Assessing Source Vulnerability and Long Term Water Source Planning For Small Water Systems

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"When the well is dry we learn the worth of water"

Benjamin Franklin

Presentation Overview

1) Types of water sources
2) Planning process
3) Discussion of what makes a good well site
4) Case Study 1 – Errol NH
5) Case Study 2 – Whip O Will MHP Plymouth NH
6) Final Thoughts

Water Supply Sources

Surface Water

- River/Stream Withdrawal
- Lake/Pond

Ground Water

- Overburden Wells
  - Gravel Well (Natural Gravel)
  - Gravel Well (Gravel Pack)
  - Spring
  - Dug Well
- Bedrock Wells

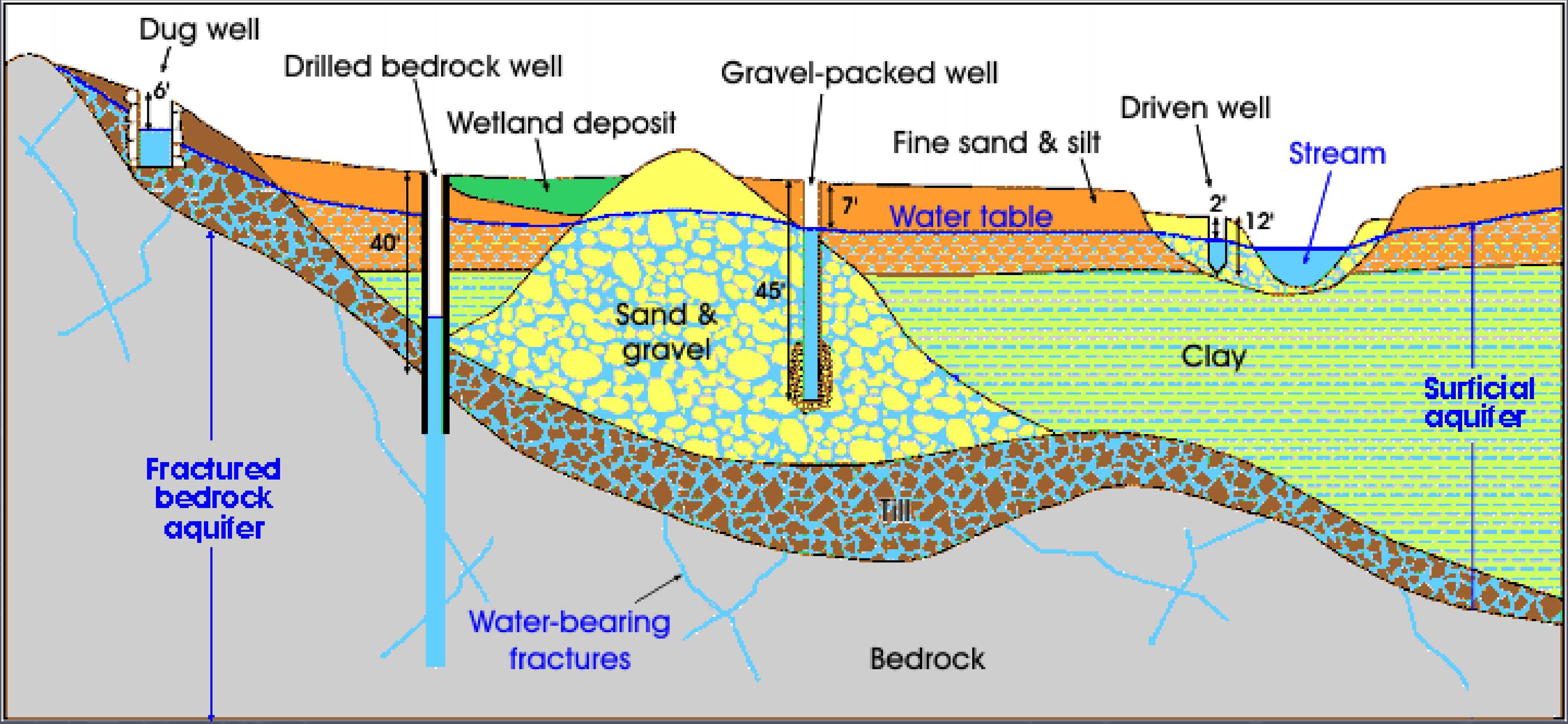
Overburden Supply Sources

- Limited areas of sand and gravel aquifer* in the State of NH
- Typically shallow (less than 100')
- Often easier to develop high yields when adequate aquifer is present. Yields >100 gpm are common.
- Often have good water quality
- Typical contaminants of concern are nitrate and iron/manganese
- Can be highly susceptible to impacts from land use and susceptible to drought.

*term "aquifer" is often discussed but not always understood

Anatomy of Groundwater Sources

Dug Wells, Springs, and Driven Wells



Source: Maine DEP

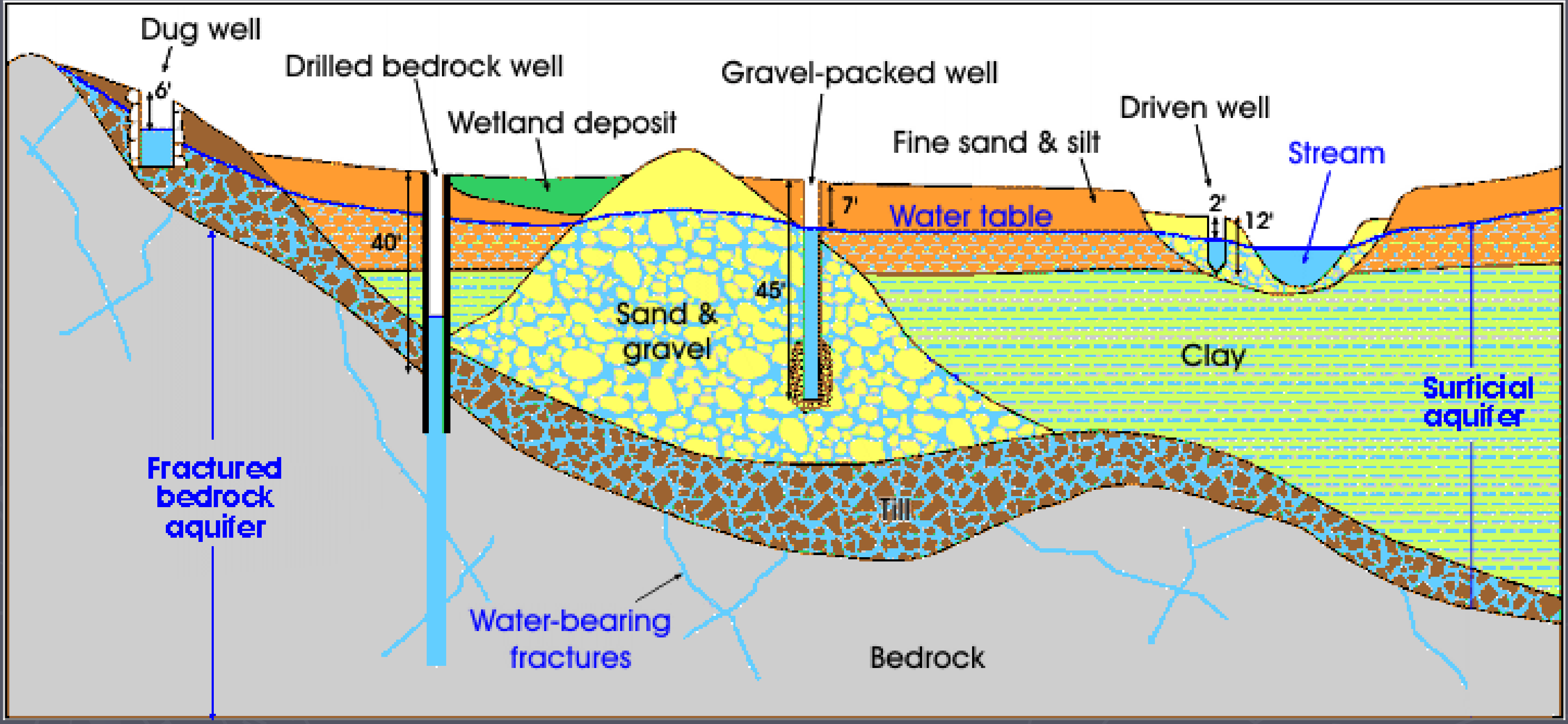
Bedrock Supply Sources

- Difficult to predict yield prior to drilling
- Typically deep (average of ~350’, sometimes over 1,000’)
- Can be difficult to obtain adequate yield
- Highly variable water quality depending on area
- Typical contaminants of concern are metals (iron, manganese, arsenic), and radionuclides.
- Can be highly susceptible to impacts from land use and susceptible to drought.

*term “aquifer” is often discussed but not always understood

Anatomy of Groundwater Sources

Dug Wells, Springs, and Driven Wells



Source: Maine DEP

Do I Need to Plan for a New Source?

Questions to Ask:

- Does system have limited source diversity (all sources at one well field)?
  - Is well field in an area with adequate sanitary and source water protection?
- What percentage of **<u>TESTED</u>** source capacity is being used
  - Using 50% or less is ideal
- Has yield or pumping level been declining over time?
- Have there been any changes in water quality or current issues?
- Has there been development or land use changes that could impact the source?

PLANNING AHEAD

•Larger systems should have more source diversity, but all systems should strive for adequate reserve capacity

•Need to look at current sources holistically

- Yield Trends
- Water Quality Trends
- Source Protection

•Source development from concept to well operation typically Takes 1-3 years.

•New source costs vary widely (~$50,000 to $1M+), more later..

•Plan ahead and budget before an emergency situation arises

•PLAN FAR AHEAD

A Few Thoughts :

•The closer a well is pumped to it's maximum capacity as dictated by hydraulics, the probability and rate of yield decline with increase. Therefore it's important to identify decline early.

•When decline is caught early rehabilitation efforts are most effective. However, even with successful rehab new source planning should be considered.

•Water quality problems can arise both slowly over time, or very quickly and without warning.

WHAT MAKES A GOOD WELL SITE?

•Willing Landowner

•Adequate Land Area For Sanitary Protection

•Close to Existing Infrastructure

•Adequate Source Water Protection

•Wetlands and Surface Water Setbacks Can Be Met

•Adequate Yield Can be Developed

•Acceptable Water Quality

IT CAN BE VERY DIFFICULT TO FIND A SITE THAT MEETS ALL CRITERIA!

Well Field #1 – GOOD LOCATION

System With ~650 Service Connections

Well Field #2 – NOT IDEAL

System With ~150 Service Connections

Source: Google Earth

WELL SITE CRITERIA

Groundwater Source Permitting Governed by State of NH Rules:

ENV-DW 302 for LARGE SUPPLIES (>57,600 gallons per day)
ENV-DW 305 for SMALL SUPPLIES (<57,600 gallons per day)

- 50' setback from surface water and wetlands inundated >30 consecutive days annually
- Can't be under the influence of surface water
- Casing elevation above 100 year flood elevation
- Sanitary Protective Area in "Natural State"
- Waivers are possible, but must be justified

SO HOW MUCH LAND DO I REALLY NEED?

Sanitary Protective Area in "Natural State"
Env-Dw 405 Design Standards for
Small Public Water Systems

Table 405-2: Sanitary Protective Area

Permitted Production Volume (gpd)	Sanitary Protective Radius Length (ft.)
0 - 750	75
751 - 1440	100
1441 - 4320	125
4321 - 14,400	150
14,401 - 28,800	175
28,801 - 57,600	200
57,601 - 86,400	250
86,401 - 115,200	300
115,201 - 144,000	350
Greater than 144,000	400

40 gpm well = 2.9 acres, minimum lot size is typically ~5 acres

100 gpm well = 11.5 acres, minimum lot size is typically ~20 acres

When two wells are inside an SPA, you use the sum of both yields to establish the proper radius

Ownership or Deeded Control of Sanitary Protective Area Required

Budgeting Items to Consider

- Initial planning and research work
- Property negotiations (legal, appraisel)
- Testing
  - Hydrogeology
  - Access Road
  - Drilling and yield testing
- Property purchase
- Well Installation (if not covered under testing)
- Source Permitting
- Well Interconnection
  - Water main
  - Power
  - Pump house
  - Controls
  - Site work/security
  - Plumbing
  - Treatment????

Developing New Water Supplies is Expensive

Don't Underestimate the Cost!

WHIP O WILL COOPERATIVE
DRAFT - CONCEPTUAL COST ESTIMATE
NEW WELL WITH NEW CONTROLS
Prepared by Horizons Engineering, Inc.
Jan-16

Scope: Connect new Well No. 6 with new dedicated water line and power feed to existing pump station. Purchase abutting lot, construct access road, drill second new well (Well No.7). Re-wire station to allow for direct control of new wells and existing Well No. 4, including VFD for Well No. 6 and proposed Well No. 7 Re-plumb existing station to facilitate well connection and allow treatment system blending ratio adjustment.

ITEM	UNITS	NO. UNITS	UNIT COST	TOTAL COST
Well and Well Pump				
6" Well to 1,300 feet	EA	2.00	$19,500.00	$39,000
Well Pump, Drop Pipe, Pitless	EA	2.00	$25,000.00	$50,000
Well Acccess Road	LF	300.00	$45.00	$13,500
Pump Station and System Connection				
Mobilization	EA	1.00	$6,000.00	$6,000
Underground Electric Service	LF	600.00	$50.00	$30,000
Trench Ledge Removal	CY	20.00	$250.00	$5,000
2" HDPE Water Line	LF	900.00	$45.00	$40,500
'C Control Conduit From Tank to Pump House	LF	700.00	$20.00	$14,000
Electrical Service Modifications	EA	1.00	$5,000.00	$5,000
3ate Valve, Blow Off, and System Connection	EA	1.00	$2,000.00	$2,000
Electrical	EA	1.00	$55,000.00	$55,000
Control System	EA	1.00	$18,000.00	$18,000
Plumbing Mods in Existing Pump House	EA	1.00	$10,000.00	$10,000
Surface Restoration	LS	1.00	$3,500.00	$3,500
Erosion Control	LS	1.00	$2,000.00	$2,000
				$293,500
			10% Contingency	$29,350
			Total Construction Cost	$322,850
			Property Purchase	$80,000
			20% Engineering	$58,700
			Hydrogeology and Permitting	$35,000
			Total Conceptual Project Cost	**$496,550**

Process for Developing a New Source…

1) Identify Need and Degree of Urgency
2) Prepare Preliminary Budgets for Exploration and Total Project
3) Demonstrate Need and Obtain Concurrence to Proceed
4) Secure Exploration Funding and Establish Timeline

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5) Review Available Mapping and Information
6) Identify Potentially Available Land Parcels
7) Rank Potential Sites in Order of Feasibility
8) Initial Discussions with Landowners and then NHDES
9) Secure Property for Testing (P&S)
10) Initial Testing
11) Secure Project Funding
12) Wellfield Development and Permitting

Two Case Studies:

Case Study 1:

Town of Errol, NH

Pre-Project Water System Overview

•Small Community Water System

•73 Service connections, including several businesses

•Three existing bedrock wells:

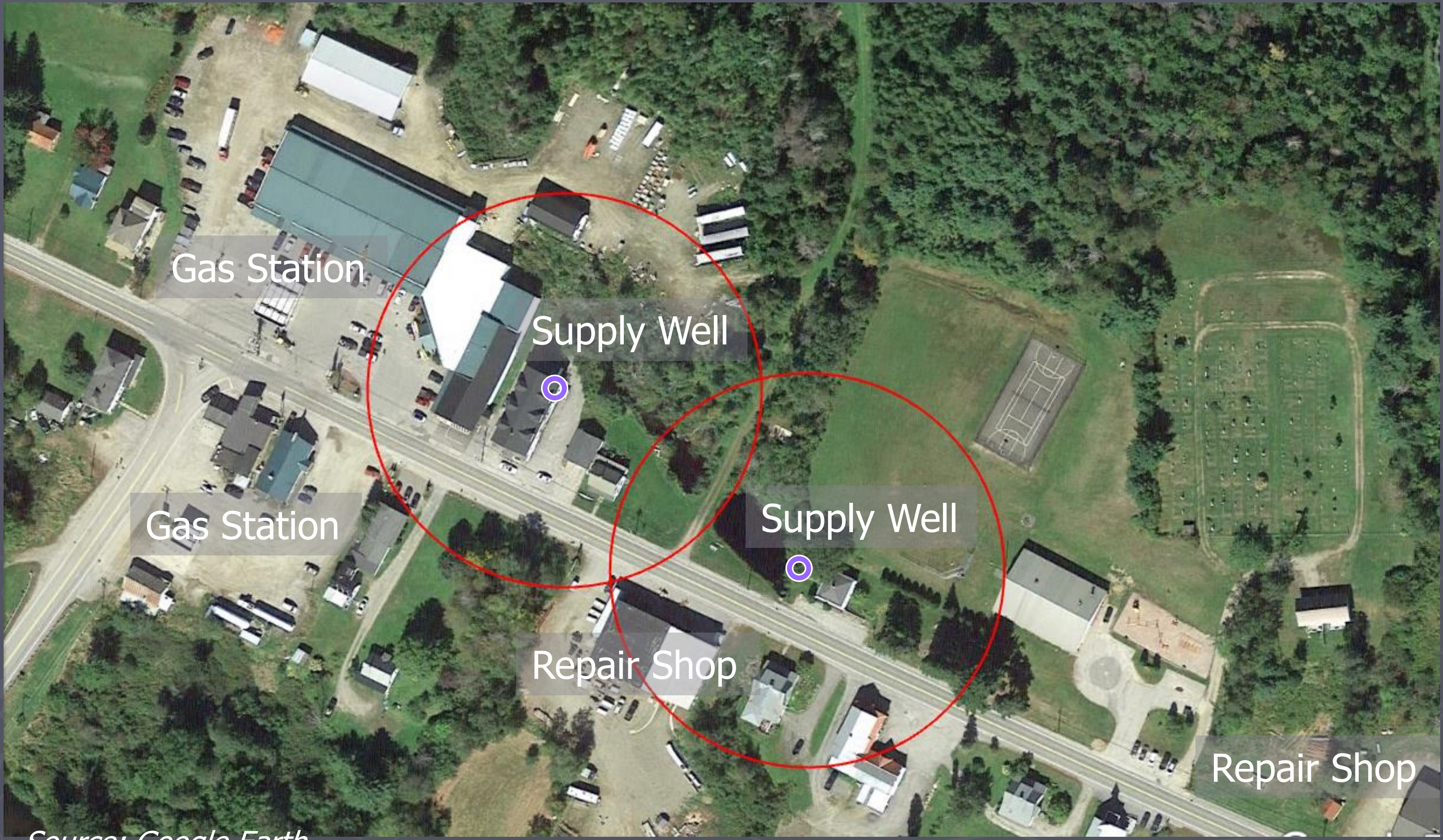
- Town Hall Well – low yield, good water quality, no protective area
- Library Well –moderate yield, variable water quality, no protective area
- Well 3 east of Town – low yield, good water quality, some protective area

Town suffered from water shortages due to leakage and breakage, concern about well yield, inadequate sanitary protection for most heavily relied on source. However, need was not urgent.

Funding secured through USDA Rural Development

Goal: Develop new source with 30-40 gpm capacity

Town of Errol, NH

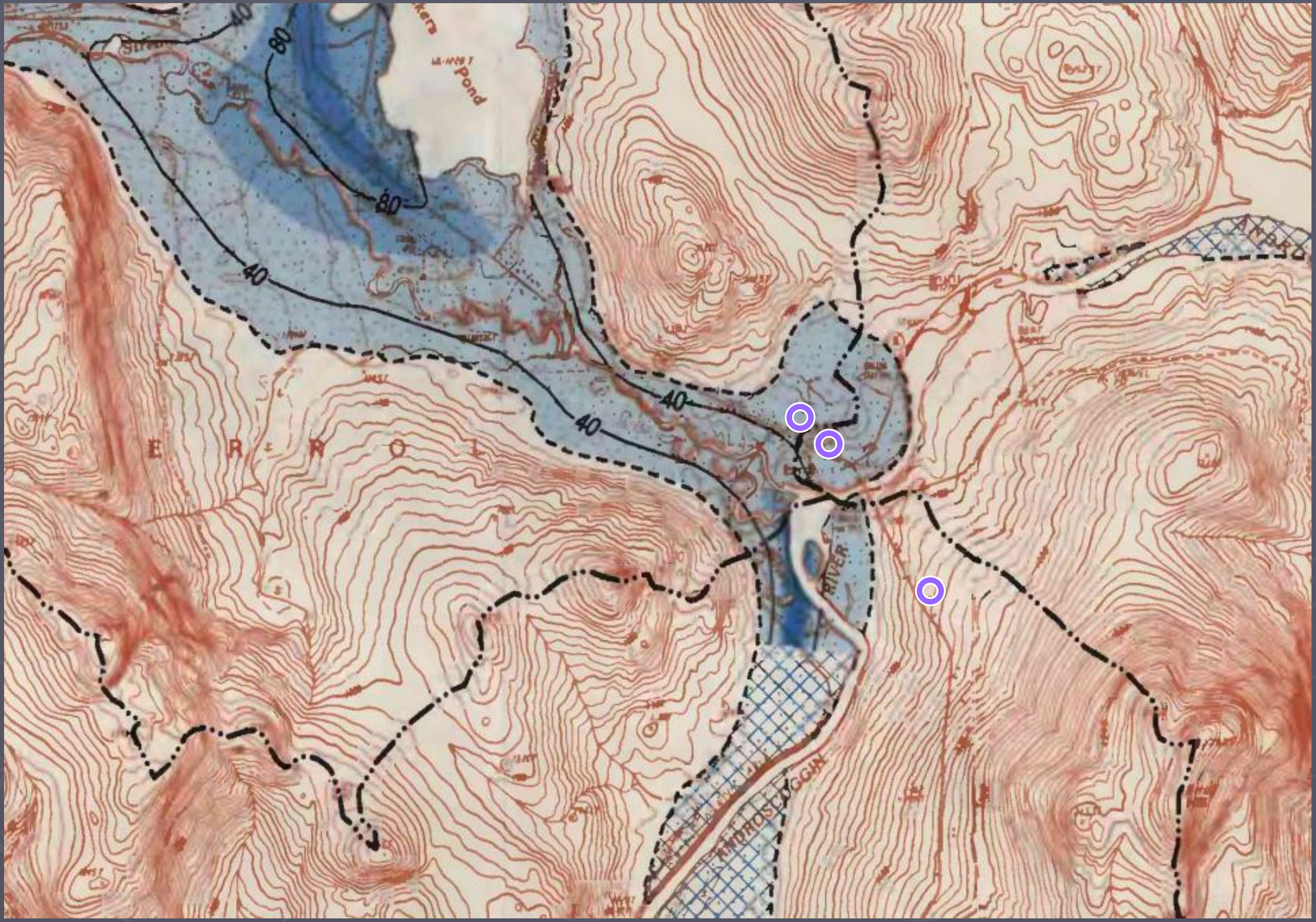


Source: Google Earth

Town of Errol, NH

Source: Google Earth

Sand and Gravel Aquifer Mapping



Source: USGS WRIR 96-4318

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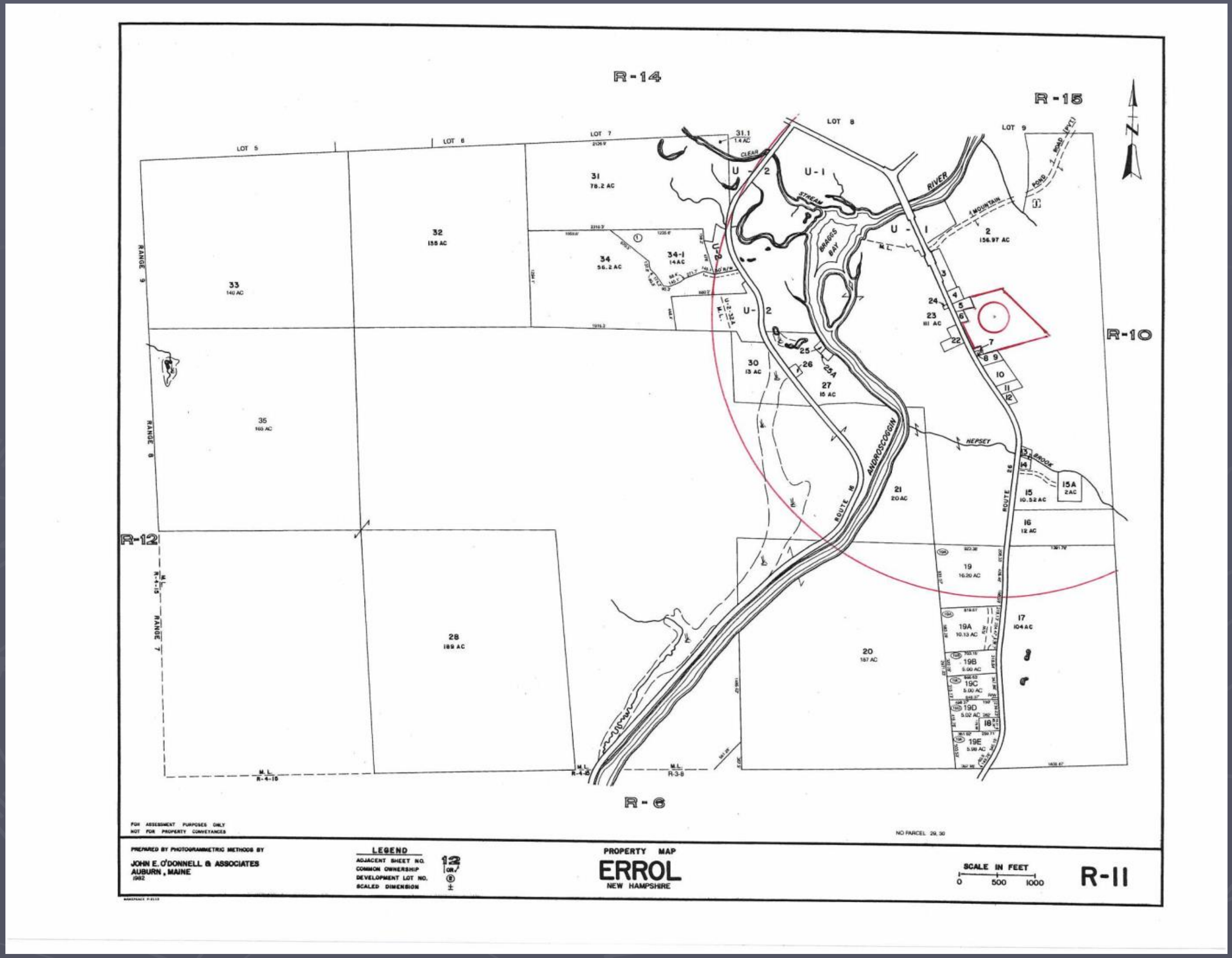
Bedrock Lineament Mapping

Source: USGS Open File Report 99-90

Available Land?

Start with Tax Maps



Project Steps:

1) P&S Negotiated with owner
2) Well site selected
3) Access road constructed
4) Test drilling completed

New source preliminary yield estimate of 50 gpm at ~780’

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BORING LOG & WELL DIAGRAM

BORING NO.: WELL #4
WELL ID:
Page 4 of 4

PROJECT	Water System Improvements - Bedrock Test Well	HORIZONS FILE NO.	13212
LOCATION	Errol, New Hampshire	PROJECT MGR.	Mike Duffy
CLIENT	Town of Errol Water System	FIELD REP.	Bruce Cox, Jon Warzocha
CONTRACTOR	Tri-State Drilling & Boring	DATE STARTED	March 16, 2015
DRILLER	Neal Faulkner	DATE COMPLETED	March 25, 2015

Elevation: ft. Datum: Boring Location: Approximately 350 feet northeast of Well #3

GROUNDWATER READINGS: Date | Depth (ft) | Reference

SAMPLER: Type: Hammer (lb): Fall (in):

Rig Make & Model: Foremost DR-12

- ☑ Truck ☐ ATV ☐ Tripod
- ☐ Hollow Stem Auger ☐ Cable Tool ☐ Drive & Wash
- ☐ Mud Rotary ☑ Dual Rotary ☐ Direct Push

Protective Casing: ☐ Roadbox ☐ Standpipe ☑ None

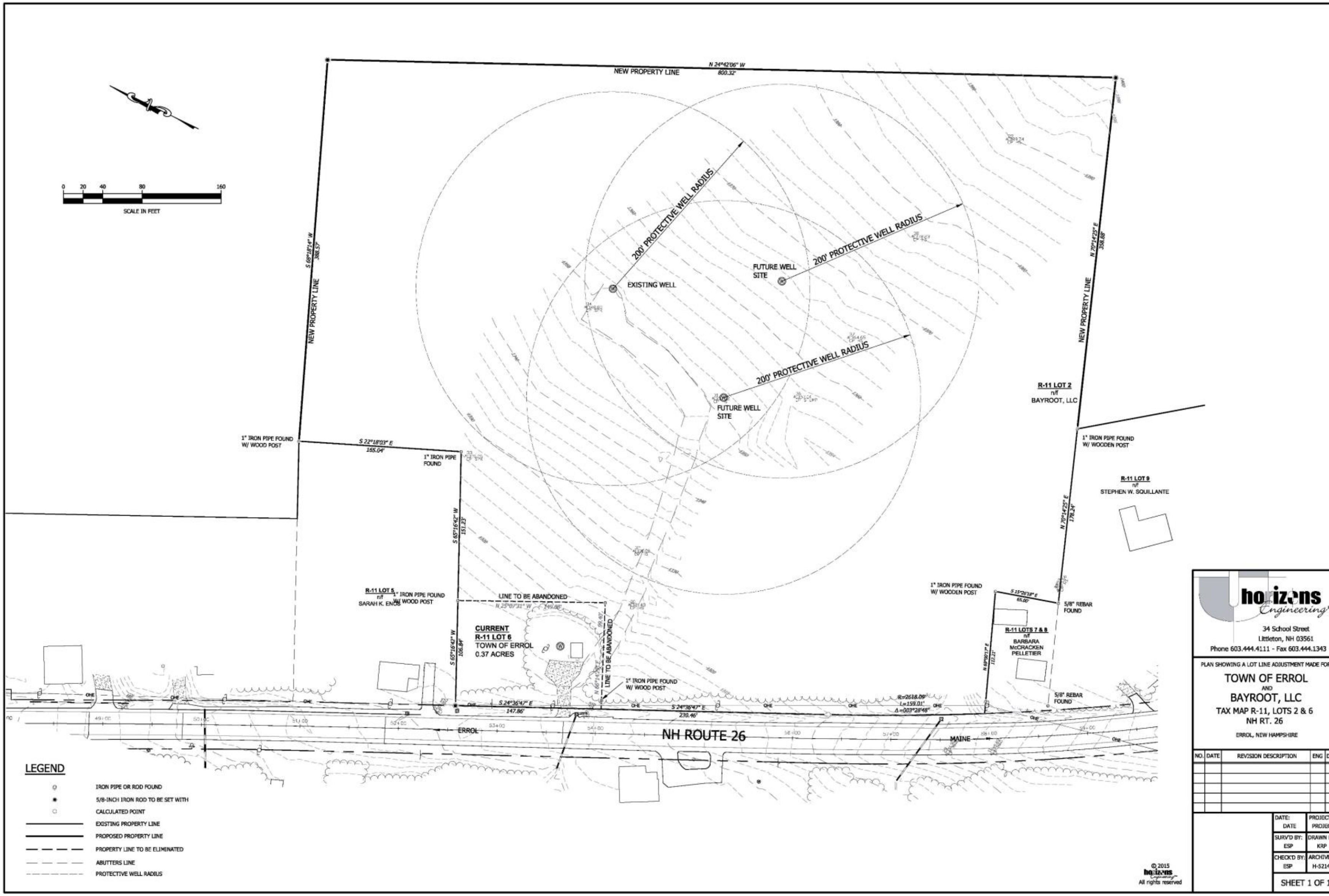
Well Development: ☑ Air Lift ☐ Bailer ☐ Peristaltic

DEPTH (FT)	SAMPLE ID	BLOWS PER 6 IN	PEN / REC (IN)	FIELD SCREENING (ppm)	WELL DETAIL	SAMPLE DESCRIPTION Burmister Visual-Manual Identification & Description (density/consistency, color, maximum particle size in sampler, structure, odor, moisture, optional descriptions, geologic interpretation)	LITHOLOGIC DESCRIPTION
600							
						600' - 620' 14 1/2 minutes, light gray return water.	
						620' - 640' 18 minutes, light gray return water.	
650						640' - 660' 17 minutes, light gray return water.	
						660' - 680' 20 minutes, light gray to light yellow gray return water. 665' - 670'± light yellow granite.	
						680' - 700' 29 1/2 minutes light gray return water.	
700						700' - 720' 19 minutes, light gray return water.	
						720' - 740' 29 minutes, light gray return water.	
750						740' - 760' 30 minutes, light gray return water.	
						760' - 780' 40 minutes, light gray return water.	
						Stopped advancement at 780'.	
						Drillers air lift yield = 50 gpm±.	
800							

GRANULAR SOILS BLOWS/FT	CONSISTENCY	COHESIVE SOILS BLOWS/FT	CONSISTENCY	LEGEND	INTERVAL (FT)		SUMMARY	
0 - 4	V. LOOSE	<2	V. SOFT	Concrete		BGS	Overburden (linear ft.):	205
4 - 10	LOOSE	2 - 4	SOFT	Backfill		BGS	Feet of air hammer	680
10 - 30	M. DENSE	4 - 8	M. STIFF	Grout	0-220	BGS	Well casing length (ft)	220
30 - 50	DENSE	8 - 15	STIFF	Bentonite		BGS	Well standpipe height ags:	2±
>50	V. DENSE	15 - 30	V. STIFF	Rock Boring	100-780	BGS	Well diameter (in.):	6
		>30	HARD	10" Casing	0-80	BGS	Screen length (ft.):	
				6" Casing	0-220	BGS	Screen slot size:	

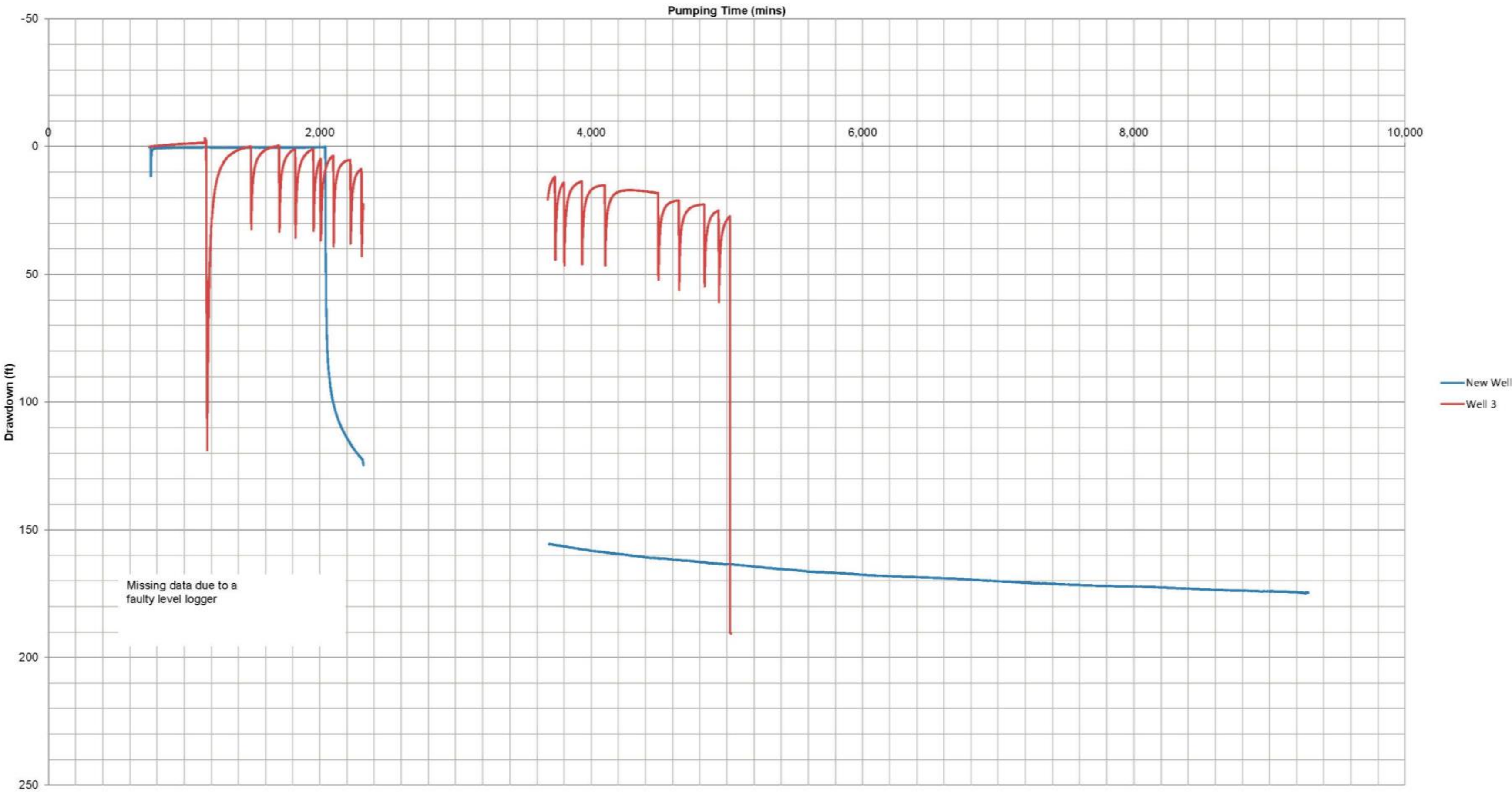
LITHOLOGIC DESCRIPTION: SAND, SILT, CLAY, SAND & GRAVEL, TILL, FILL, ROCK / COMPETENT, ROCK / WEATHERED

NOTES:



P:\13212 Errol - Water System Improvements\DWGS\FINAL\13212_LLA-02.dwg, 5/26/2015 12:30:33 PM, eposspesil

Errol Water System June 2105
Figure 8 - Composite Drawdown: Arithmetic



Case Study 1:

Town of Errol, NH

Project Outcome

•New Well Installed and Permitted for ~40 gpm (~57,600 gpd)

•Excellent Water Quality

•No Waivers Required

•Land Reserved for Two Additional Future Wells If Ever Required

Case Study 2:

Whip O Will MHP, Plymouth

Pre-Project Water System Overview

•Small Community Water System

•~65 Service connections

•Two existing bedrock wells:

- Well #4– low yield, high FE/MN, adequate protective area
- Well #5– moderate yield until catastrophic failure, no longer viable

Whip O Will MHP Cooperative suffered from poor quality water. Primary producing well failed due to collapse. Community forced to truck in water.

Funding secured through USDA Rural Development

Goal: Develop new source with 20 gpm capacity immediately

Ridgewood Pl
Maple Dr
Daniel Webster Hwy
Pine Dr
Birch Pl
Hemlock Ter
Highland Ter
Tamarac Pl
0
150
300ft

Case Study 2:

Whip O Will MHP, Plymouth

Project Progress

•New bedrock well (Well #6) installed at best available location

•Drilled to 1400+', drillers estimated yield of 15 gpm, good water quality

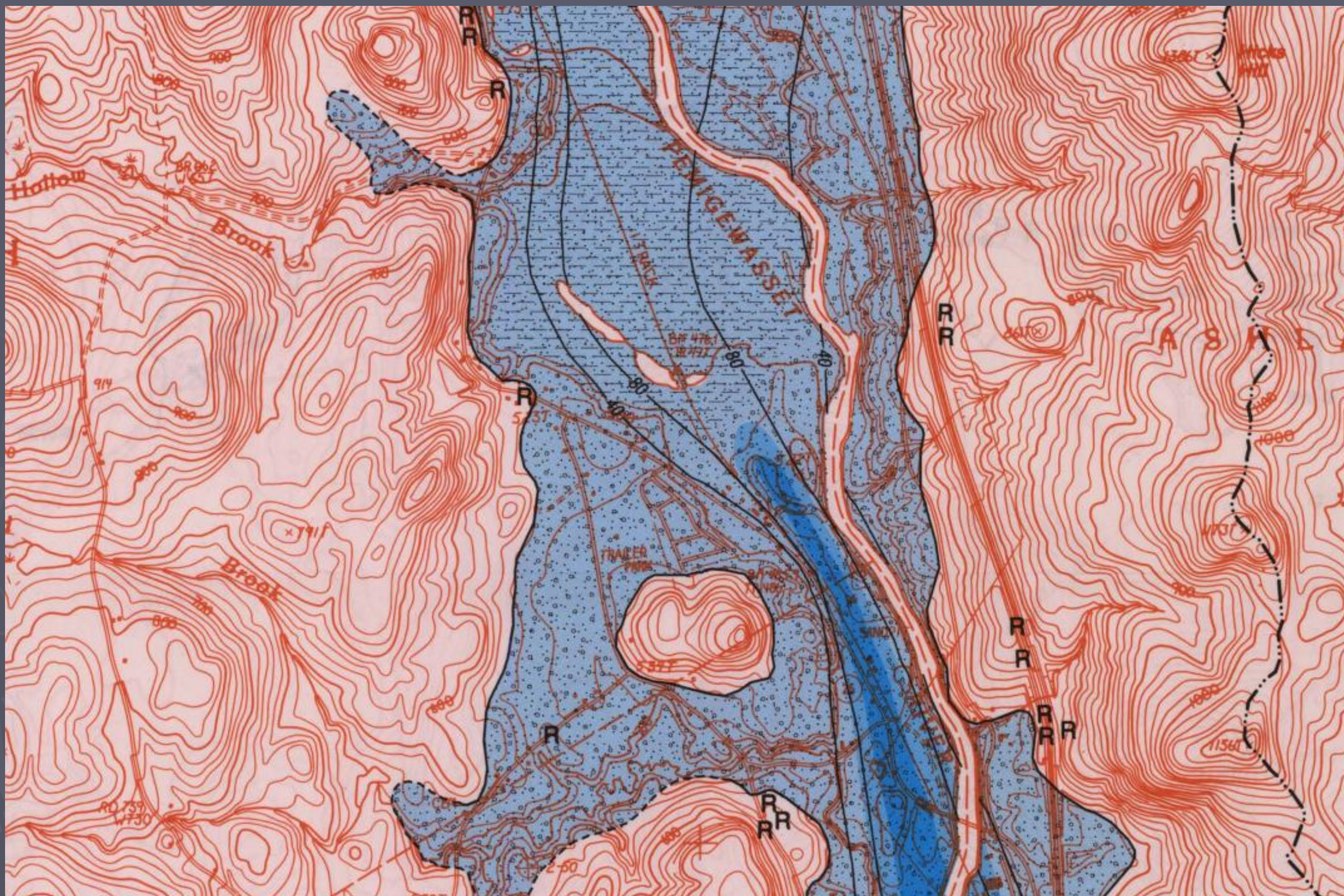
•Well connected via temporary connection

•Well yield began decline almost immediately, currently pumping at ~6 gpm

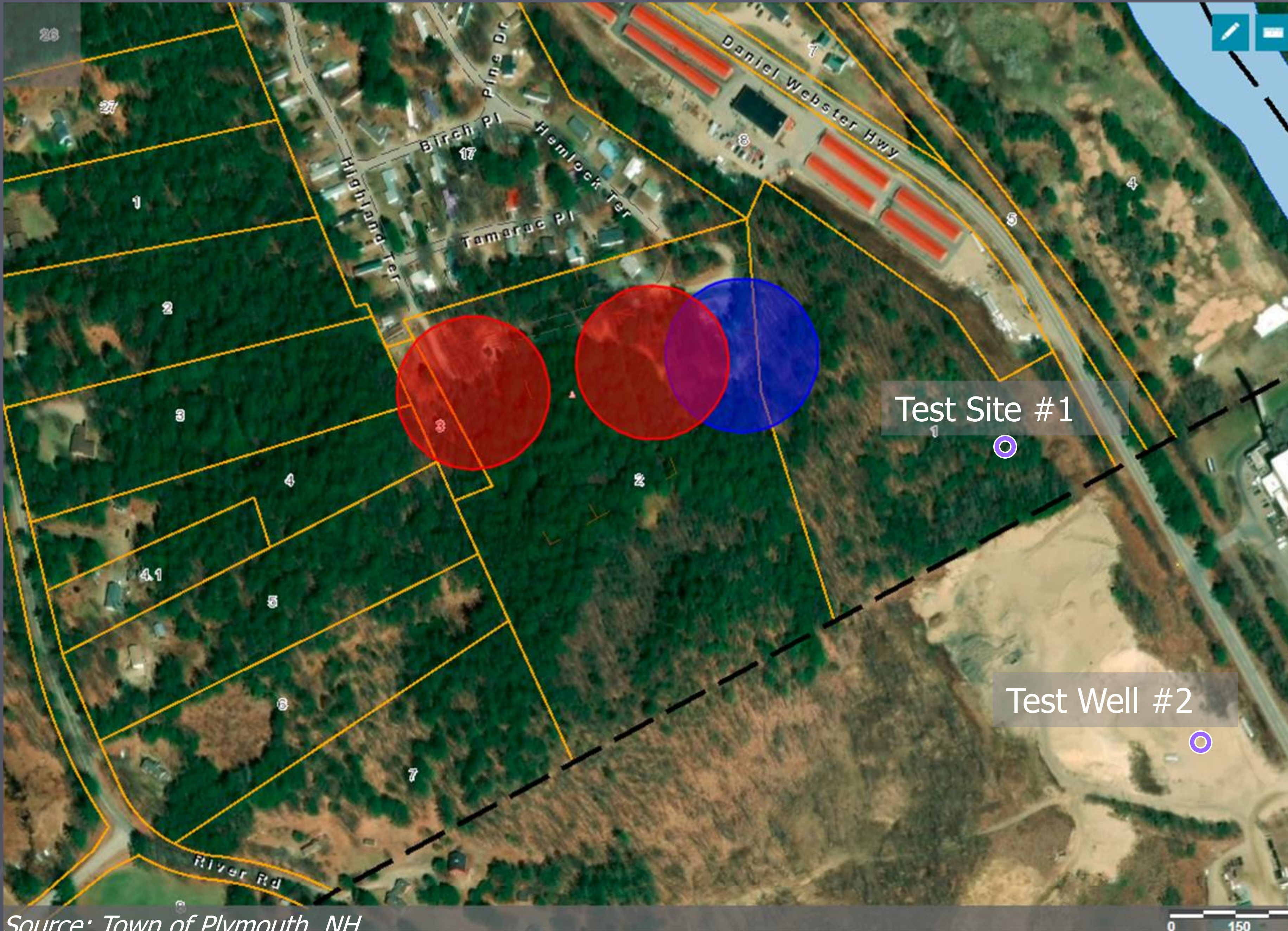
•Community no longer trucking water but wells pumping almost 24/7

•ADDITIONAL SOURCE NEEDED

Sand and Gravel Aquifer Mapping



Source: USGS WRIR 94-4083



Source: Town of Plymouth, NH

Test Drilling and Yield Testing

- Location 1 drilled to ~90'. No adequate formation material identified, poor air lift yield

- Location 2 drilled to ~140'. Excellent formation material identified below 100', air lift yield >150 gpm. Testing underway.

Case Study 2:

Whip O Will MHP

Project Outcome

- New bedrock well installed which gave adequate interim supply but not adequate long-term supply

- Negotiations with abutting landowners resulted in gaining access to additional property under a purchase and sales agreement.

- Two test wells drilled, one with yield in excess of 150 gpm.

- Several waivers needed on well setbacks. NHDES consulted early before test drilling.

- Preliminary water quality appears excellent, final well permitting underway now.

FINAL THOUGHTS

- Locating and permitting new water sources is generally a lengthy, expensive process.

- Assess the vulnerability of existing supplies from a long-term perspective before a problem arises.

- Complete adequate ongoing monitoring of well field health, including yield and water quality.

- Adequately consider each step, and be prepared for setbacks.

Thank you!

Source: Google Earth