Emery & Garrett
GROUNDWATER INVESTIGATIONS
A Division of GZA

UNDERWOOD engineers

PUBLIC HEARING

Preliminary Application for a Large Groundwater Withdrawal Permit

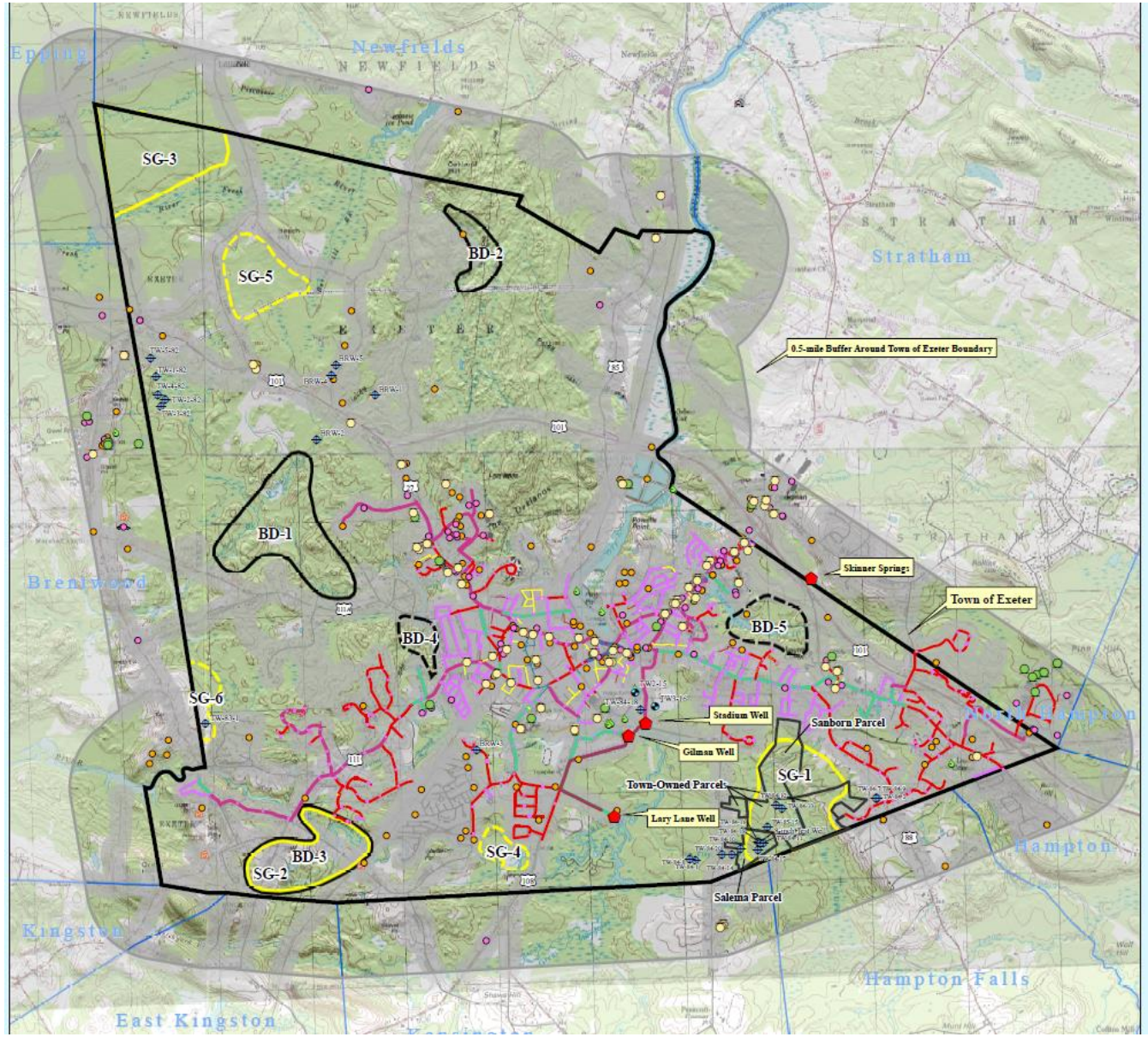
Drinkwater Road Production Well
Exeter, New Hampshire
February 22, 2023

Presented by:
James M. Emery, PG and Thomas Page, PE

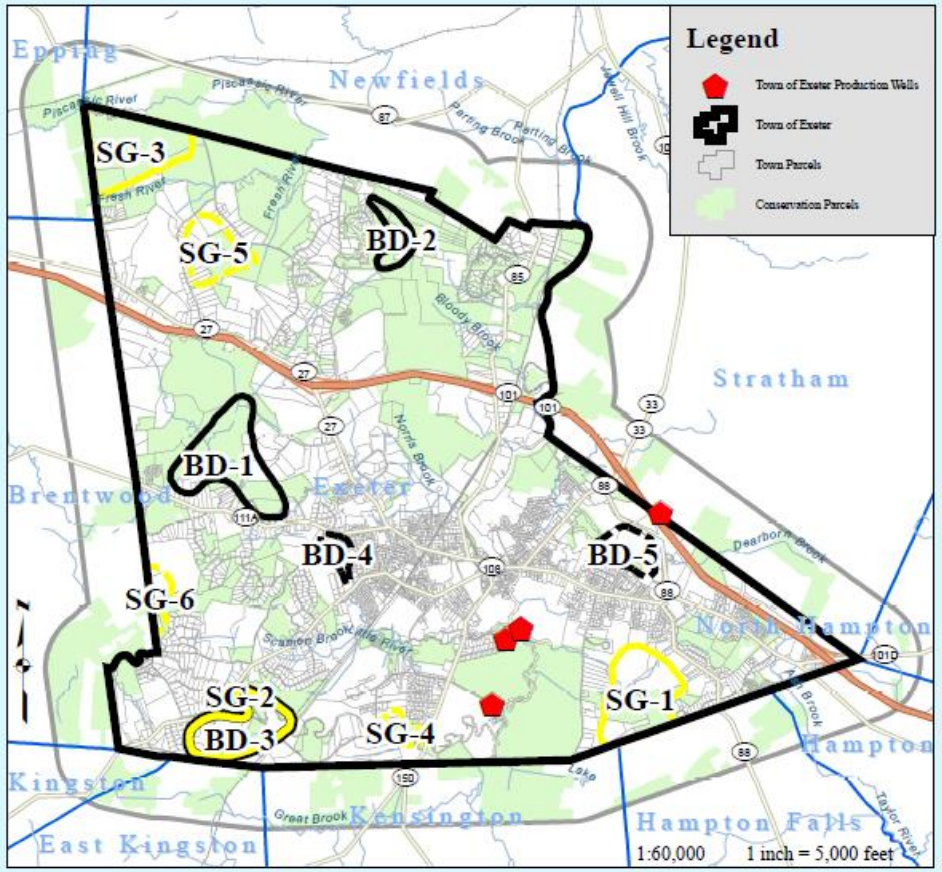
Summary of Presentation

- Why are we developing additional drinking water supplies?
- Where did we conduct our groundwater supply search?
- How did we conduct our investigation?
- Why have we selected the property we have for groundwater development?
- What did we discover/what are the results of the exploratory test well drilling?
  - Yield
  - Water Quality
- What are the Next Steps?

Topographic Setting, Contaminant Threats, and Water Infrastructure

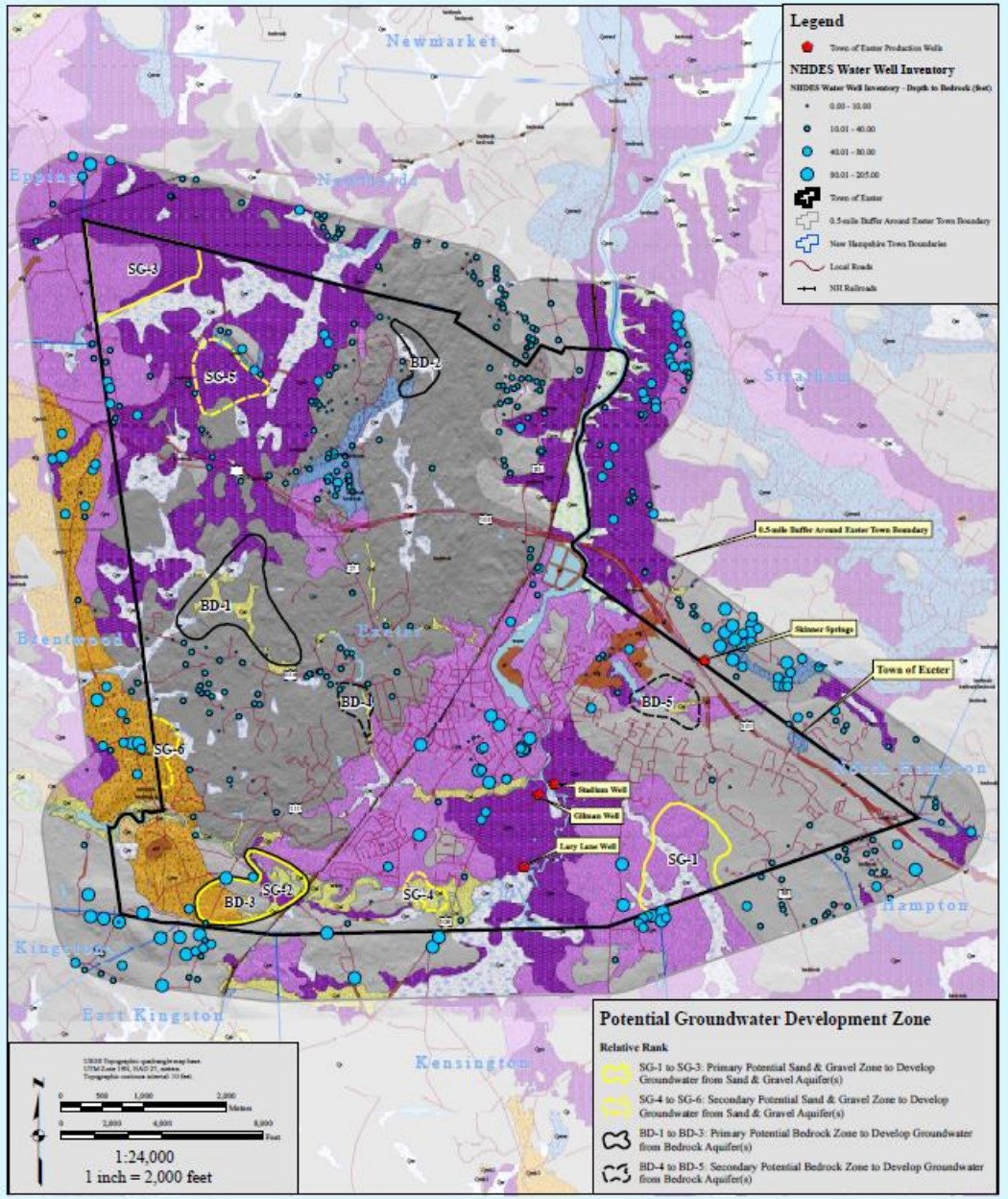


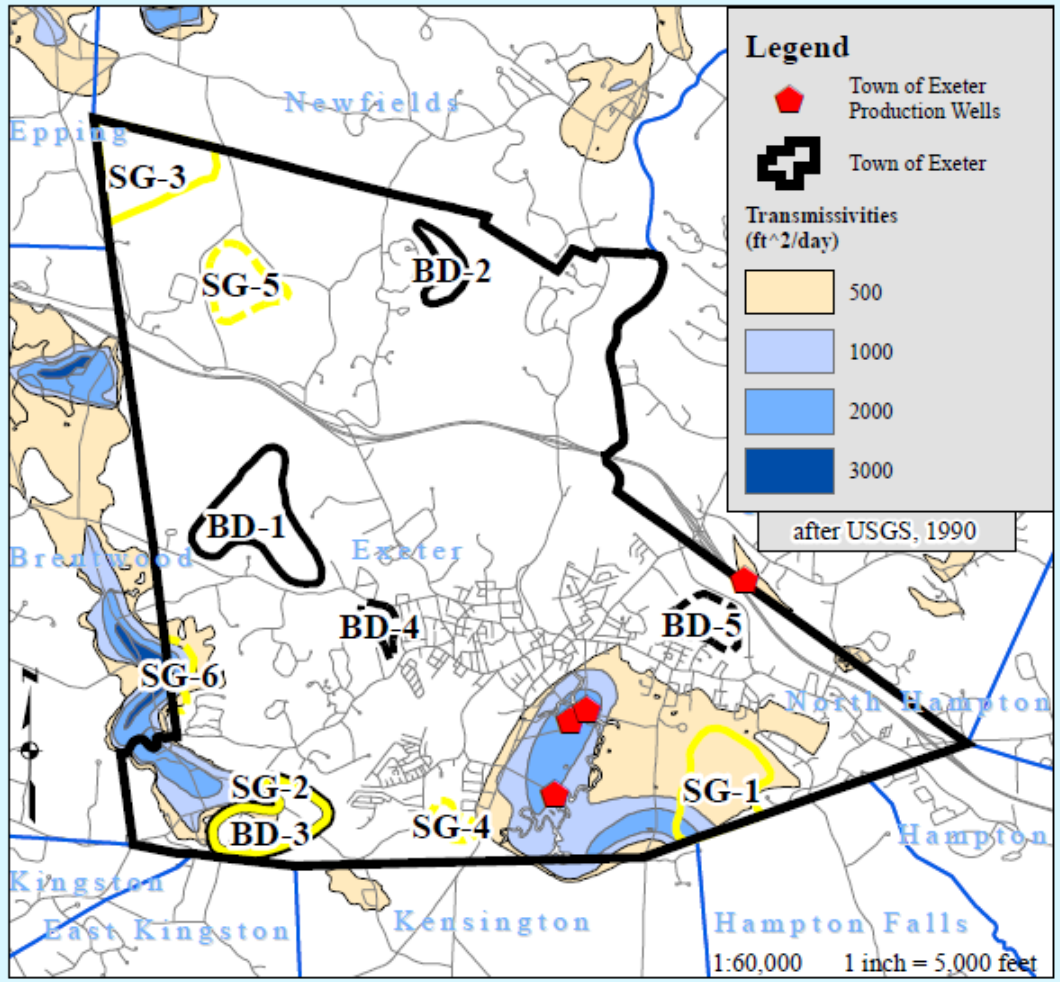
View B



Surficial Geology and Depth to Bedrock

View A





View B

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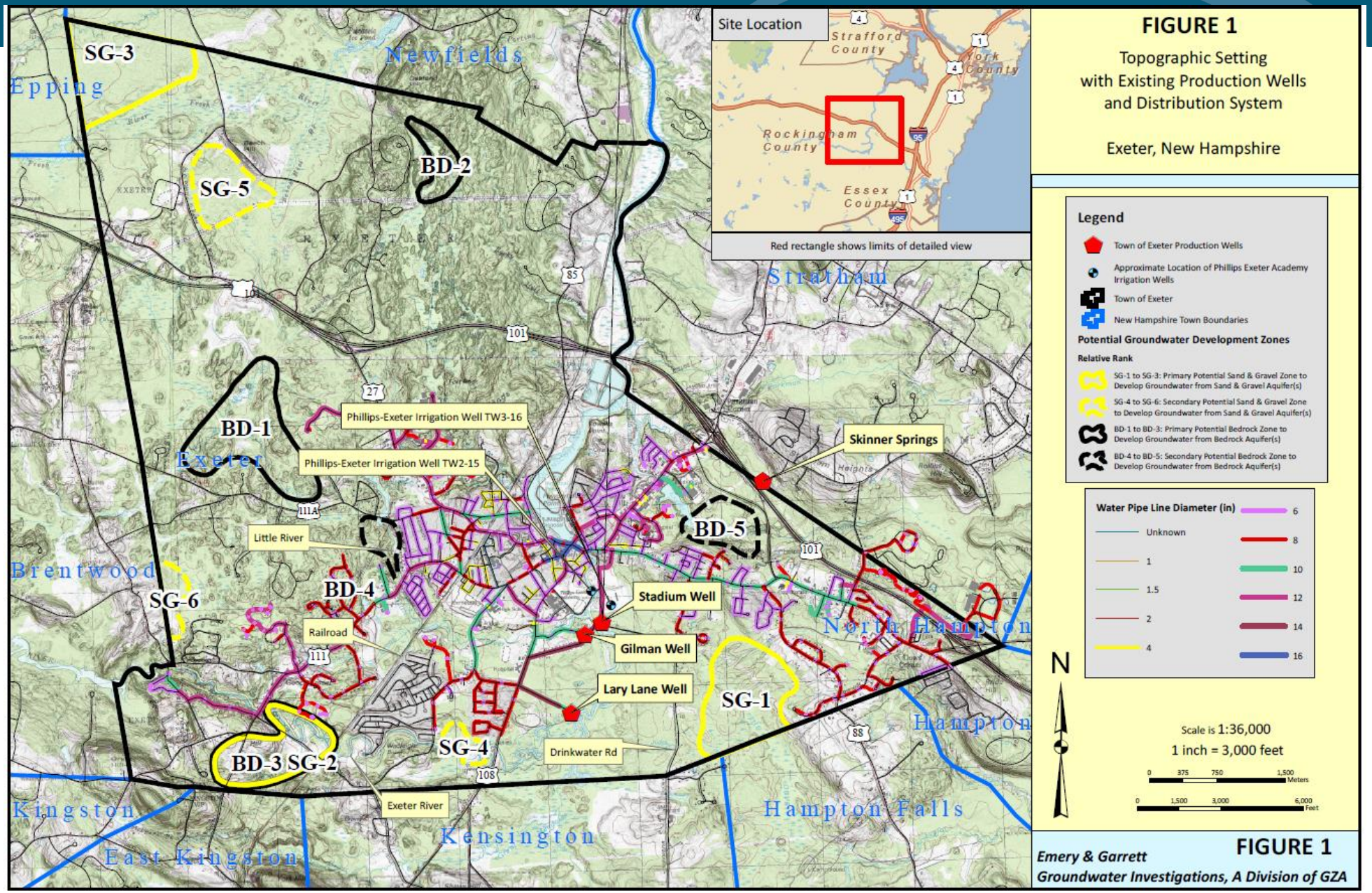
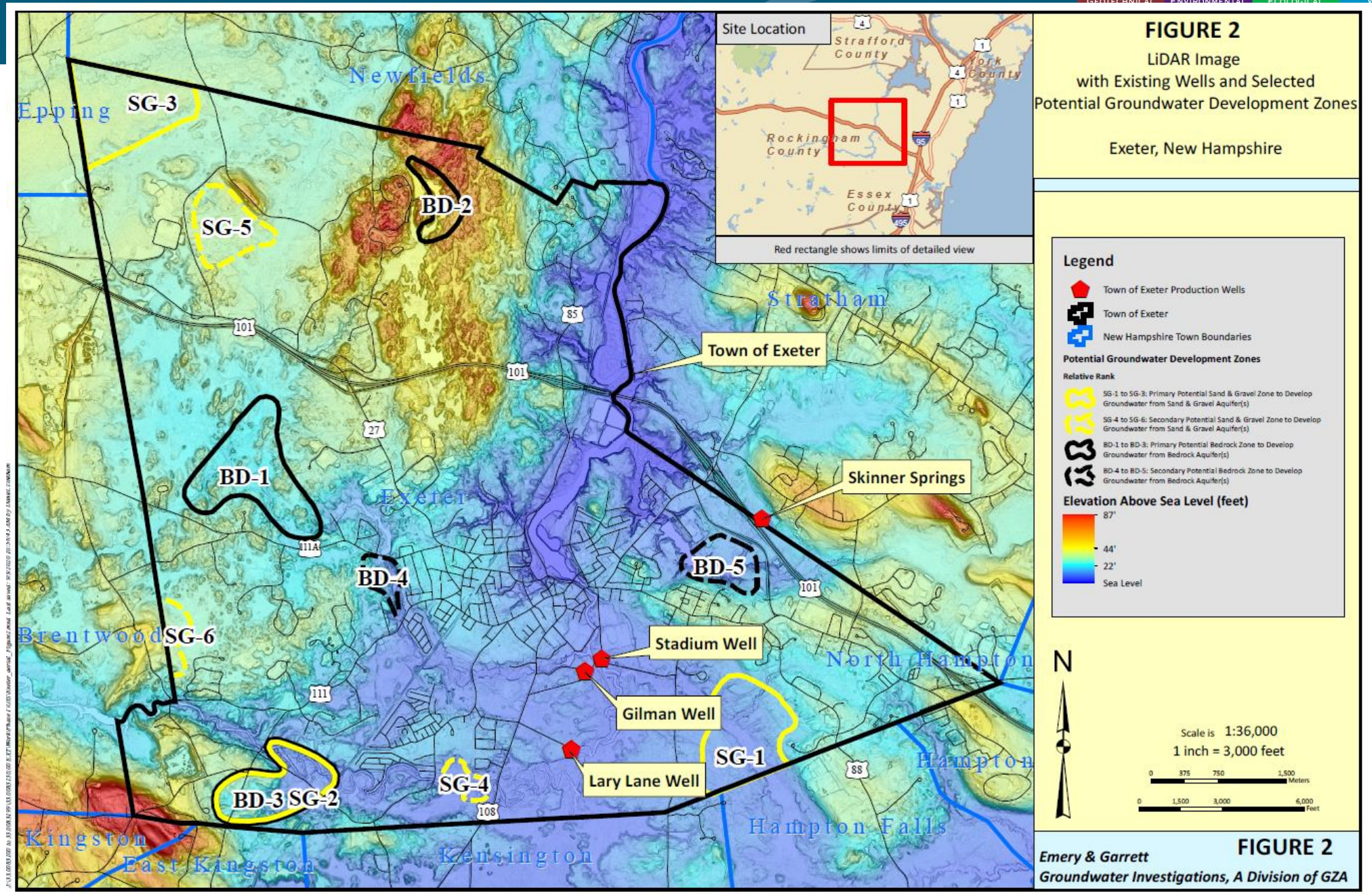


FIGURE 1
Topographic Setting
with Existing Production Wells
and Distribution System
Exeter, New Hampshire
Site Location
Strafford County
York County
Rockingham County
Essex County
Red rectangle shows limits of detailed view
Legend
Town of Exeter Production Wells
Approximate Location of Phillips Exeter Academy Irrigation Wells
Town of Exeter
New Hampshire Town Boundaries
Potential Groundwater Development Zones
Relative Rank
SG-1 to SG-3: Primary Potential Sand & Gravel Zone to Develop Groundwater from Sand & Gravel Aquifer(s)
SG-4 to SG-6: Secondary Potential Sand & Gravel Zone to Develop Groundwater from Sand & Gravel Aquifer(s)
BD-1 to BD-3: Primary Potential Bedrock Zone to Develop Groundwater from Bedrock Aquifer(s)
BD-4 to BD-5: Secondary Potential Bedrock Zone to Develop Groundwater from Bedrock Aquifer(s)
Water Pipe Line Diameter (in)
Unknown
1
1.5
2
4
6
8
10
12
14
16
N
Scale is 1:36,000
1 inch = 3,000 feet
0 375 750 1,500 Meters
0 1,500 3,000 6,000 Feet
SG-3
SG-5
BD-2
BD-1
SG-6
BD-4
BD-3
SG-2
SG-4
SG-1
BD-5
Phillips-Exeter Irrigation Well TW3-16
Phillips-Exeter Irrigation Well TW2-15
Little River
Railroad
Skinner Springs
Stadium Well
Gilman Well
Lary Lane Well
Drinkwater Rd
Exeter River
Newfields
Epping
Exeter
Brentwood
Kingston
East Kingston
Kensington
Hampton Falls
Hampton
North Hampton
Stratham
FIGURE 1
Emery & Garrett
Groundwater Investigations, A Division of GZA


Site Location
Strafford County
York County
Rockingham County
Essex County
Red rectangle shows limits of detailed view
FIGURE 2
LiDAR Image
with Existing Wells and Selected
Potential Groundwater Development Zones
Exeter, New Hampshire
Newfields
Epping
SG-3
SG-5
BD-2
Stratham
Town of Exeter
Skinner Springs
BD-1
Exeter
BD-4
BD-5
Brentwood
SG-6
Stadium Well
North Hampton
Gilman Well
SG-1
Lary Lane Well
SG-4
BD-3 SG-2
Hampton
Hampton Falls
Kingston
East Kingston
Kensington
101
85
27
111A
111
108
88
Legend
Town of Exeter Production Wells
Town of Exeter
New Hampshire Town Boundaries
Potential Groundwater Development Zones
Relative Rank
SG-1 to SG-3: Primary Potential Sand & Gravel Zone to Develop Groundwater from Sand & Gravel Aquifer(s)
SG-4 to SG-6: Secondary Potential Sand & Gravel Zone to Develop Groundwater from Sand & Gravel Aquifer(s)
BD-1 to BD-3: Primary Potential Bedrock Zone to Develop Groundwater from Bedrock Aquifer(s)
BD-4 to BD-5: Secondary Potential Bedrock Zone to Develop Groundwater from Bedrock Aquifer(s)
Elevation Above Sea Level (feet)
87'
44'
22'
Sea Level
N
Scale is 1:36,000
1 inch = 3,000 feet
0 375 750 1,500 Meters
0 1,500 3,000 6,000 Feet
FIGURE 2
Emery & Garrett
Groundwater Investigations, A Division of GZA

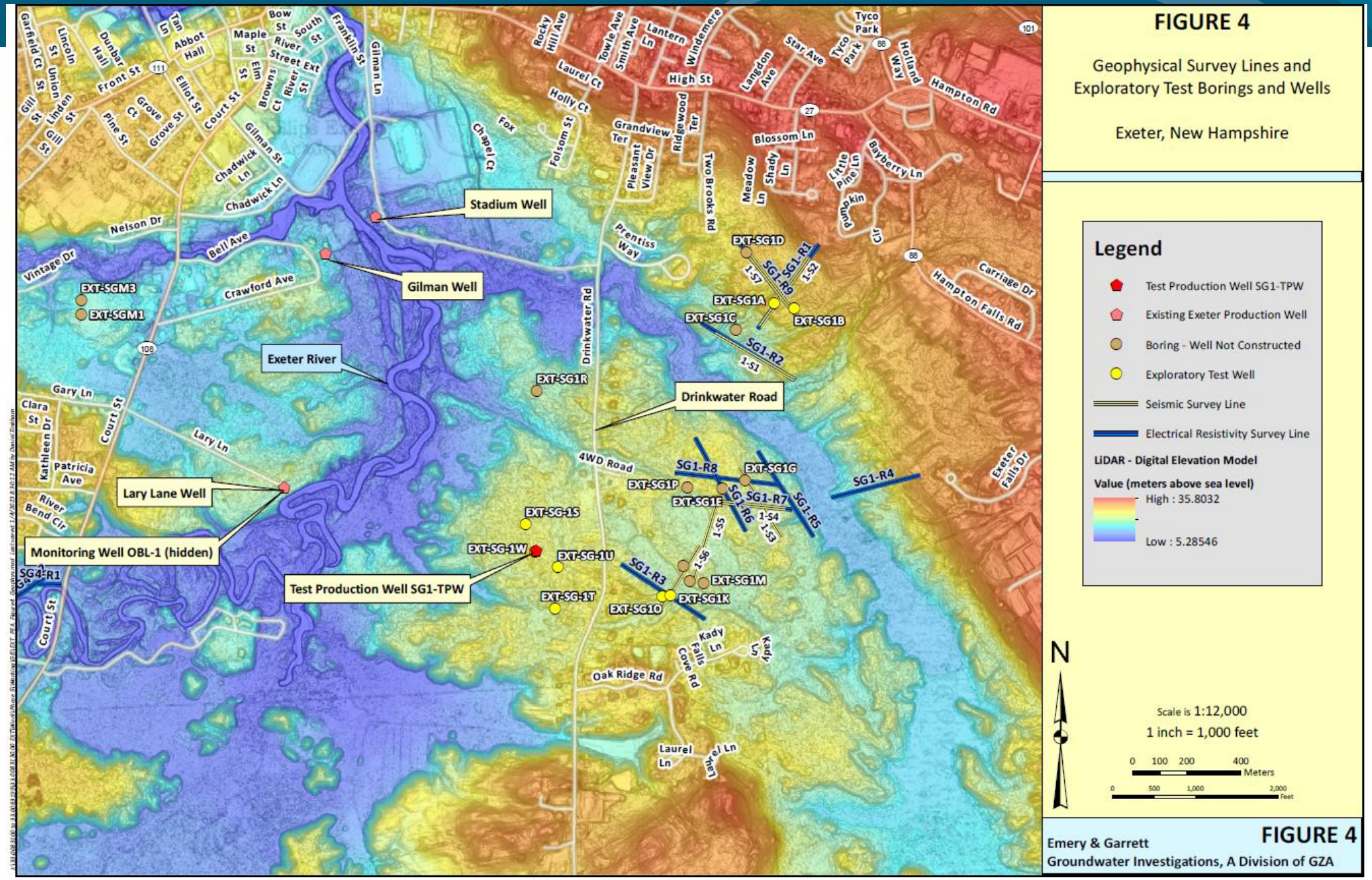


FIGURE 4
Geophysical Survey Lines and Exploratory Test Borings and Wells
Exeter, New Hampshire
Legend
Test Production Well SG1-TPW
Existing Exeter Production Well
Boring - Well Not Constructed
Exploratory Test Well
Seismic Survey Line
Electrical Resistivity Survey Line
LiDAR - Digital Elevation Model
Value (meters above sea level)
High : 35.8032
Low : 5.28546
N
Scale is 1:12,000
1 inch = 1,000 feet
0 100 200 400 Meters
0 500 1,000 2,000 Feet
Stadium Well
Gilman Well
Exeter River
Drinkwater Road
Lary Lane Well
Monitoring Well OBL-1 (hidden)
Test Production Well SG1-TPW
EXT-SGM3
EXT-SGM1
EXT-SG1D
EXT-SG1A
EXT-SG1B
EXT-SG1C
EXT-SG1R
EXT-SG1P
EXT-SG1E
EXT-SG1G
EXT-SG-1S
EXT-SG-1W
EXT-SG-1U
EXT-SG-1T
EXT-SG1M
EXT-SG1K
EXT-SG1O
SG1-R1
SG1-R2
SG1-R3
SG1-R4
SG1-R5
SG1-R6
SG1-R7
SG1-R8
SG1-R9
1-S1
1-S2
1-S3
1-S4
1-S5
1-S6
1-S7
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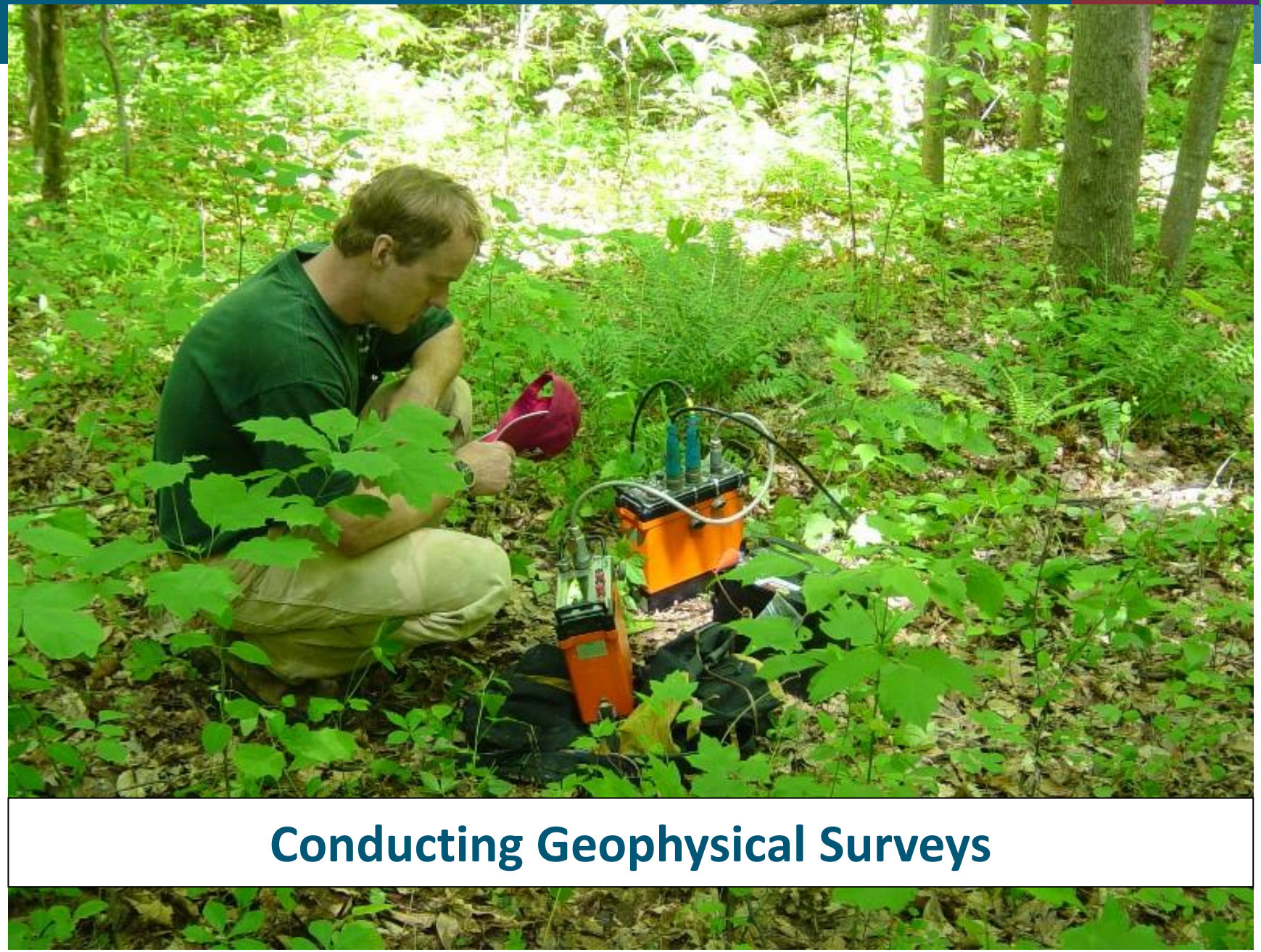
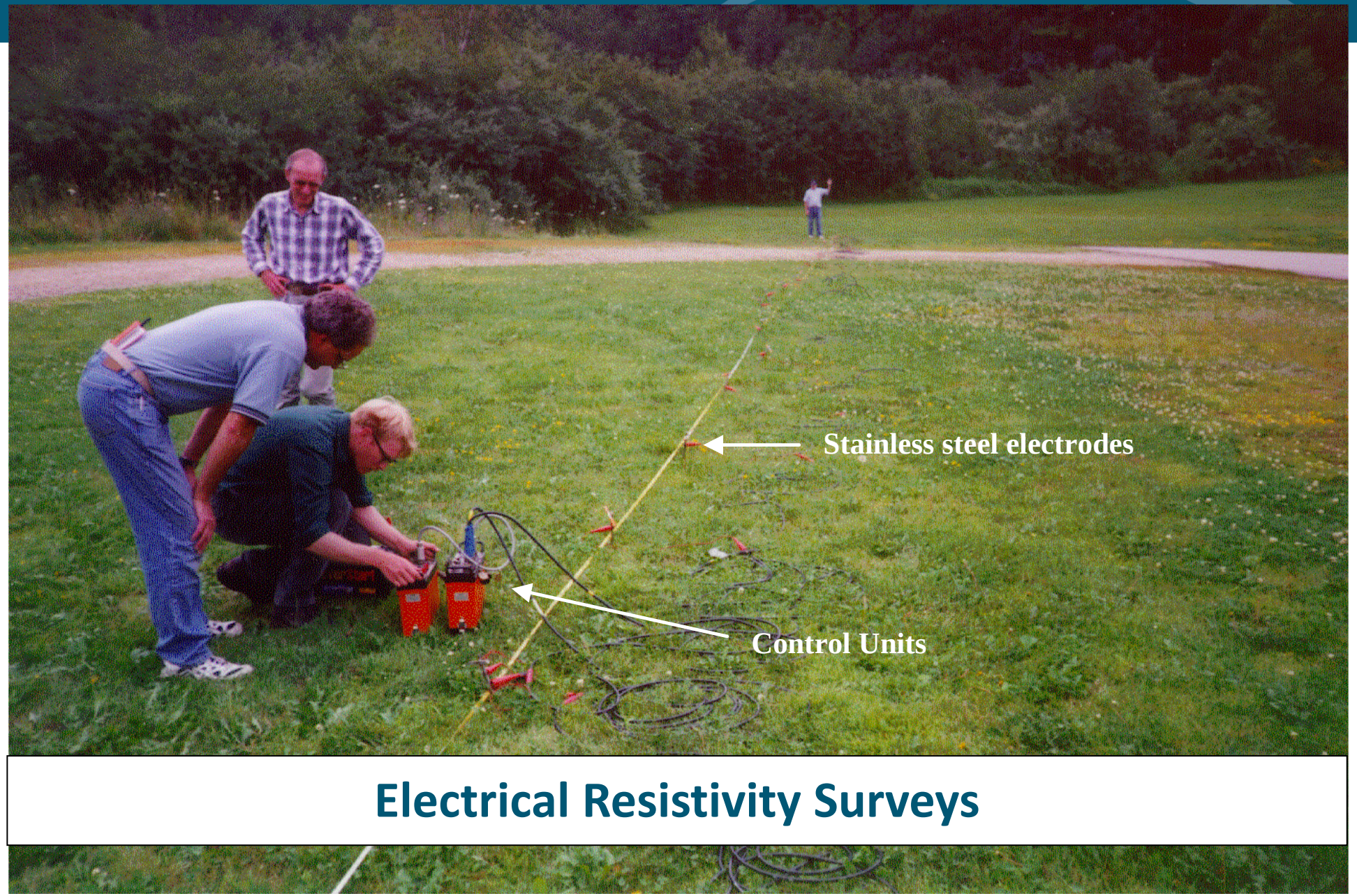
FIGURE 4

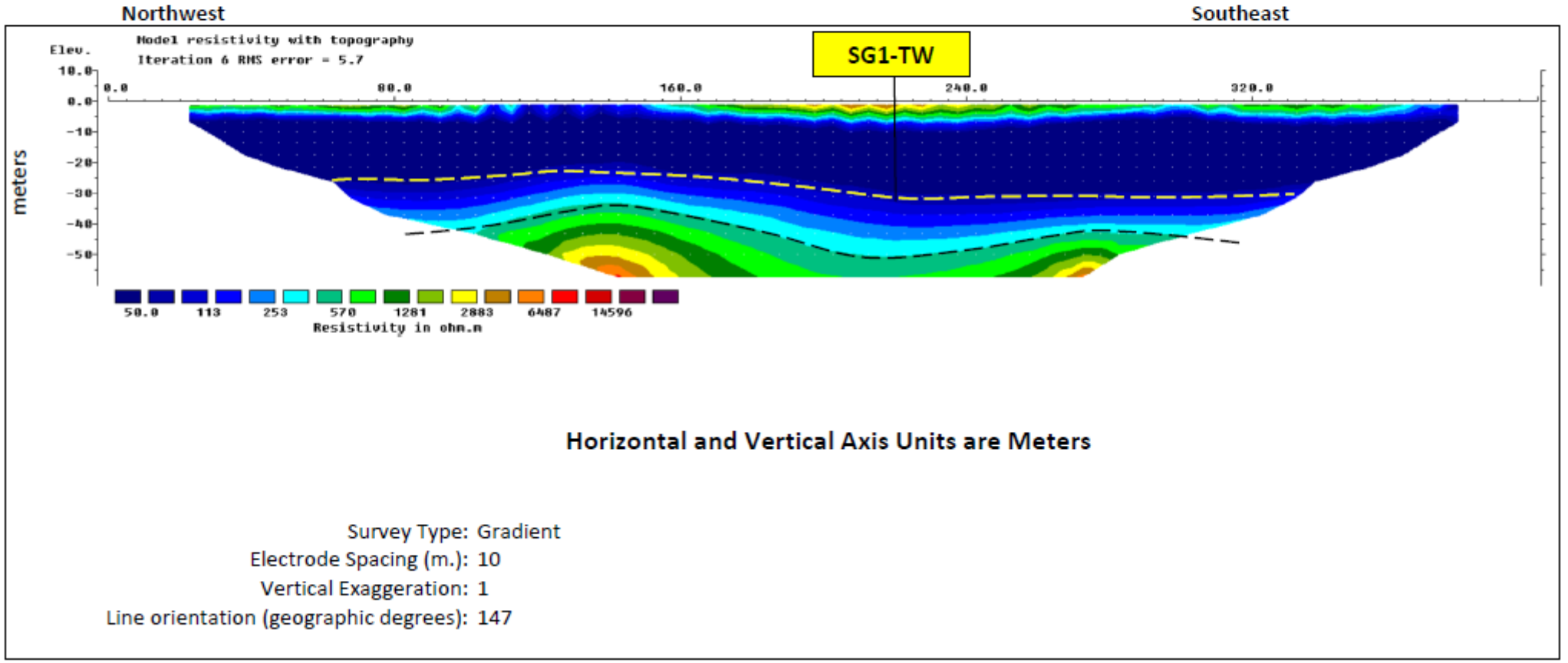


Conducting Geophysical Surveys



Electrical Resistivity Surveys

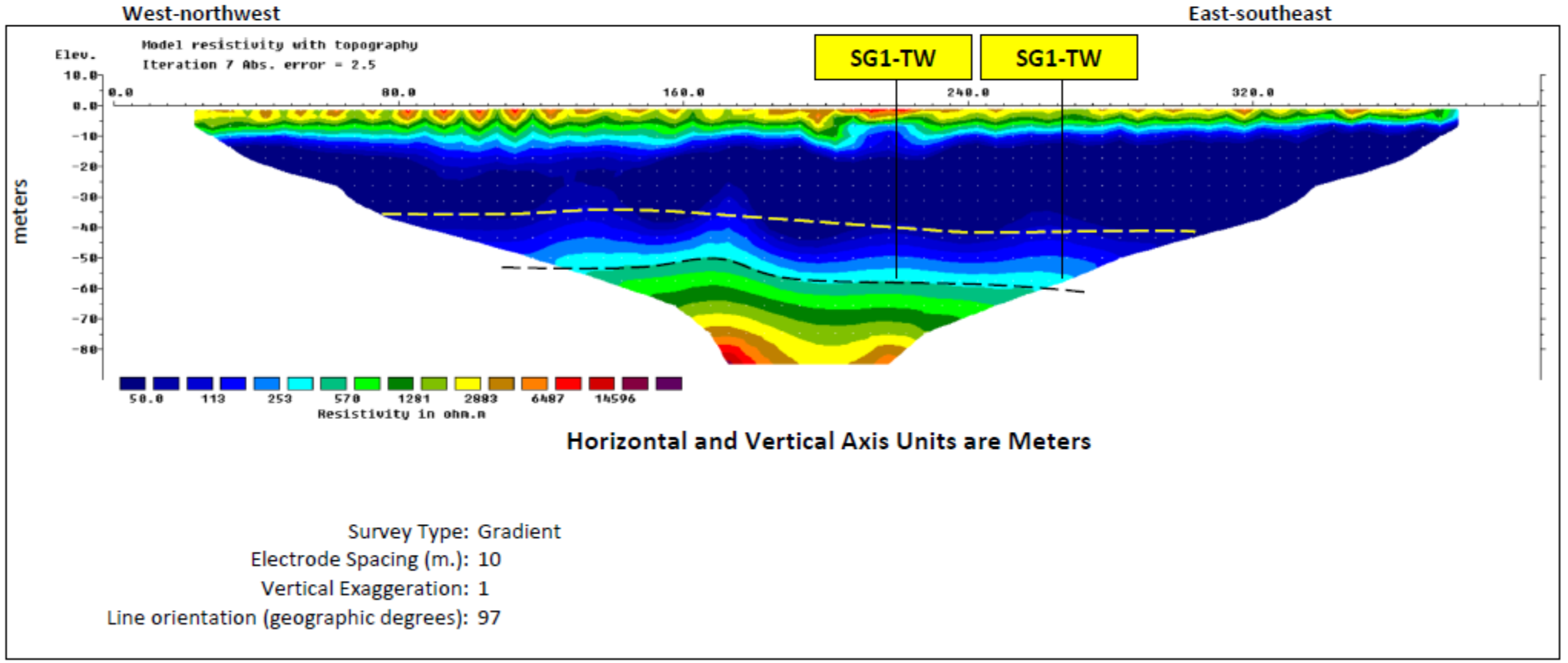
Electrical Resistivity Survey Line R5 - Gradient Method
Potential Groundwater Development Zone - EXT-SG1
Exeter, New Hampshire



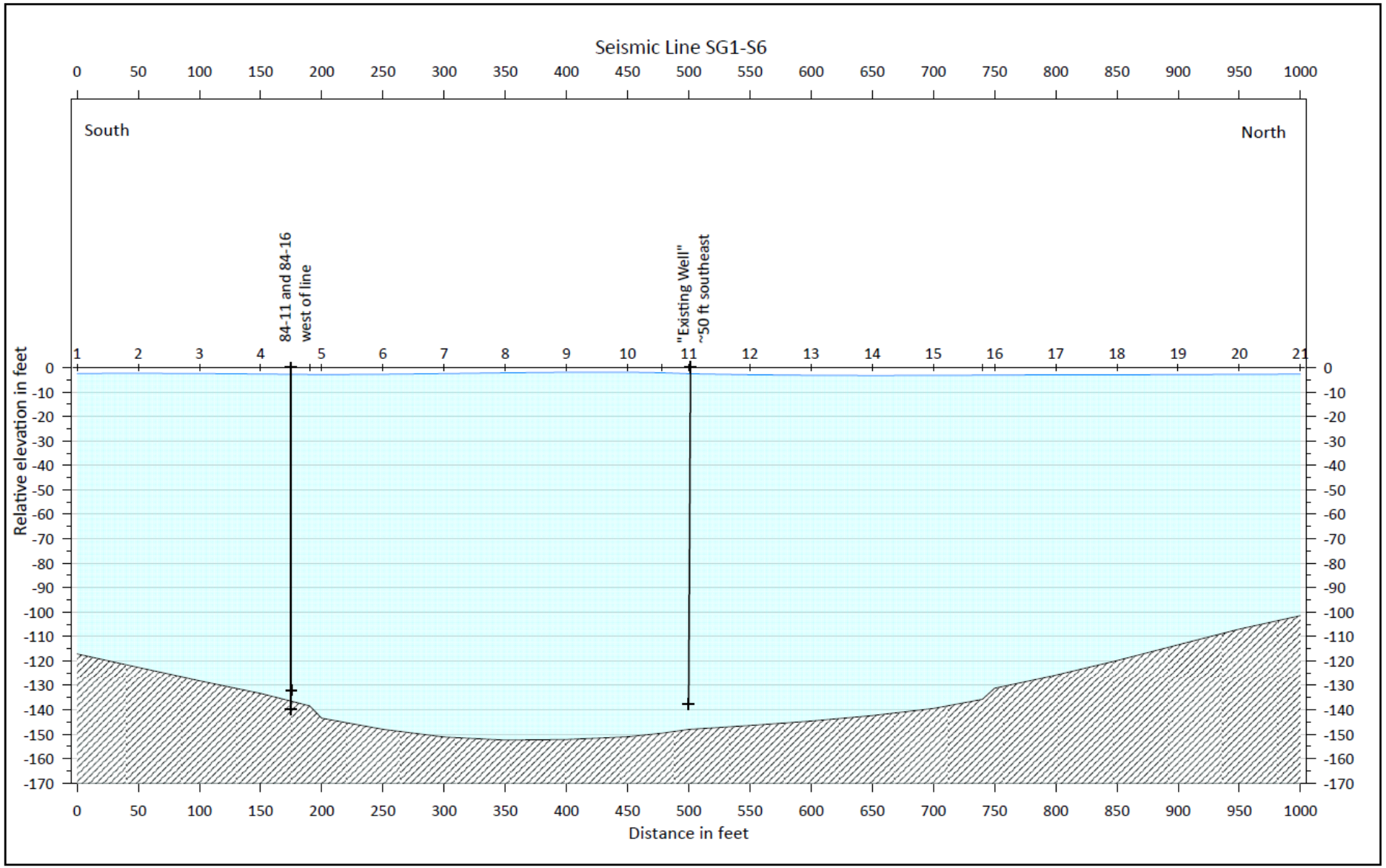
Horizontal and Vertical Axis Units are Meters

Survey Type: Gradient
Electrode Spacing (m.): 10
Vertical Exaggeration: 1
Line orientation (geographic degrees): 147

Electrical Resistivity Survey Line R8 - Gradient Method
Potential Groundwater Development Zone - EXT-SG1
Exeter, New Hampshire



Seismic Surveys



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Exploratory Test Well Drilling


GREAT WOR
'98 1 6

TABLE 1

Exploratory Test Well Summary of Construction and Development Information

Exeter, New Hampshire

	Total Depth of Boring (feet)	Total Depth of Well (feet)	Screened Interval/ Slot Size (feet / inches)	Pre-Pumping Water Level (feet)	Testing Duration (hours)	Pumping Rate (gpm)	Pumping-Induced Drawdown (feet)	Specific Capacity During Testing (gpm/ft)
Exploratory Test Borings/Wells								
SG-1A (North)	40	36.5	26.5-36.5/0.010	6.83	0.1	0.5	31.67	0.016
SG-1B (North)	42.5	41	31-41/0.020	4.92	1.0	0.5	34.78	0.014
SG-1C (North)	45	No Well Constructed						
SG-1D (North)	45	No Well Constructed						
SG-1E	137	No Well Constructed						
SG-1G	120	No Well Constructed						
SG-1J	135	No Well Constructed						
SG-1K	125	108	98-108/0.020	6.01	0.5	12.0	22.37	0.54
SG-1M	132	No Well Constructed						
SG-1N	125.5	No Well Constructed						
SG-1O	145	138	118-138/0.020	11.47	1.0	24.0	2.03	11.8
SG-1P	117	No Well Constructed						
SG-1R	103	No Well Constructed						
SG-1S	107	100	88-100/0.020	16.87	2.0	43.3	1.18	36.7
SG-1T	93.5	86	75-85/0.020	14.35	2.0	38.3	33.02	1.16
SG-1U	130	112	86.5-106.5/0.020	12.92	1.0	18.0	0.72	25.0
SG-1W	127	124	110-124/0.020	13.18	1.0	18.0	0.35	51.4
SG-4A	47	No Well Constructed						
SG-4B	44	No Well Constructed						
SG-4C	59	59	49-59/0.020	9.58	1.0	25.0	1.37	18.2
SG-M1	32	No Well Constructed						
SG-M3	28	No Well Constructed						

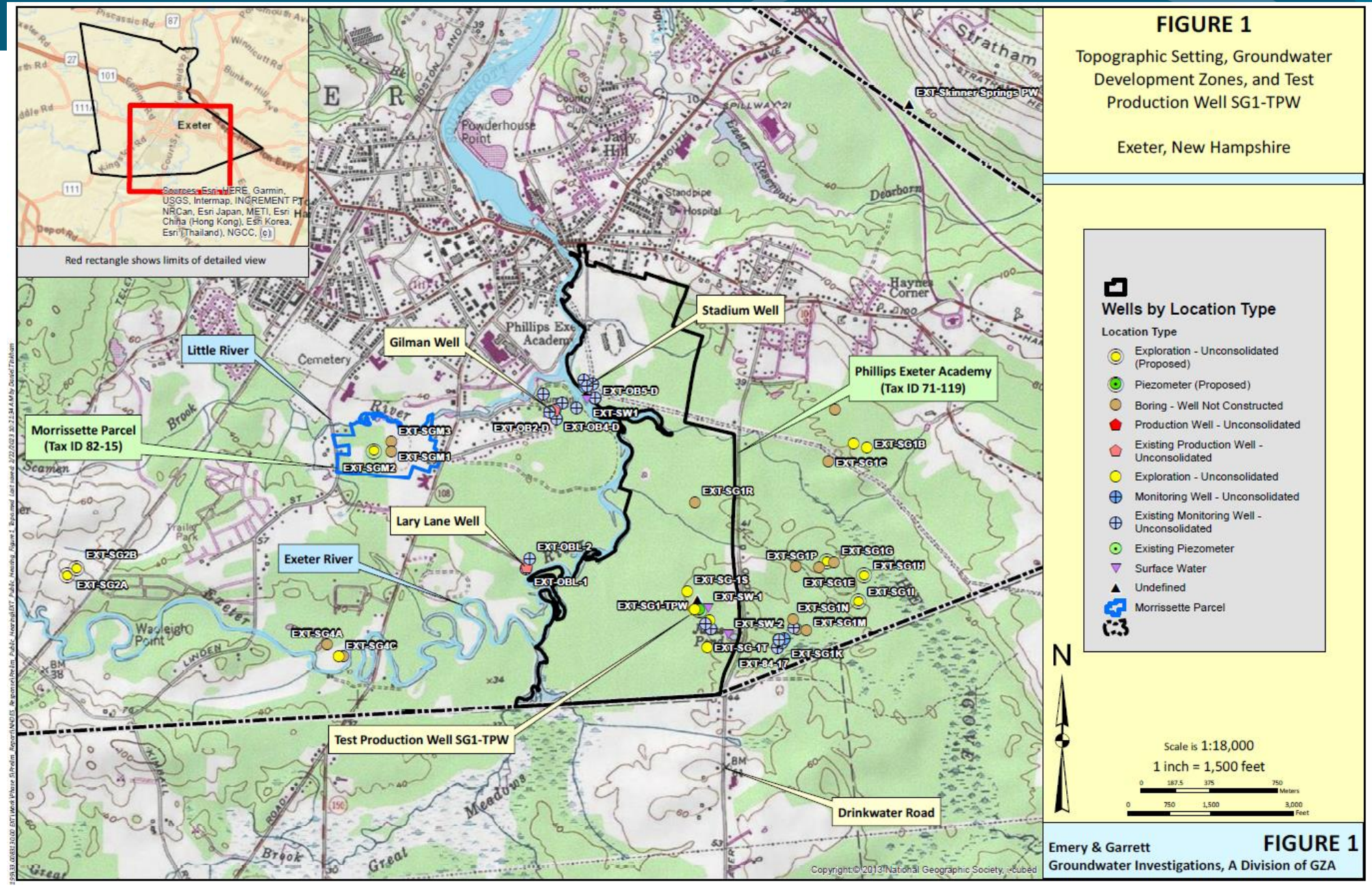
FIGURE 1
Topographic Setting, Groundwater Development Zones, and Test Production Well SG1-TPW
Exeter, New Hampshire
Red rectangle shows limits of detailed view
Stadium Well
Gilman Well
Little River
Phillips Exeter Academy (Tax ID 71-119)
Morrissette Parcel (Tax ID 82-15)
Lary Lane Well
Exeter River
Test Production Well SG1-TPW
Drinkwater Road
EXT-Skinner Springs PW
EXT-OB5-D
EXT-SW1
EXT-OB2-D
EXT-OB4-D
EXT-SGM3
EXT-SGM1
EXT-SGM2
EXT-SG1B
EXT-SG1C
EXT-SG1R
EXT-OBL-2
EXT-OBL-1
EXT-SG2B
EXT-SG2A
EXT-SG1P
EXT-SG1G
EXT-SG1H
EXT-SG1E
EXT-SG1I
EXT-SG1S
EXT-SW-1
EXT-SG1-TPW
EXT-SG1N
EXT-SW-2
EXT-SG1M
EXT-SG1T
EXT-SG1K
EXT-84-17
EXT-SG4A
EXT-SG4C
Wells by Location Type
Location Type
Exploration - Unconsolidated (Proposed)
Piezometer (Proposed)
Boring - Well Not Constructed
Production Well - Unconsolidated
Existing Production Well - Unconsolidated
Exploration - Unconsolidated
Monitoring Well - Unconsolidated
Existing Monitoring Well - Unconsolidated
Existing Piezometer
Surface Water
Undefined
Morrissette Parcel
N
Scale is 1:18,000
1 inch = 1,500 feet
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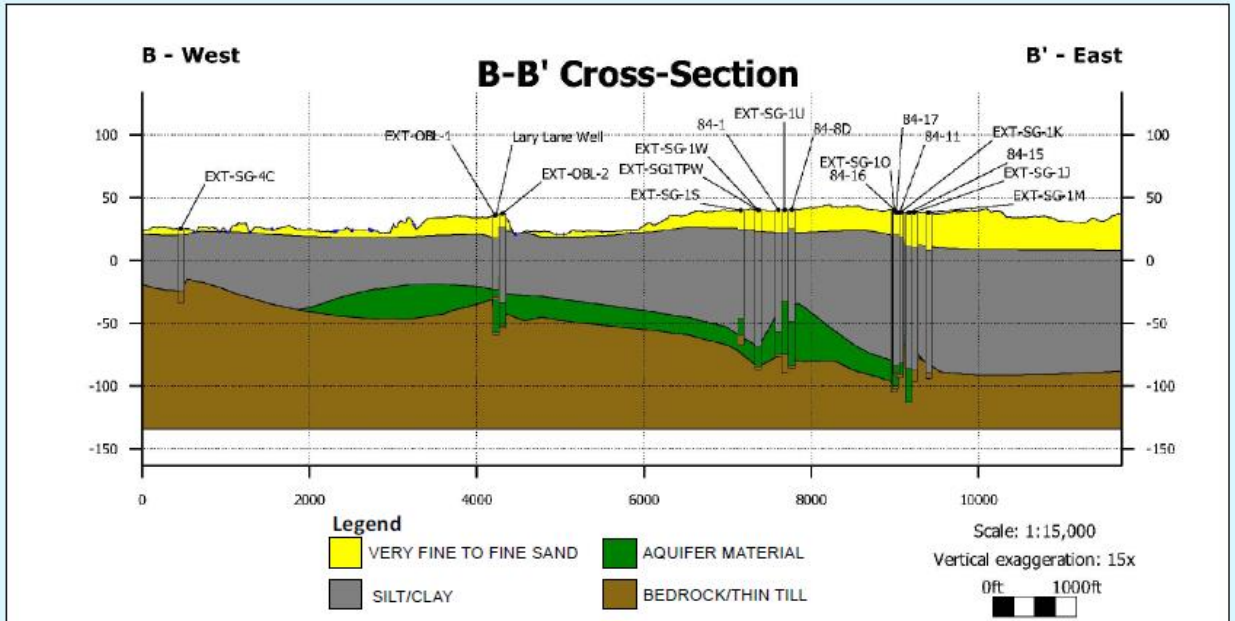
FIGURE 1



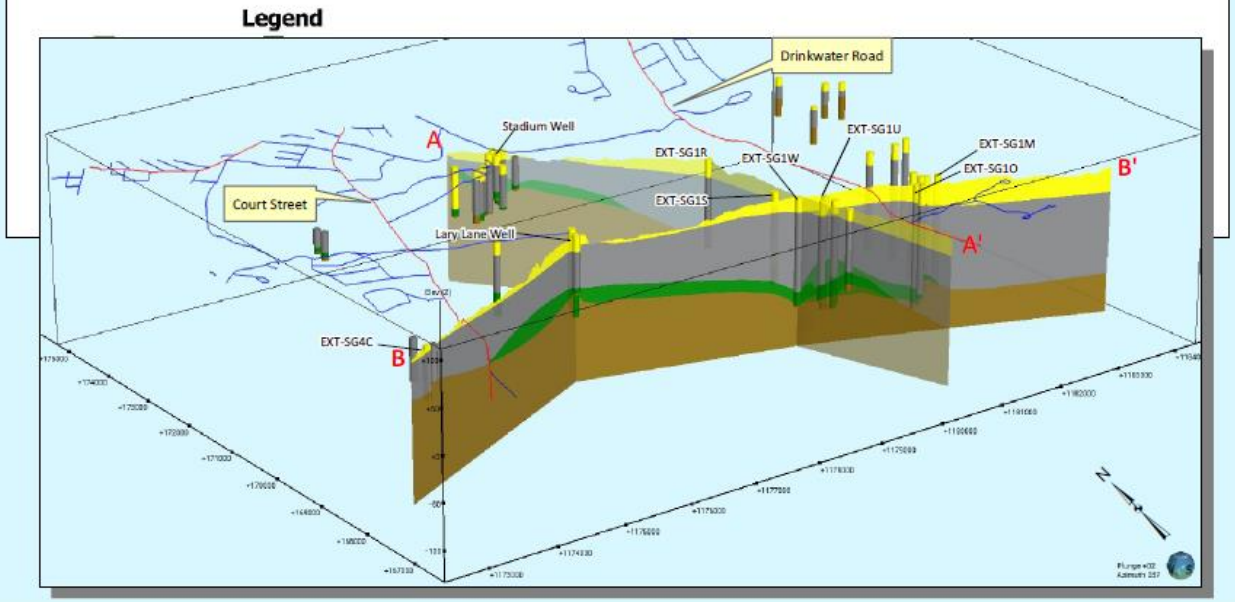


FIGURE 6

Schematic Geologic Cross-Section B-B'
Town of Exeter
Exeter, New Hampshire

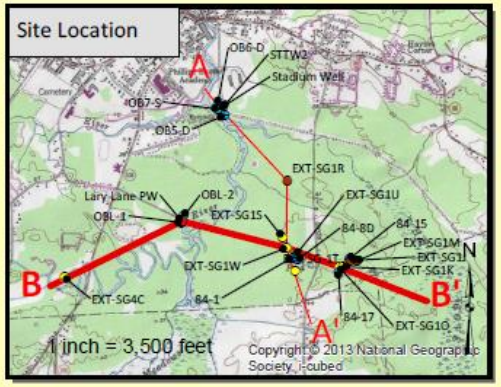


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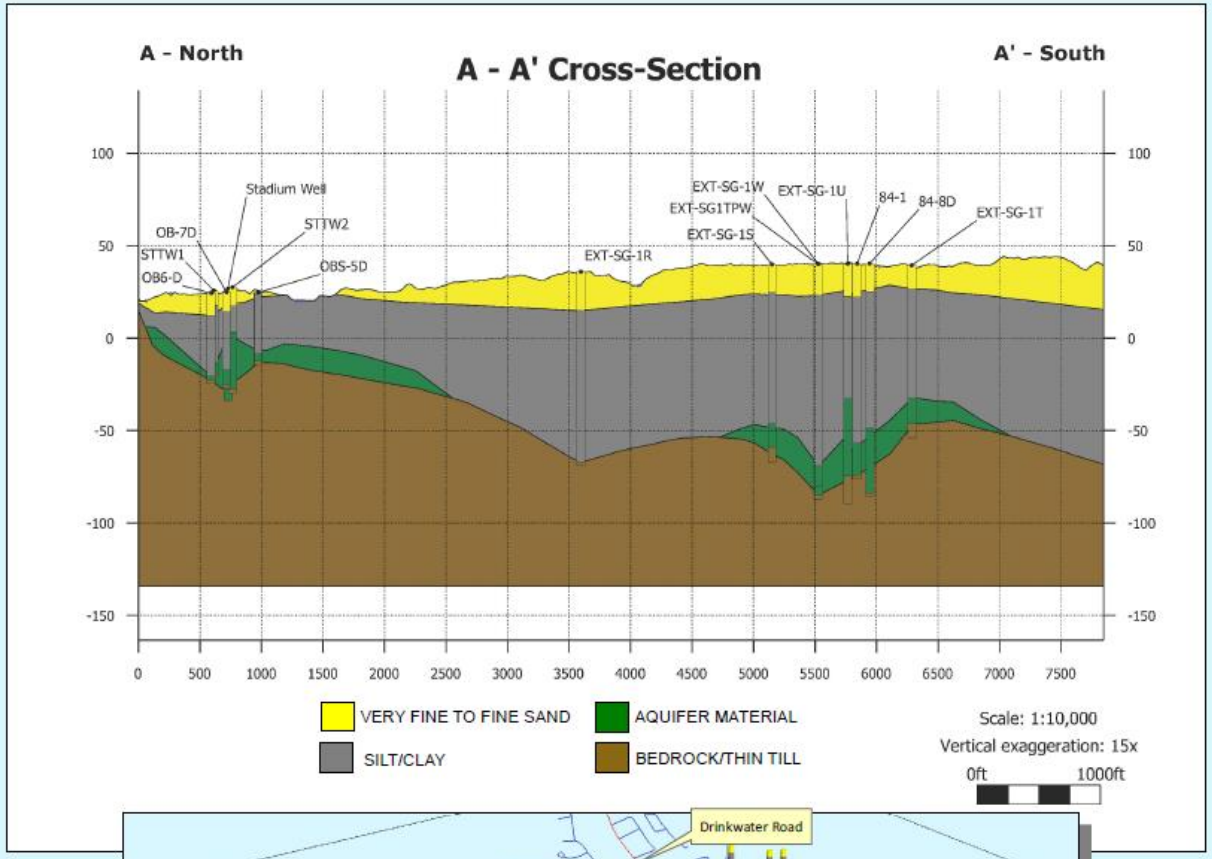
FIGURE 6



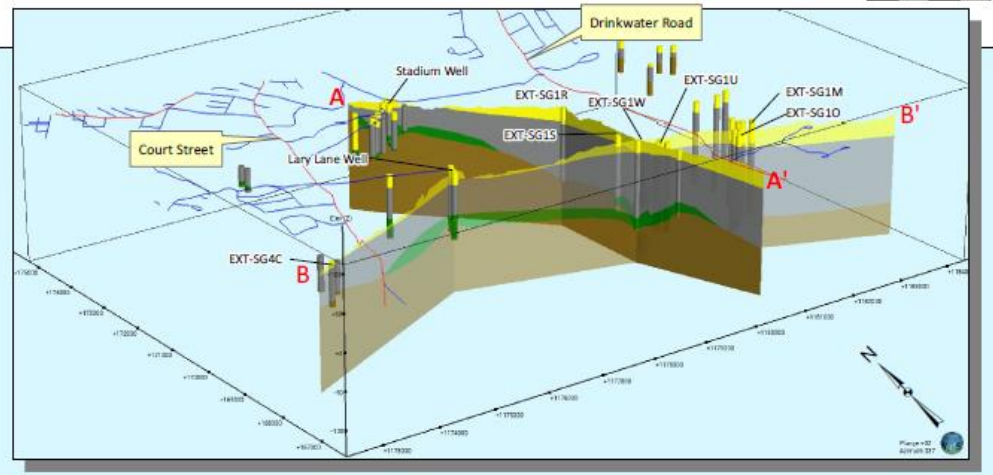


FIGURE 5

Schematic Geologic Cross-Section A-A'
Town of Exeter
Exeter, New Hampshire

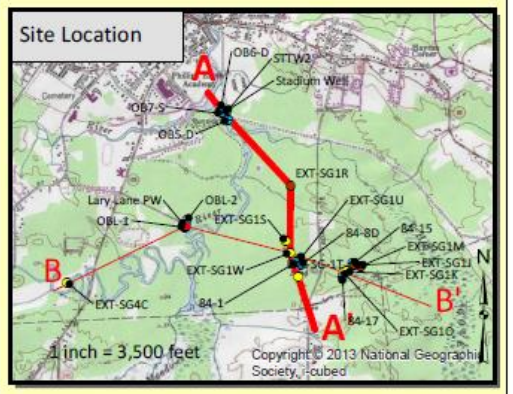


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FIGURE 5

Installation of 8-Inch Test Well

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Figure 7

CONSTRUCTION LOG FOR TEST PRODUCTION WELL SG1-TPW
PHILLIPS EXETER ACADEMY PROPERTY
EXETER, NEW HAMPSHIRE

Project: *Installation of Test Production Well SG1-TPW*
Driller: *Barrie Miller Well & Pump Company*
Geologist: *Dan Tinkham*
Date Drilled: *September 2, 2022*
Drill Method: *Casing Advancement with Cable Tool Rig*

Total Depth of Boring: *120'*
Depth to Bedrock/Till: *120'*
Static Water Level: *17.26' on 9/1/22*
Screen Intervals (Slot Size): *92-96' and 116-120' (0.200")*

DEPTH (feet)	GEOLOGIC DESCRIPTION	DRILL LOG	WELL CONSTRUCTION
0			
4	0' - 15': Very Fine Sand		
8	to Medium Sand		0'-10': Natural Cuttings
12			
16			Static Water Level
20			
24			
28			
32			10'-80': Bentonite (Holeplug)
36			
40			
44			
48	15' - 83': Gray, Silt to Clay,		
52	Trace Fine Sand		
56			
60			0'-120': Temporary 12-inch Steel Casing
64			(Removed after Well Construction)
68			
72			8-inch-diameter steel casing
76			
80			
84			80'-89': #4 Sandpack
88	83' - 97': Coarse Sand to		89'-98': 3/16" - 3/8" Sandpack
92	Pebbles/Cobbles		92'-96': 4.0 Feet of 8-inch-diameter stainless
96			steel, wire-wound screen (0.200-inch openings)
100			
104	97' - 114': Fine Sand		98'-114': #3 Sandpack
108			
112			114'-120': 3/16" - 3/8" Sandpack
116	114' - 120': Coarse Sand to		116'-120': 4.0 Feet of 8-inch-diameter stainless
120	Pebbles/Cobbles		steel, wire-wound screen (0.200-inch openings)
124	120': Bottom of boring.		120': Bottom of Well

Conducted 72-Hour Pumping Test

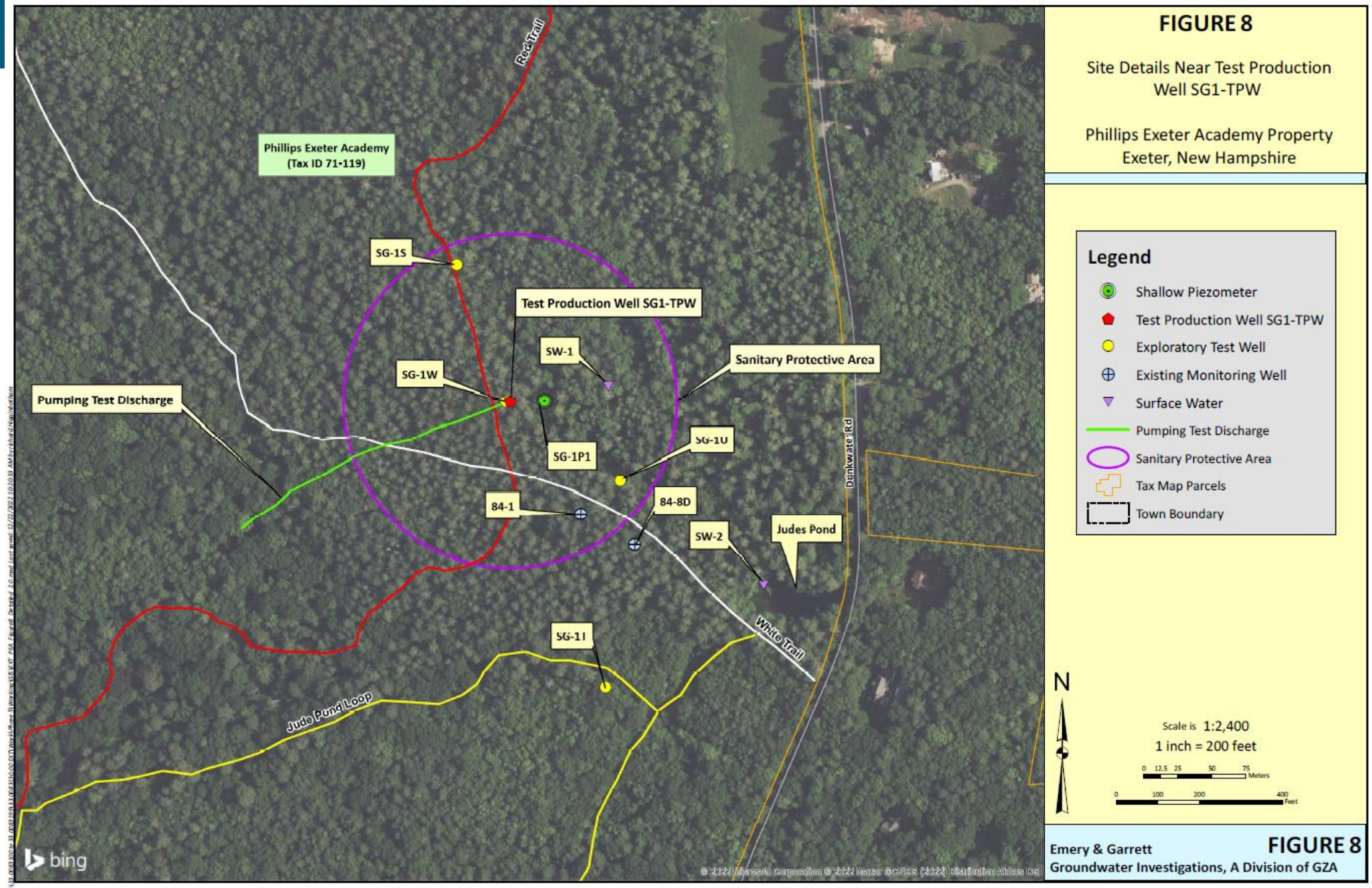

FIGURE 8

Site Details Near Test Production Well SG1-TPW

Phillips Exeter Academy Property
Exeter, New Hampshire

Legend

- Shallow Piezometer
- Test Production Well SG1-TPW
- Exploratory Test Well
- Existing Monitoring Well
- Surface Water
- Pumping Test Discharge
- Sanitary Protective Area
- Tax Map Parcels
- Town Boundary

N

Scale is 1:2,400
1 inch = 200 feet

0 12.5 25 50 75 Meters
0 100 200 400 Feet

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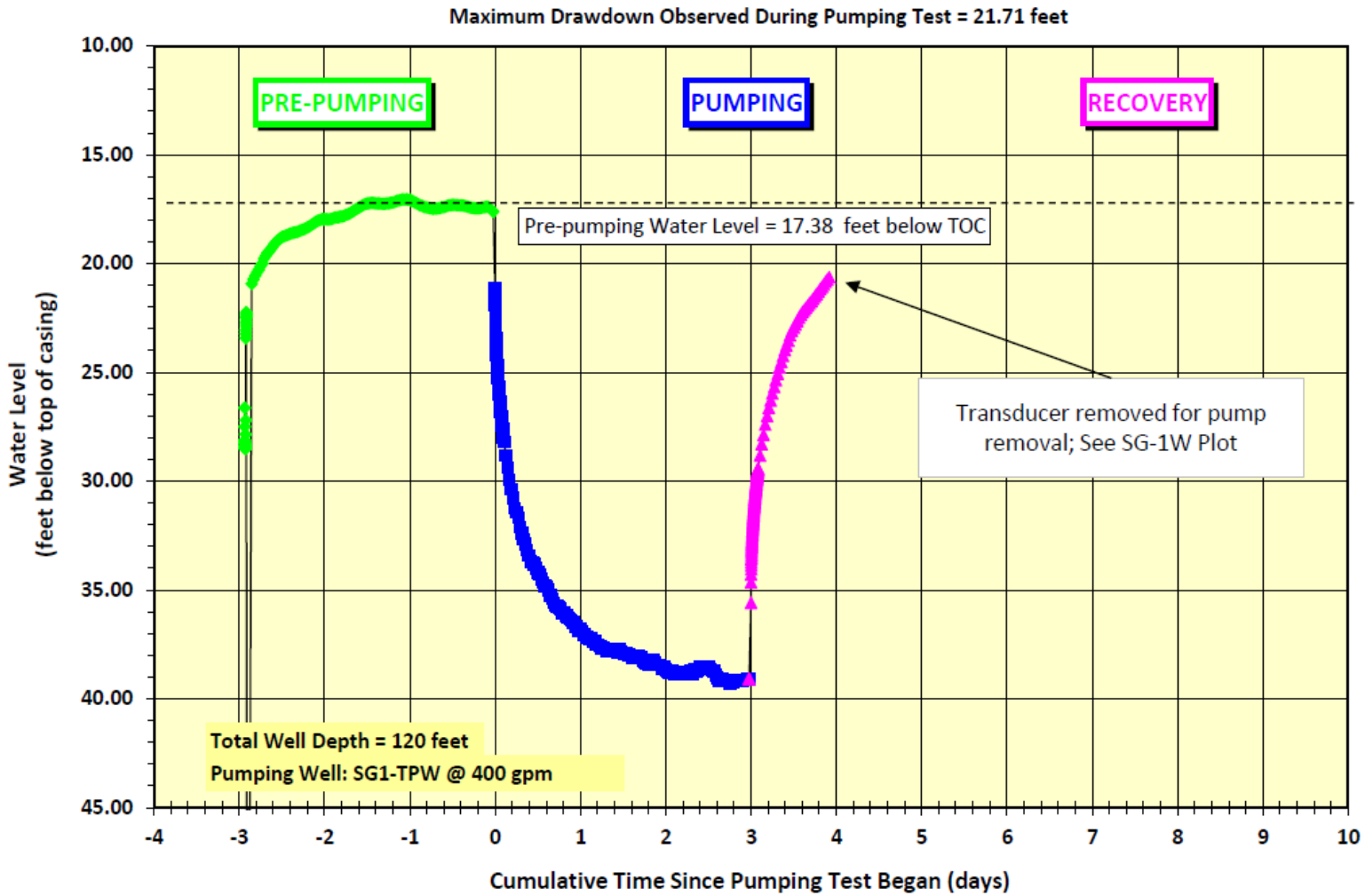
FIGURE 8

Figure 9: Water Level Response in Test Production Well SG1-TPW



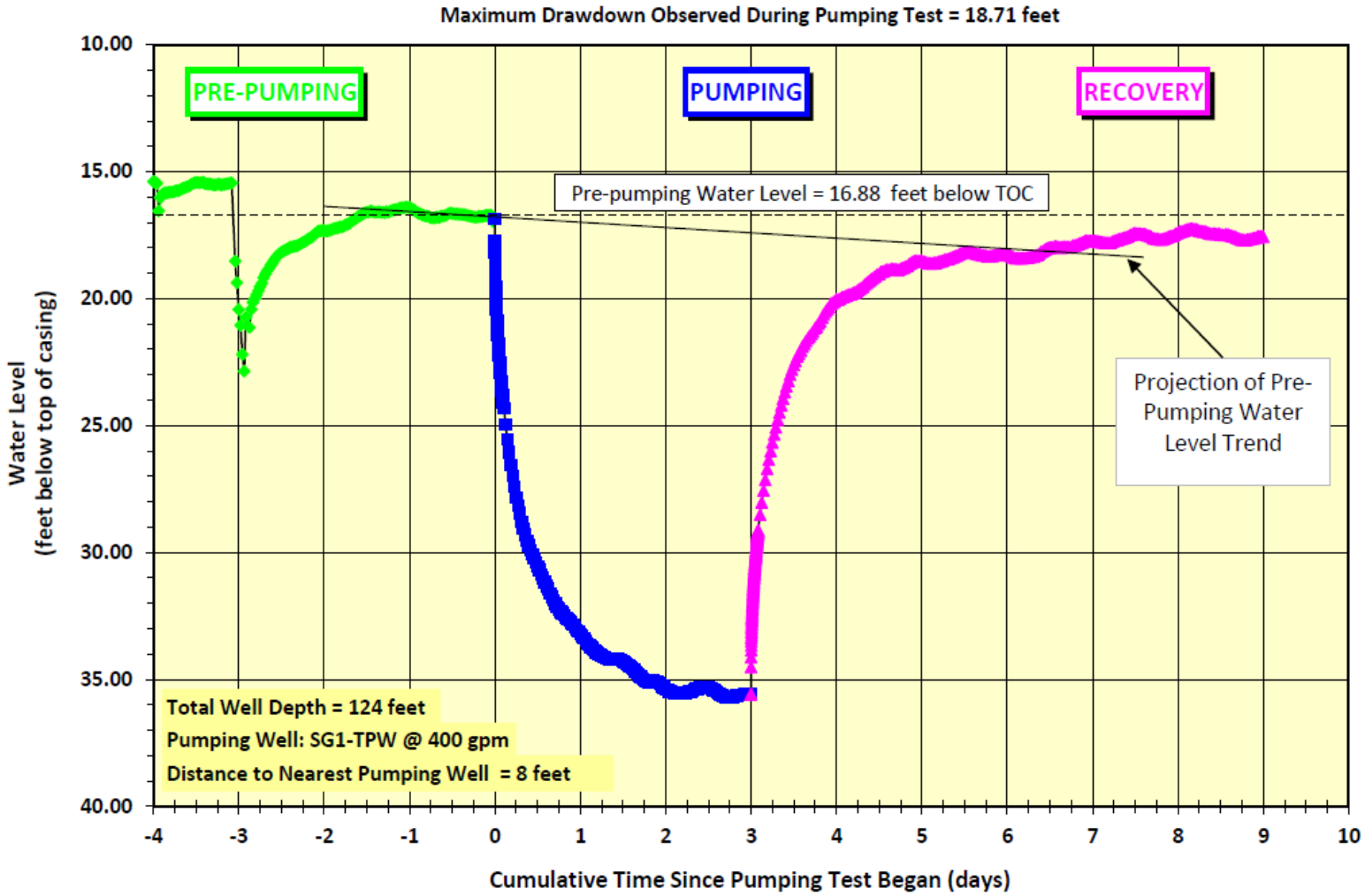
Plot of Water Level versus Time for August 25 to September 2, 2022
Preliminary 72-Hour Pumping Test of Test Production Well SG1-TPW
Exeter, New Hampshire

TABLE 4
Results of the Preliminary Pumping Test
Test Production Well SG1-TPW, Phillips Exeter Academy Property
Exeter, New Hampshire

Well Name	Pre-Pumping Water Level (feet)*	Start and Stop Time of Pumping Test (date, 24-hr. time)	Test Duration (hours)	Average Pumping Rate (gpm)	Total Volume Pumped (gallons)	Final Water Level Drawdown (feet)	Available Drawdown** (feet)	Percent of Available Drawdown Used*	Final Specific Capacity*** (gpm/ft)
Well SG1-TPW	17.38	8/29/22, 10:00 9/1/22, 10:00	72	400	1,728,000	21.71	75.0	28.9%	18.4

* Measured in feet below top of casing
** The available drawdown for the pumping well was calculated by subtracting the pre-pumping water level from the depth to the top of the screer
*** The final specific capacity is calculated by dividing the final pumping rate by the final drawdown

Figure 11: Water Level Response in Monitoring Well SG-1W



Plot of Water Level versus Time for August 25 to September 8, 2022
Preliminary 72-Hour Pumping Test of Test Production Well SG1-TPW
Exeter, New Hampshire

TABLE 5

Selected Laboratory Results of Water Quality Samples Collected During the Preliminary Pumping Test
Test Production Well SG1-TPW, Phillips Exeter Academy Property
Exeter, New Hampshire

Well	Date Sampled	Lab	Iron (mg/L)	Manganese (mg/L)	Arsenic (mg/L)	pH	Alkalinity (mg/L)	Chloride (mg/L)	Sodium (mg/L)	Hardness (mg/L)	Nitrate 70	Sulfate (mg/L)	Fluoride (mg/L)	Total Dissolved Solids (mg/L)
		MCL or SMCL	*0.30*	*0.05*	*0.005*	*6.5-8.5*	*none*	*250*	*none*	*100*	*10*	*250*	*4.0*	*500*
Well SG1-TPW	8/30/2022	NTL	0.093	0.032	**0.007**	7.9	100	14.0	11	**120**	ND	19.0	ND	160
	9/1/2022	NTL	0.091	0.033	**0.008**	7.9	110	15.0	12	**130**	ND	18.0	ND	170
	9/1/2022	EAI	0.089	0.029	**0.0076**	8.14	100	20	11	**120**	ND	22	ND	190

Well	Date Sampled	Lab	VOCs (ug/l)	SOCs (mg/l)	1,4-Dioxane (mg/l)	PFAS				Radium 226 (pCi/L)	Radium 228 (pCi/L)	Radon (pCi/L)	Gross Alpha (pCi/L)	Uranium (ug/L)
						PFHxS (ng/l)	PFOA (ng/l)	PFOS (ng/l)	PFNA (ng/l)					
					none	*18*	*12*	*15*	*11*	*Combined: 5*		*none*	*15*	*30*
Well SG1-TPW	8/30/2022	NTL	0.001 [1]	ND	--	--	--	--	--	--	--	--	--	--
	9/1/2022	NTL	0.001 [1]	ND	--	--	--	--	--	--	--	--	--	--
	9/1/2022	EAI	ND	ND	ND	ND	ND	ND	ND	0.3	ND	526	3.3	1.8

-- = not analyzed
ND - not detected above the miniumum detection level
EAI - Eastern Analytical, Inc.
NTL - National Testing Laboratories, Ltd.
[1] Styrene detected

BACTERIOLOGICAL RESULTS:
SG1-TPW: Total Coliform: ND E. coli: ND

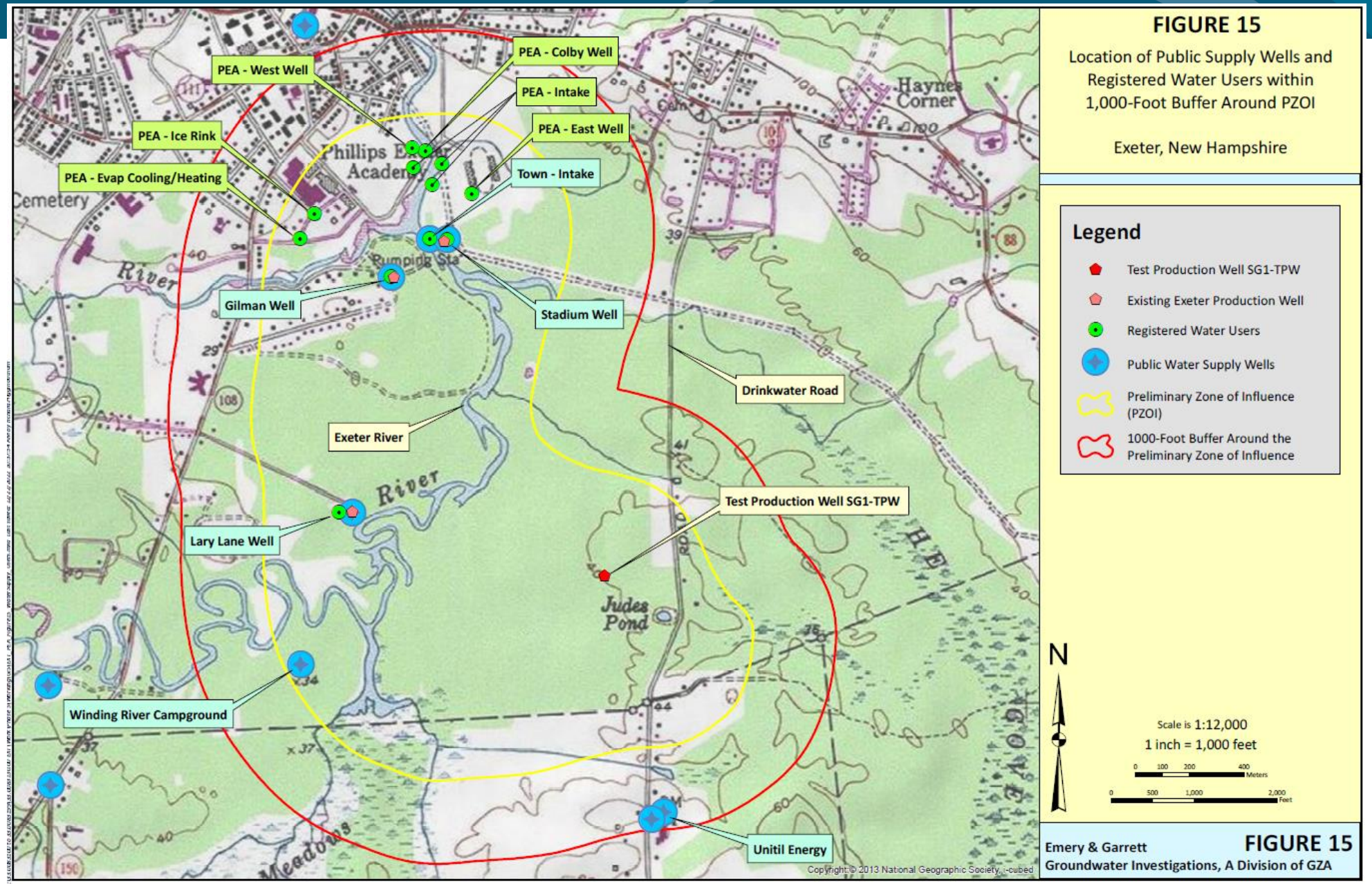

PEA - West Well
PEA - Colby Well
PEA - Intake
PEA - East Well
PEA - Ice Rink
PEA - Evap Cooling/Heating
Town - Intake
Gilman Well
Stadium Well
Drinkwater Road
Exeter River
Test Production Well SG1-TPW
Lary Lane Well
Winding River Campground
Unitil Energy
Haynes Corner
Phillips Exeter Academy
Cemetery
River
Pumping Sta
Judes Pond
Meadows
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FIGURE 15
Location of Public Supply Wells and Registered Water Users within 1,000-Foot Buffer Around PZOI
Exeter, New Hampshire
Legend
Test Production Well SG1-TPW
Existing Exeter Production Well
Registered Water Users
Public Water Supply Wells
Preliminary Zone of Influence (PZOI)
1000-Foot Buffer Around the Preliminary Zone of Influence
N
Scale is 1:12,000
1 inch = 1,000 feet
0 100 200 400 Meters
0 500 1,000 2,000 Feet
Emery & Garrett
Groundwater Investigations, A Division of GZA
FIGURE 15

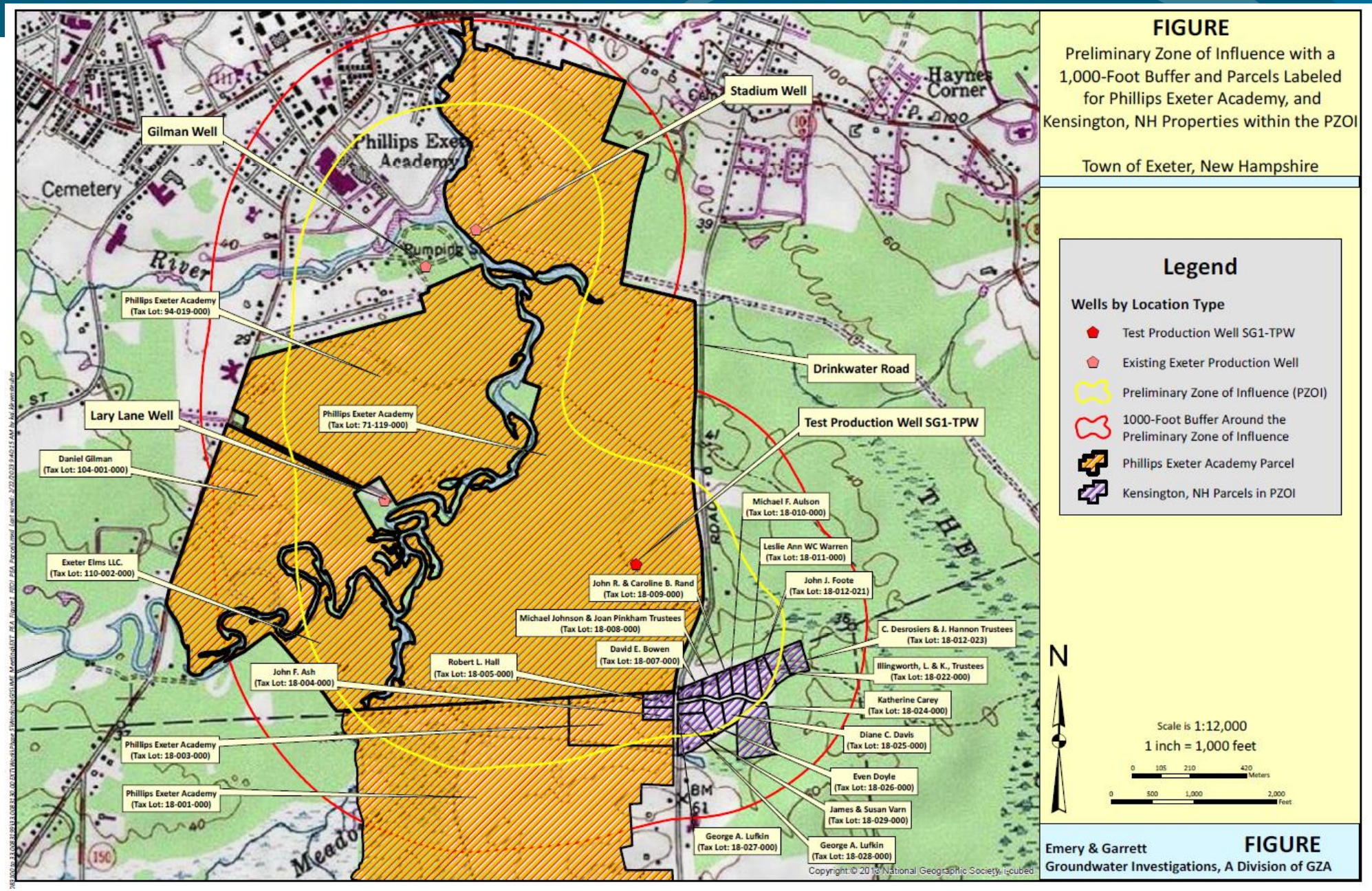
FIGURE
Preliminary Zone of Influence with a 1,000-Foot Buffer and Parcels Labeled for Phillips Exeter Academy, and Kensington, NH Properties within the PZOI
Town of Exeter, New Hampshire
Legend
Wells by Location Type
Test Production Well SG1-TPW
Existing Exeter Production Well
Preliminary Zone of Influence (PZOI)
1000-Foot Buffer Around the Preliminary Zone of Influence
Phillips Exeter Academy Parcel
Kensington, NH Parcels in PZOI
Stadium Well
Gilman Well
Drinkwater Road
Test Production Well SG1-TPW
Lary Lane Well
Phillips Exeter Academy (Tax Lot: 94-019-000)
Phillips Exeter Academy (Tax Lot: 71-119-000)
Daniel Gilman (Tax Lot: 104-001-000)
Exeter Elms LLC. (Tax Lot: 110-002-000)
Michael F. Aulson (Tax Lot: 18-010-000)
Leslie Ann WC Warren (Tax Lot: 18-011-000)
John J. Foote (Tax Lot: 18-012-021)
John R. & Caroline B. Rand (Tax Lot: 18-009-000)
Michael Johnson & Joan Pinkham Trustees (Tax Lot: 18-008-000)
David E. Bowen (Tax Lot: 18-007-000)
C. Desrosiers & J. Hannon Trustees (Tax Lot: 18-012-023)
Illingworth, L. & K., Trustees (Tax Lot: 18-022-000)
Robert L. Hall (Tax Lot: 18-005-000)
John F. Ash (Tax Lot: 18-004-000)
Katherine Carey (Tax Lot: 18-024-000)
Diane C. Davis (Tax Lot: 18-025-000)
Phillips Exeter Academy (Tax Lot: 18-003-000)
Even Doyle (Tax Lot: 18-026-000)
Phillips Exeter Academy (Tax Lot: 18-001-000)
James & Susan Varn (Tax Lot: 18-029-000)
George A. Lufkin (Tax Lot: 18-027-000)
George A. Lufkin (Tax Lot: 18-028-000)
Haynes Corner
Phillips Exeter Academy
Cemetery
River
Meadow
N
Scale is 1:12,000
1 inch = 1,000 feet
0 105 210 420 Meters
0 500 1,000 2,000 Feet
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FIGURE

Next Steps

- Installation of Production Well
- Final Testing of Production Well for Yield and Quality
- Environmental Impact Assessments
  - Wetlands
  - Surface Water
  - Off-site Impacts
- Submittal of Final Hydrogeologic Report to NHDES in Accordance with ENV-Dw-302 and ENV-Wq-403 under RSA-45C:21
- Final Public Comment Period/ Final Public Hearing if Needed
- Final Permitting of Public Groundwater Supply Source

Questions?