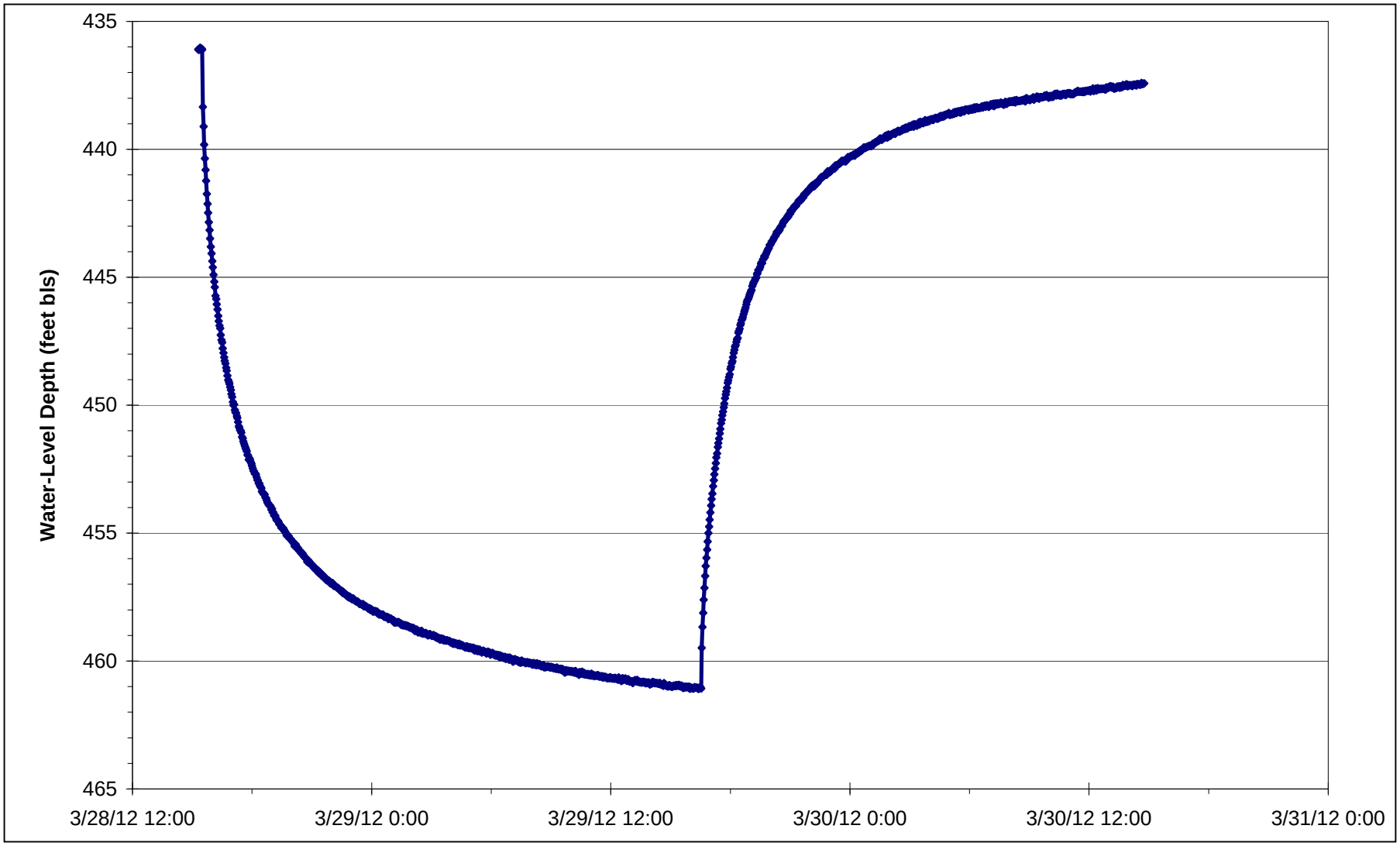


TD = 740 ft.

WELL COMPLETION, LITHOLOGY AND GEOPHYSICAL LOG FOR HEADWATERS MONITOR WELL 14

FIGURE 3

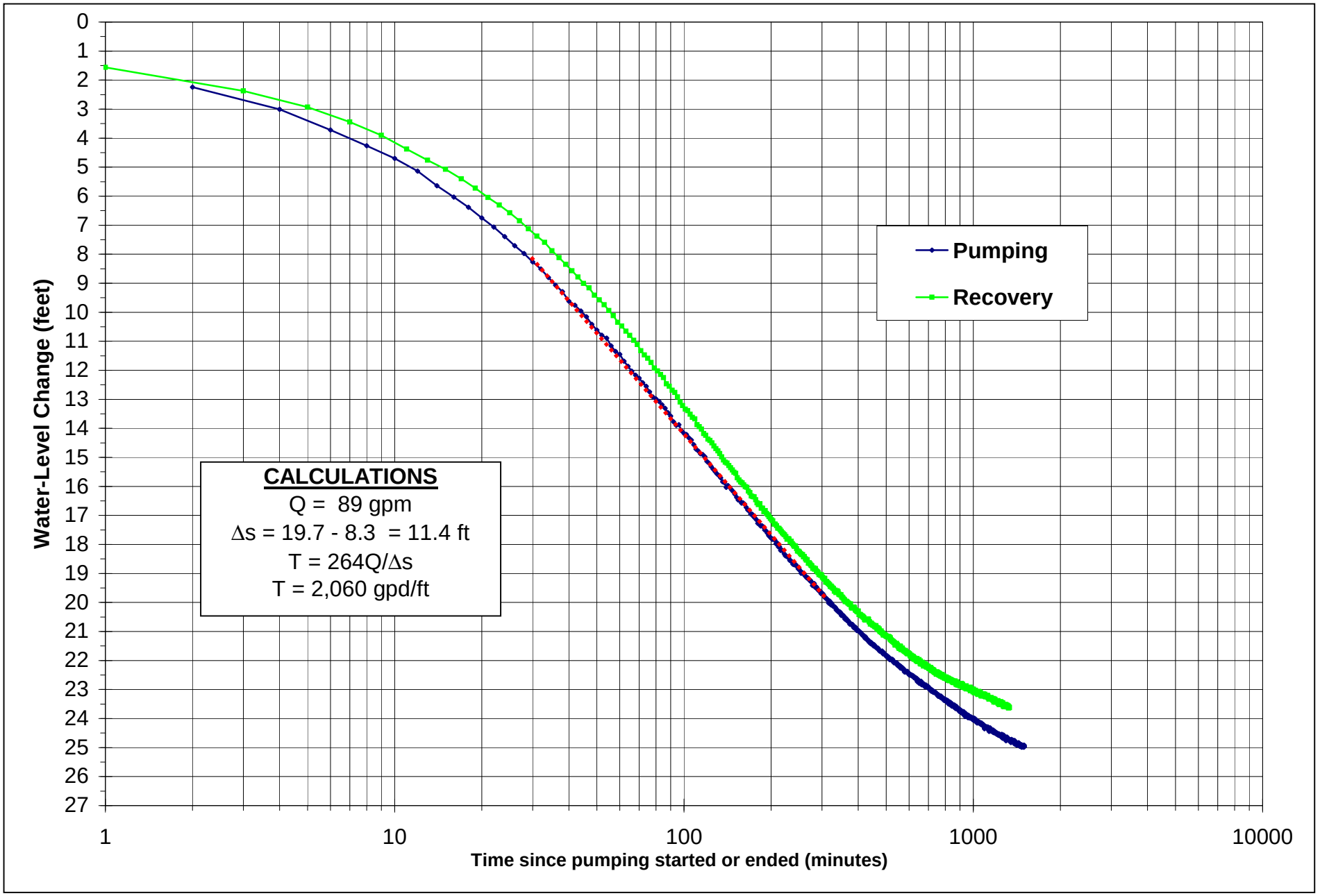
LBG-GUYTON ASSOCIATES



HYDROGRAPH FOR PUMPING TEST OF HEADWATERS UWCD MONITOR WELL 14

LBG-GUYTON ASSOCIATES

FIGURE 4



SEMILOG PLOT AND CALCULATIONS OF PUMPING TEST FOR HEADWATERS UWCD MONITOR WELL 14

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FIGURE 5

Appendix 1

Driller's Well Report

Edwards 56-64 302
Trinity 56-64 31

Texas Department of Licensing and Regulation

Water Well Driller/Pump Installer Section
P.O. Box 12157 Austin, Texas 78711 (512)463-7880 FAX (512)463-8616
Toll free (800)803-9202
Email address: water.well@license.state.tx.us Web address: www.license.state.tx.us

Attention Owner: Confidentiality Privilege Notice on reverse side of owner's copy.

This form must be completed and filed with the department and owner within 60 days upon completion of the well.

WELL REPORT

(1) WELL IDENTIFICATION AND LOCATION DATA

1) OWNER

Name:	Address:	City:	State:	Zip:
Stuart D. Properties	146 Kiebel Ln	Fredricksburg	TX	78624

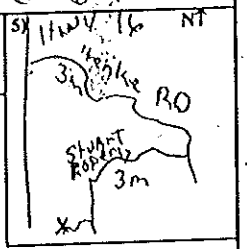
2) WELL LOCATION

Well # or # of wells drilled	County:	Physical Address:	City:
1	Kerr		

Lat. 30-06-52.09 Long. 99-02-07.58 Grid # 56-64-3

3) Type of Work
☒ New Well ☐ Reconditioning ☐ Replacement ☐ Deepening

4) Proposed Use (check) ☒ Monitor ☐ Environmental Soil Boring ☐ Domestic ☐ Extraction ☐ Industrial ☐ Irrigation ☐ Injection ☐ Closed-Loop Geothermal ☐ De-watering ☐ Testwell ☐ Rig Supply ☐ Stock ☐ Public Supply – If Public Supply, were plans approved? ☐ Yes ☐ No



6) Drilling Date
Started 10 / 13 /2011
Completed 11 / 21 /2011

Diameter of Hole

Dia.(in)	From (ft)	To (ft)
12 1/4	Surface	543
7 7/8	543	740

7) Drilling Method (check)
☐ Driven ☒ Air Rotary ☐ Mud Rotary ☐ Bored ☐ Air Hammer ☐ Cable Tool ☐ Jetted ☐ Hollow Stem Auger ☐ Reverse Circulation ☐ Other

From (ft)	To (ft)	Description and color of formation material
0	20	Rocks & Dirt
20	140	Limestone
140	160	Blue Shale
160	185	Limestone
185	420	Blue Shale
420	440	Coal (Black
440	460	Brown Sand
460	540	Tan Sand no H20
540	600	Soft Tan Sand H20
600	700	Tan Coarse Sand
700	740	Tanner Sand increase H20

(Use reverse side of Well Owner's copy, If necessary)

8) Borehole Completion ☐ Open Hole ☐ Straight Wall ☐ Under-reamed ☒ Gravel Packed ☐ Other
Gravel packed interval from: 543 ft. to: 300 ft. Size: 3/4

Casing, Blank Pipe, and Well Screen Data

Dia. (in.)	New Or Used	Steel, Plastic, etc. Perf., Slotted, etc Screen Mfg., if commercial	Setting (ft) From	Setting (ft) To	Gage Casing Screen
6 7/8	New	Steel	0	543	
1"	New	Galv. - 40' torch cut screen	0	231	
6"	New	Steel 180' torch cut screen	523	740	
		Gravel Pack 1"	300	60	3/4

9) Annular Seal Data: i.e. (from 0 ft to 100 ft Rocks & material Licensed)
from 300 ft. to 40 ft. #sacks & material 70 cmt
from 40 ft. to 0 ft. #sacks & material 15 cmt
from ____ ft. to ____ ft. #sacks & material ____
Method Used Tremie Performed By Edmond
Distance to septic field or other concentrated contamination 1000 ft.
Distance to Property Line 1000 ft
Method Verified: Tremie

10) Surface Completion (If steel cased, leave blank)
☒ Surface Slab Installed ☐ Surface Sleeve Installed ☐ Pitless Adapter Used ☐ Alternative Procedure Used

11) Water Level
Static level 430 ft. Date: 11 / 21 /2011
Artesian Flow ____ gpm Edwards W/L 75'

12) Packers:

Type	Depth	Type	Depth

13) Plugged ☐ Well plugged within 48 hours
Casing left in well: Cement/Bentonite placed in well:

From (ft)	To (ft)	From (ft)	To (ft)	# Sacks & Material Used

14) Type Pump
☐ Turbine ☐ Jet ☒ Submersible ☐ Cylinder ☐ Other
Depth to pump bowls, cylinder, jet etc., ____ ft.

15) Water Test
Type test ☐ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: ____ gpm with ____ ft. drawdown after ____ hrs.

16) Water Quality
Type of water ____ Depth of Strata: ____ Was a chemical analysis made? ☐ Yes ☐ No
Did you knowingly penetrate a strata which contains undesirable constituents? ☐ Yes ☒ No If yes, Continue:
Check One: ☐ Naturally poor-quality groundwater – type ____ ☐ Hydrocarbons (i.e. gas, oil, etc.) ☐ Hazardous material/waste contamination encountered ☐ Other (describe) ____

DEC 27 2011 RECEIVED

I certify that while drilling, deepening, or otherwise altering the above described well, undesirable water or constituents was encountered and the landowner was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.

By signing this well report, I certify that I drilled or supervised the drilling of this well and that each and all of the statements herein are true and correct.

Company & Individual's Name: (type or print) Edmonds Drilling Co Lic. No.: 58357W
Address: 13552 P.O Box City: Kerrville State: TX Zip 78029
Signature: [signature] 11 / 21 /2011 Signature:
Licensed Driller/Pump Installer Date Apprentice Apprentice Reg Number#

TDLR FORM 001WWD / 7-08 TDLR (Original) Landowner (copy) Driller/Pump Installer (copy)

Appendix 2
Laboratory Reports

LCRA Environmental Laboratory Services

Date: *10-Apr-12*

CLIENT: LBG-Guyton Associates
Project: LBG-Stein New Well
Lab Order: 1203A13

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Tag Number	Date Collected	Date Received
1203A13-001A	Head Waters MW-14		3/29/2012 1:40:00 PM	3/29/2012 4:12:00 PM
1203A13-001B	Head Waters MW-14		3/29/2012 1:40:00 PM	3/29/2012 4:12:00 PM

Final Analysis Report

LCRA Environmental Laboratory Services

Date: *10-Apr-12*

CLIENT:	LBG-Guyton Associates	**Client Sample ID:**	Head Waters MW-14
Lab Order:	1203A13	**Collection Date:**	3/29/2012 1:40:00 PM
Project:	LBG-Stein New Well	**Matrix:**	DRINKING WATER
Lab ID:	1203A13-001	**Tag No:**	

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS IN DRINKING WATER		**E200.7**				Analyst: **MV**
Calcium	56.4	0.200	A	mg/L	1	4/4/2012 2:54:35 PM
Iron	0.729	0.0500	X	mg/L	1	4/4/2012 2:54:35 PM
Magnesium	45.0	0.200		mg/L	1	4/4/2012 2:54:35 PM
Potassium	5.82	0.200		mg/L	1	4/4/2012 2:54:35 PM
Sodium	18.3	0.600		mg/L	1	4/4/2012 2:54:35 PM
ICPMS METALS IN DRINKING WATER		**E200.8**				Analyst: **SW**
Aluminum	0.0193	0.00500		mg/L	1	4/4/2012 2:37:39 PM
Arsenic	< 0.00200	0.00200		mg/L	1	4/4/2012 2:37:39 PM
Copper	< 0.00200	0.00200		mg/L	1	4/4/2012 2:37:39 PM
Manganese	0.0142	0.00100		mg/L	1	4/4/2012 2:37:39 PM
Zinc	0.313	0.00500		mg/L	1	4/4/2012 2:37:39 PM
ANIONS BY ION CHROMATOGRAPHY		**E300.0**				Analyst: **WR**
Chloride	37.5	5.00		mg/L	5	3/30/2012 5:06:00 PM
Fluoride	0.705	0.050		mg/L	5	3/30/2012 5:06:00 PM
Nitrogen, Nitrate (As N)	< 0.050	0.050		mg/L	5	3/30/2012 5:06:00 PM
Nitrogen, Nitrite	< 0.050	0.050		mg/L	5	3/30/2012 5:06:00 PM
Sulfate	47.5	5.00		mg/L	5	3/30/2012 5:06:00 PM
ALKALINITY		**SM2320 B**				Analyst: **KH**
Alkalinity, Bicarbonate (As CaCO3)	277	2	A	mg/L CaCO3	1	4/3/2012
Alkalinity, Total (As CaCO3)	277	2	A	mg/L CaCO3	1	4/3/2012
CATION/ANION BALANCE		**CALCULATION**				Analyst: **AMJ**
Cation/Anion Balance	1.07	5.0	A	%	1	4/9/2012
PH		**SM4500-H+B**				Analyst: **KH**
pH @ 25°C [for information only]	7.6	0	A	pH Units	1	3/30/2012
TOTAL DISSOLVED SOLIDS		**SM2540C**				Analyst: **ZP**
Total Dissolved Solids (Residue, Filterable)	413	25.0		mg/L	10	3/30/2012

Qualifiers:

A Not Available for Accreditation
B Analyte Detected in Method Blank
E Value Above Quantitation Range
H Holding Time Exceeded
N Not Accredited
S Spike Recovery Outside Recovery Limits
X Value Exceeds Maximum Contaminant Level (MCL)

PQL: Practical Quantitation Limit

Values Below PQL Considered Estimated

SUMMIT
ENVIRONMENTAL TECHNOLOGIES, INC.
Analytical Laboratories

LABORATORY REPORT

Client
LCRA Environmental Laboratory Services
P.O. Box 220 78767-0220
Austin, TX 78744

Order Number
1207575

Project Number
N/A

Issued
Thursday, April 12, 2012

Total Number of Pages
4 (excluding C.O.C. and cooler receipt form)

Approved By :

QA Manager

NELAC Accreditation #E87688

SUMMIT
ENVIRONMENTAL TECHNOLOGIES, INC.
Analytical Laboratories

April 12, 2012

Client: LCRA Environmental Laboratory Servi
Address: P.O. Box 220 78767-0220
Austin. TX 78744

Received: 4/4/2012
Project #: N/A

Client ID#	Lab ID#	Collected	Analyte	Result	Units	Matrix	Method	DF	LOQ	Run	Analyst
1203A14-001A	1207575-01	29-Mar-12	Uranium	6.3	ug/L	DW	200.8	1	1	09-Apr-12	TXN
1203A14-001A	1207575-01	29-Mar-12	Gross Alpha	6.25 +/- 3.11	pCi/L	DW	900.0	1	3	11-Apr-12	CM
1203A14-001A	1207575-01	29-Mar-12	Gross Beta	9.34 +/- 1.93	pCi/L	DW	900.0	1	4	11-Apr-12	CM
1203A14-001A	1207575-01	29-Mar-12	Radium-226	2.2 +/- 0.41	pCi/L	DW	903.0	1	1	12-Apr-12	CM
1203A14-001A	1207575-01	29-Mar-12	Radium-228	5.4 +/- 1.07	pCi/L	DW	904.0	1	1	11-Apr-12	CM

"Analytical Integrity" · EPA Certified · NELAP Certified
3310 Win Street · Cuyahoga Falls, Ohio 44223 • Phone: 330-253-8211 · Fax: 330-253-4489
Web Site: www.settek.com