HYDROGEOLOGIC REPORT

SWSA SNOW POND

INDIAN CAVE ROAD, SALISBURY, CONN.

Prepared by Patrick R. Hackett, P.E.

September 23, 2024

PROJECT DESCRIPTION

The Salisbury Winter Sports Association, Inc, better known by the acronym SWSA, proposes to build a pond for providing water in the winter to make snow for their operation. The pond will be situated to the immediate north of the existing tile pipe setup that is currently used to provide water for the snow making operation, and to the west of the base of the hill where the jumps are located. The proposed pond will have a normal pool elevation of 667.0 (based on existing tile observed water elevations), an area of 0.27 acres, and a usable volume of 1.3 acre-feet. (see plan for map). All water from the pond used to make snow will ultimately end up in the same aquifer.

SCOPE OF PROJECT

Work consists of removing vegetation and trees in the proposed disturbed area (0.68 acres). The 2 feet of organic material will be stockpiled as shown on the plan, to the west of the pond, where it can dry out. The 8' balance of the excavation consists of stratified drift and will be stockpiled for dewatering. Both stockpiles are temporary and will ultimately be used on-site to fill between ski jumps.

There will be a fence cordoning the pond that allows passage of small wildlife. Areas at the fence will be wide enough to mow, allowing any invasives to be mowed until they are no longer present.

PURPOSE OF PROJECT

The simple answer as to why a pond is needed for the continued operation of the ski jump activities is climate change. Typical snowfall depth in recent times is inadequate to provide sufficient ground cover for jumping. Temperatures between frozen precipitation events diminish what does fall. This fact drives the use of snow making. There are also fewer days and nights in northwest Connecticut suitable for making snow. To make up the difference required to provide sufficient snow, there needs to be an increased volume of available water.

ALTERNATIVES TO INCREASE WATER VOLUME PROVIDED BY POND STORAGE

The goal of any work is to provide sufficient storage to make more snow in less time. Ways to store water can be:

- Pond (proposed)
- Storage container
    - Underground tank
    - Underground cistern

Any reasonable volume of storage would cost in excess of $1 million ($250,000 quote for a 50,000 gallon tank delivered to site, no site work involved). Estimates of a cast in place are lower but still considerably more than the pond option.

SCOPE OF STUDY

This report investigates the availability of groundwater to keep the pond full and if there would be a measurable impact on Moore Brook which is 500 feet west of the proposed pond. A yield test of the existing 9' deep tile pipe is part of this report. Connecticut Water Resources Bulletin Number 12, Water Resources Inventory of Connecticut Part 6 Upper Housatonic River Basin 1972 and other local data will be used to evaluated impact.

GEOLOGY OF SUBJECT VICINITY

The north-west corner of Connecticut has a band of metamorphosed carbonate rock that runs north into Massachusetts and beyond (Stockbridge and beyond) and south into Inwood, New York and beyond. It was deposited during Cambrian, lower Ordovician age (500 mya) and transformed into marble via continents colliding. The vicinity of the proposed pond is within this formation.

Bedrock found on site:

Ow - Walloomsac Schist (Middle Ordovician) - Black to dark-or silvery-gray, rarely layered schist or phyllite, composed of quartz, albite, and commonly garnet and staurolite or sillimanite (locally strongly retrograded to chlorite and muscovite). Locally feldspathic or calcareous near the base.

Ose - Units e and d [of Stockbridge Marble] (Lower Ordovician) - White to gray massive calcite marble, commonly mottled with dolomite and locally interlayered with dolomite marble and calcareous siltstone and sandstone.

Owm - Basal marble member [of Walloomsac Schist] (Middle Ordovician) - Dark-gray to white, massive to layered schistose or phyhllitic calcite-phlogopite marble.

Ꞓsb - Unit b [of Stockbridge Marble] (Upper and Middle? Cambrian) - White, pink, cream, and light-gray, generally well-bedded dolomitic marble interlayered with phyllite and schist and with siltstone, sandstone, or quartzite, commonly dolomitic.

Ꞓsc - Unit c [of Stockbridge Marble] (Upper Cambrian) - Gray, generally massive dolomite marble, commonly contains quartz grains, locally beds of sandstone; may be calcitic near top.

WATERSHED CHARACTERISTICS

Here is an excerpt from the Connecticut Water Resources Bulletin Number 21, Water Resources Inventory of Connecticut Part 6 Upper Housatonic River Basin 1972 (CWRB 21)

The upper Housatonic River basin report area has an abundant supply of water of generally good quality, which is derived from precipitation on the area and streams entering the area. Annual precipitation has averaged about 46 inches over a 30-year period. Of this, approximately 22 inches of water is returned to the atmosphere each year by evaporation and transpiration; the remainder flows overland to streams or percolates downward to the water table and ultimately flows out of the report area in the Housatonic River or in smaller streams tributary to the Hudson River. During the autumn and winter precipitation normally is sufficient to cause a substantial increase in the amount of water stored in surface reservoirs and in aquifers, whereas in the summer, losses through evaporation and transpiration result in sharply reduced streamflow and lowered ground-water levels. Mean monthly storage of water in November is 2.8 inches more than it is in June.

The annual precipitation average subsequent to the 30-year period (1929-1960) above have increased substantially. From 1991 to 2020 the average annual precipitation amount for Norfolk, CT is 52.9 inches and 54.3 inches for Torrington (NOAA National Centers for Environmental Information (NCEI).

SITE CHARACTERISTICS

The proposed pond will be located within the stratified drift area of the landscape. Given how the aquifer is bounded by a significantly lower permeable area on the east side (uphill glacial till and bedrock), the aquifer will be modeled as a bounded aquifer. In lieu of 2π (circumference), π (half-circumference) is used. There are already a number of small ponds north and south of west base of Wetauwanchu Mountain, east of the proposed pond. See the USGS vicinity map. Many of these ponds have been functioning well without any need of surficial runoff. There are 4 public water supply wells 1,100 feet to the south with yields of 75gpm. The aquifer protection line shown at 1000 scale for these wells can be found in the appendix (Salisbury Aquifer Protection Zone). The proposed pond is outside of the zone. The surficial geology map for the State of Connecticut indicates sand and gravel deposits over fines at the site of proposed pond. A 500 scale of the area can be found in the appendix (Surficial Geology). 2 Test holes were dug in the area of the proposed pond (see plan for location). Both holes indicated 2 feet of a dark organic soil over stratified-drift. Strata observed varied from coarse sand and fine gravel to fine to medium uniform sand.

PUMP TEST

A pump test was run on August 24 of this year at the existing well tile shown on the site plan. Pump well level stabilized around 58 gpm (note drawdown continued at 62gpm rate and rebounded at 52 gpm. Flow was controlled by the snow making machine which has set intervals.

Comment	Reading t	Reading d	t_o GPM	t_f GPM	Δ min	Vol Gal	Sum Gal	Reading Feet	Sum t	Elev
Start	11:00 AM	25.75	0	62	-		0	0	0	667.4
Reading	1:50 PM	57	62	62	170	10540	10540	-2.60	170	664.8
Reduced Flow	3:41 PM	58.5	62	52	111	5772	16312	-2.73	281	664.7
Reading	4:34 PM	55.25	52	52	53	2756	19068	-2.46	334	664.9
Reading	5:26 PM	54.5	52	52	52	2704	21772	-2.40	386	665.0
Reading	5:39 PM	54	52	62	13	806	22578	-2.35	399	665.0
End	7:40 PM	61.25	62	62	121	7502	30080	-2.96	520	664.4
AM	6:20 AM	25.75	0	0	640	0	30080	0	1160	667.4

DEMAND FOR SNOW

Existing well conditions allow for a steady pumping rate of 58 gallons per minute (determined in well test). Any rate higher draws the well down requiring flow to be throttled back. At this rate the snow making operation snow can continue for over 14 hours before a 50,000 gallon volume is exceeded. Since snow is only made at night this volume is not currently exceeded. A diversion permit will be applied for after local wetlands approval. The pond will provide the ability (ie, storage) to make more snow than is now currently possible. The area typically covered in snow for the 65m jump is 47,000 sf or 1.1 acres and 75,000 sf or 1.7 acres when covering all three jumps. Using a snow density of 180,000 to 190,000 gallons per acre-foot of snow (density of 0.55 low and 0.58 high), would result in a depth of 1.27 to 1.34 feet using the available 55,432 cubic feet of available storage (prior 2023 pond proposal was just over 2 foot of snow depth).

RECHARGE POTENTIAL

The purpose of this report is to ensure there is a sufficient volume of groundwater available for the proposed winter-time use and the impact of using the groundwater on nearby stream conditions during this time is negligible. As mentioned previously, overburden in the area west of the pond to the brook and beyond is stratified drift. To quote CWRB21, p42, *"The quantity of water that can be withdrawn on a temporary or sustained basis from a stratified-drift aquifer depends on: (1) the hydraulic properties of the aquifer, (2) the location and position of the hydraulic boundaries, (3) the quantity and variability of natural recharge and discharge, and (4) the quantity of water that can be induced to infiltrate from adjacent streams or lakes."*

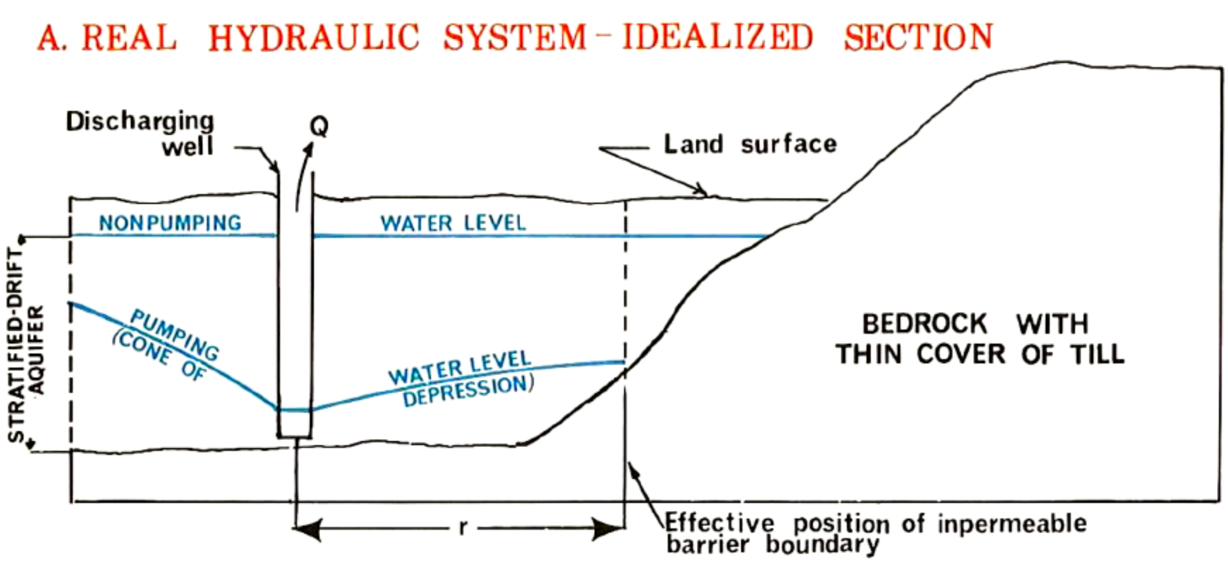
The mapping shown on Plate B-3 of the CWRB21, the Surficial Materials Map of Connecticut (1992), and actual field data, all indicate there is stratified-drift material and that it has very good hydraulic properties. The location and position of the hydraulic boundaries could be better if the proposed pond was located closer to the brook. Consideration of the location of glacial till to the east of the proposed pond has been taken into consideration in yield estimates. The quantity and variability of natural recharge and discharge will be estimated using the data provided in CWRB21. The permeable deposits that hydrogeologically connect the proposed pond to the brook is advantageous for available water. Its impact on the brook will be estimated to assure impact is negligible.

LONG-TERM MINIMUM GROUND-WATER OUTFLOW

Using the percent stratified-drift in the surface watershed, with the adjusted Annual runoff, the long-term minimum ground-water outflow is 4.5 million gallons per day

Long-Term Minimum Groundwater Outflow

Total WS at Discharge Point (A) =	10.28	SM
Area underlain by stratified drift =	3.02	SM
Percent of total WS (A)	29.4%	
Mean Annual Runoff (Fig 17) Isopleth =	0.84	
Fig 18 base mean annual flow	1.16	MGD
Mean Annual Runoff (WS*Isopleth* Mean Annual Flow =	10.0	MGD
Percent of Mean Annual flow (from Fig 37)	55.0%	
Average Annual GW Outflow	5.5	MGD
Fig 18 70% at 22.7%	0.54	CFS/SM
GW Outflow equal or greater than 7 years in ten	3.0	MGD
LT factor	45.0%	
Long-term minimum GW outflow	4.5	MGD



From Fig 35 CWRB21 1

The estimated minimum long term groundwater outflow is ten times the usable design volume of the proposed pond if pumped in one day. The existing well yield is estimated at 57 gallons per minute. If disconnected from the proposed pond (it isn't), it would take 5 days to fill the pond. The radius at the pond is roughly 6 times greater than the radius of the existing well tile and assuming same boundary conditions the usable volume will recharge in less than a day.

IMPACT OF PROPOSED POND ON BROOK

The brook lies roughly 600 feet to the west of the pond. Working elevations at the pond are between 667 and 661. Brook elevations are around 661 to 659. Stratified depths at the brook are between 40 and 80 feet where depths are between 10 and 20 (using both CWRB21 and State Stratified-Drip Map). Straight line gradient neglecting precipitation is 0.3%. A plan and section follows.

APPENDIX

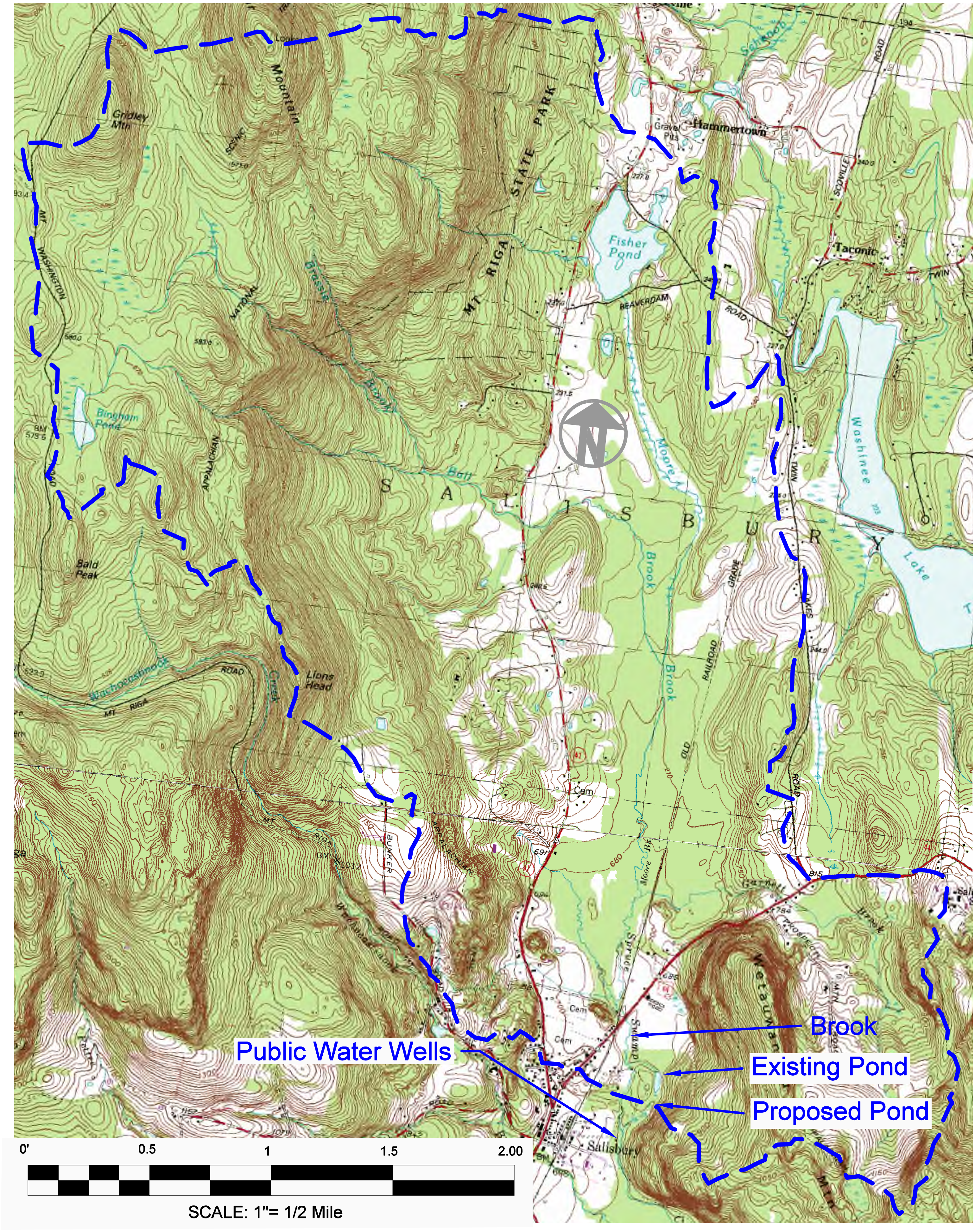
Surficial Materials Map of Connecticut 1992
http://cteco.uconn.edu/maps/state/Surficial_Materials_Map_of_Connecticut.pdf

Bedrock Geological Map of Connecticut 1985
http://cteco.uconn.edu/maps/state/Bedrock_Geologic_Map_of_Connecticut.pdf

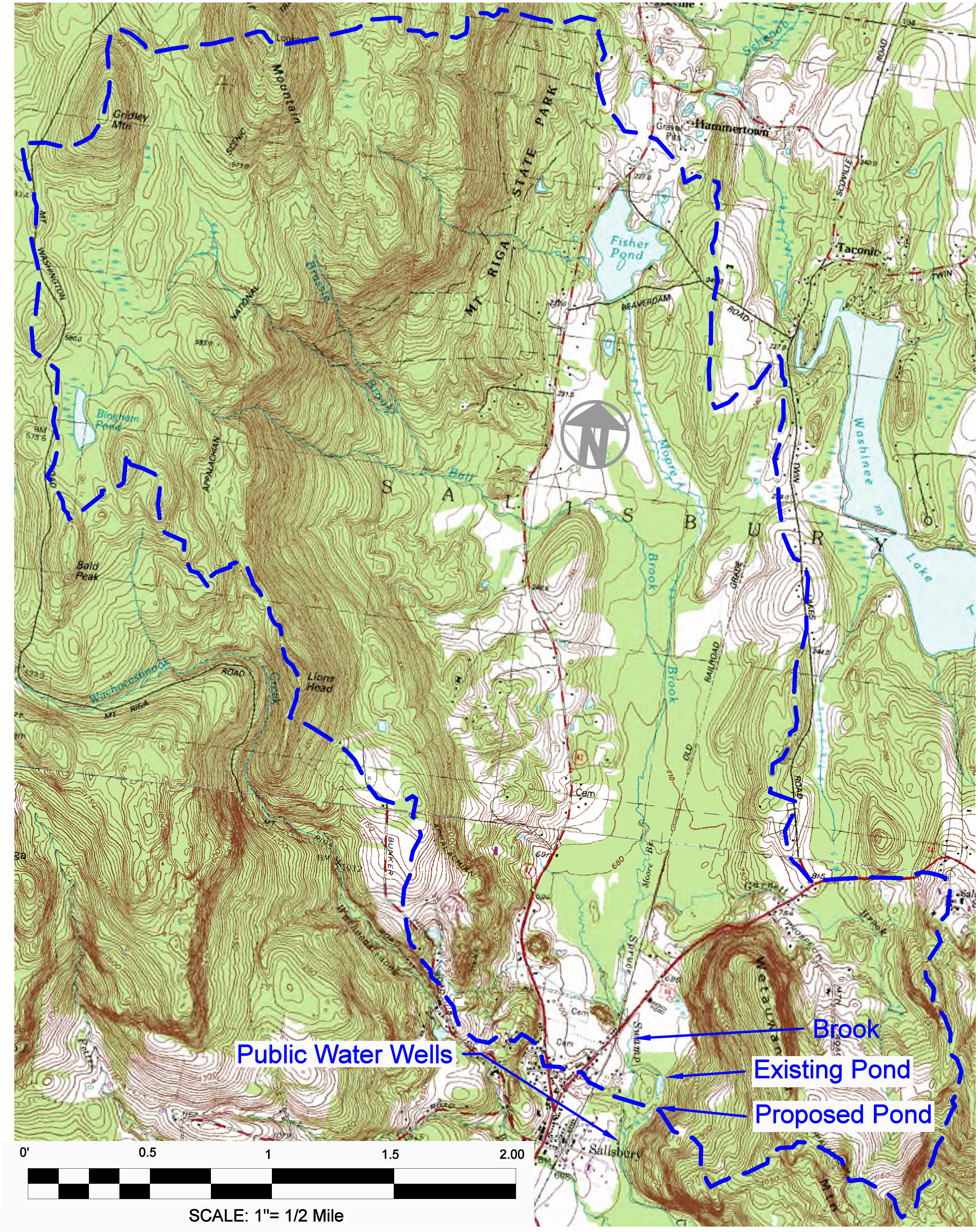
The Bedrock Geology of the Sharon Quadrangle with open plates 1979
https://portal.ct.gov/-/media/deep/geology/quadreports/qr38pamphletrev.pdf

Water Resources Inventory of Connecticut Part 6: Upper Housatonic Basin – Bulletin 21 1972
https://www.usgs.gov/publications/water-resources-inventory-connecticut-part-6-upper-housatonic-river-basin

Hydrogeologic data for the upper Housatonic River basin, Connecticut – Bulletin 22 1970
https://pubs.usgs.gov/publication/70038251



Gridley Mtn
Mountain
MT RIGA STATE PARK
Hammertown
Fisher Pond
Taconic
Washinee Lake
Bingham Pond
Bald Peak
Lions Head
S A L I S B U R Y
Salisbury
Brook
Existing Pond
Proposed Pond
Public Water Wells
0'
0.5
1
1.5
2.00
SCALE: 1"= 1/2 Mile



Brook
Existing Pond
Proposed Pond
Public Water Wells
0'
0.5
1
1.5
2.00
SCALE: 1"= 1/2 Mile
Hammertown
Taconic
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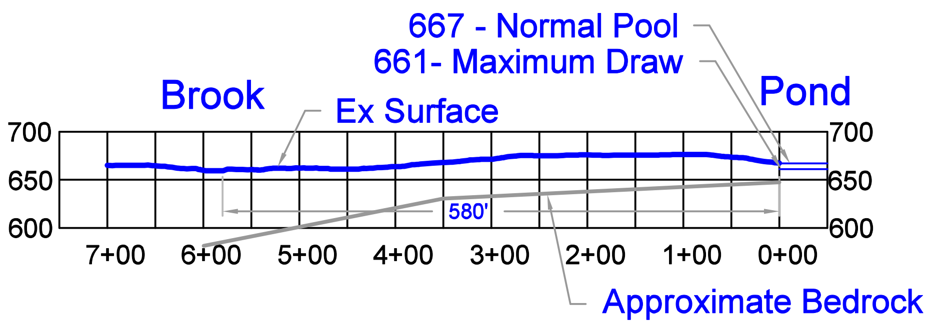
Bald Peak
Lions Head
MT RIGA STATE PARK
S A L I S B U R Y
Salisbury

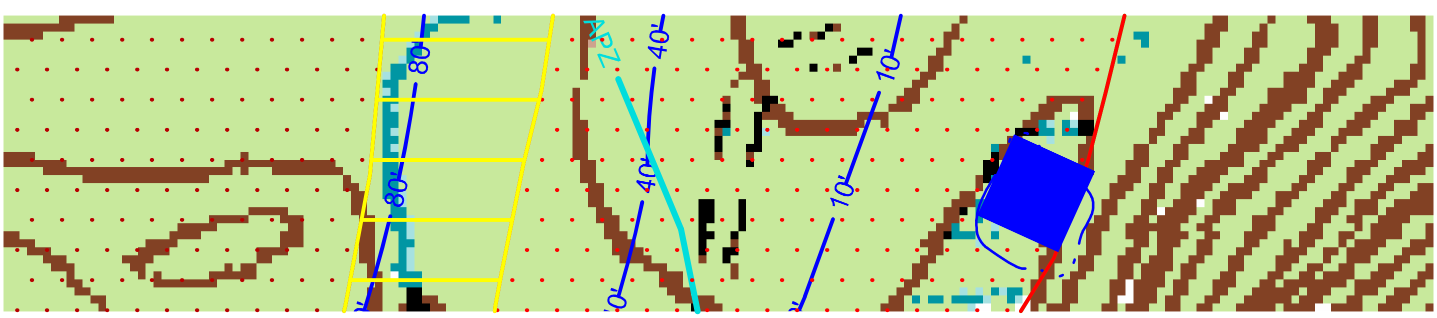
Section at Brook - Pond



Brook - Pond Profile 1:1

0' 100' 200' 400' 600' 800'

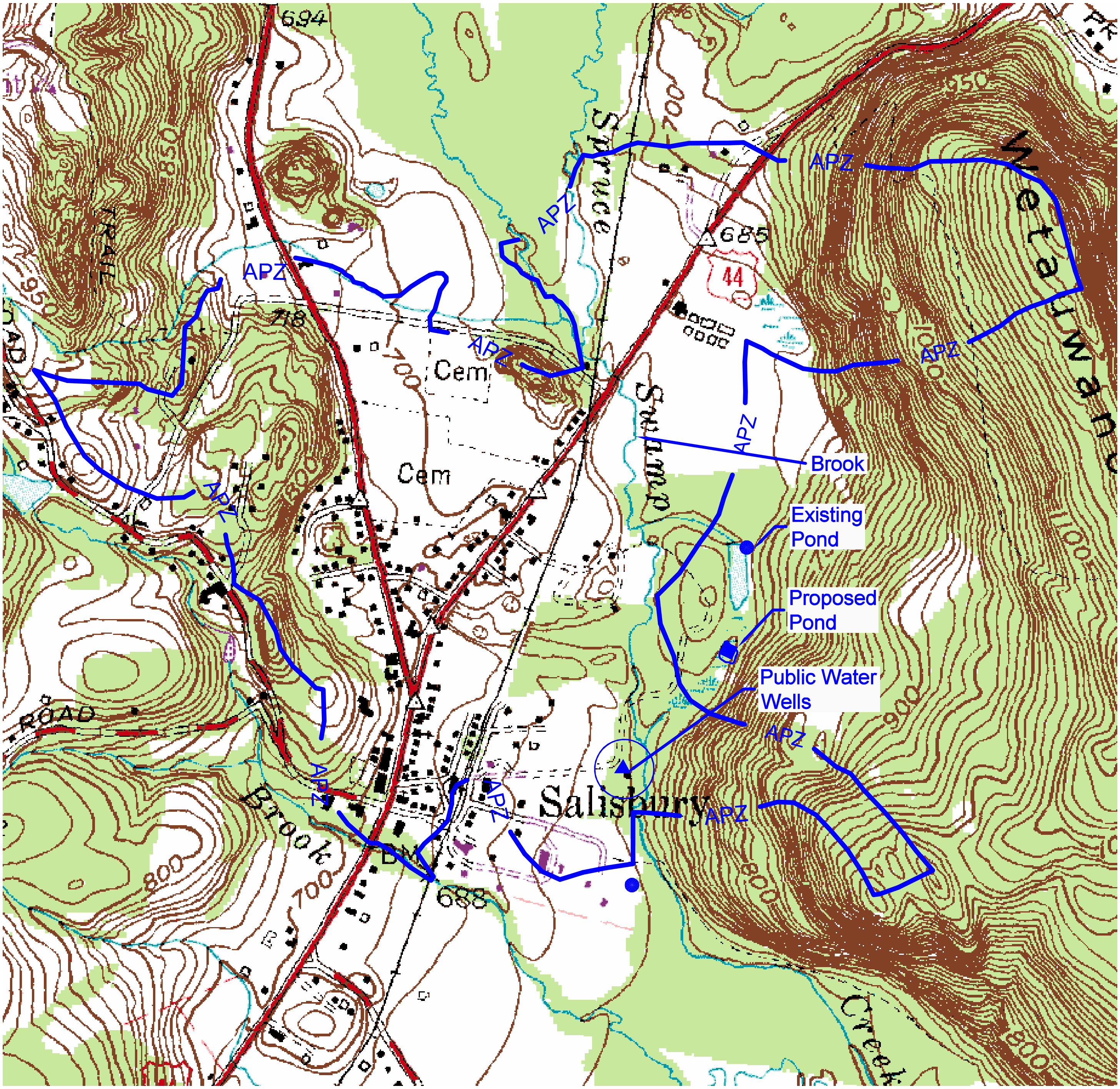
Scale: 1" = 200'



Brook - Pond

0' 100' 200' 400' 600' 800'

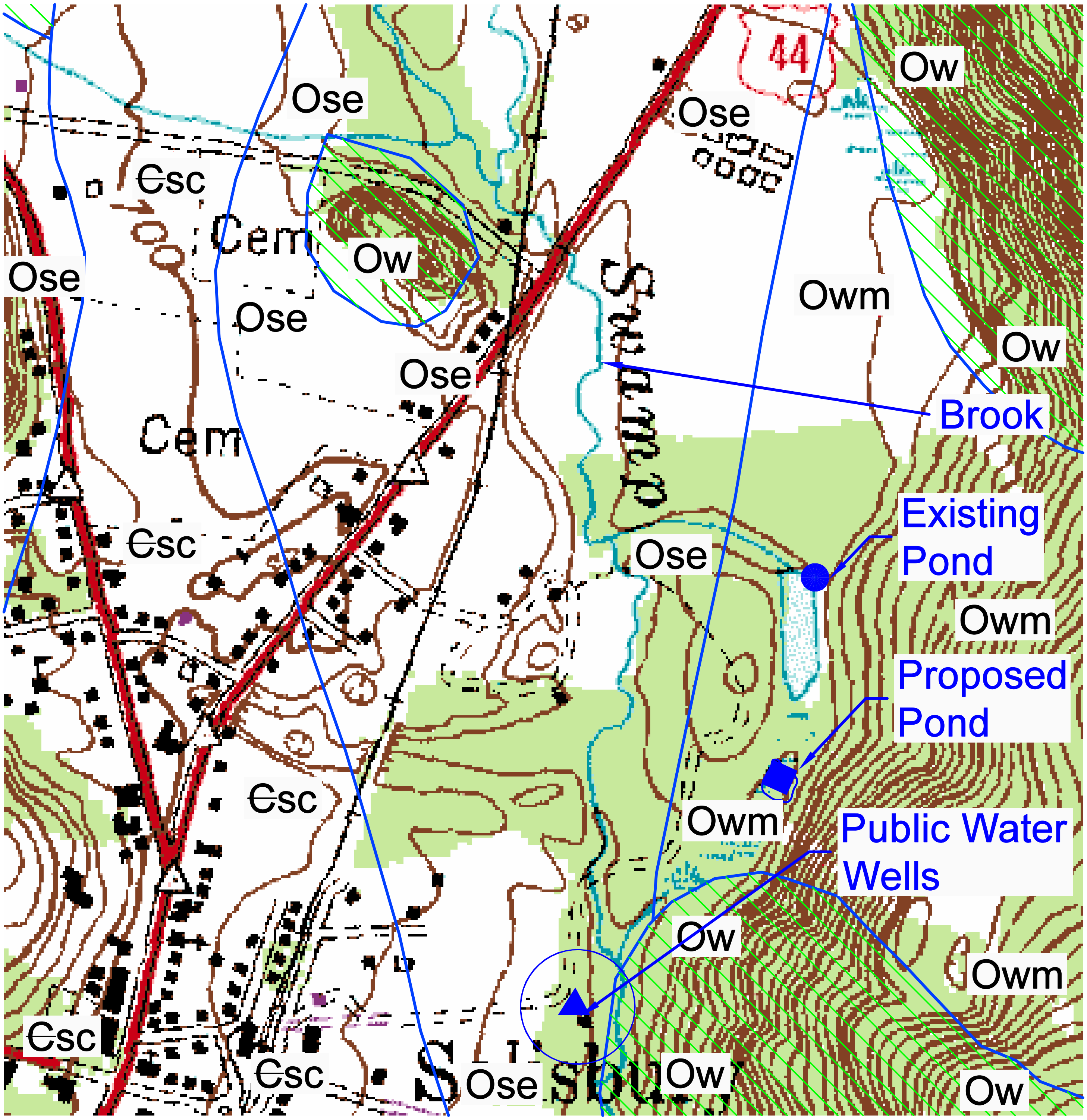
Scale: 1" = 200'



Salisbury Aquifer Protection Zone

0' 500' 1000' 2000' 3000' 4000'

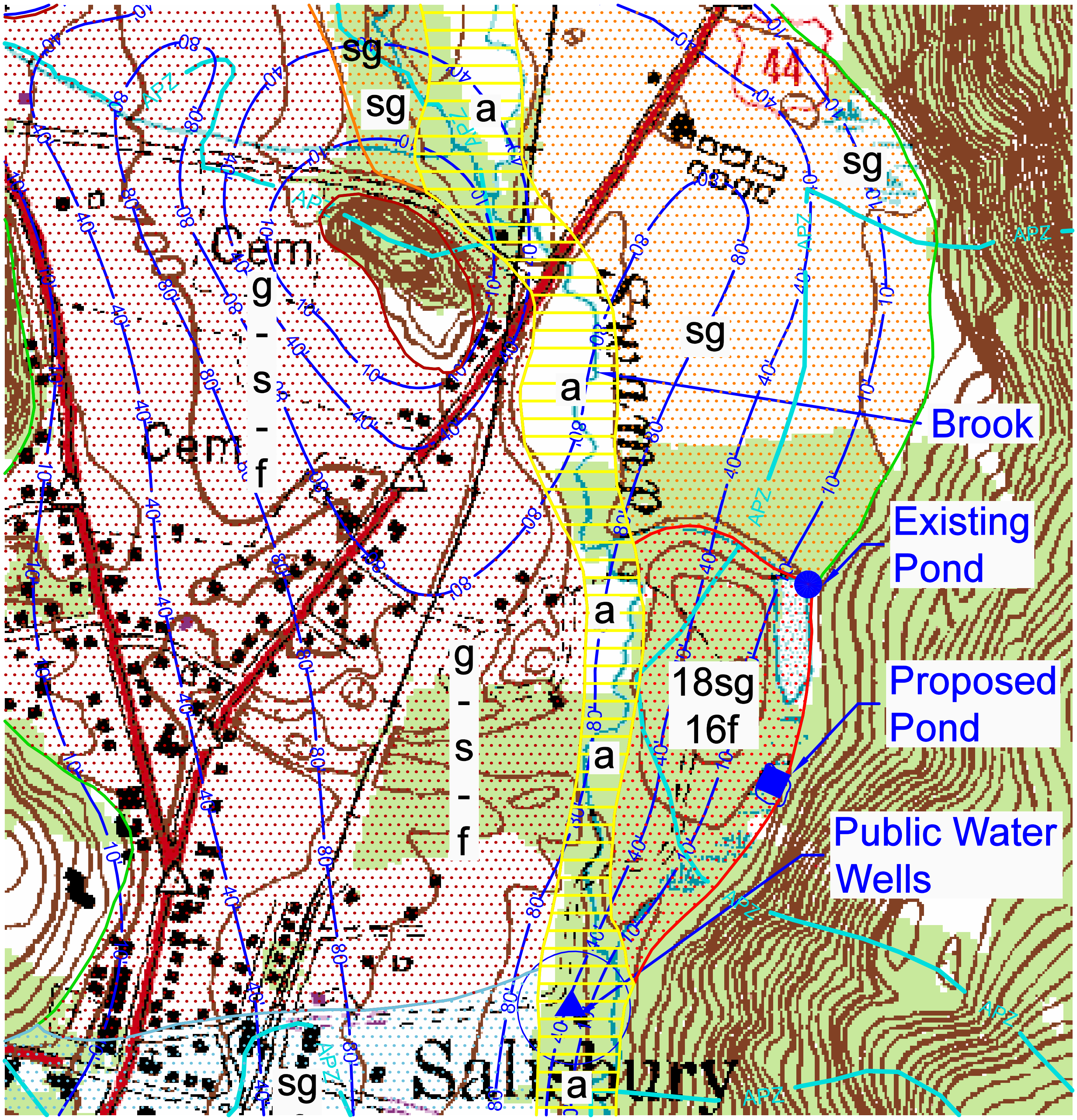
SCALE: 1" = 1000'



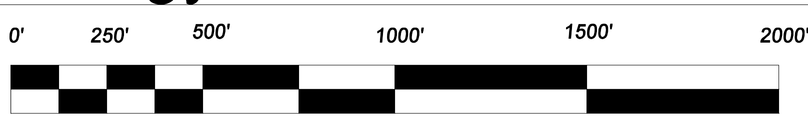
Bedrock Geology

0' 250' 500' 1000' 1500' 2000'

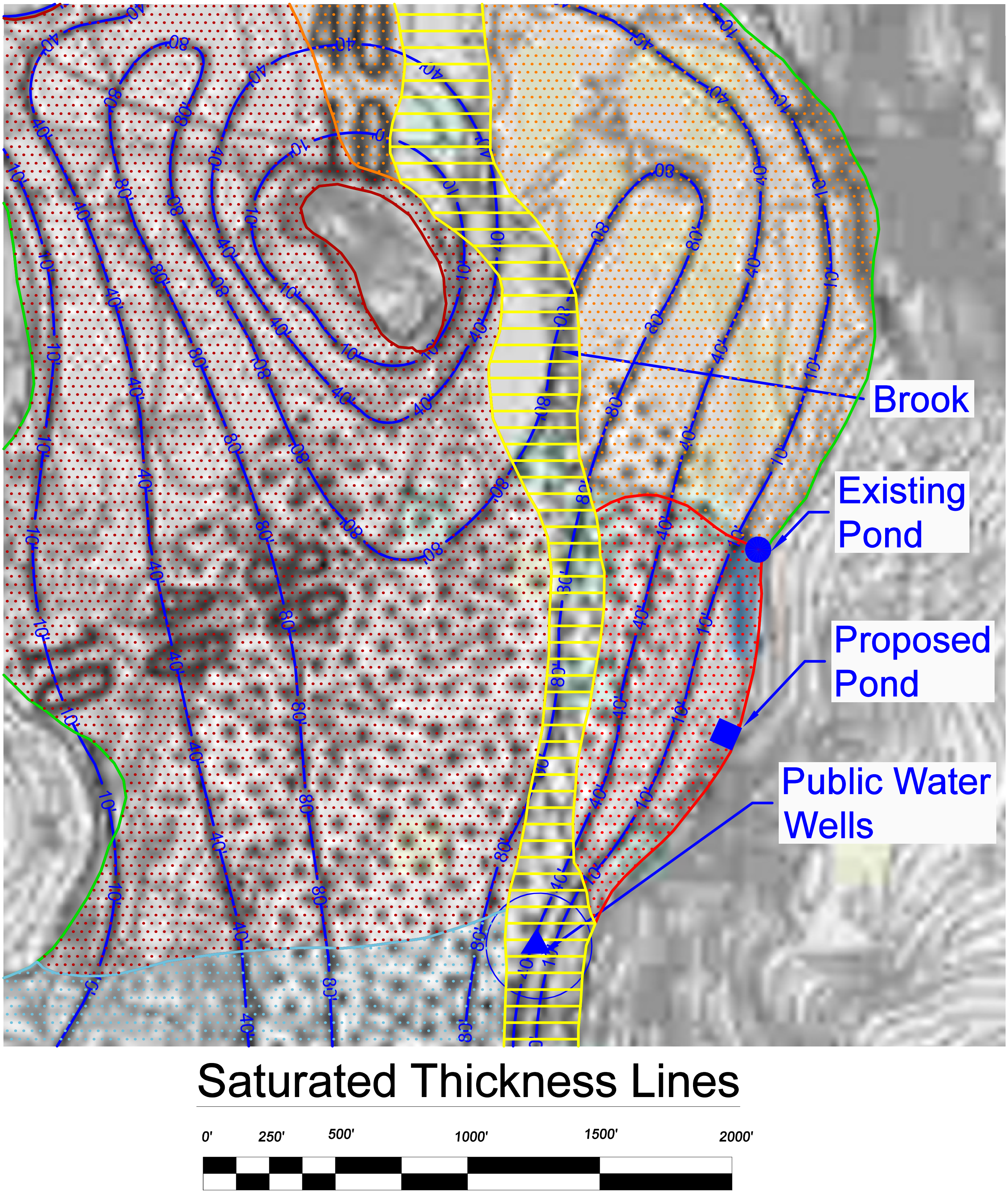
SCALE: 1" = 500'



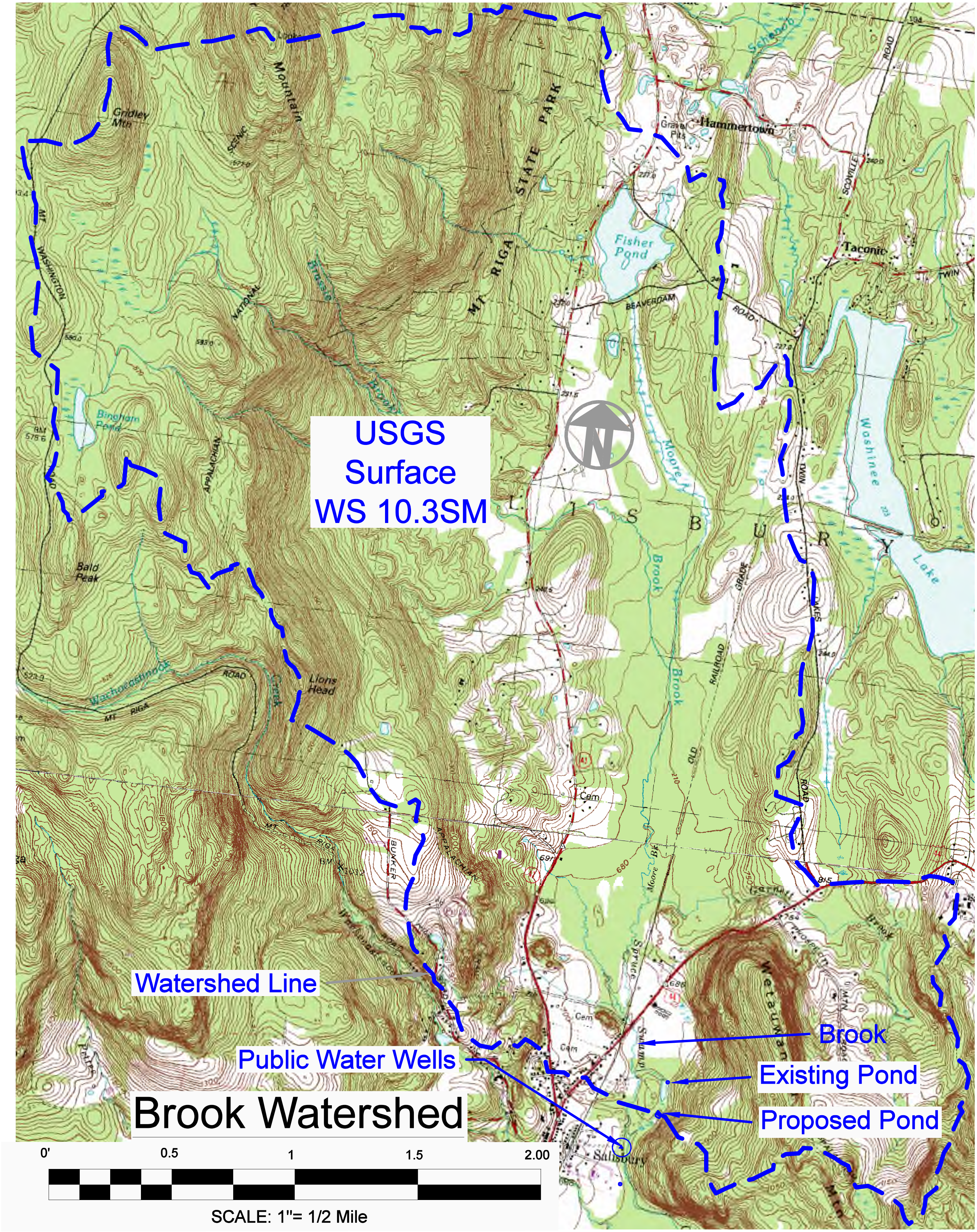
Surficial Geology & Saturated Thickness Lines



SCALE: 1" = 500'



Saturated Thickness Lines


USGS
Surface
WS 10.3SM
Watershed Line
Public Water Wells
Brook
Existing Pond
Proposed Pond
Brook Watershed
0'
0.5
1
1.5
2.00
SCALE: 1"= 1/2 Mile
Gridley Mtn
Mountain
MT. RIGA STATE PARK
Hammertown
Fisher Pond
BEAVERDAM
Taconic
Bingham Pond
APPALACHIAN
Moore
Brook
Washinee
Lake
Bald Peak
Lions Head
ROAD
MT RIGA
Cem
BUNKER
Spruce
Wetauwan
Salisbury
Mtn

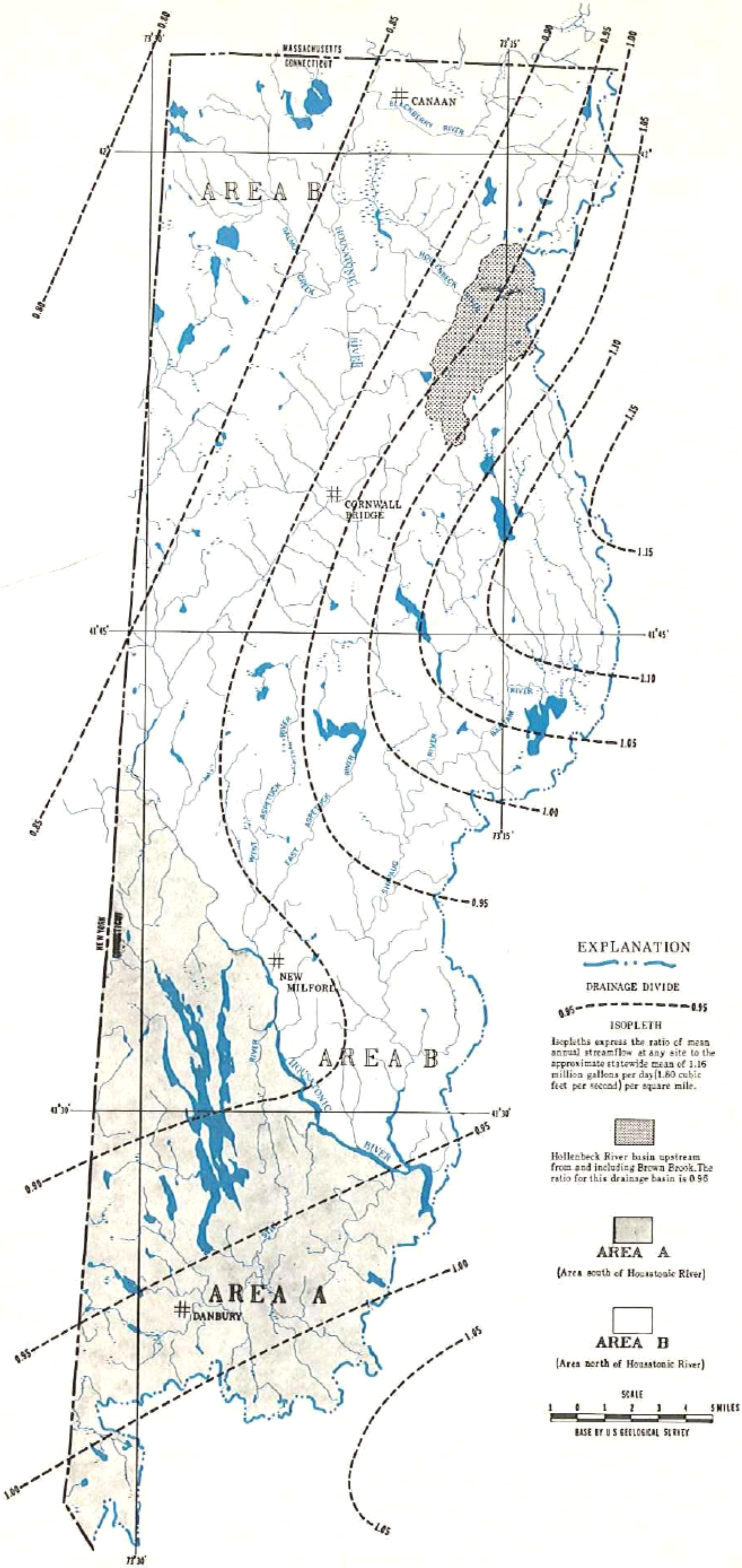
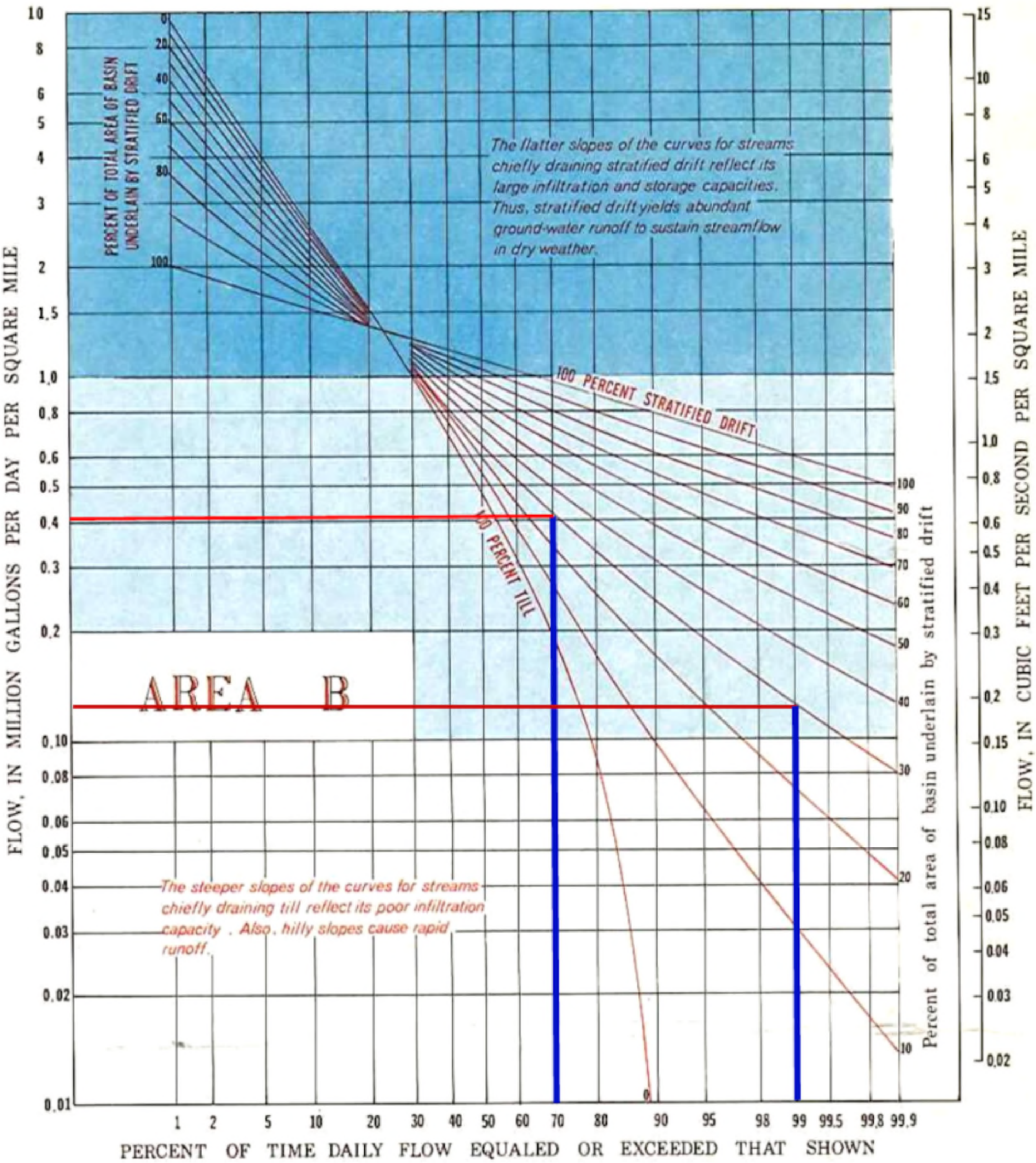
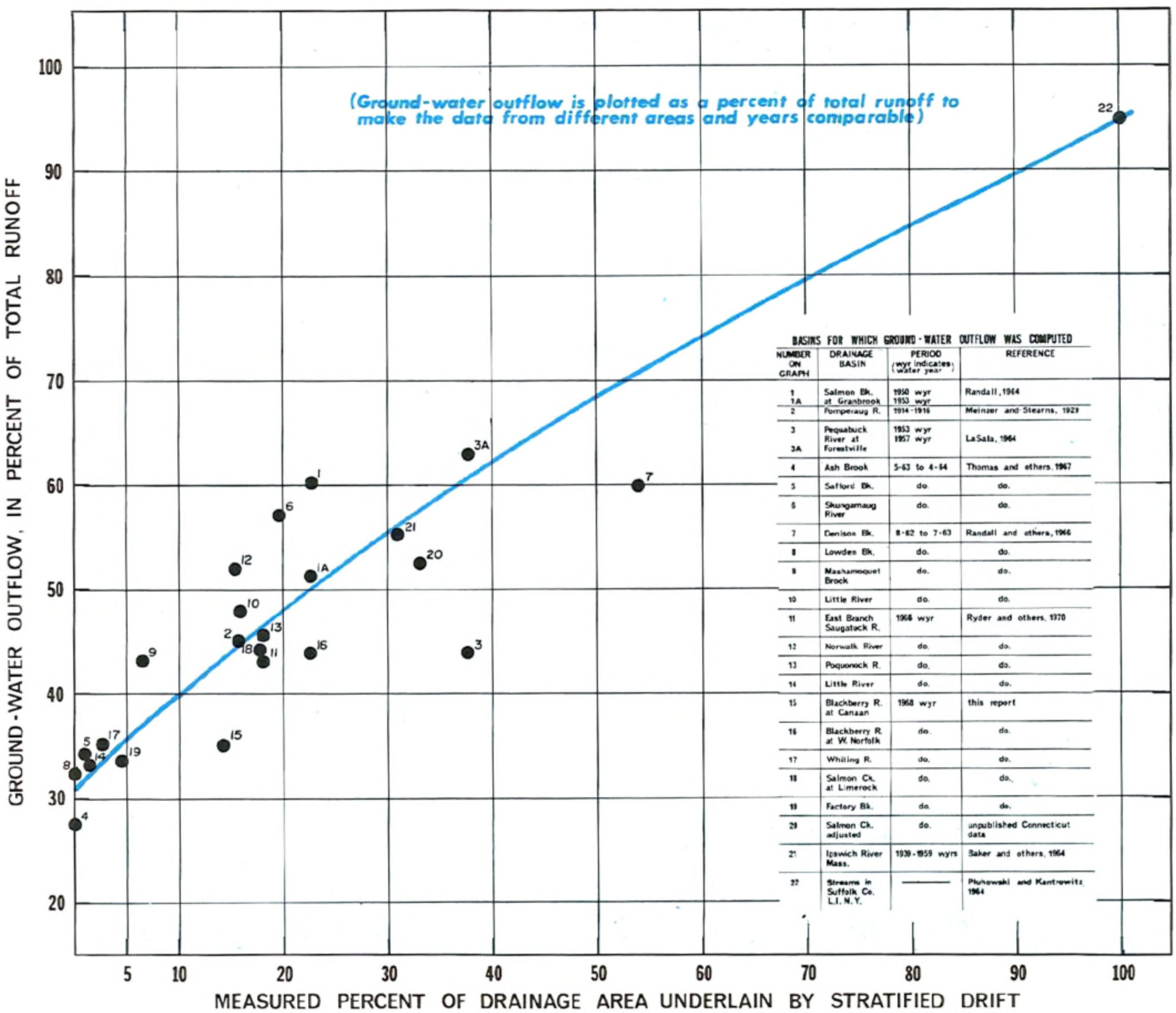


Figure 17.--Areal distribution of mean annual streamflow in the upper Housatonic River basin, water years 1931-60.



from Fig 18, Area B CWRB21



BASINS FOR WHICH GROUND-WATER OUTFLOW WAS COMPUTED

NUMBER ON GRAPH	DRAINAGE BASIN	PERIOD (wyr indicates water year)	REFERENCE
1 1A	Salmon Bk. at Granbrook	1950 wyr 1953 wyr	Randall, 1964
2	Pomperaug R.	1914-1916	Meinzer and Stearns, 1929
3 3A	Pequabuck River at Forestville	1953 wyr 1957 wyr	LaSala, 1964
4	Ash Brook	5-63 to 4-64	Thomas and others, 1967
5	Safford Bk.	do.	do.
6	Skungamaug River	do.	do.
7	Denison Bk.	8-62 to 7-63	Randall and others, 1966
8	Lowden Bk.	do.	do.
9	Mashamoquet Brock	do.	do.
10	Little River	do.	do.
11	East Branch Saugatuck R.	1966 wyr	Ryder and others, 1970
12	Norwalk River	do.	do.
13	Poquonock R.	do.	do.
14	Little River	do.	do.
15	Blackberry R. at Canaan	1968 wyr	this report
16	Blackberry R. at W. Norfolk	do.	do.
17	Whiting R.	do.	do.
18	Salmon Ck. at Limerock	do.	do.
19	Factory Bk.	do.	do.
20	Salmon Ck. adjusted	do.	unpublished Connecticut data
21	Ipswich River Mass.	1939-1959 wyrs	Baker and others, 1964
22	Streams in Suffolk Co. L.I., N.Y.	———	Pluhowski and Kantrowitz 1964

Figure 37.--Relation between ground-water outflow and percentage of area of a drainage basin 'erlain by stratified drift.

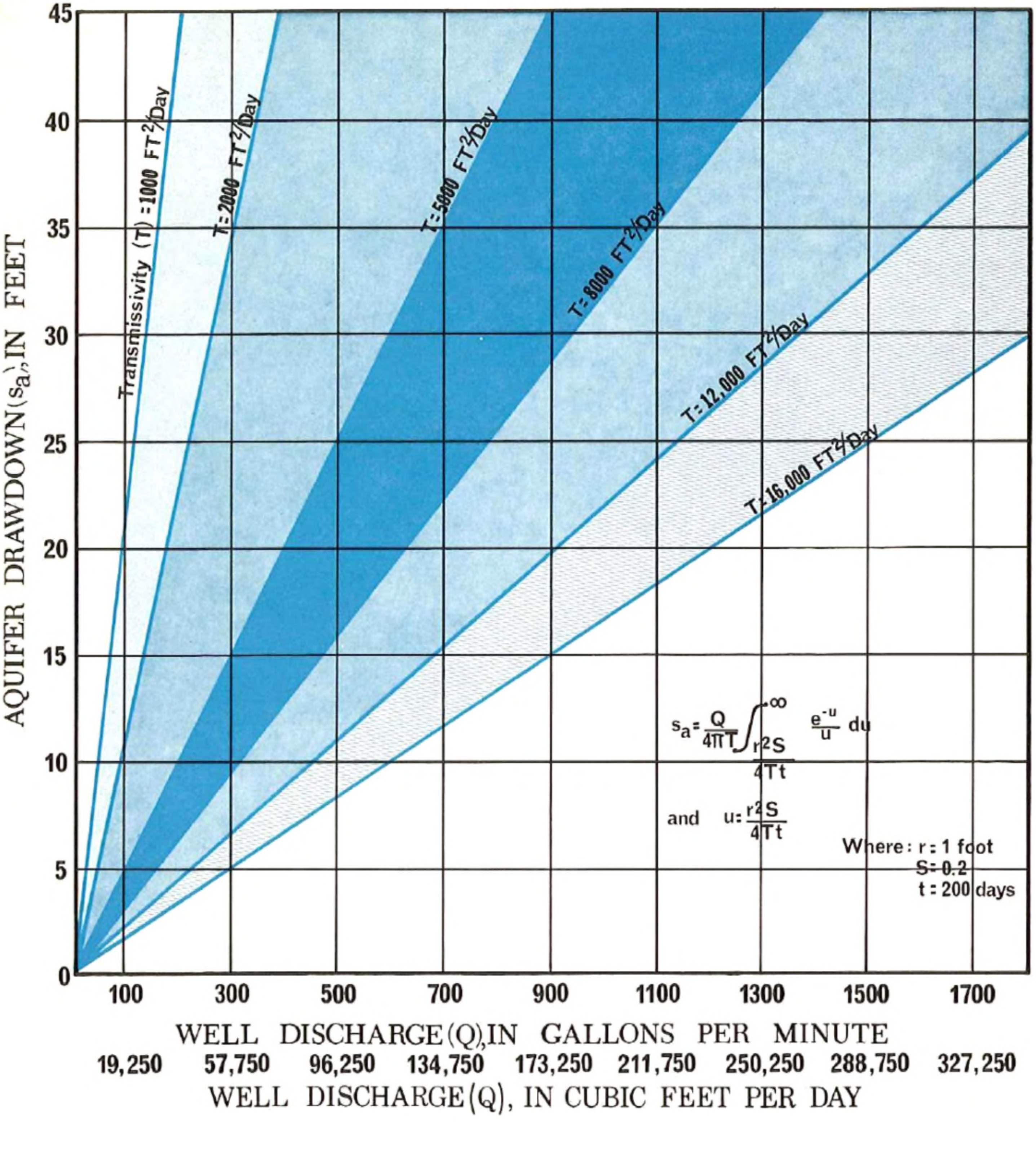
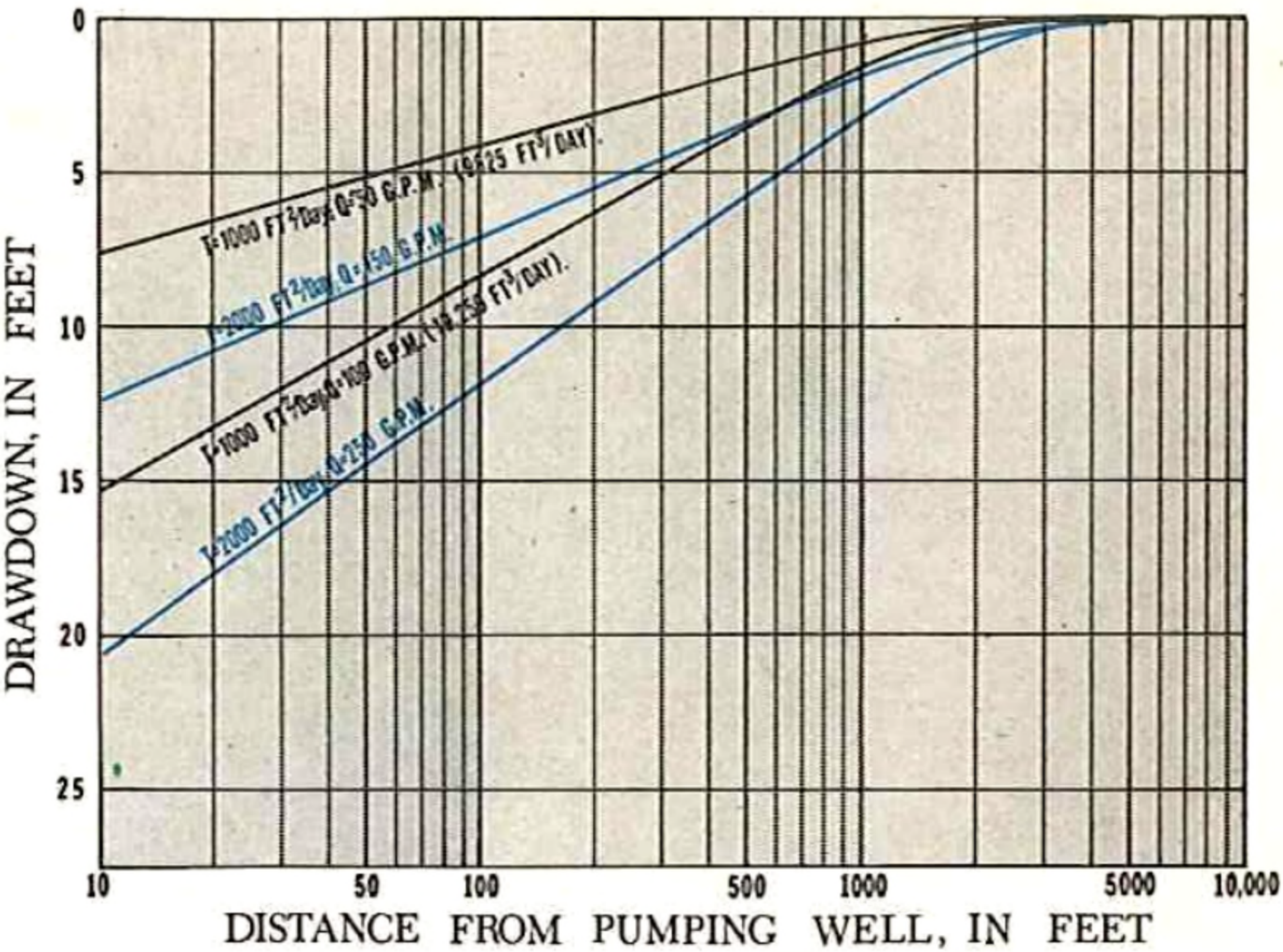


Figure 39.--Relation between aquifer drawdown and well discharge.


T=1000 FT²/Day, Q=50 G.P.M. (9625 FT³/DAY).
T=2000 FT²/Day, Q=150 G.P.M.
T=1000 FT²/Day, Q=100 G.P.M. (19,250 FT³/DAY).
T=2000 FT²/Day, Q=250 G.P.M.
0
5
10
15
20
25
DRAWDOWN, IN FEET
10
50
100
500
1000
5000
10,000
DISTANCE FROM PUMPING WELL, IN FEET

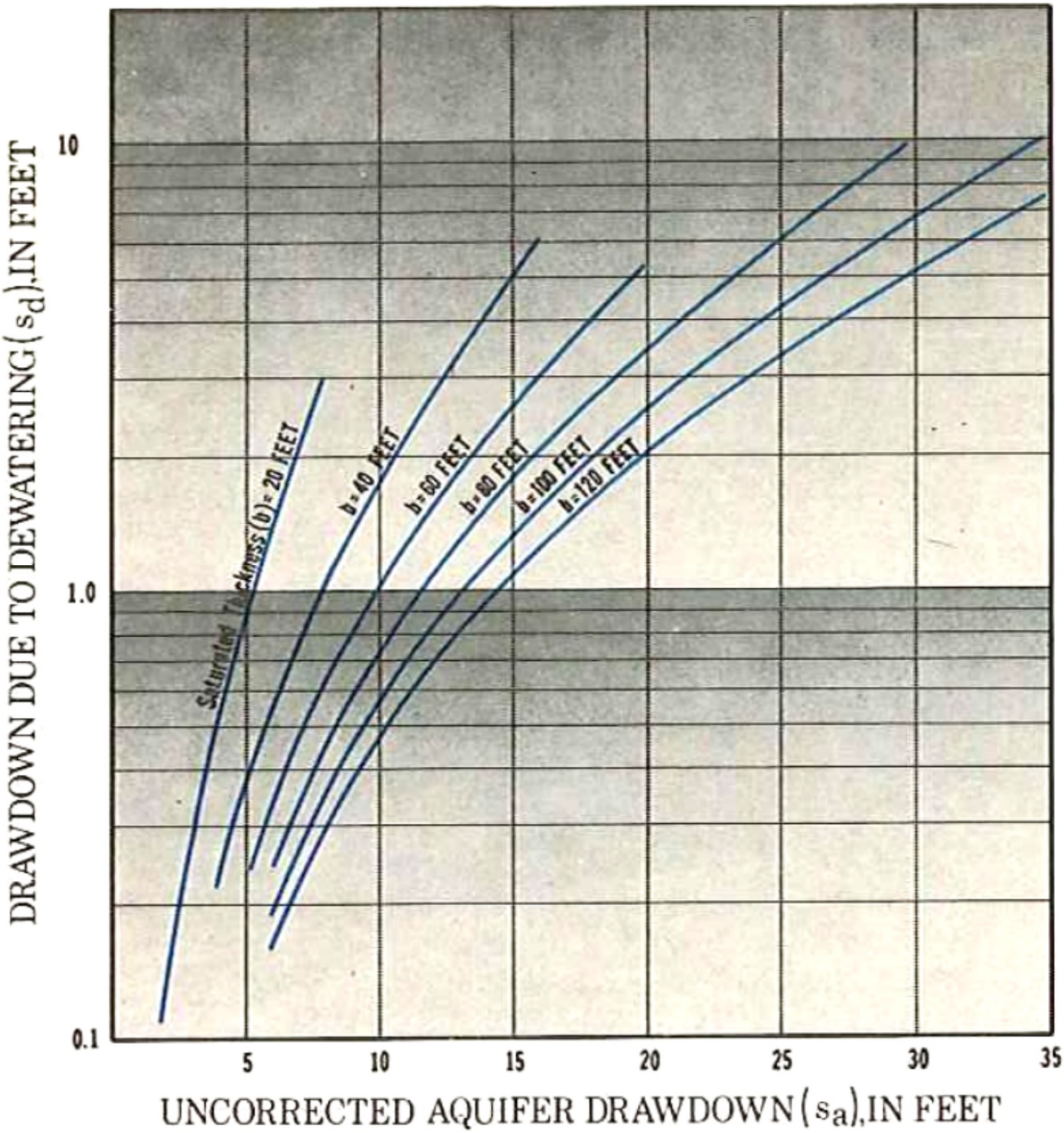


Figure 41.--Drawdown correction for dewatering of an aquifer.