

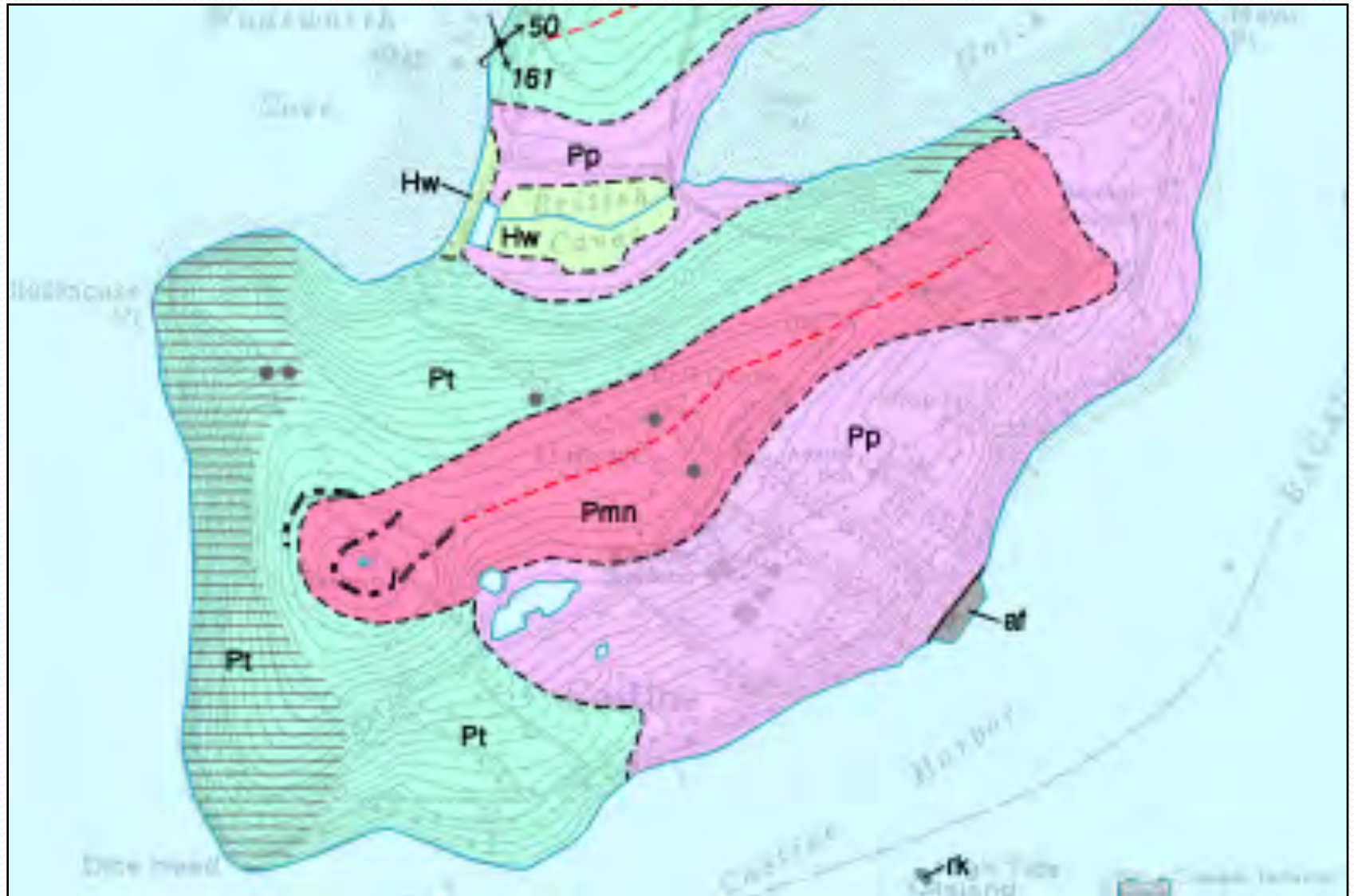
Castine's thin sand and gravel aquifer tapped by two unique well designs

Peter Garrett, Emery & Garrett Groundwater
Annaleis Hafford, Olver Associates

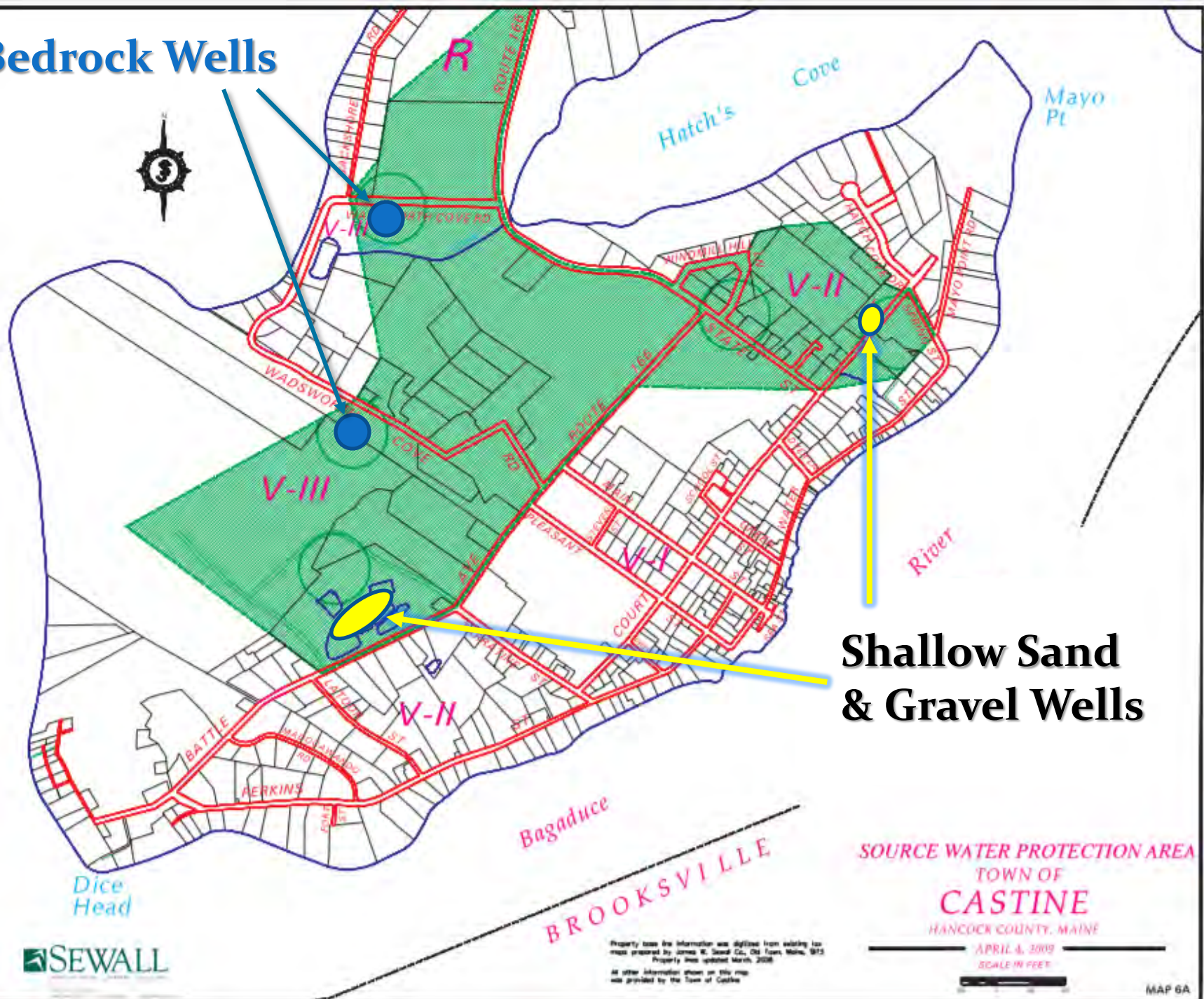
Castine's setting: like an island



Surficial Geological Map (MGS)



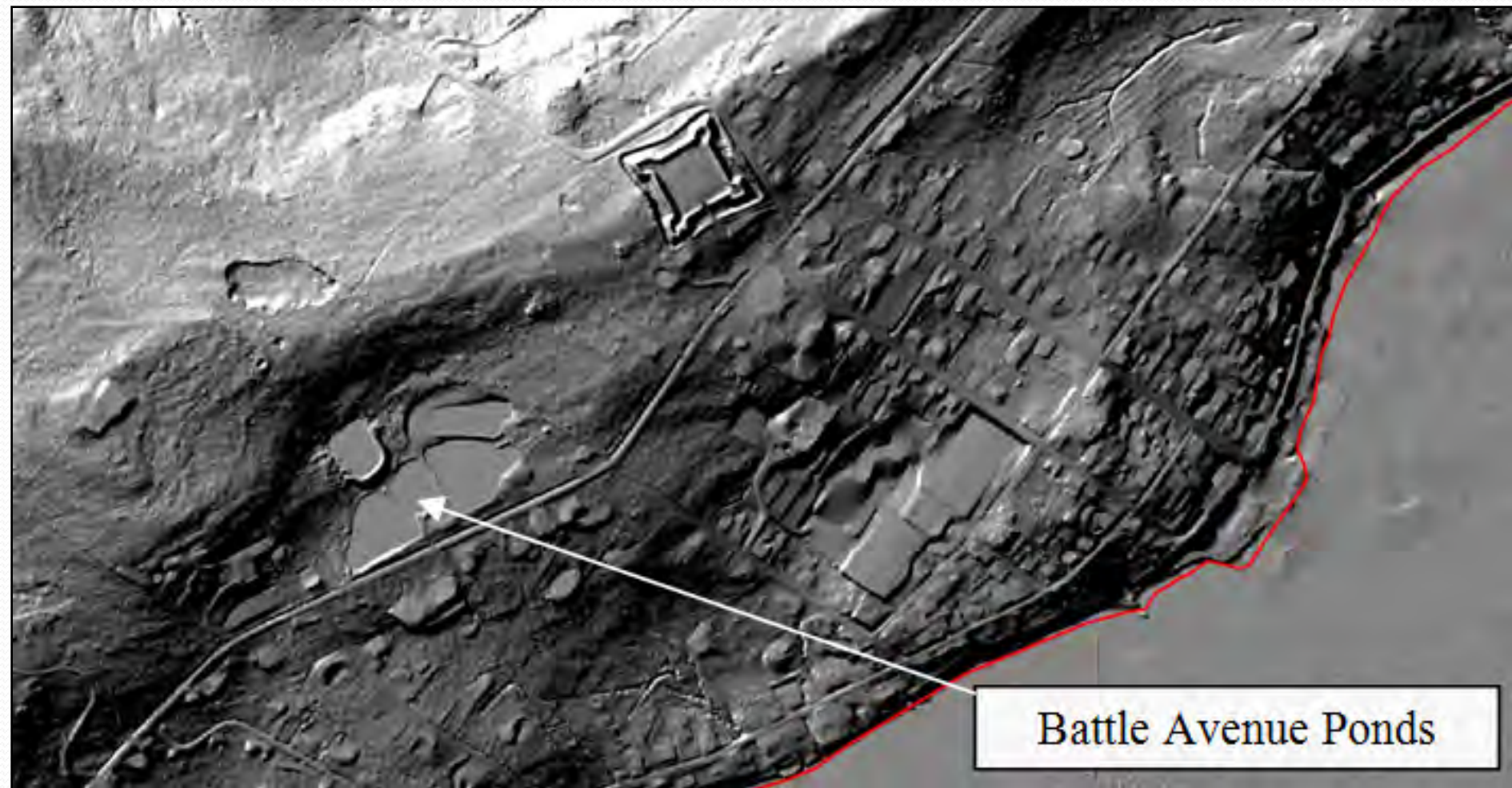
Bedrock Wells



Shallow Sand & Gravel Wells

Battle Avenue Horizontal Well

LIDAR of Castine Village area



Battle Avenue Ponds



Evolution of the System

- Springs common north of Battle Avenue
- Spring House built north of Pond #1
- Pond#1 constructed, with drain to water system
- Ponds #2, 3 and 4 constructed to capture additional flow
- Pond #5 constructed in 1970s
- Surface water treatment in use 1980s
- Pond use ceases in 1990s due to failed treatment.

Pond #1 revealed, 2013



Ponds # 2&3, connected at +138 ft elevation



Geology exposed



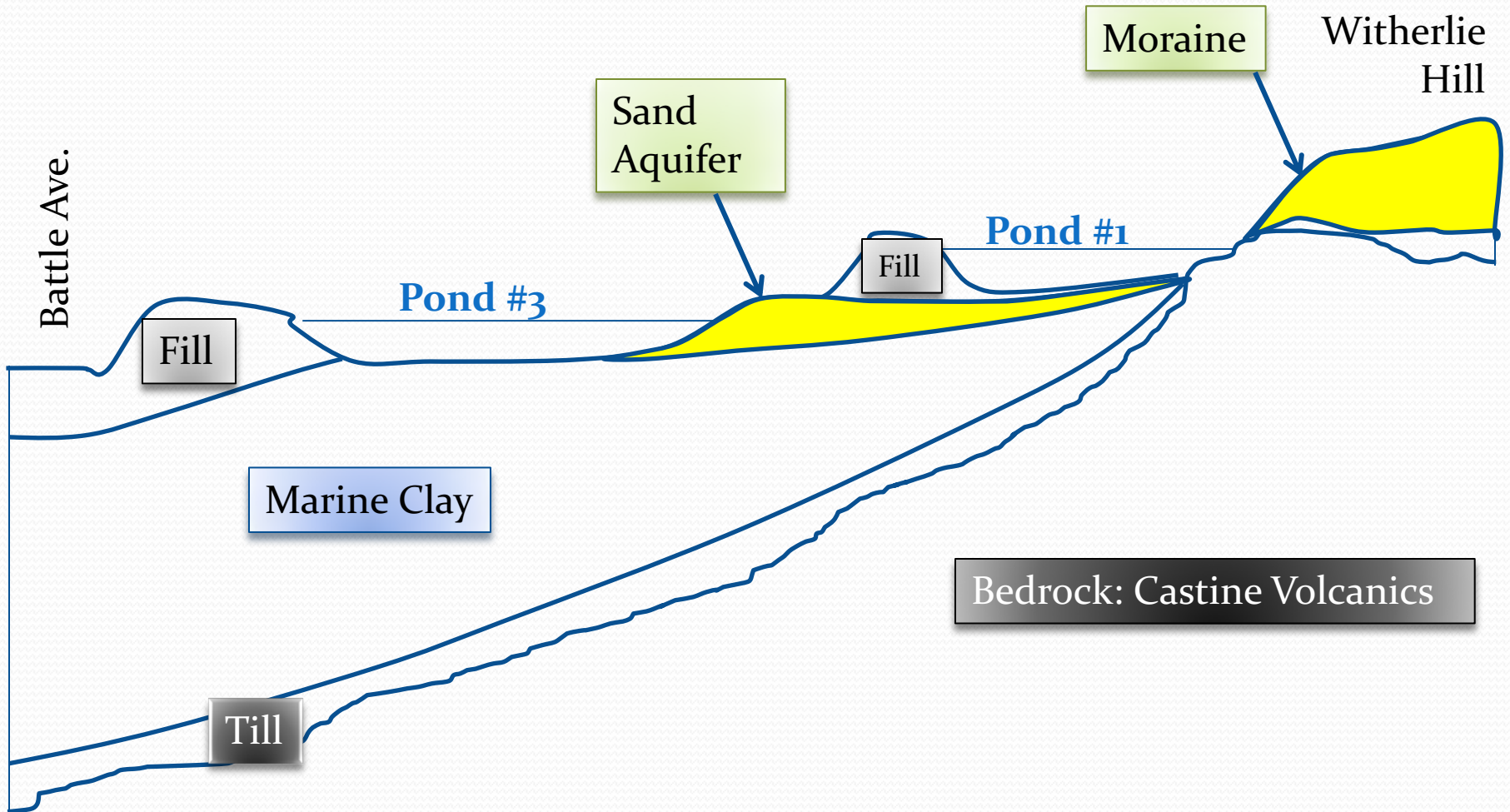
Till

**Sand &
Gravel**



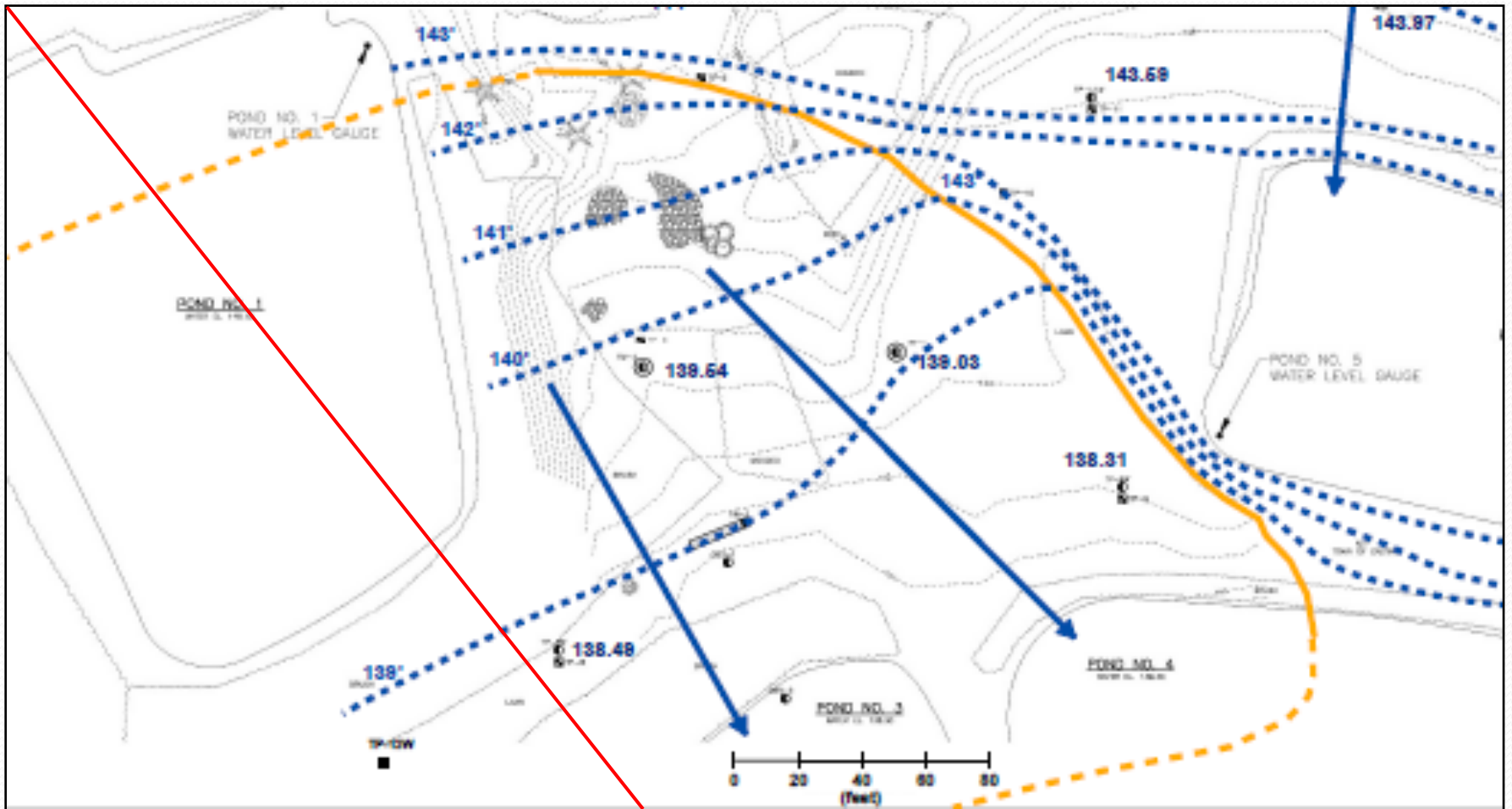
Marine Clay

Geological cross-section



Extent of Sand & Gravel.

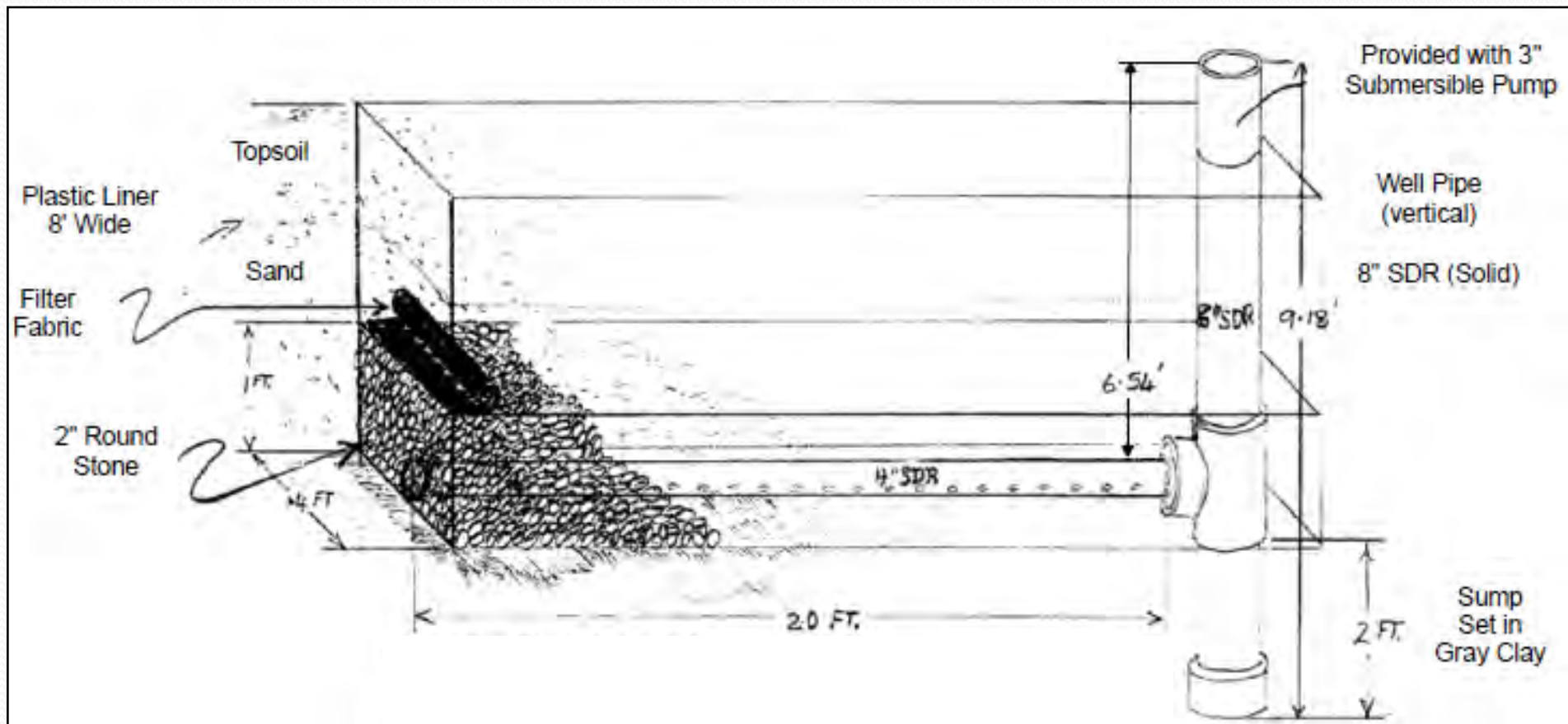
Groundwater contours & flow



Installation of test well in 7 ft of sand Dec.'12

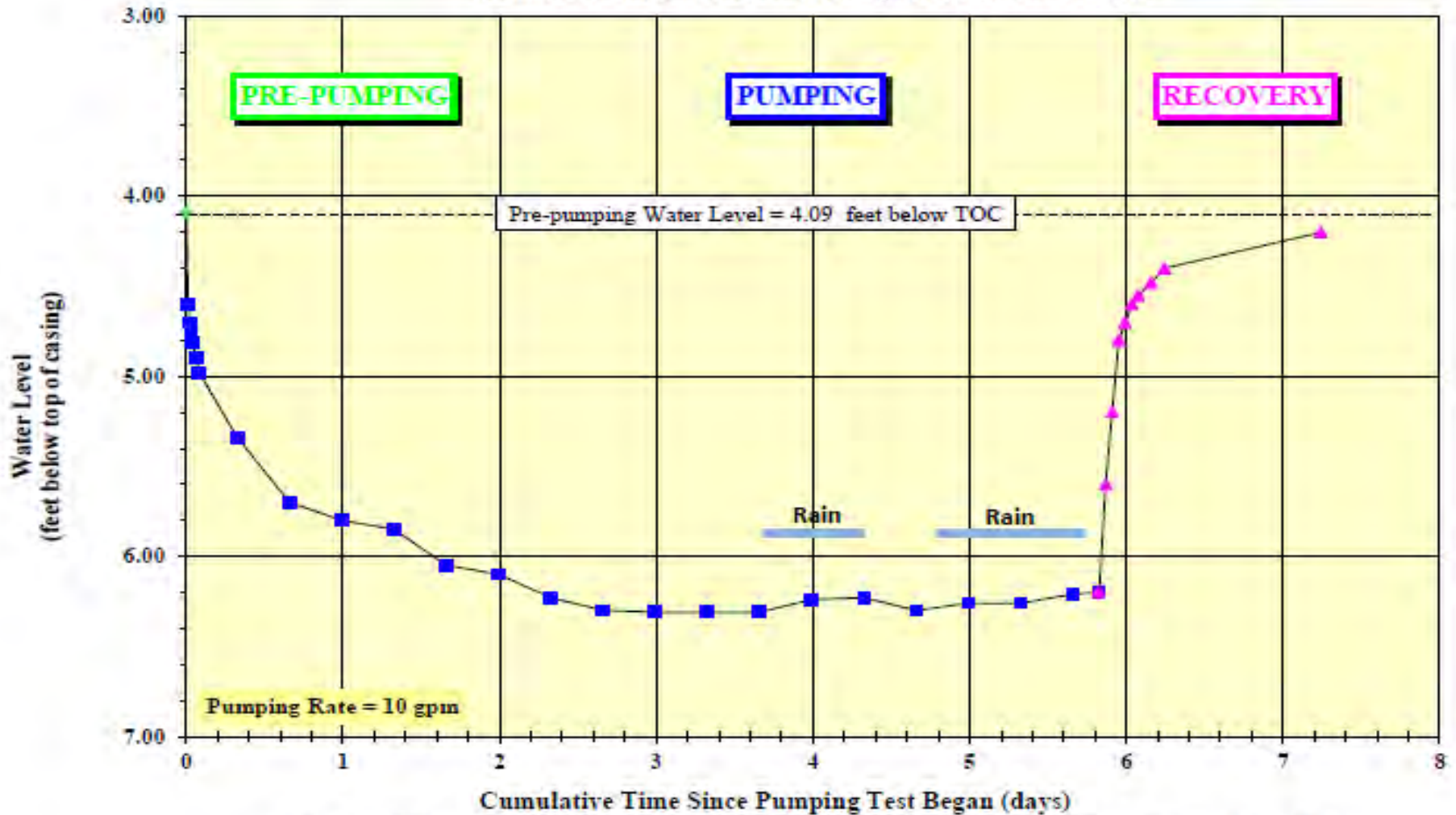


Test Well design



Pumping Test Results

Maximum Drawdown Observed During Pumping Test = 2.22 feet



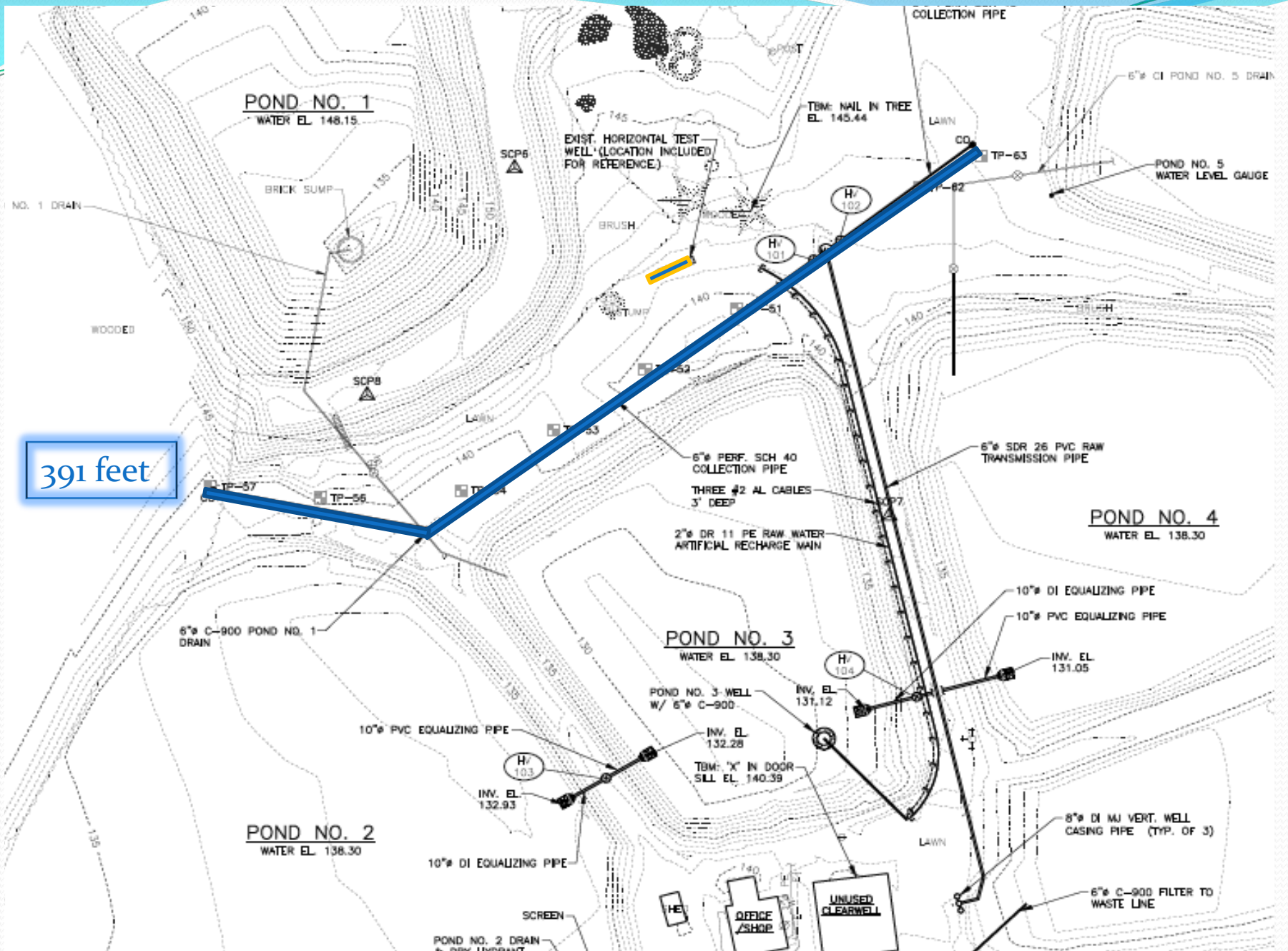
Plot of Water Level versus Time for December 11 to December 18, 2012

Water Quality

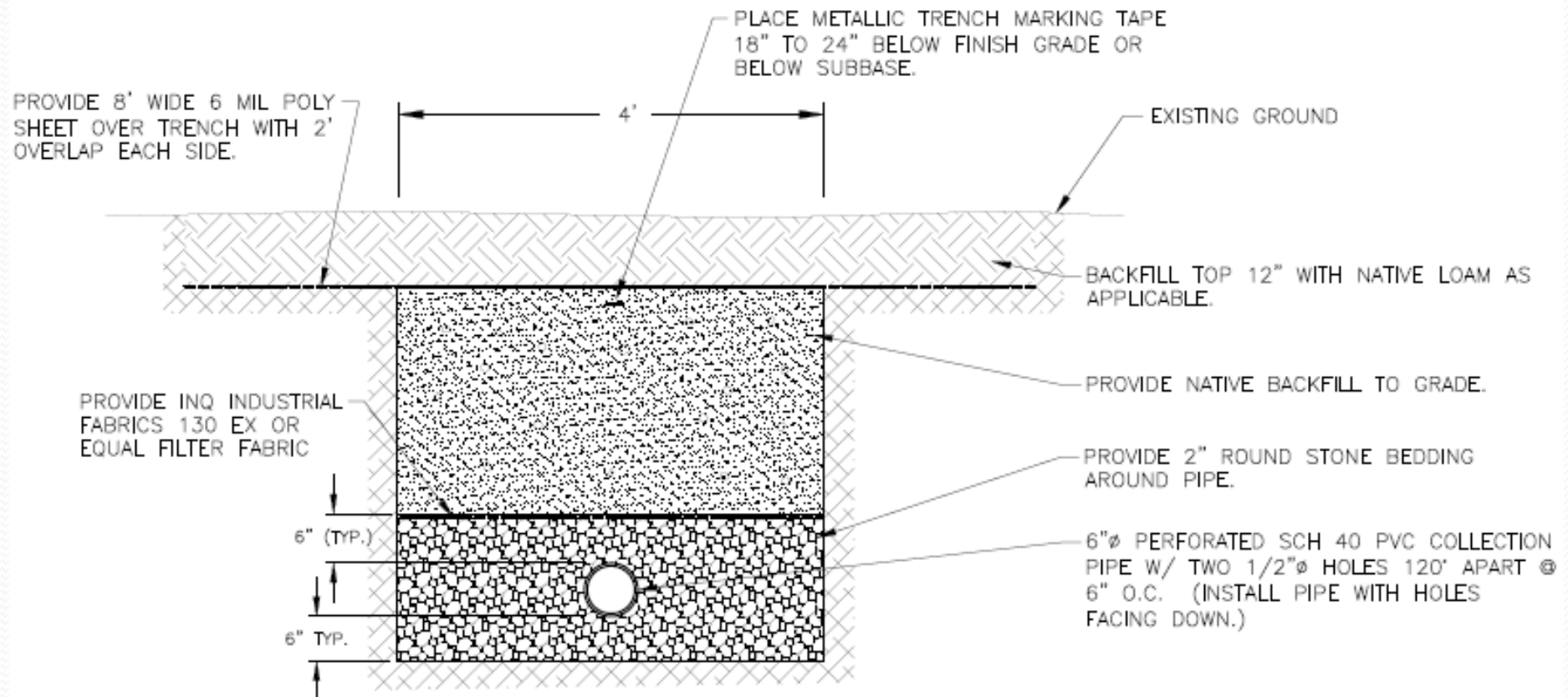
- Sampling April (wet season)

Groundwater flowing to horiz. test well from hillside

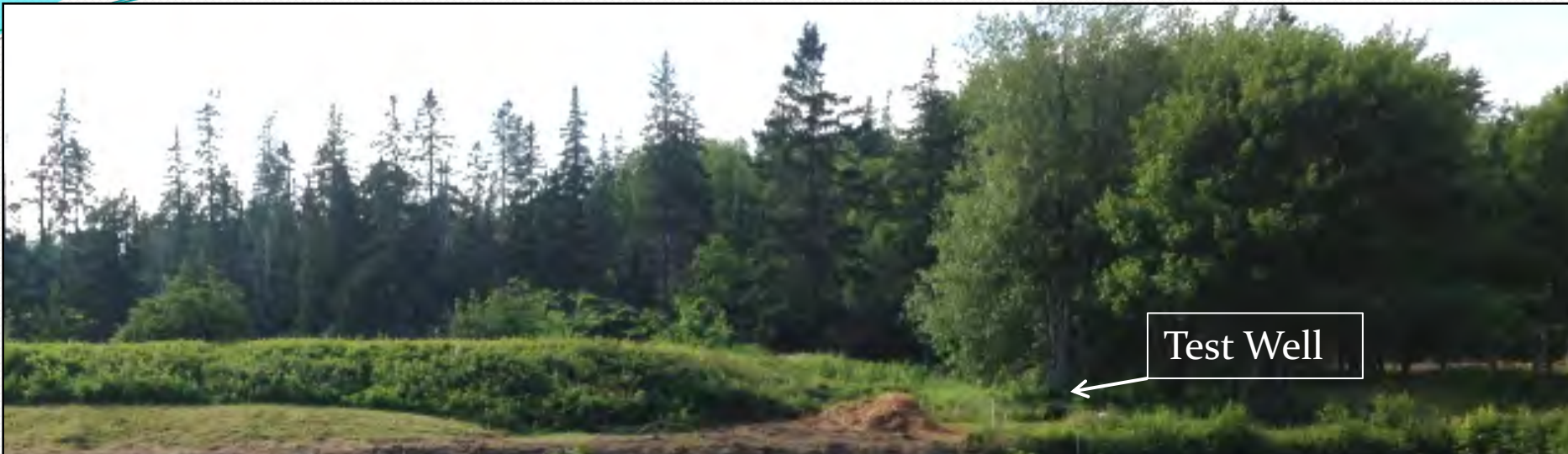
- Bacteria: none detected
 - No Giardia or Cryptosporidium
 - **MPA moderate risk** due to Diatoms, Rotifers and “other algae”
- Sampling June (after draining Pond #1)
- Groundwater flowing to horiz. test well from Pond #3
- Same results



Production Well Specifications



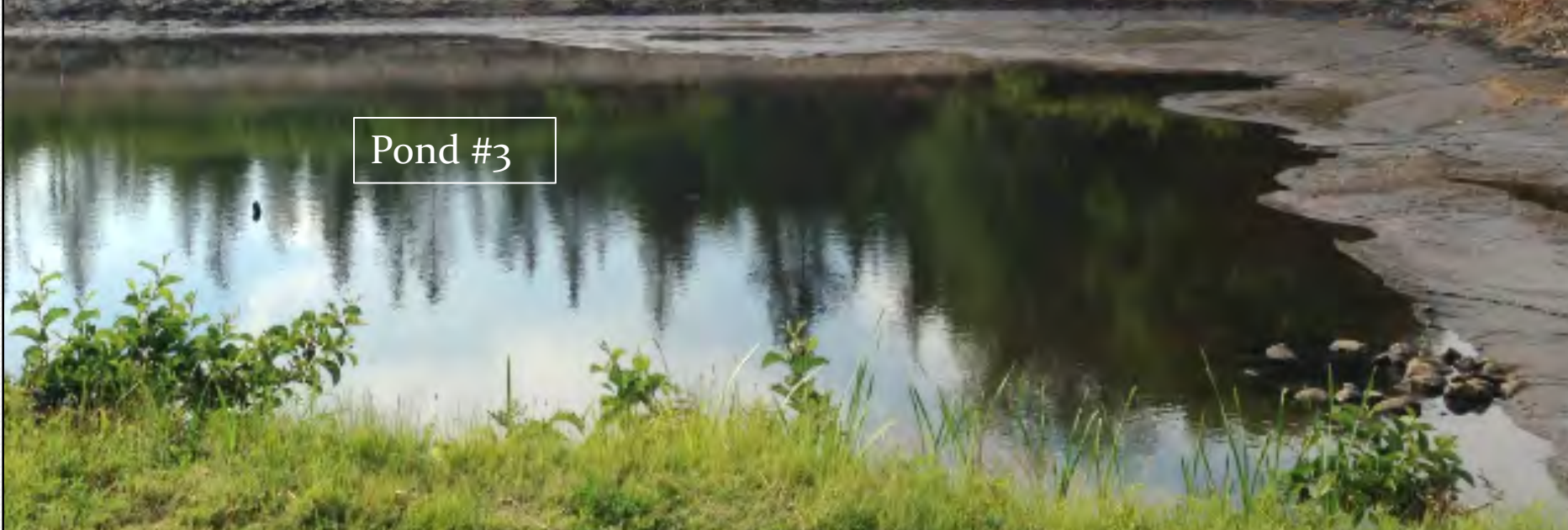
COLLECTION PIPE TRENCH DETAIL



Test Well



Production Well



Pond #3



Test Pitting prior to Production Well Construction

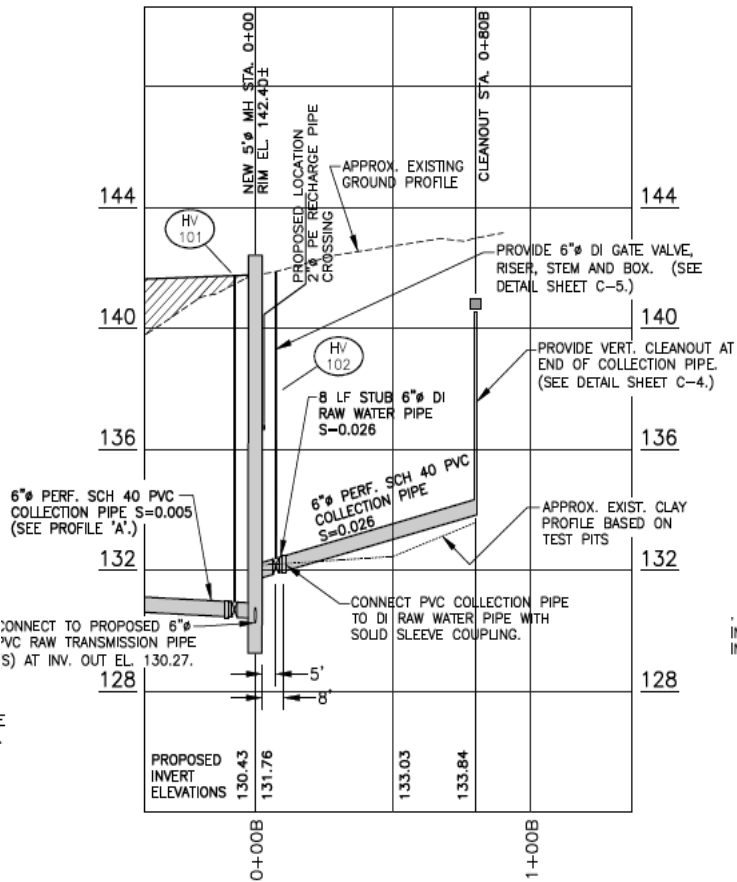
Loam over Sand over Clay



Production Well Construction



The manhole



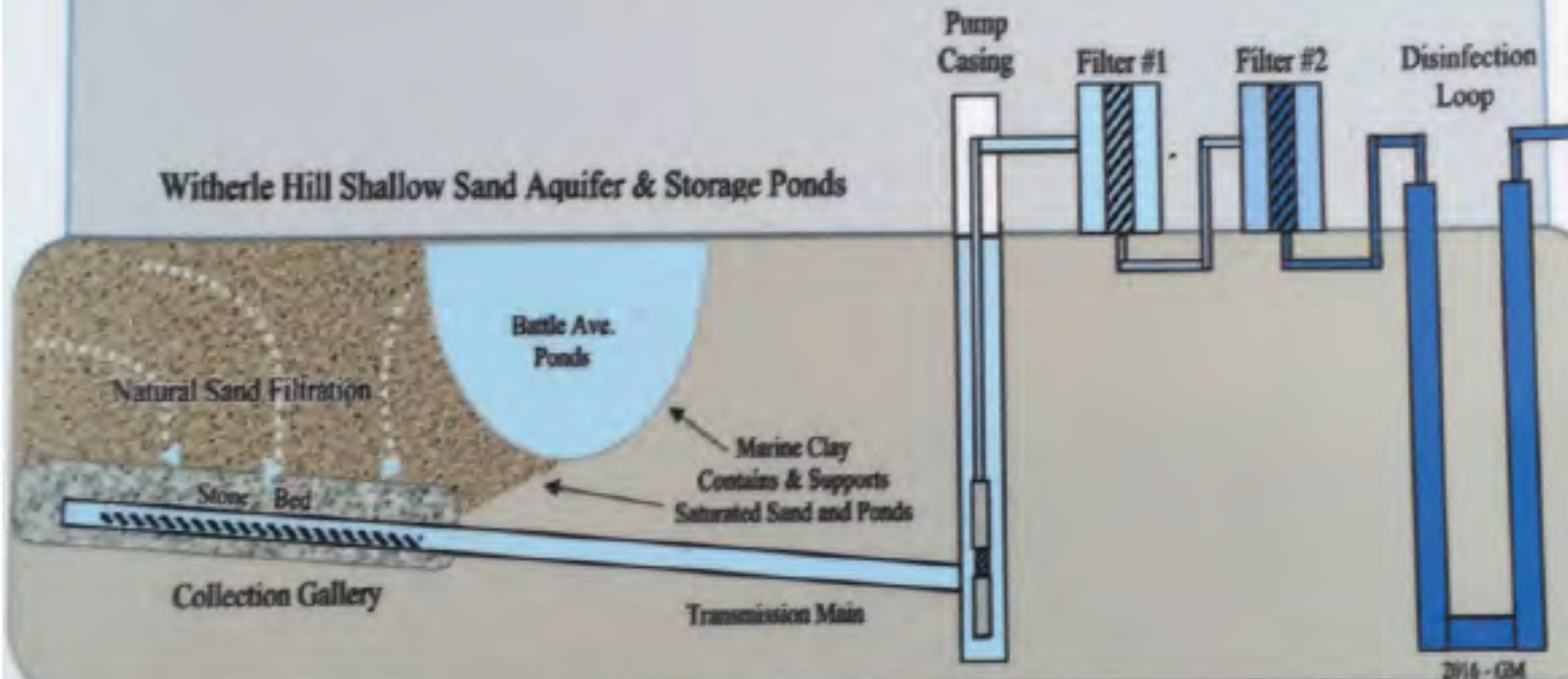
Castine Water Department



Battle Avenue Collector & Filtration Process

Castine Drinking Water

Witherle Hill Shallow Sand Aquifer & Storage Ponds



Hydrological Design:

Mechanic Design:

Collector Contractor:

Electrical:

Drinking Water Operator:

Peter Garrett, Emery & Garrett Groundwater

Annaleis Hafford & Daniel Piasecki, Olver Associates

Bowden & Son

Jeff Seeley

Jamie Bowden

Filter Contractor:

Sargent, Corp.

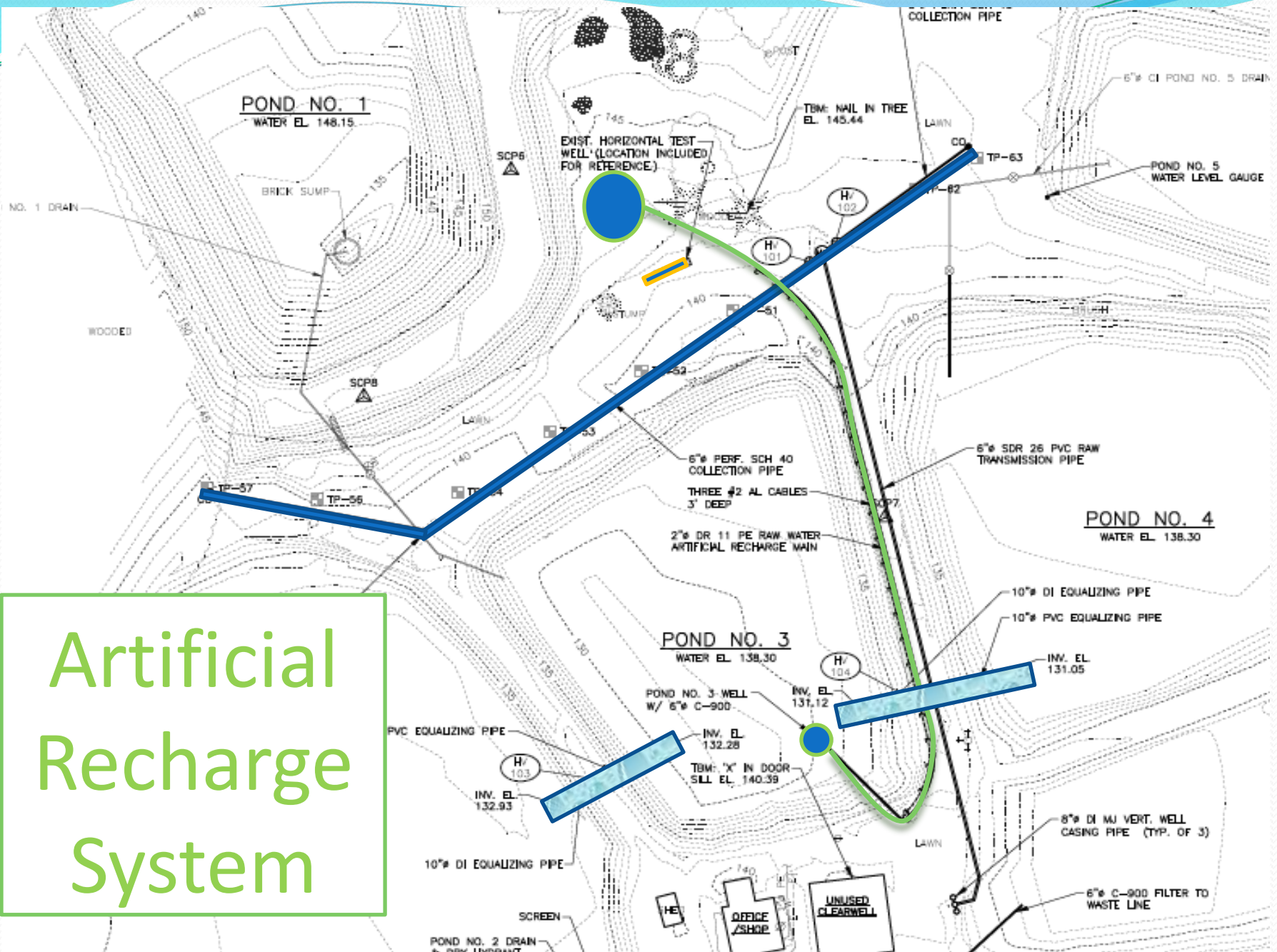
Process Control:

Fitch Co.

Project Coordinator:

George Motycka

Artificial Recharge System



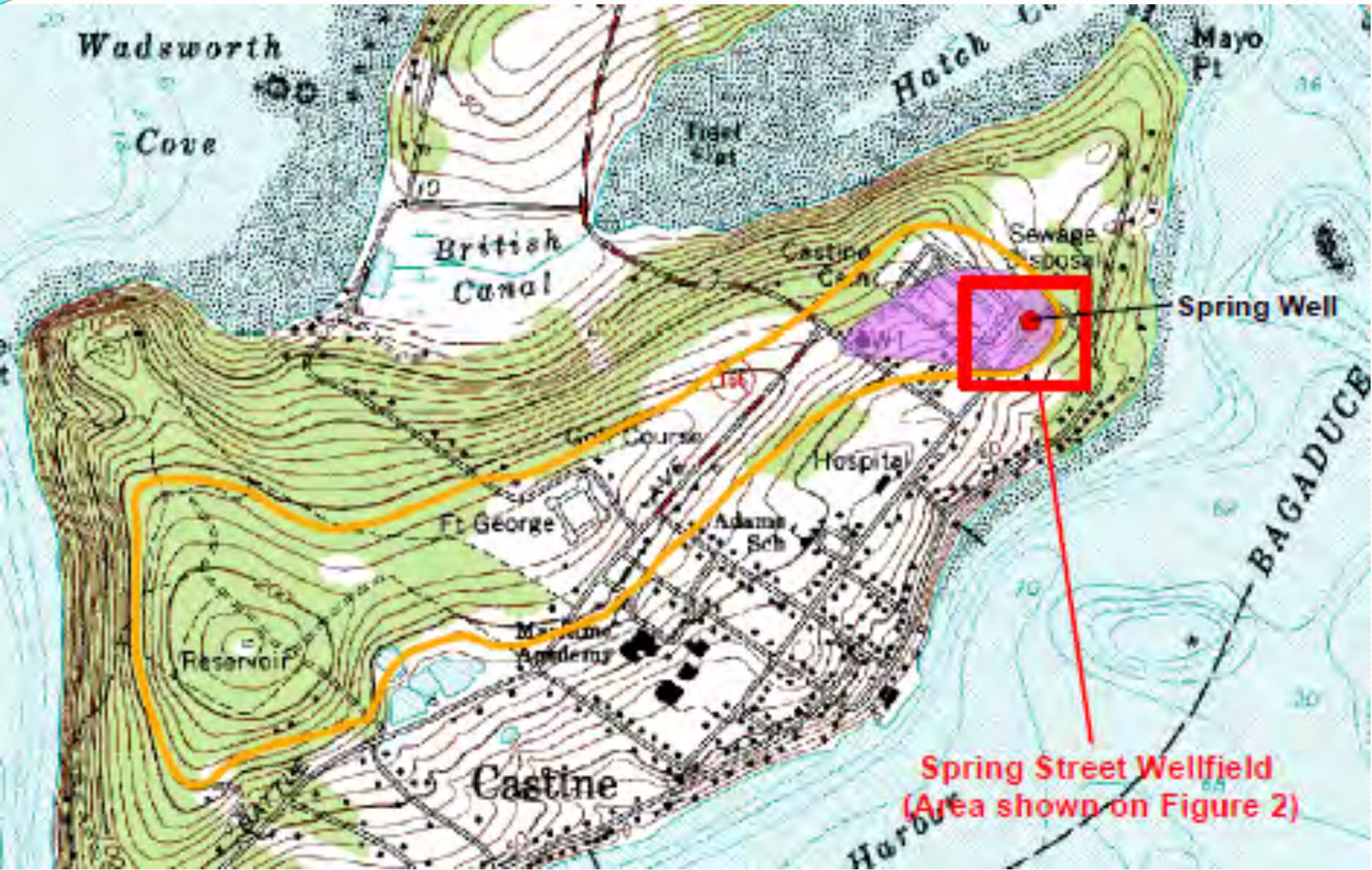
Pond #3 drained, September 2014



Timeline for the horizontal well

- December 2012. Test Borings, Test Pits, Install Test Well
- January 2013. Test Pump for water quality
- June 2013. Test again for bacteria and MPA
- Summer 2013-2014. Production Well Design
- Summer 2014. Drain Battle Avenue Ponds, Test Pitting
- October 2014. Install Production Well & Piping
- Fall 2014. Ponds fill up
- January 2015. Test pump the Production Well
- Summer 2015. Treatment system in...ready to go on-line

Spring Well



**Spring Street Wellfield
(Area shown on Figure 2)**



100 feet

SW-4

90.1

88.3 MW-1

88.1 Spring Well

SW-3

92

92.0

TW-4

90

88

SW-1

86.6

SW-2

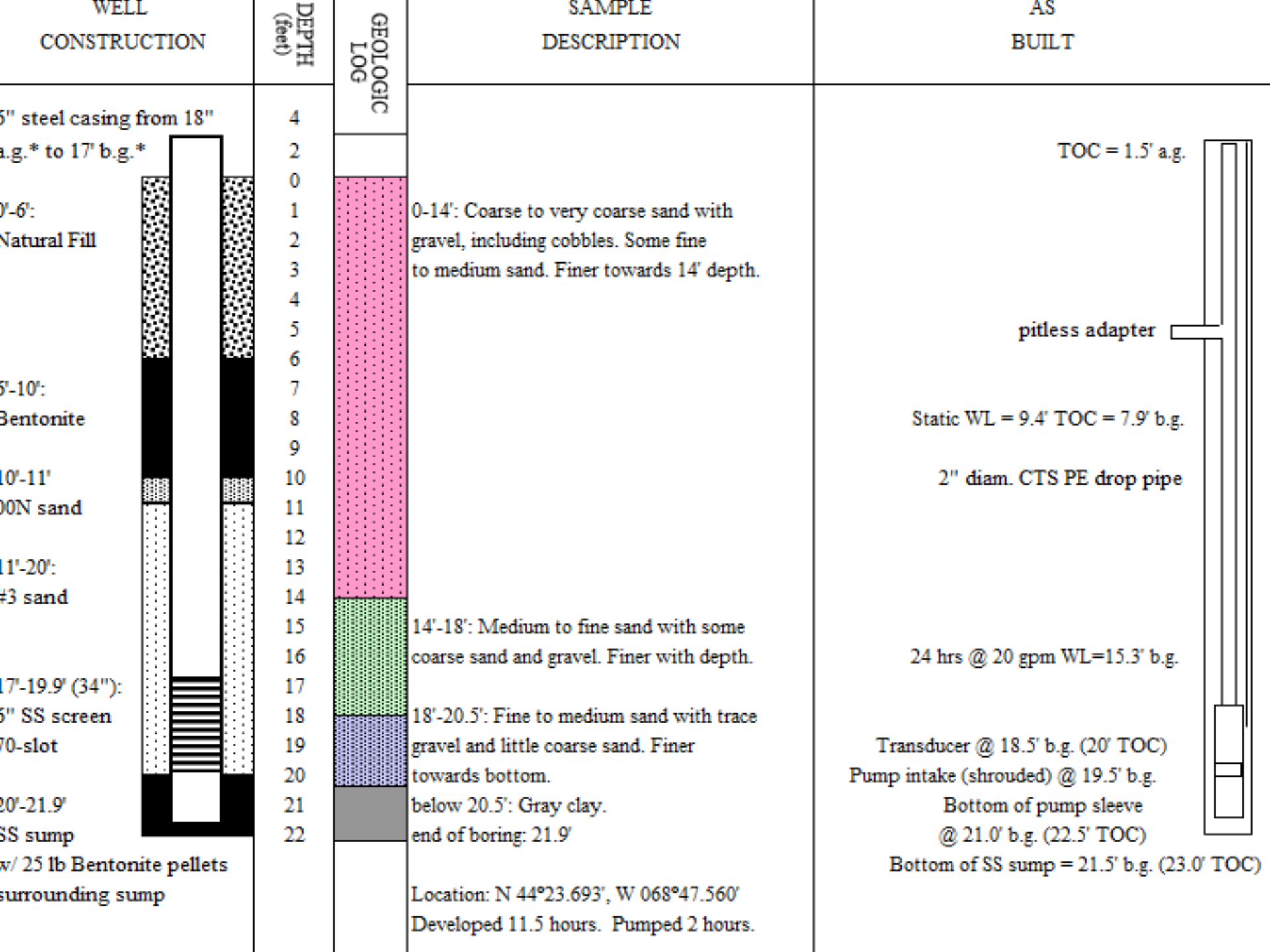
86.5

Springs





Aquifer materials as drilled

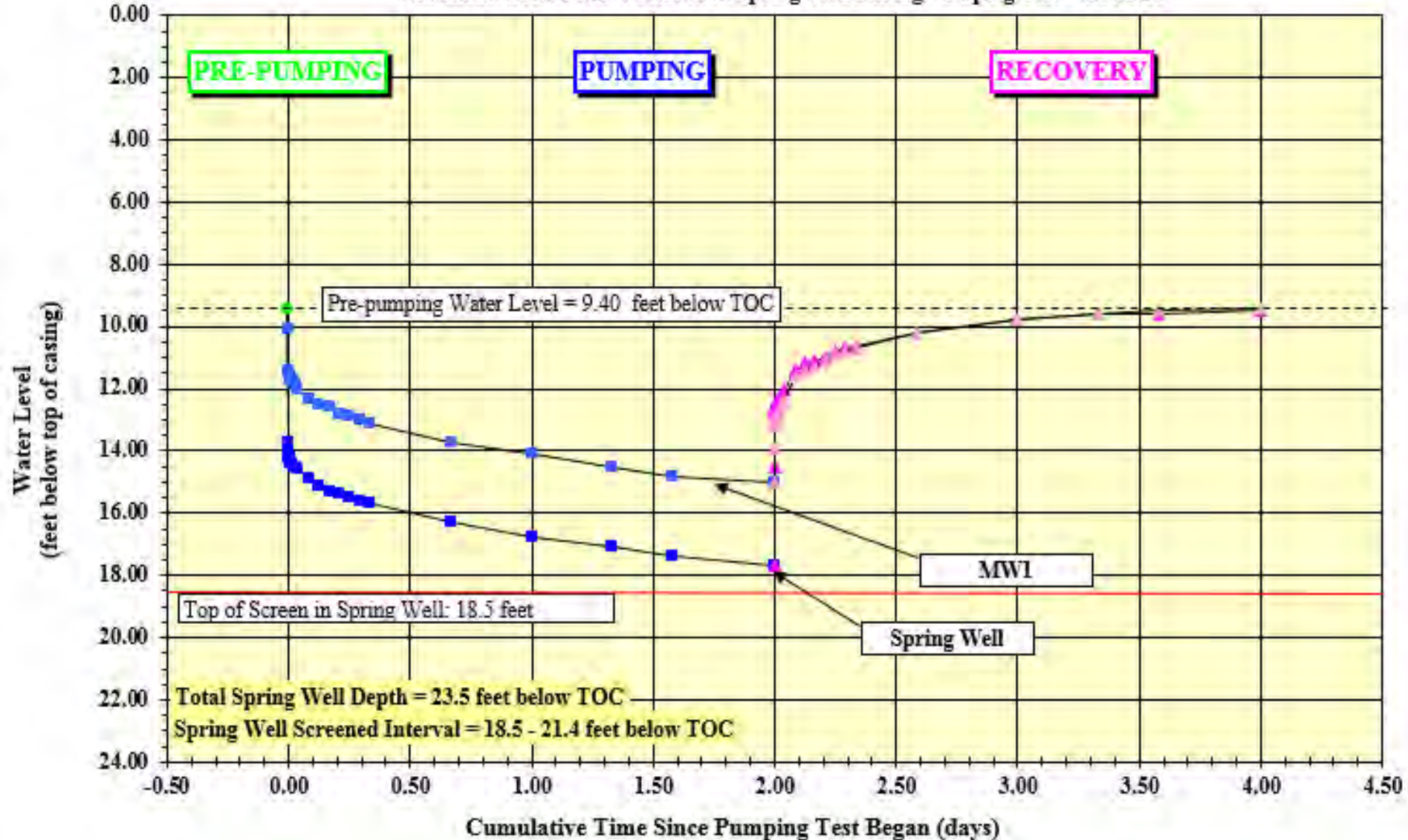




The well prior
to installation,
with:
6" steel casing,
70-slot screen,
and sump

Spring Well: 48 Hour Pumping Test

Maximum Drawdown Observed in Spring Well During Pumping Test = 8.30 feet





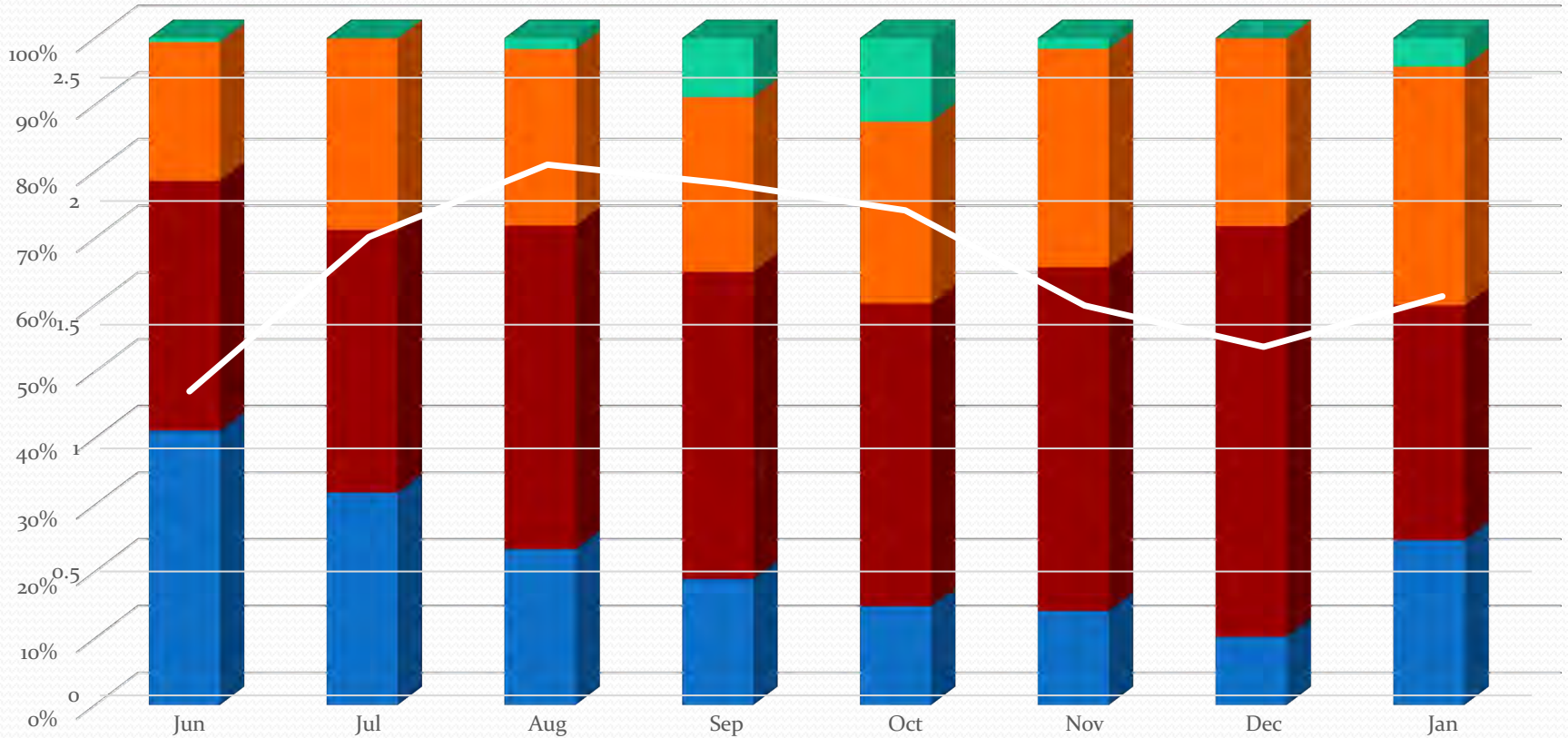
The completed Spring Well site

Castine Water's Operational Details

- **Spring Well.** Cleanest and least costly source. Aquifer Dries up in Summer.
- **BC Well.** Next cleanest. Yield limited due to Tidal Influence.
- **350 Well.** Arsenic treatment is expensive. Well has Highest and Consistent Yield.
- **Battle Avenue Well.** Treatment with Filters expensive. In Drought, a 9MG Backup Source.

Relative Use of Castine's G'W Sources

Total Production



Jun

Jul

Aug

Sep

Oct

Nov

Dec

Jan

■ Spring Street ■ 350 Well ■ BC Well ■ Battle Avenue

Questions?

- Peter Garrett, 207-592-0004
- Annaleis Hafford, 207-223-2232