Ground Water Extraction, Surface Water Recharge, and the New DEP In-Stream Flow Rule: Rangeley Water District Case Study

Presented by:

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Introduction

- The Rangeley Water District (RWD) taps a remote aquifer for its water supply in Dallas Plantation
- The well is close to the South Branch of the Dead River
- The LURC permit for the well restricts withdrawal based on the flow rate of the South Branch
- A new DEP regulation restricts direct or indirect withdrawal from Maine rivers

Introduction

- Is the river-flow based restriction on pumping reasonable?
- What is the actual influence of the well on the stream (and vice versa)?
- How does the current flow-based restriction compare to the new DEP rules?
- Can the RWD increase its pumping rate without harming the river ecosystem?

Presentation Outline

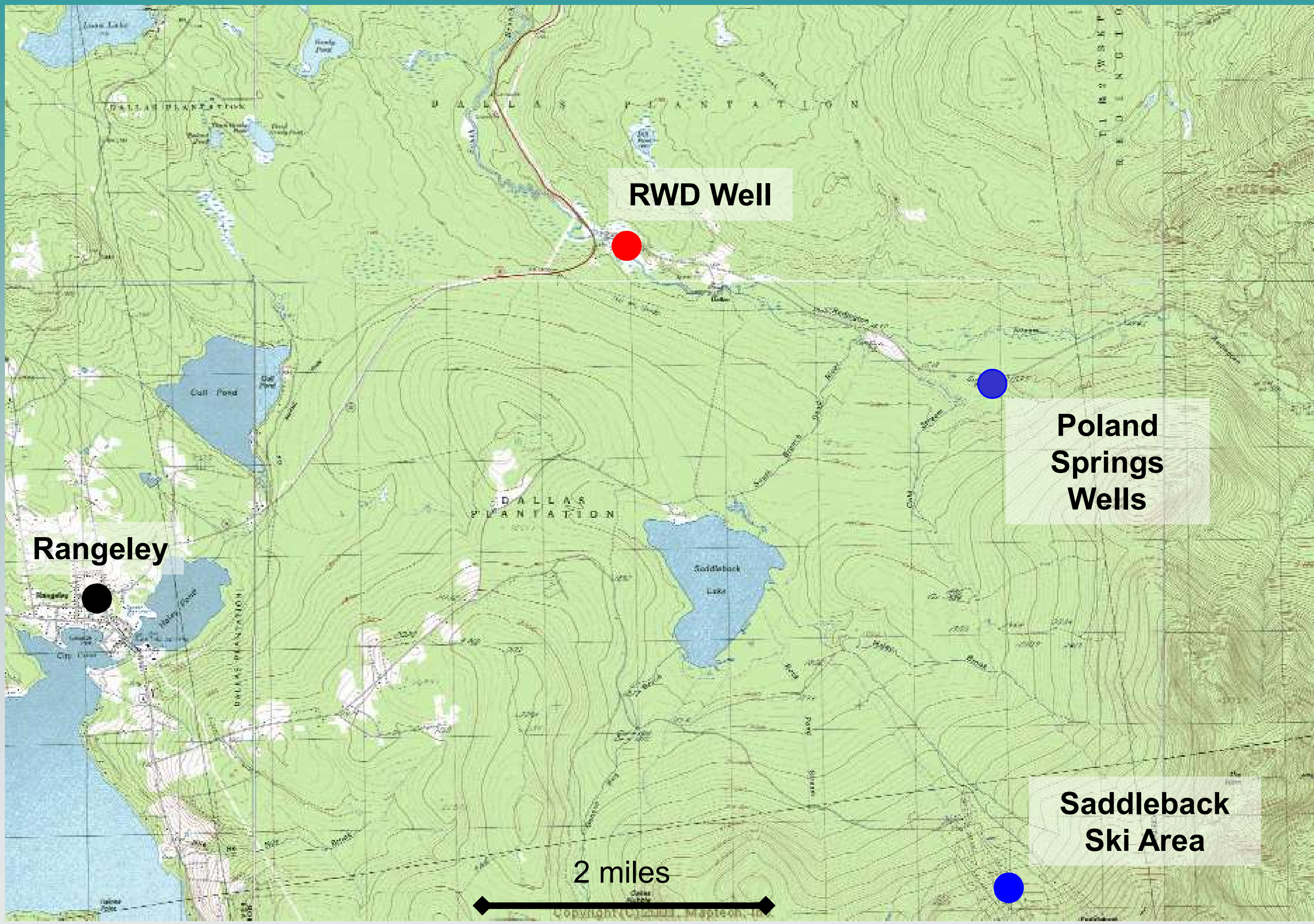
1. Background on the RWD and its supply
2. Regional Hydrogeology of the aquifer
3. Local Hydrogeology of the aquifer and well
4. New DEP Ch. 587 In-Stream Flow Rule
5. River to Well Recharge estimates
6. Resolution of RWD supply needs and DEP flow rules

1. Background

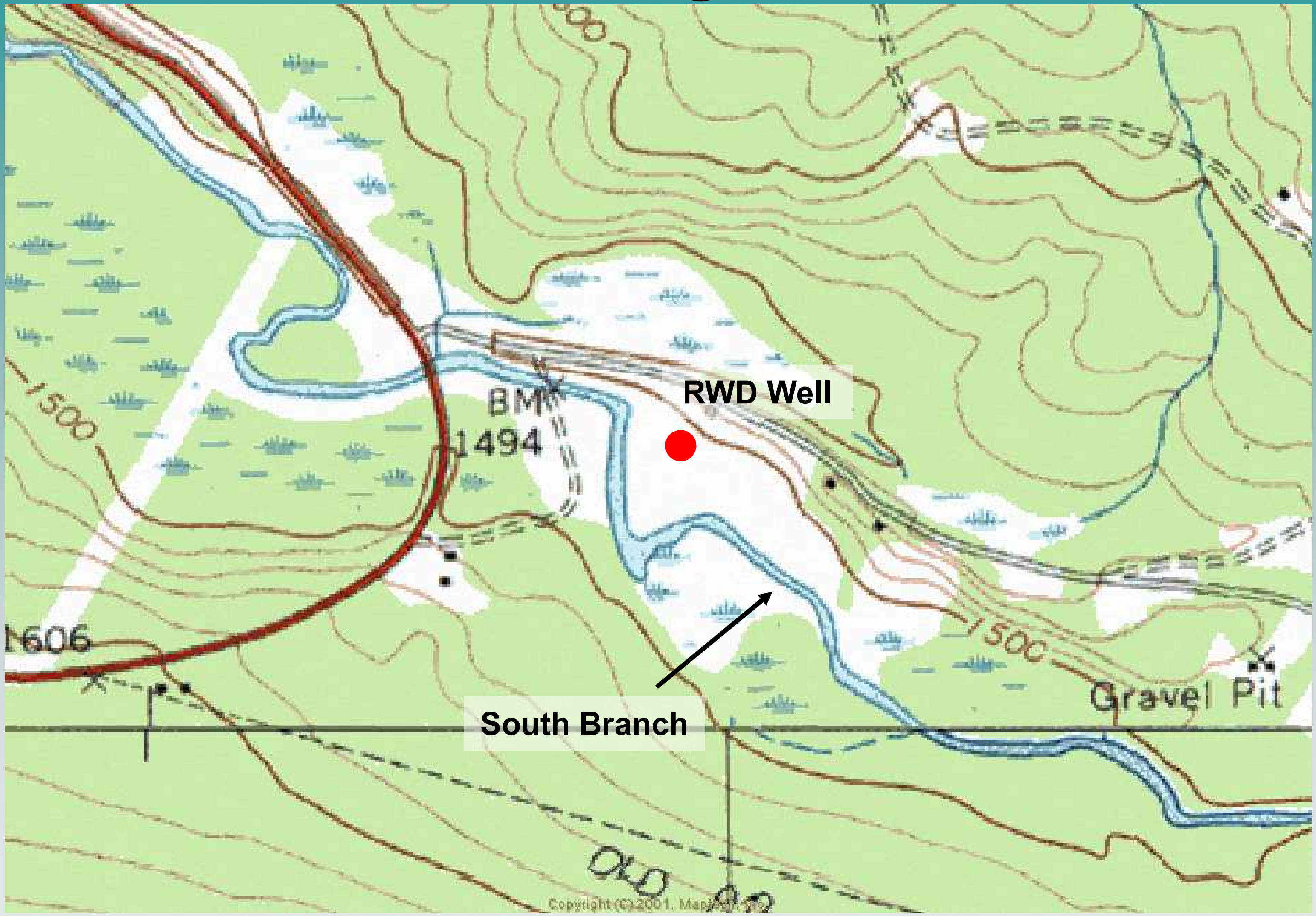
Rangeley Water District

- Serves 965 in Rangeley area from a well drilled in 1995. Well is in Dallas Plt. northeast of town.
- When pumping, rate is 250 gpm for about 80,000 gallons per day (~6 hrs/night or 60 gpm annual average).
- Well located within 200 feet of the South Branch of the Dead River (South Branch).
- LURC permits restricts withdrawal to 0.5 cfs (225 gpm) if stream flow <17 cfs (based on USFWS aquatic baseflow (ABF) of 0.5 cfsm)

1. Background

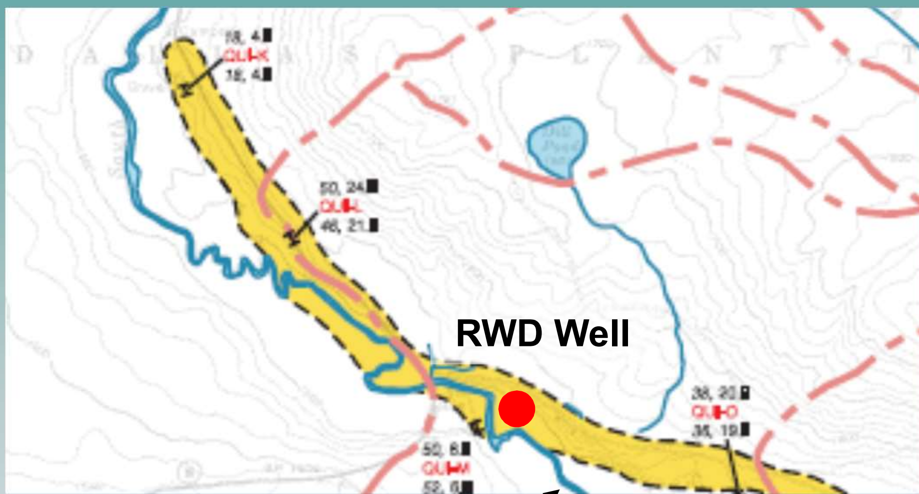


1. Background

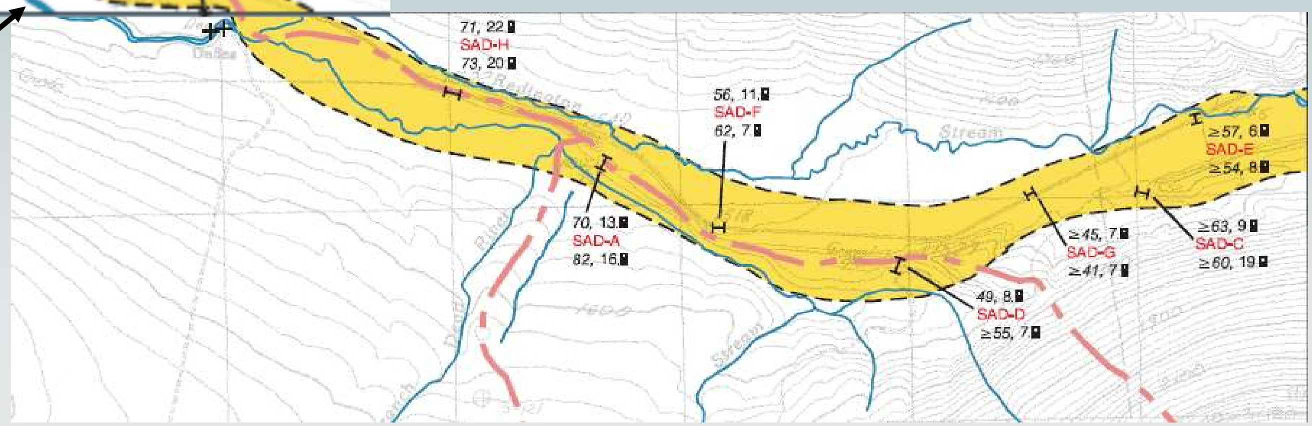


2. Regional Hydrogeology

- South Branch valley filled with 50 to 70 feet of sand and gravel. Narrow aquifer.



- South Branch streambed crosses on and off the aquifer.



2. Regional Hydrogeology

- Part of valley fill sand and gravel consists of an esker.

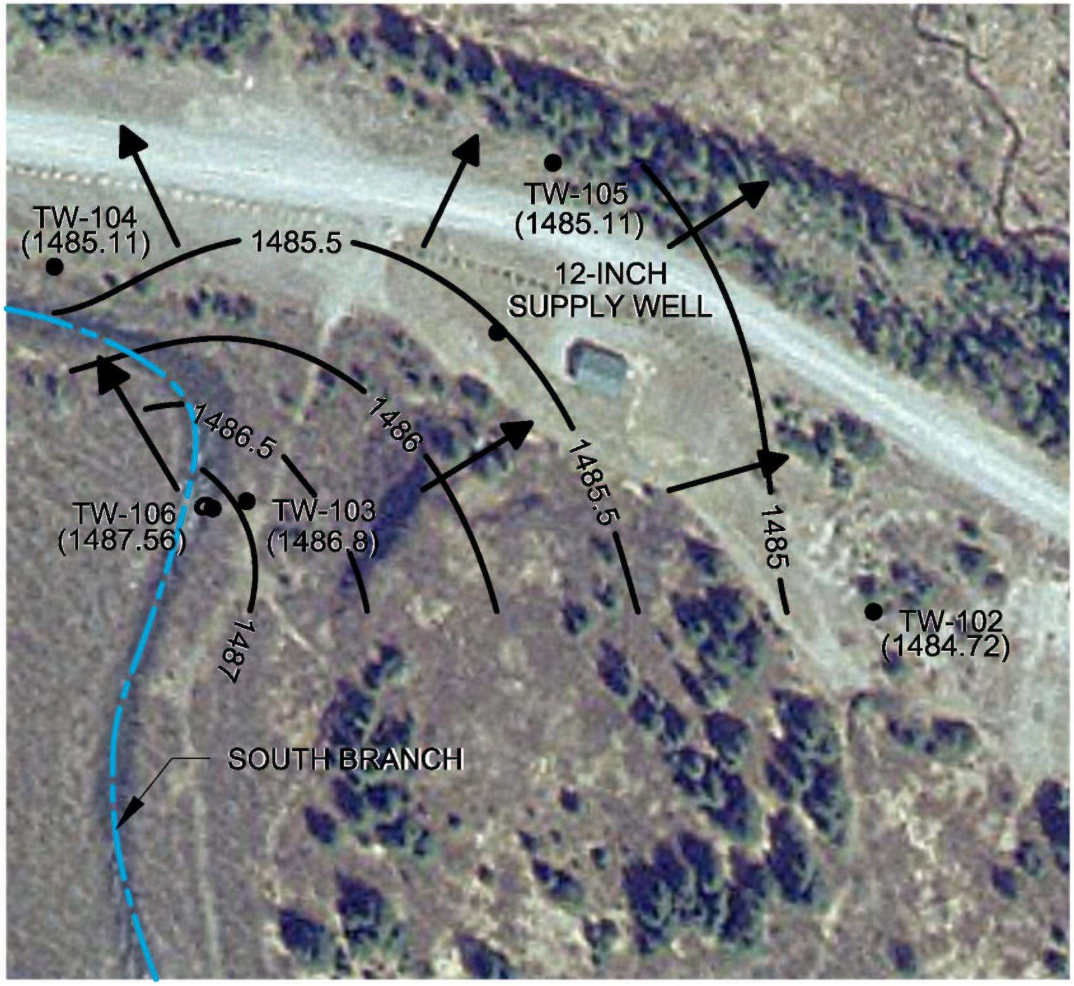
- Esker was the target of B. Caswell when he sited the well.

Poland Spring wells can yield 400 gpm, esker very productive.

3. Local Hydrogeology

- Ground water elevation measurements were collected from monitoring wells (Oct, Nov, Dec, Apr, May)
- Stream flow measurements collected near well (by Poland Springs)
- 5 ground water contour maps prepared

3. Local Hydrogeology



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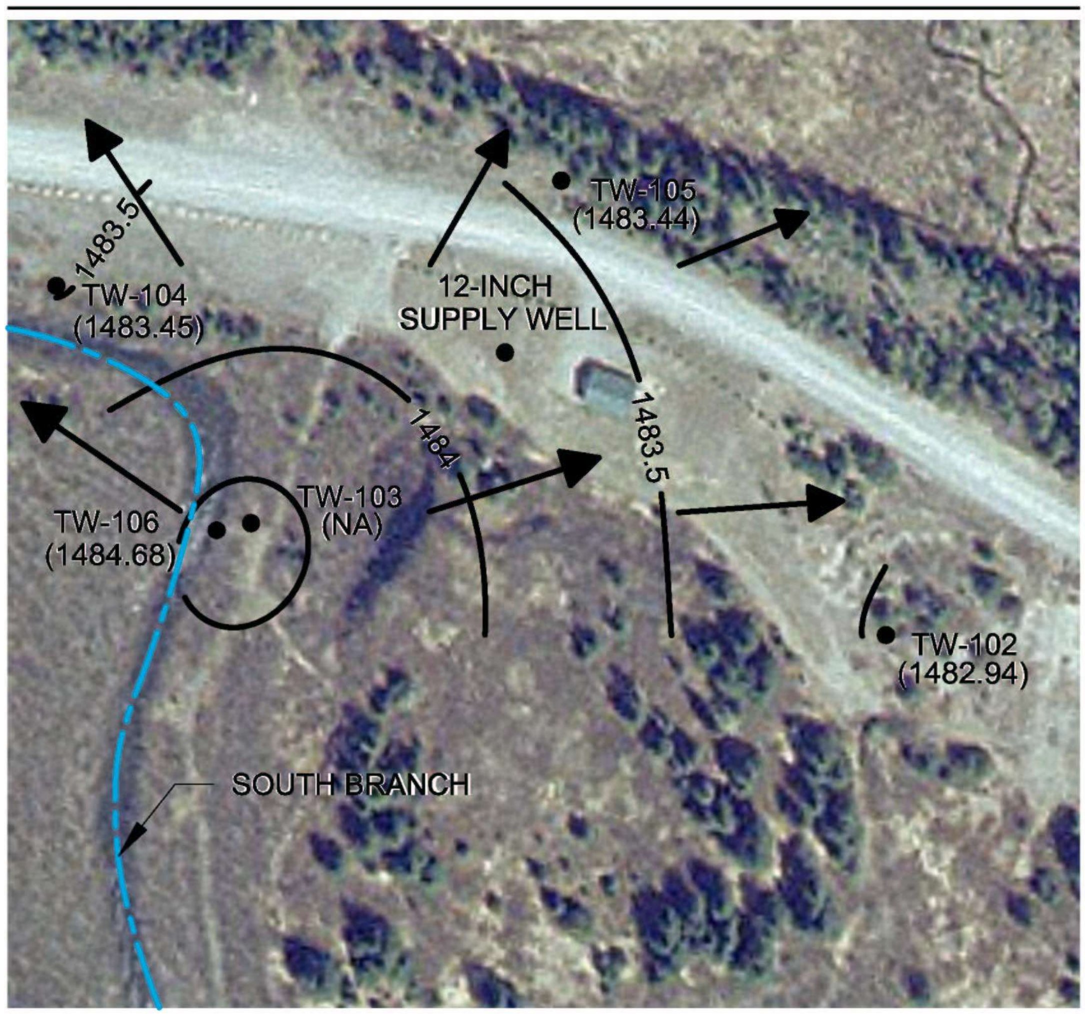
3. Local Hydrogeology



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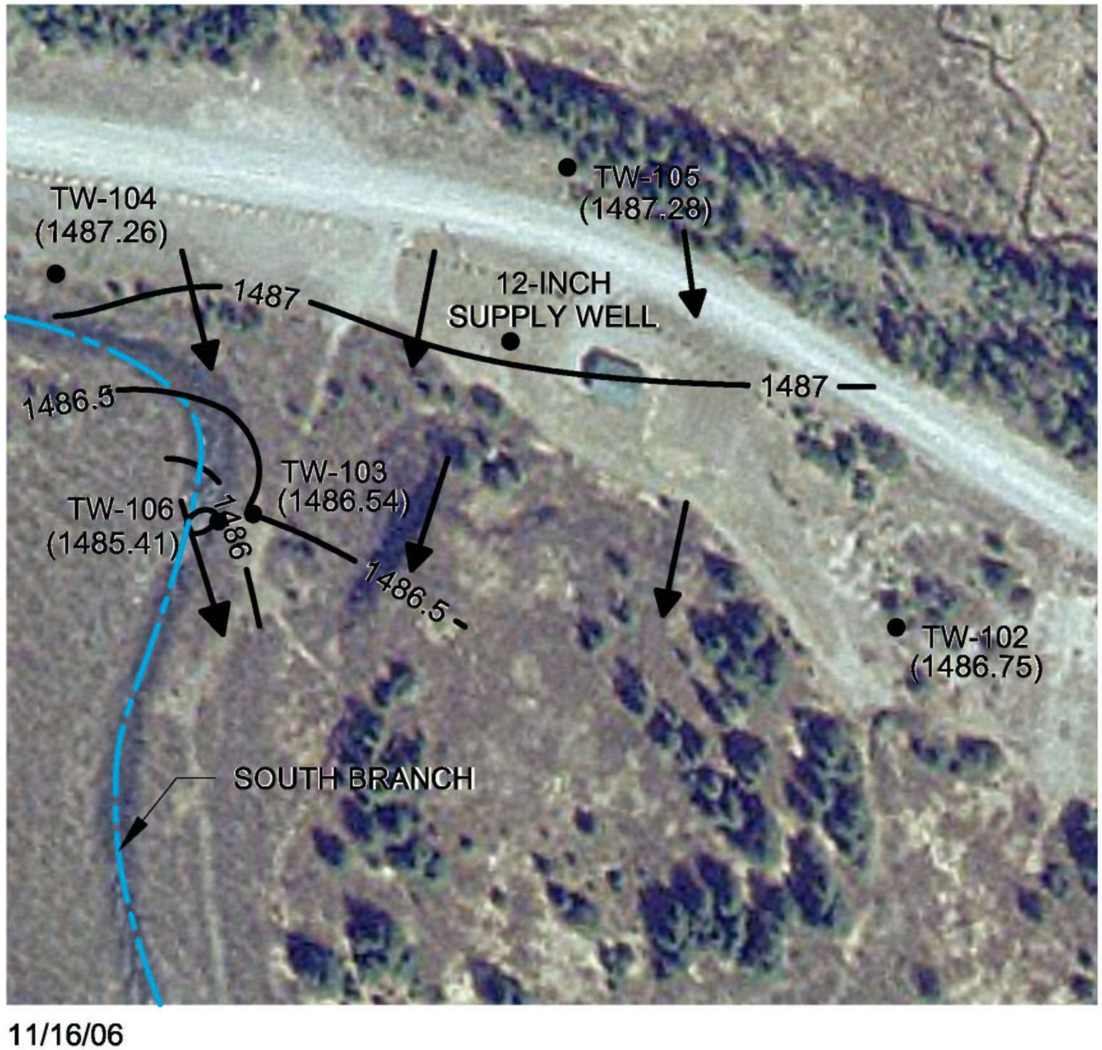

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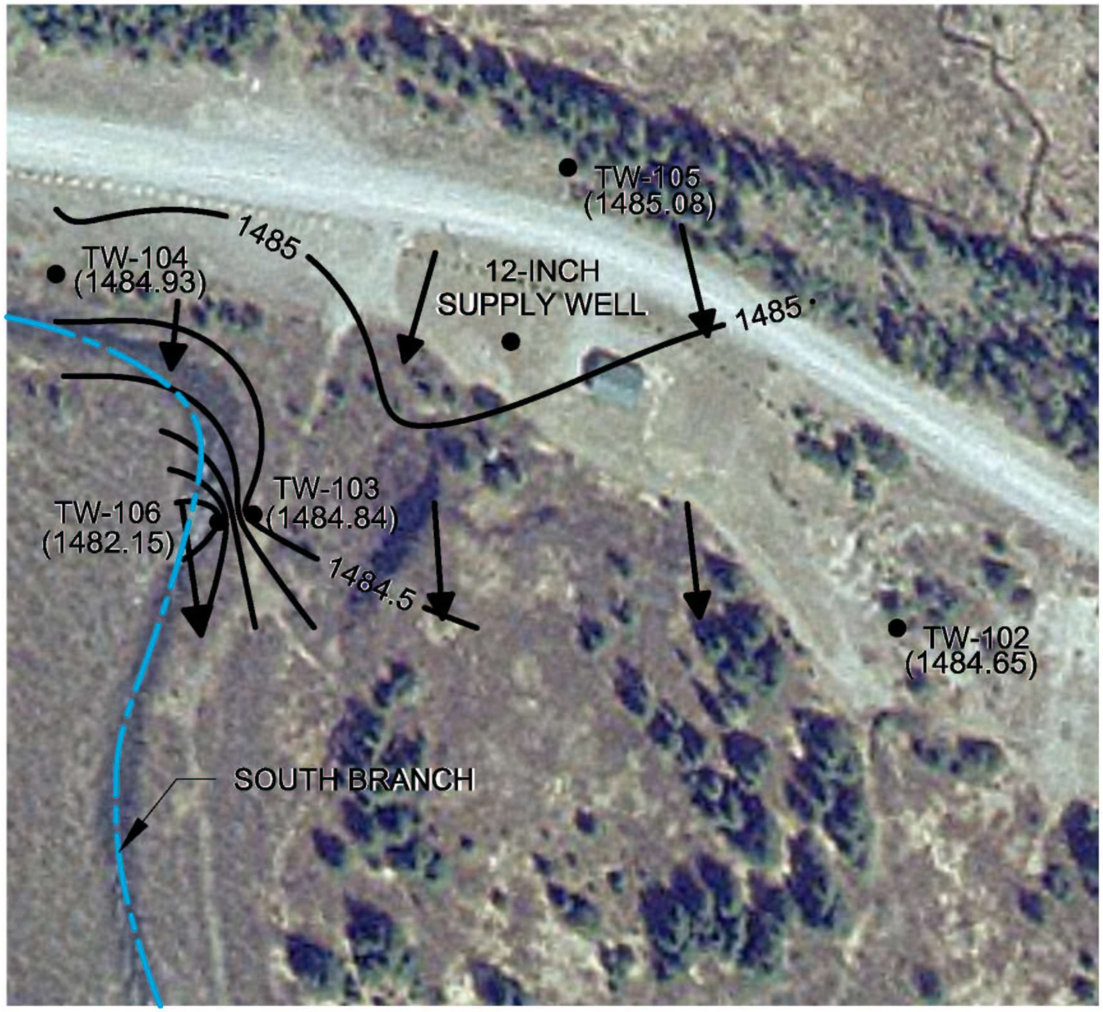

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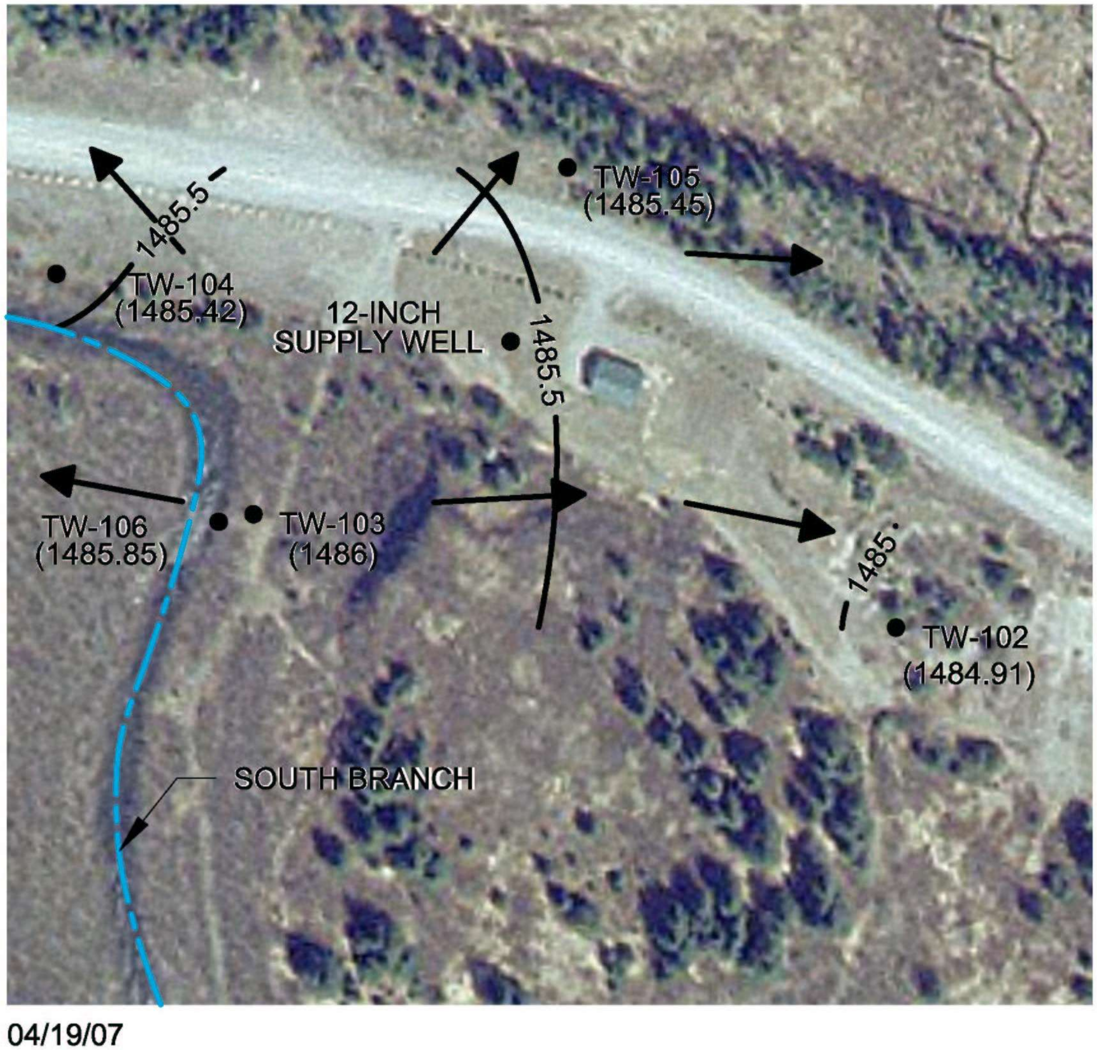
3. Local Hydrogeology



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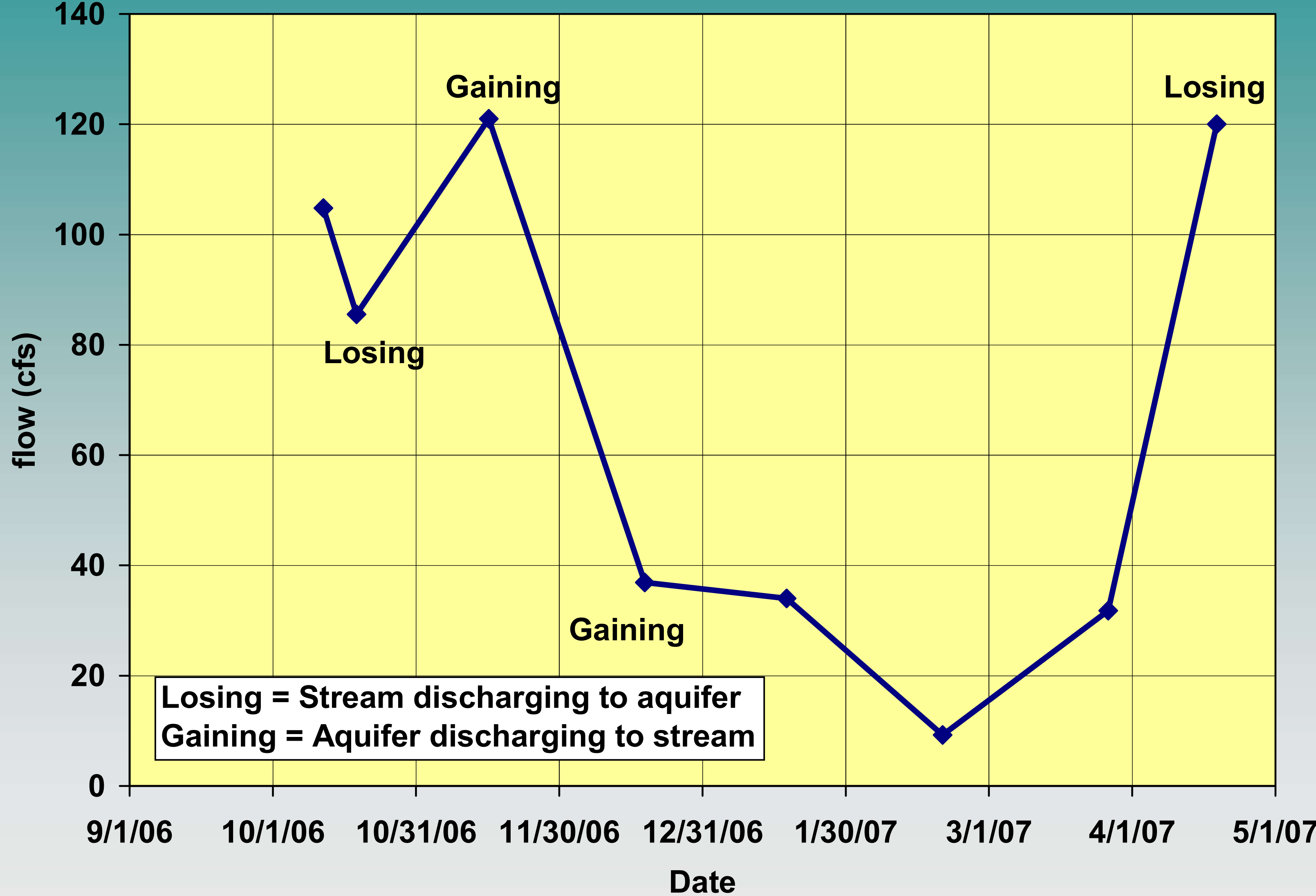
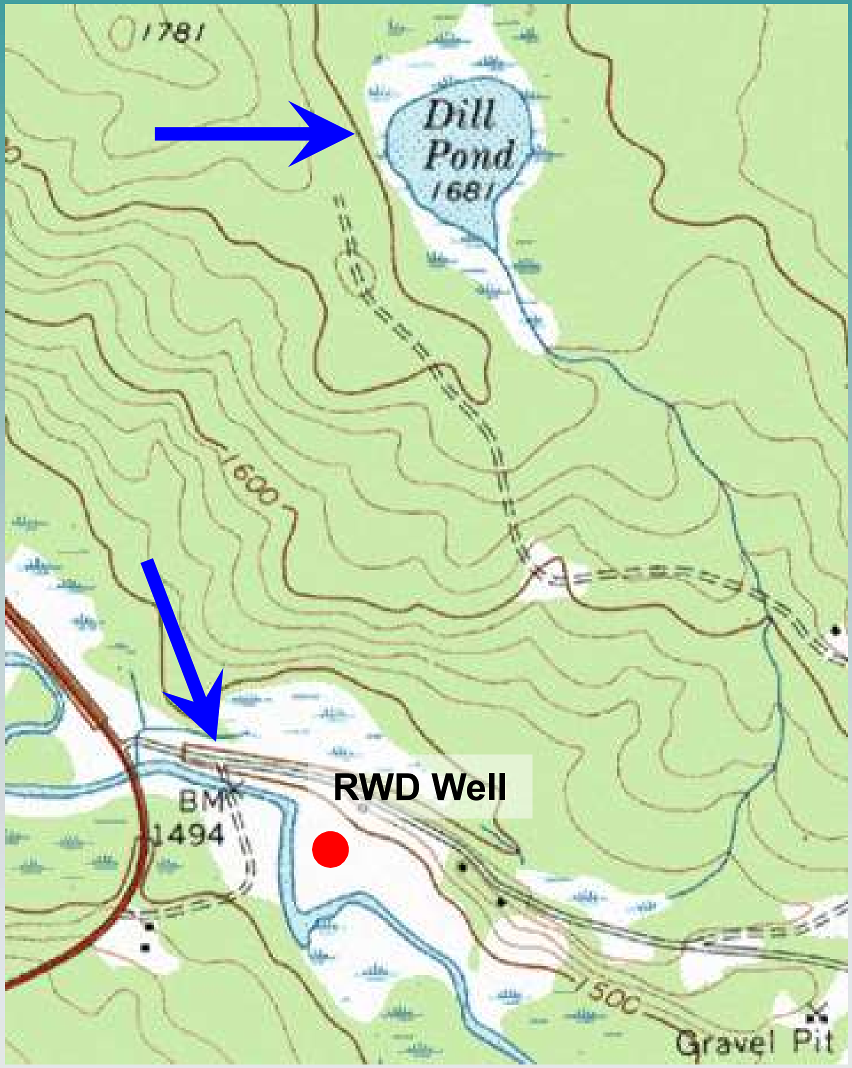


3. Local Hydrogeology

Observations

- Stream and aquifer “flip-flop” recharge roles frequently
- No consistent relationship between stream flow and recharge
- Other factors probably play a role:
  - Frozen ground inhibiting direct recharge
  - Local discharge from nearby pond (see map)
  - Damming effect of bridge (see map)

3. Local Hydrogeology



4. New DEP Ch. 587 In-Stream Flow Rule

- "Establishes river and stream flows and lake and pond water levels to protect natural aquatic life and ***other designated uses*** in Maine's waters"
- Actually puts aquatic life ahead of other uses with the exception of public water supplies
- Effective August 2007
- Focus here is on stream flow

4. New DEP Ch. 587 In-Stream Flow Rule

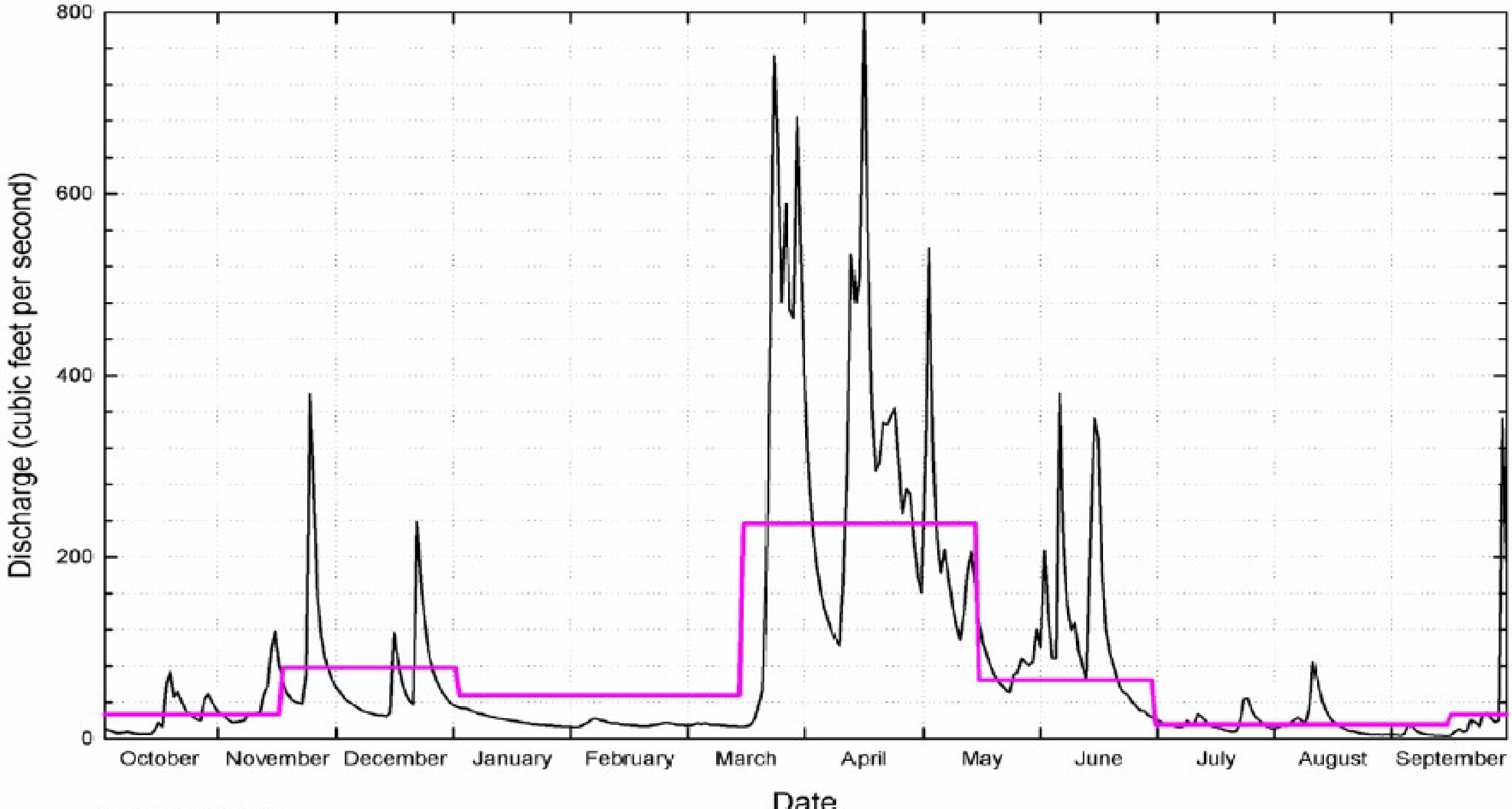
- Rule's ideal goal is to prohibit withdrawals when flow is below seasonal **median**
- Contrast with USFWS ABF of 0.5 cfsm
- Rules separate Class AA, A, and B/C streams; South Branch Class A stream
- <u>Regulated withdrawal from Class AA and A includes nearby wells</u>
- Seasonal median determined from 10 yrs data from site or similar watershed or…
- Dudley USGS regression calculations based on water shed characteristics

4. New DEP Ch. 587 In-Stream Flow Rule

In-Stream Flow Standards

Season	Begin	End	Median Standard
Winter	1-Jan	15-Mar	February
Spring	16-Mar	15-May	April
Early Summer	16-May	30-Jun	June
Summer	**1-Jul**	**15-Sep**	**August**
Fall	16-Sep	15-Nov	October
Early Winter	16-Nov	31-Dec	December

Grower 37



Water year 2003

Drainage area:	**64 sq mi**
Mean annual precipitation:	**42.7 inches**
Fraction aquifer:	**0.0**
Distance from coast:	**86 mi**
Withdrawal thresholds:	**from Dudley (2003)**
Hydrograph:	**Kingsbury Stream near Abbot Village - 94.5 sq mi**

4. New DEP Ch. 587 In-Stream Flow Rule

Several ways to get DEP to approve alternatives:

- Water Flow Plan
- Withdrawal Certificate for Public Supplies
- Exceptions for droughts
- Existing permits from LURC or for hydropower stay in effect
- DEP also agreed not to require Public Supplies to meet standards until 5 years after DEP asks.

5. RWD Recharge Estimates

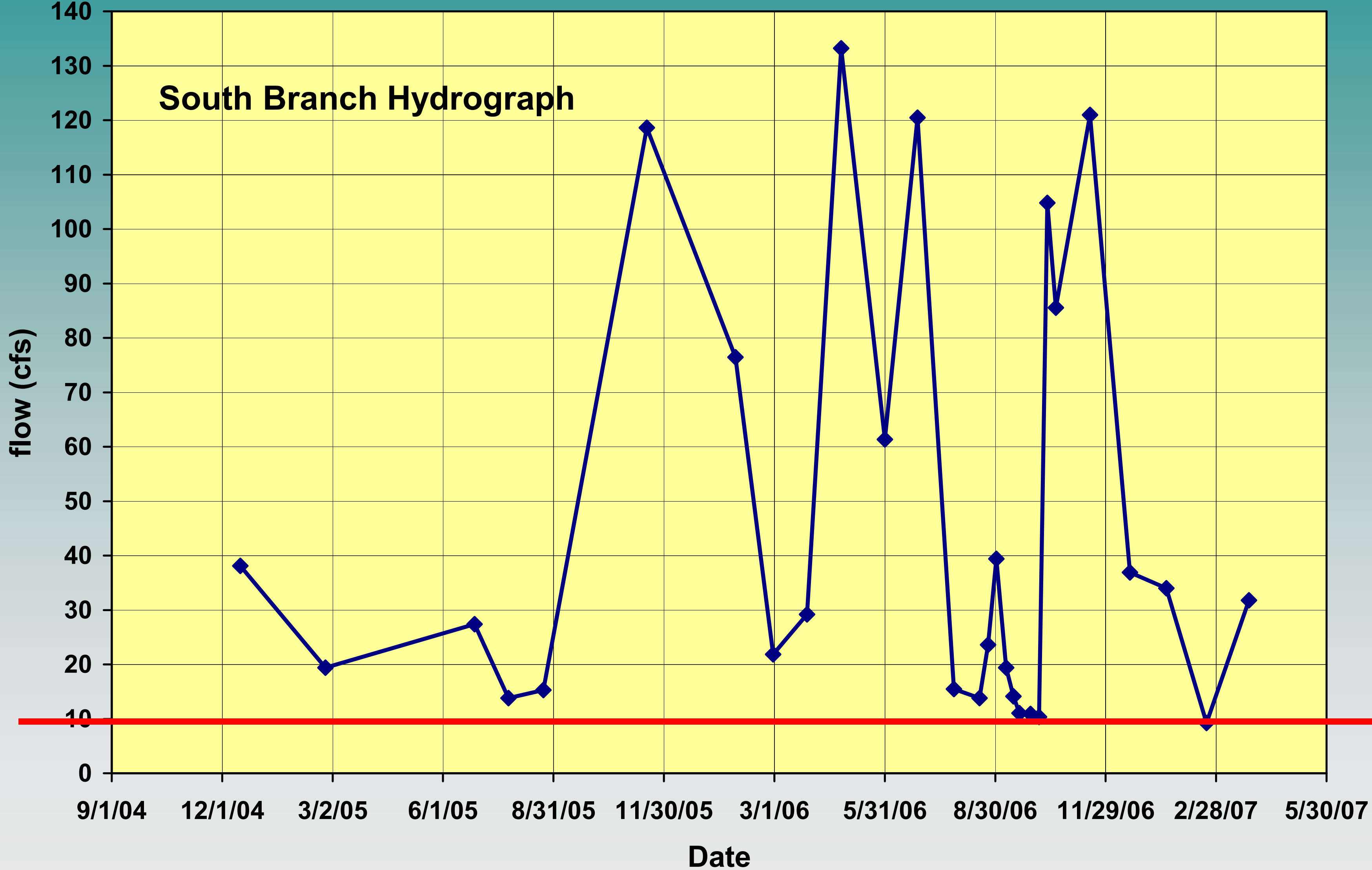
- RWD wanted to remove LURC permit limitations on withdrawal (0.5 ABF outdated) but had to consider new DEP Rule
- Low pumping rate suggested well had little influence on stream
- Ground water contour maps did not show consistent pattern between stream flow and ground water flow
- Not a simple “well feeding off stream” scenario

4. RWD Recharge Estimates

Streamflow statistics using Dudley methods

Annual mean	$Q = 1.151\,(A)^{0.991}\,10^{0.023pptW}$				
	A (acres)*	A (sq.mi.)	pptW**	Q (cfs)	Q actual***
	21,993	34.36	8.4	59.8	45
Annual median	$Q = 0.239\,(A)^{1.006}\,10^{0.057pptW}$				
	A (acres)*	A (sq.mi.)	pptW (in.)**	Q (cfs)	Q actual***
	21,993	34.36	8.4	25.3	28
August median	$Q = 0.152\,(A)^{1.120}\,10^{1.31SG}$				
	A (acres)*	A (sq.mi.)	SG*	Q (cfs)	Q actual***
	21,993	34.36	0.05	9.4	NA

4. RWD Recharge Estimates



5. RWD Recharge Estimates

- Streamflow capture analysis
- **Jenkins, 1970** (who based his math on Theis, Hantush, etc.) Available reference is Peters, 1987 (USGS WRIR 86-4199)
- Uses nomographs and calculations based t, Q, T, S, a. Basic assumptions:
  - T, Q constant
  - Isotropic, homogeneous aquifer (no delay)
  - Fully penetrating, straight stream

5. RWD Recharge Estimates

S	tp or tp + ti	V	q	q	v	v	v
---	d	gal	ft3/d	cfs	ft3	gal	% of V
0.25	0.23	82,800	14,920	0.17	1,439	10,764	13.0%
0.25	0.5	0	5,775	0.07	4,813	36,000	43.5%
0.25	0.75	0	3,369	0.04	5,535	41,400	50.0%
0.25	1	0	2,406	0.03	7,219	54,000	65.2%
0.1	0.23	82,800	26,470	0.31	3,653	27,324	33.0%
0.1	0.5	0	4,813	0.06	4,813	36,000	43.5%
0.1	0.75	0	1,925	0.02	5,775	43,200	52.2%
0.1	1	0	963	0.01	6,738	50,400	60.9%
0.25	1	360,000	28,877	0.33	19,732	147,599	41.0%
0.1	1	360,000	36,096	0.42	28,877	215,998	60.0%

5. RWD Recharge Estimates

- Calculations show:
- After one night of pumping, contribution from stream had reached about 0.2 cfs, but rate drops quickly when pumping stops
- About 60% of water from stream over entire pumping cycle, but withdrawal rate (v) remains low
- Peak recharge rate from stream equals about 3% of predicted August median stream flow (9 cfs)

5. RWD Recharge Estimates

- If pumping 24 hrs at 250 gpm (rather than 6 hr/night), v increases to 0.4 cfs or about 4% of August median
- Even if all pumped water came from stream, it would only equal about 6% of August median stream flow
- Model is conservative because:
  - Stream is fully penetrating
  - No recharge to aquifer
  - Does not consider variations in stream flow

6. Summary

- Estimated August median flow is about 9 cfs, less than in permit (based on 0.5 cfsm ABF)
- Original LURC restriction on flow (0.5 cfs withdrawal max if stream flow is <17 cfs) overly conservative:
  - August median is much lower than ABF suggests (9 vs 17 cfs)
  - Ground water flow and stream flow do not have close relationship
  - Pumping predicted to use less than 5% of stream flow under August median conditions

6. Summary

- Application to alter LURC permit conditions submitted last month
- Requests pumping at 250 gpm up to 24 hrs per day
- With that said, DEP says they are not really interested in flow rate calculations
- Will base decision on visual inspection of stream ecosystem such as wetted surface (?)
- One of the first applications of new rule…