Missouri Department of
Natural Resources

Pump Tests for Public Water Supply Wells

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MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

Pump Tests

An “aquifer test” or a “pump test” is typically performed on newly constructed or rehabilitated wells. When done properly, such a test can accomplish two things:

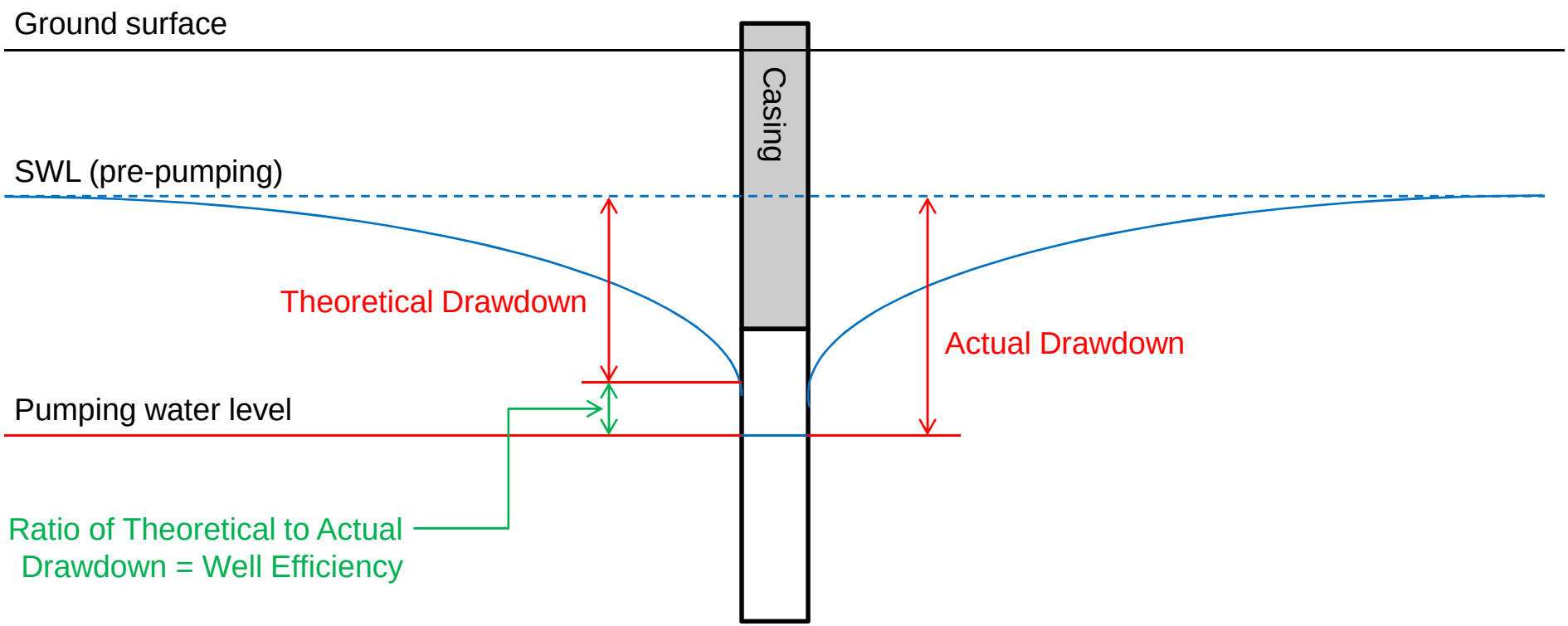
1. Determine the performance of the well
2. Determine the hydrologic characteristics of the aquifer at that location

Pump Tests

Determine the performance of the well

- Drawdown characteristics for sizing pump and depth to set pump
- Well efficiency - ratio of theoretical drawdown to actual drawdown (most important for alluvial/glacial drift wells)

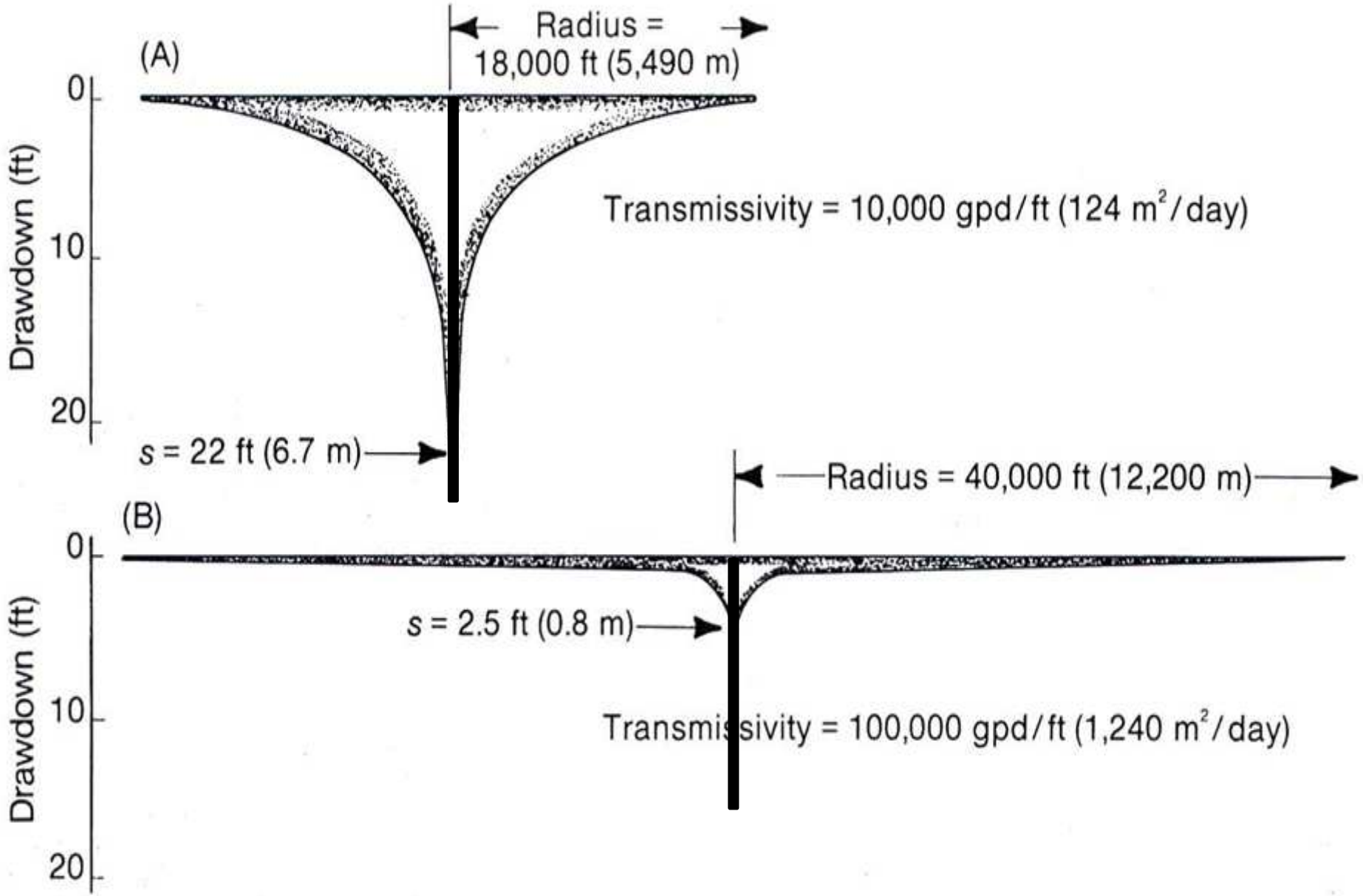
Well Efficiency



Pump Tests

Determine the hydrologic characteristics of the aquifer at that location

- Transmissivity - rate at which water moves through the aquifer
- Specific yield or storage coefficient - the ratio of water that a given mass of rock will yield
- Presence of boundary conditions - groundwater divides, bodies of water, other wells, confining layers
- Radius of influence - distance from a well drawdown can be measured


(A)
Radius =
18,000 ft (5,490 m)
0
10
20
Drawdown (ft)
Transmissivity = 10,000 gpd/ft (124 m²/day)
s = 22 ft (6.7 m)
(B)
Radius = 40,000 ft (12,200 m)
0
10
20
Drawdown (ft)
s = 2.5 ft (0.8 m)
Transmissivity = 100,000 gpd/ft (1,240 m²/day)

Public Wells Requiring Pump Tests

- Consolidated and unconsolidated community wells greater than 300 feet TD with a casing of 8” or greater
  - Constant rate method
- Unconsolidated community wells less than 300 feet TD
  - Constant rate method
  - Variable rate method
  - Step continuous composite method
- All non-community wells unless exempted
  - No test specified, but constant rate test recommended

Public Wells Not Requiring Pump Tests

- Pump test not required, but recommended
- Community wells
  - Consolidated wells less than 300 feet TD
  - Consolidated and unconsolidated wells greater than 300 feet TD **AND** casing less than 8 inches
- Non-community wells
  - Casing less than 8 inches
  - Pump capacity is less than well yield
  - Upon approval from department

Observation Wells

- An observation well is a well other than the pumped well that can be used to measure the effects of pumping on the aquifer, not just the effects inside of the pumped well.
- The more variable the aquifer, the greater the need for multiple observation wells placed different distances and directions from the pumped well. Multiple observation wells most commonly used in alluvial and glacial drift aquifers.
- Distance between pumped well and observation well, typically 50 to 300 feet in an unconfined aquifer, 100 to 700 feet in a confined aquifer.
- An observation well allows the well efficiency and the storage coefficient to be accurately determined.

Constant Rate Pump Tests

(Consolidated greater than 300 feet TD and unconsolidated wells)

- Pumping rate 1.5 times designed rate
- Drawdown and recovery water level measured at specific intervals (unconsolidated wells must have 1-2 observation wells)
- Discharge must be maintained at rate +/- 5%
  - If the rate varies more than 5%, the test must be stopped, the well allowed to recover, and the test restarted
- Test conducted for 24 hours or a minimum of 8 hours if the drawdown has stabilized for 2 hours
- Recovery data must be collected immediately following the test
- Test must be submitted to WRC before certification is approved by WHP

Variable Rate Pump Tests

(Unconsolidated wells less than 300 feet TD)

- Require 1-2 observation wells 100-300 feet from the well
- Pumping rate 1.5 times designed rate until suction is lost
- After suction is lost, decrease pump rate until water level stabilizes and then reduce an additional 5%
- Drawdown and recovery water level measured at specific intervals in the production well and observation wells
- Test conducted for 24 hours or a minimum of 4 hours if the drawdown has stabilized for those 4 hours
- Recovery data must be collected immediately following the test
- Test must be submitted to WRC before certification is approved by WHP

Step Continuous Composite Pump Tests

(Unconsolidated wells less than 300 feet TD)

- Require 1-2 observation wells 100-300 feet from the well
- Pumping rate 0.5, 0.75, 1.0, 1.5 times designed capacity
- Discharge must be maintained at +/- 5% of designated flow
- Drawdown and recovery water level measured at specific intervals in the production well and observation wells
- Test conducted until water level stabilizes for four hours
- Water level must be allowed to recover to SWL after each step
- Test must be submitted to WRC before certification is approved by WHP

Data to Be Collected During Test

- Static water level before test begins
- Designated pumping rate
- Time since pumping started
- Depth pump is set
- Drawdown water level during pumping and recovery after the pump is shut off (in both pumping well and observation wells)

Data Collection Intervals

Drawdown is greatest at the beginning of a constant rate pumping test, and decreases throughout the test. Similarly, recovery is greatest immediately after the pumping is stopped. Required data collection intervals…

Time since pumping began or pump shut off	Data collection interval
1-10 minutes	1 minute
10-50 minutes	5 minutes
50-90 minutes	10 minutes
90-180 minutes	30 minutes
180-end of test	60 minutes

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PUMP TEST RECORD
WATER RESOURCES CENTER
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Water Supply Name _____Well #_____

Location: County _____Sec. _____, T _____N, R_____E or W

Total Depth_____ft., Casing length_____ft., Casing Diameter_____in., Hole Diameter_____in.

Date of Test _____, SWL _____ft., Pumping Rate_____gpm., Pump Setting(ps)_____ft.

Airline Length _____ft.

PUMPING DATA

TIME	TOTAL TIME	A.L.	P.L. (ps-al)	D.D.(ps-al-swl)	REMARKS
	0				
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	12				
	14				
	16				
	18				
	20				
	25				
	30				
	35				
	40				
	45				
	50				
	55				
	60				
	70				
	80				
	90				
	100				
	110				
	120				
	150				

A.L. = Airline Reading (specify whether in psi or feet) P.L. = Pumping Level D.D.= Drawdown

PUMPING DATA (continued)

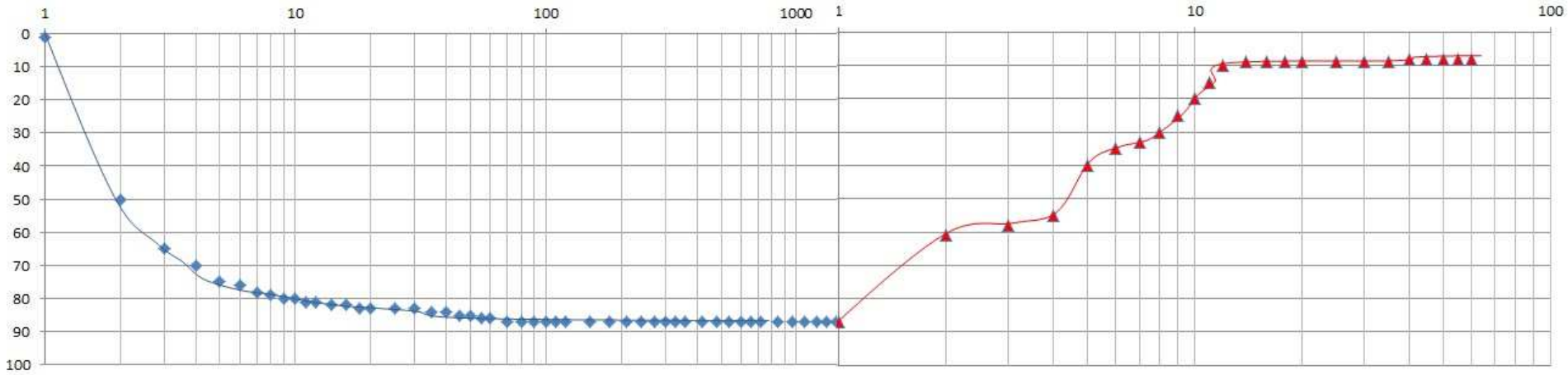
TIME	TOTAL TIME	A.L.	P.L. (ps-al)	D.D.(ps-al-swl)	REMARKS
	180				
	210				
	240				
	270				
	300				
	330				
	360				
	420				
	480				
	540				
	600				
	660				
	720				
	840				
	960				
	1080				
	1200				
	1320				
	1440				

RECOVERY DATA

WELL_____DATE_____

TIME	TOTAL TIME	A.L.	P.L (ps-al)	D.D.(ps-al-swl)	REMARKS
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	12				
	14				
	16				
	18				
	20				
	25				
	30				

Drawdown vs Recovery Graph



Constant pumping rate of 480 gpm during test
Well Total Depth = 1000 feet Casing Depth = 400 feet
SWL = 265 feet

Time (min)	Drawdown (ft)	Pumping rate (gpm)
	SWL=235	
1	45	470
2	65	460
3	75	450
4	75	440
5	80	
6	85	
7	87	
8	95	
9	95	
10	95	
15	105	435
20	110	430
25	115	425
30	117	420
45	145	405
60	155	390
90	155	
120	155	
150	155	
180	175	370
210	185	365
240	185	
300	185	
360	185	
420	185	

Incorrect data collection intervals

Beginning/ ending pumping rate decreases more than 5%

385 gpm pump installed. Test not conducted at 1.5 times pumping rate.

480	185	350
540	185	
600	185	
660	185	
720	195	340
780	195	
840	195	
900	205	330
960	210	325
1020	215	320
1080	215	
1140	215	
1200	195	340
1260	205	330
1320	215	
1380	205	
1440	195	

Recovery

Time (min)	Drawdown (ft)
0	195
5	135
10	115
15	90
20	85
25	83
30	83
45	83
60	83
?	0

Incorrect data collection intervals

Final recovery time unknown

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800 gpm pump installed. Test not conducted at 1.5 times pumping rate.

Time (min)	Drawdown (ft)	Pumping rate (gpm)
	SWL=80	
5	60	473
10	62	
15	62	
20	62	
25	62	
30	62	
35	62	
40	65	
45	65	
50	65	
55	65	
60	68	
65	68	
70	70	
75	70	
80	70	
85	70	
90	70	
95	130	800
100	135	
105	140	
110	145	
115	150	
120	150	
125	150	

Incorrect data collection intervals

Pumping rate increases more than 5%

130	151
135	152
140	153
145	154
150	155
155	156
160	157
165	158
170	159
175	160
180	161
195	165
200	165
225	165
240	165
255	169
270	169
285	169
300	170
315	170
330	171
345	171
360	175
375	175
390	179
420	180
450	180
480	180

Incorrect data collection intervals

Water level not stabilized for two hours before end of test

Recovery Time (min)	Drawdown (ft)
0	70
1	60
2	60
3	60
4	60
5	55
7	50
10	45
15	40
20	40
25	35
30	35
35	30
40	30
45	25
50	25
55	25
60	25
65	25
70	25
?	0

Incorrect data collection intervals

Final recovery time unknown

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35 gpm pump installed. Test conducted at a constant 50 gpm

Time (min)	Drawdown (ft)	Pumping rate (gpm)
	SWL=20	
1	7	50
2		
3	13.5	
4	22.5	
5	30	
6	41	
7	50	
8	60.5	
9	70	
10	76	
12	81.5	
14	82	
16	83.5	
18	84	
20	85	
30	85.5	
40	86	
50	86.5	
60	87	
75	87	
90	87.5	
120	88	
180	88	
210	88.5	
240	89	
270	89	
300	89	
360	89.5	
420	90	
480	90.5	
540	90.5	
600	90.5	
660	90.5	
720	90.5	
780	90.5	

Constant pumping rate

More data collection intervals than required

Water level stabilized for six hours before end of test

Recovery Time (min)	Drawdown (ft)
0	90.5
1	60
2	44
3	34
4	25
5	20.5
7	15
9	11
11	7.5
13	5.5
15	5
30	3
45	1
75	0
105	0

Incorrect data collection intervals

Water level returned to SWL

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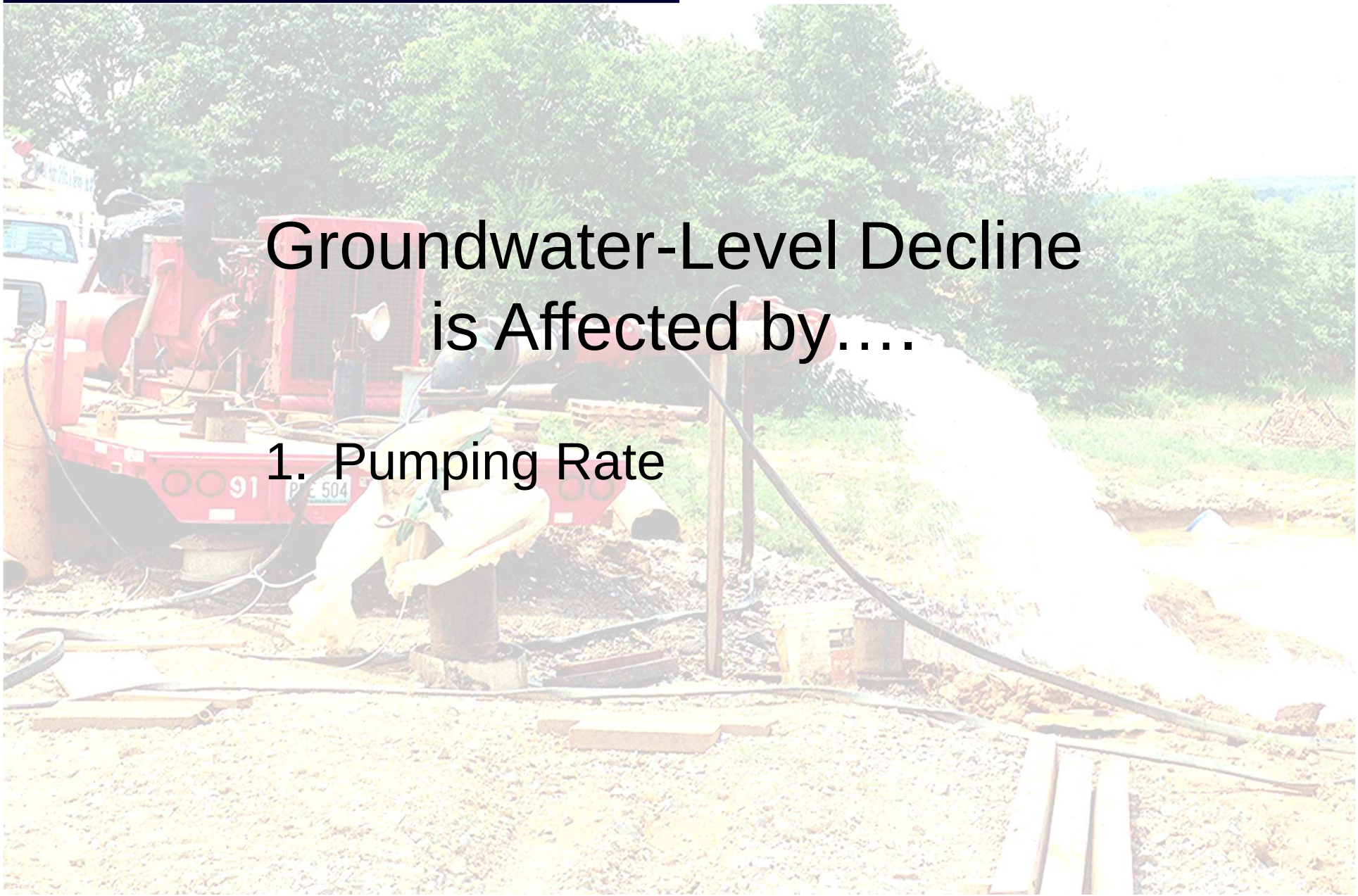
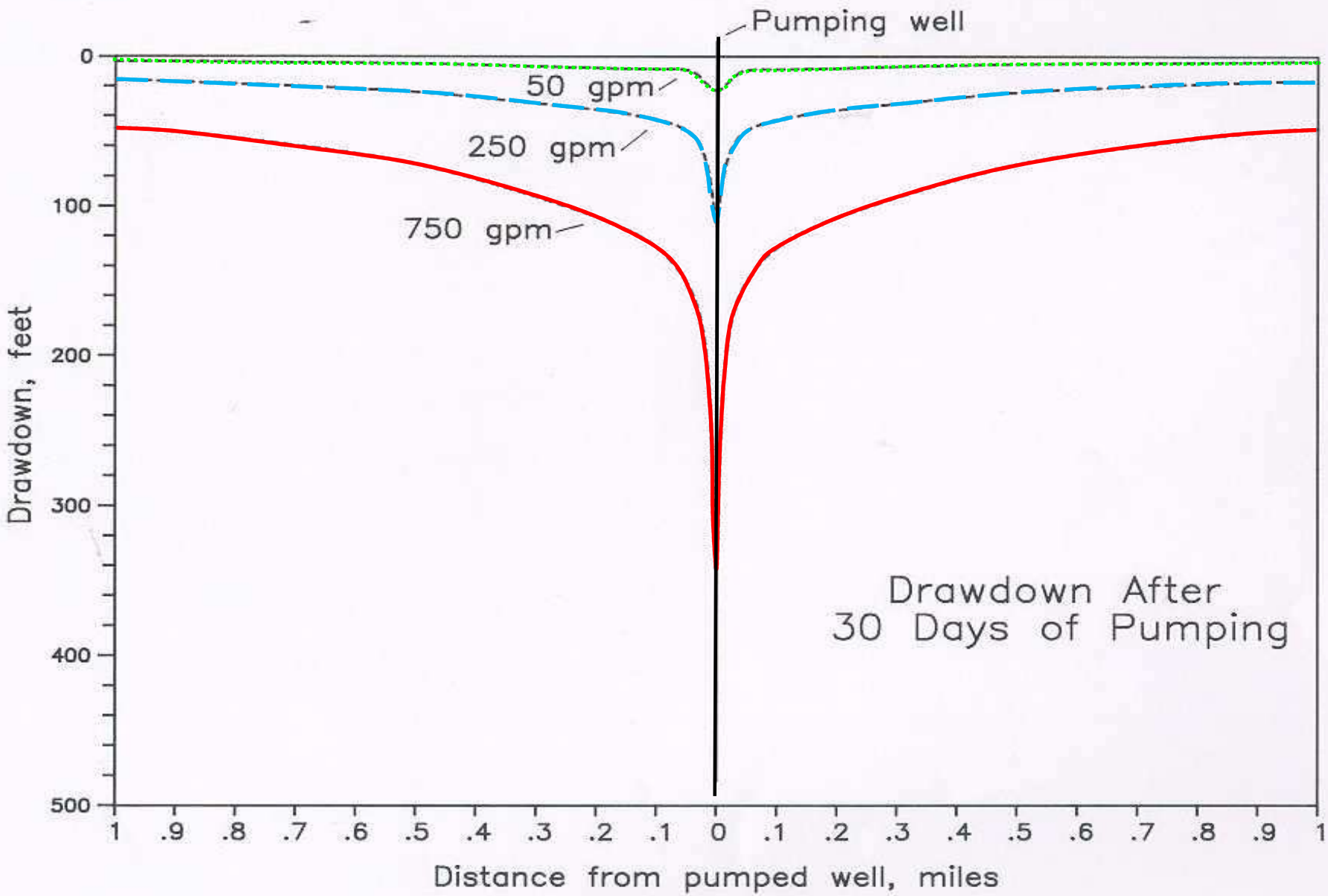
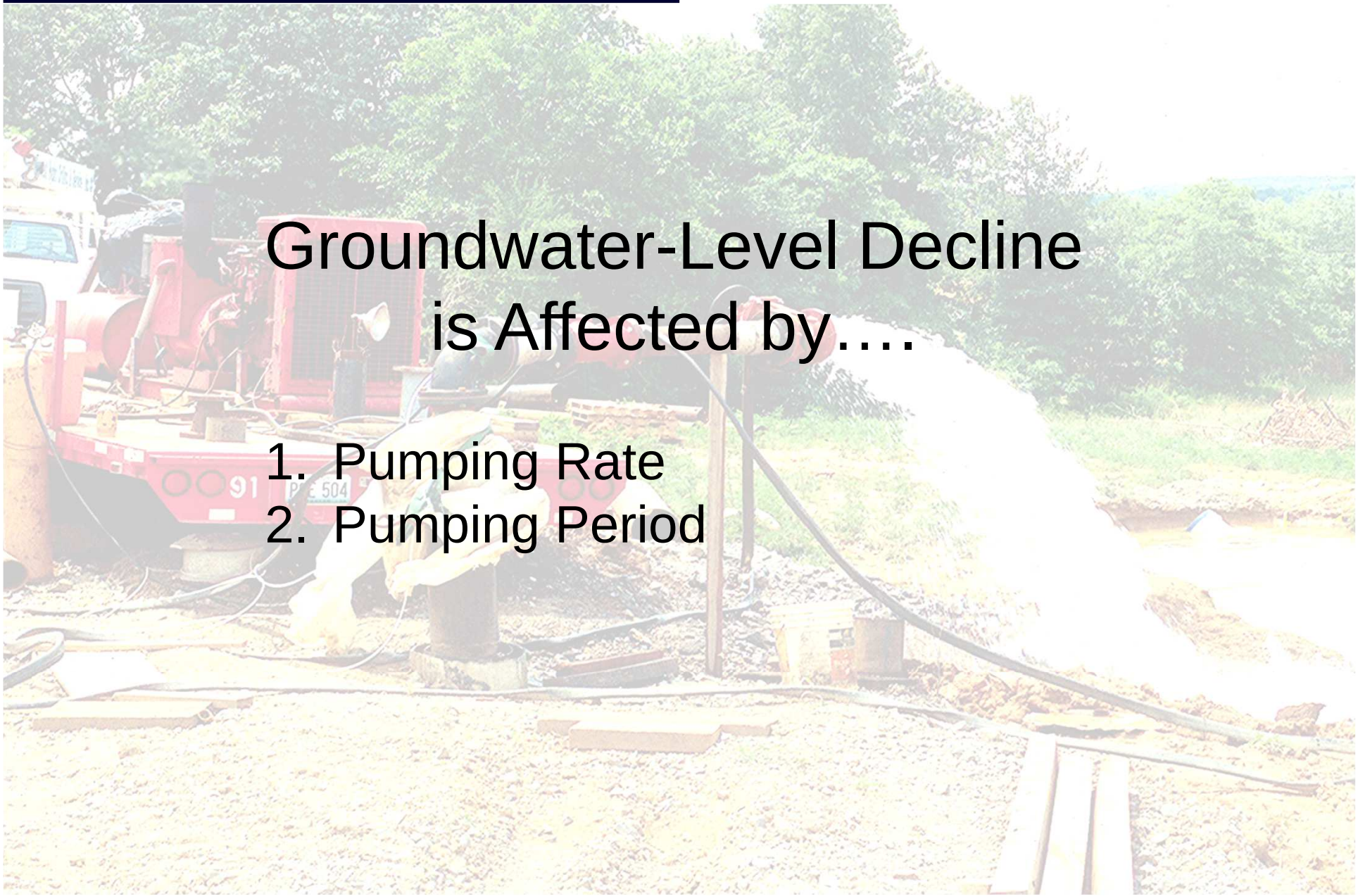


Groundwater-Level Decline is Affected by….

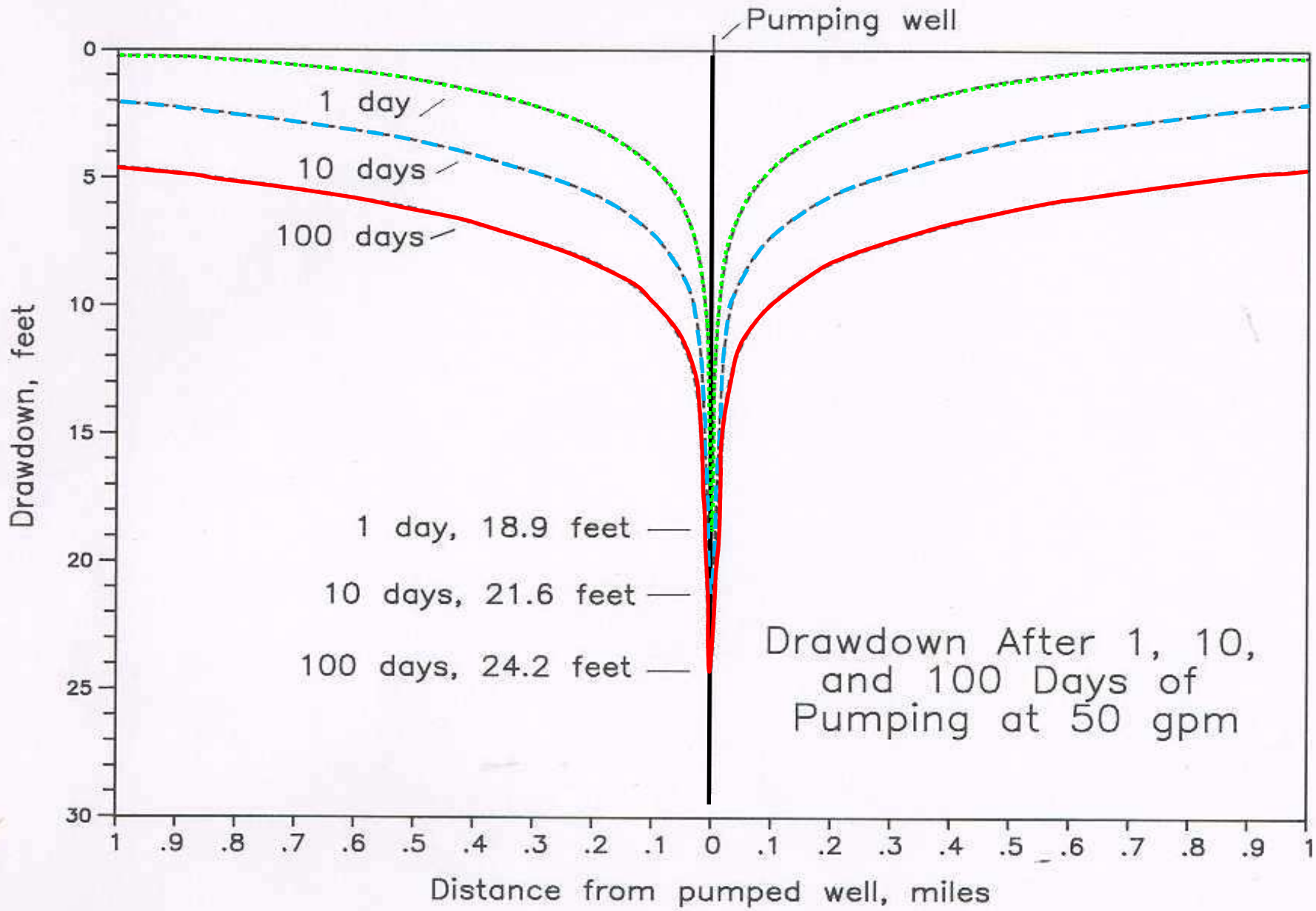
1. Pumping Rate

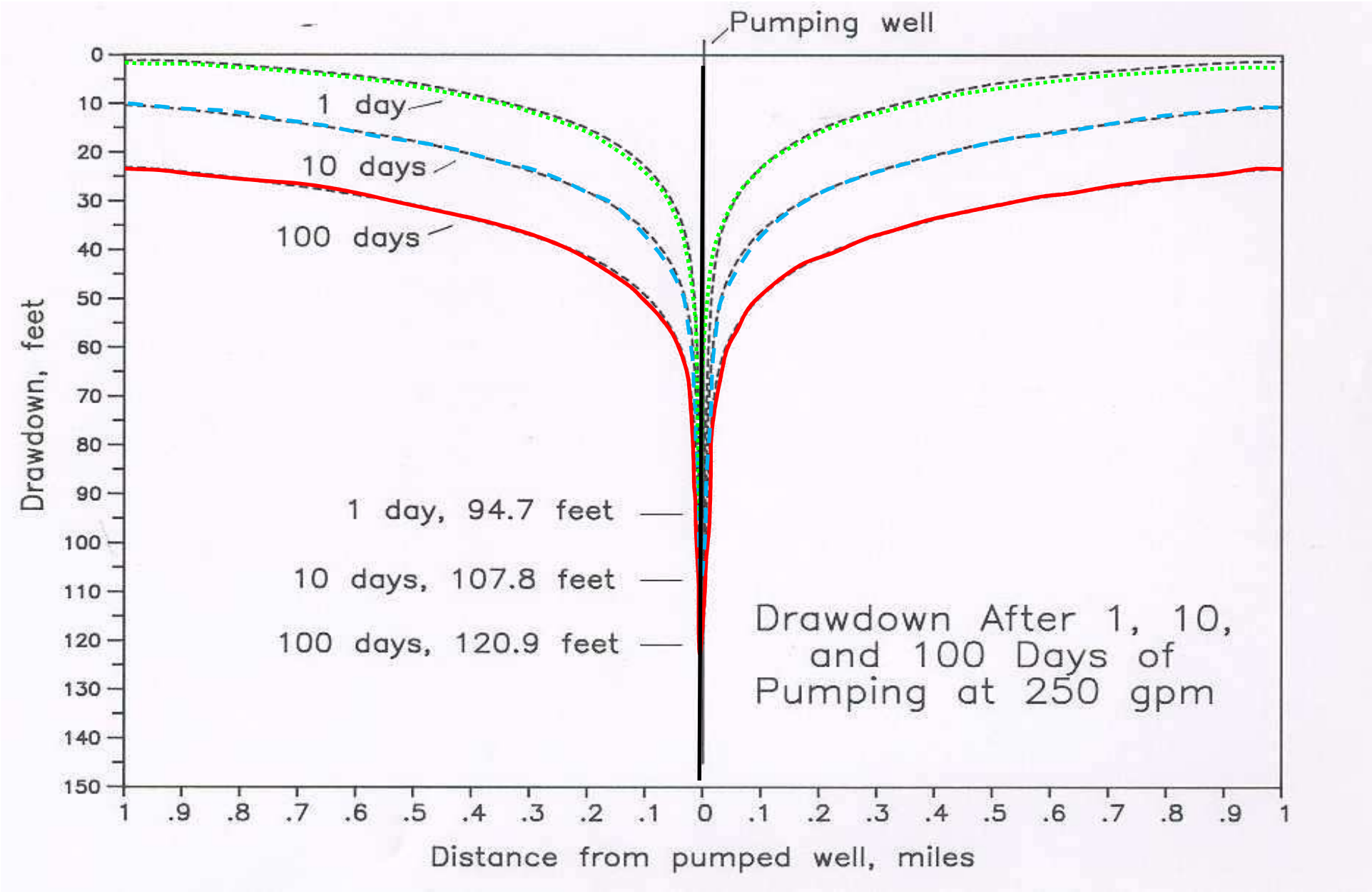

Pumping well
50 gpm
250 gpm
750 gpm
Drawdown After
30 Days of Pumping
Drawdown, feet
0
100
200
300
400
500
1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
Distance from pumped well, miles

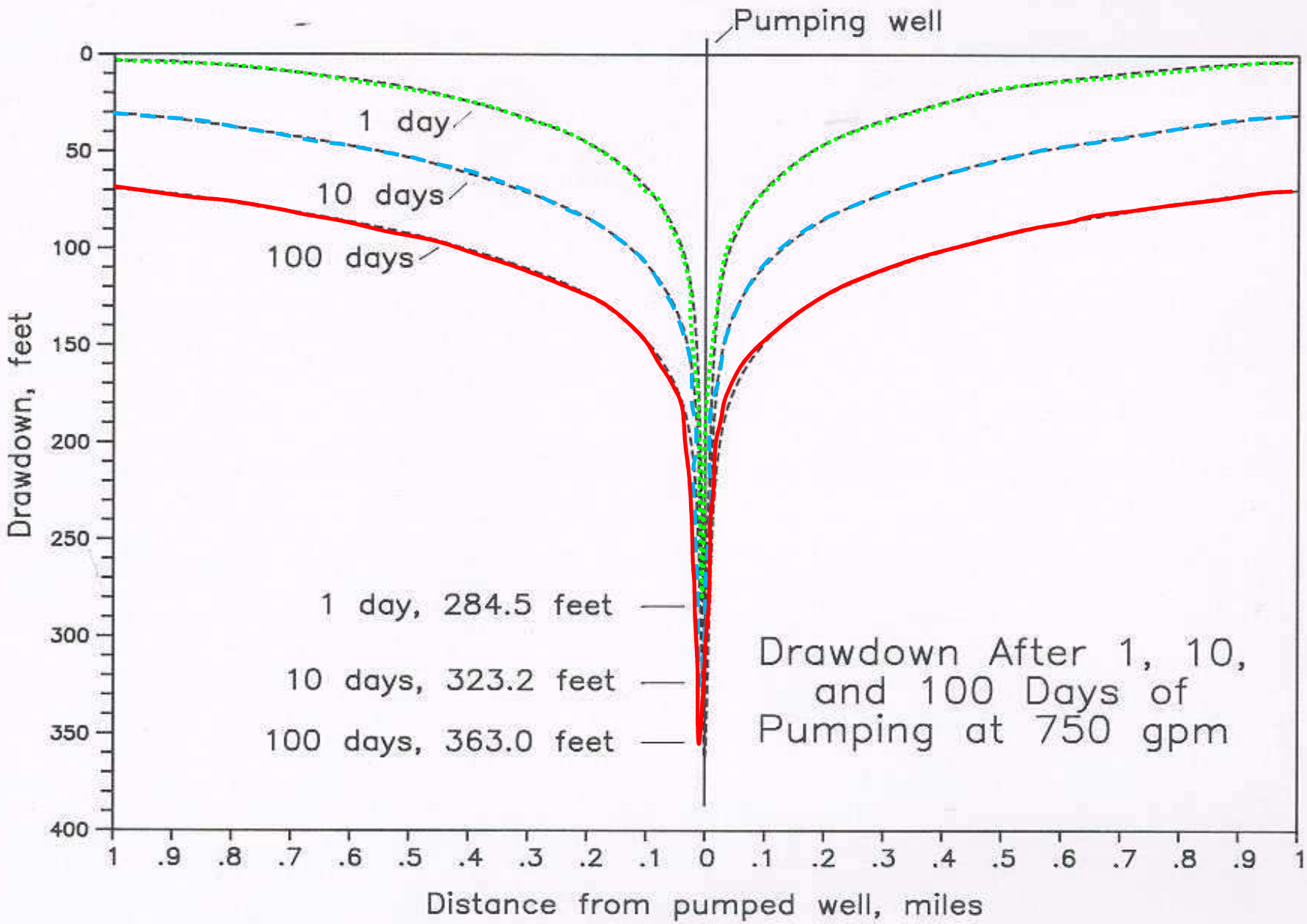


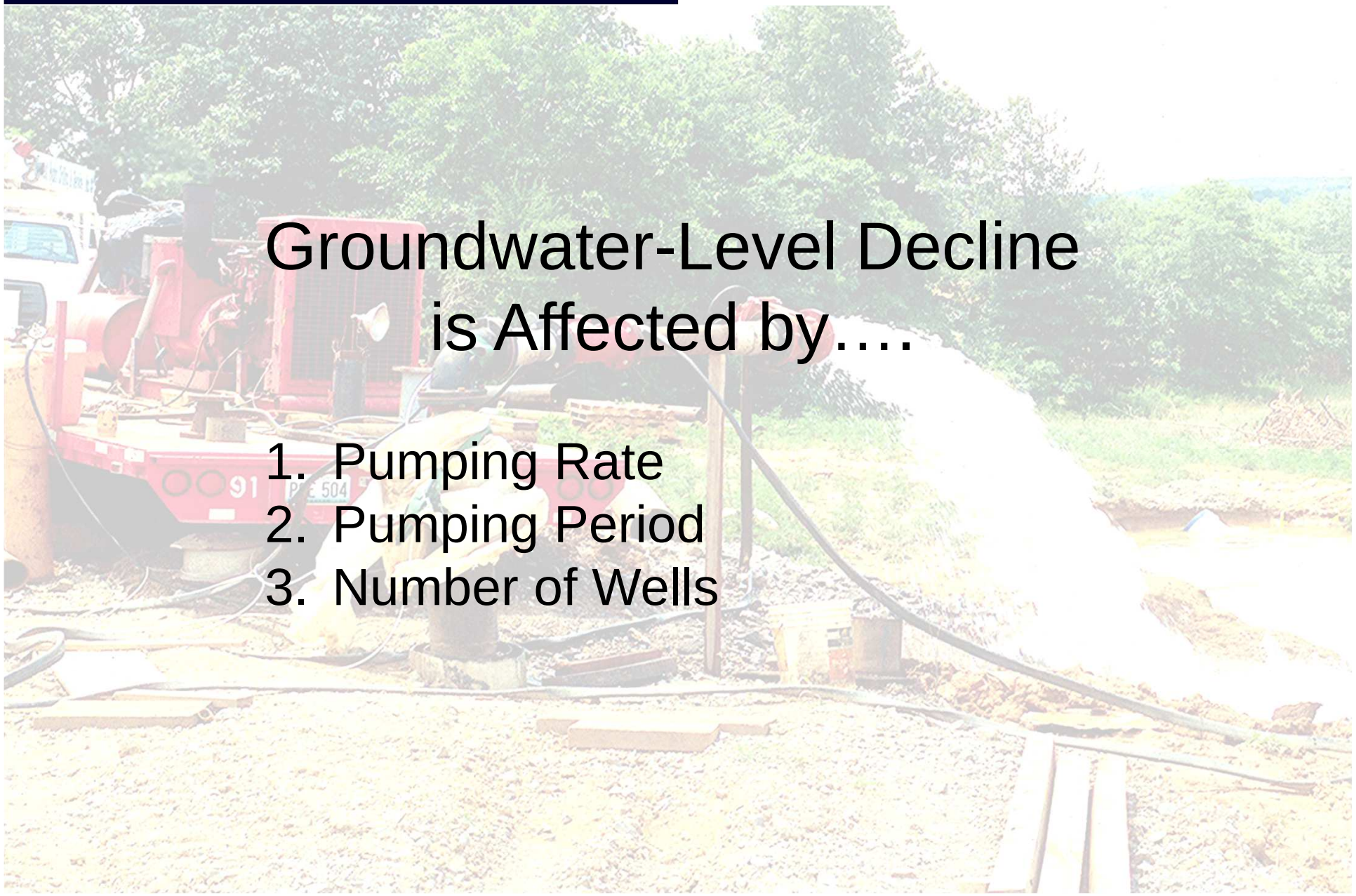
Groundwater-Level Decline is Affected by….

1. Pumping Rate
2. Pumping Period


Pumping well
1 day
10 days
100 days
1 day, 18.9 feet
10 days, 21.6 feet
100 days, 24.2 feet
Drawdown After 1, 10, and 100 Days of Pumping at 50 gpm
Drawdown, feet
0
5
10
15
20
25
30
1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
Distance from pumped well, miles


Pumping well
1 day
10 days
100 days
1 day, 94.7 feet
10 days, 107.8 feet
100 days, 120.9 feet
Drawdown After 1, 10, and 100 Days of Pumping at 250 gpm
Drawdown, feet
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
Distance from pumped well, miles


Pumping well
1 day
10 days
100 days
1 day, 284.5 feet
10 days, 323.2 feet
100 days, 363.0 feet
Drawdown After 1, 10, and 100 Days of Pumping at 750 gpm
Drawdown, feet
0
50
100
150
200
250
300
350
400
1 .9 .8 .7 .6 .5 .4 .3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
Distance from pumped well, miles

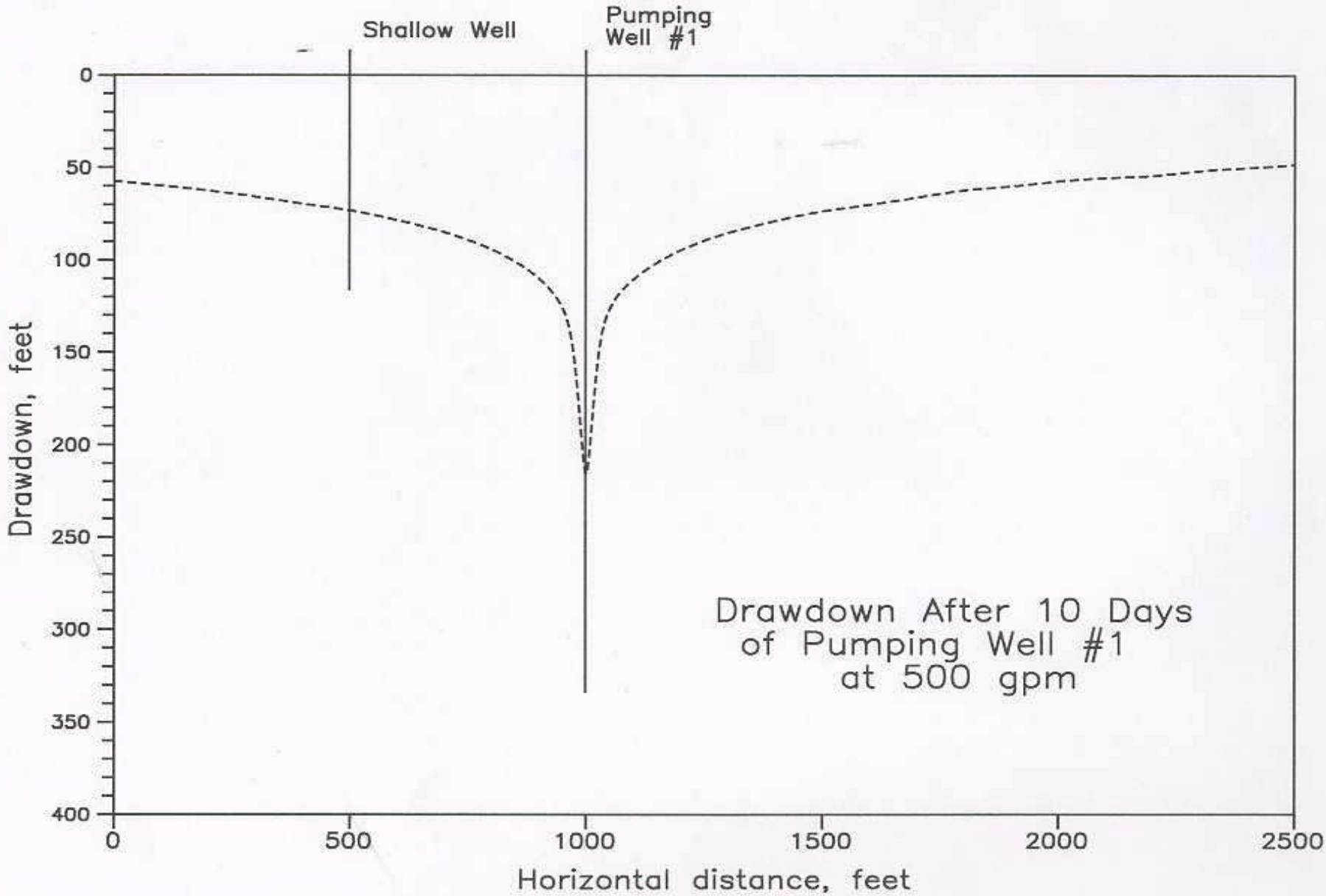


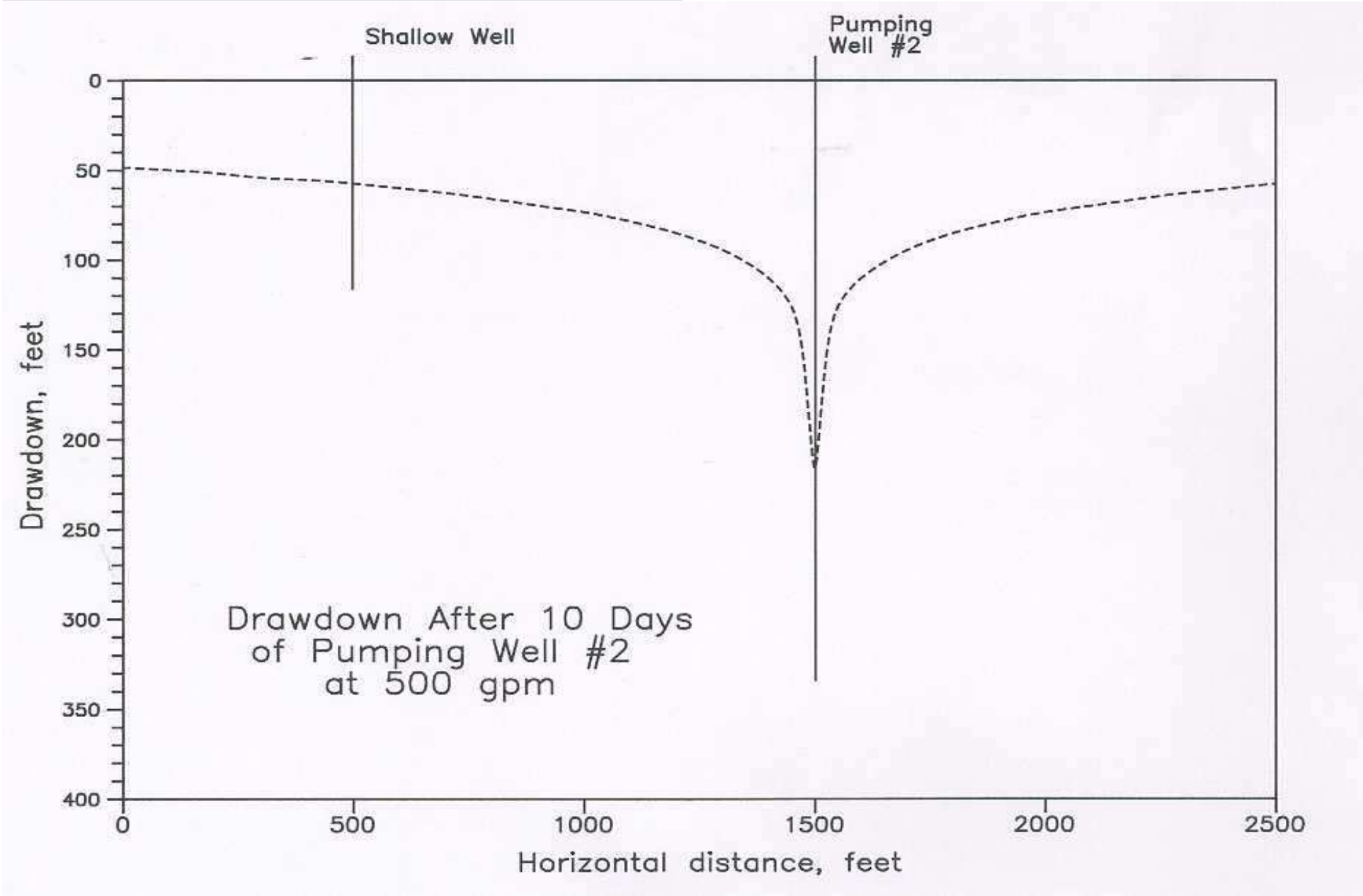
Groundwater-Level Decline is Affected by….

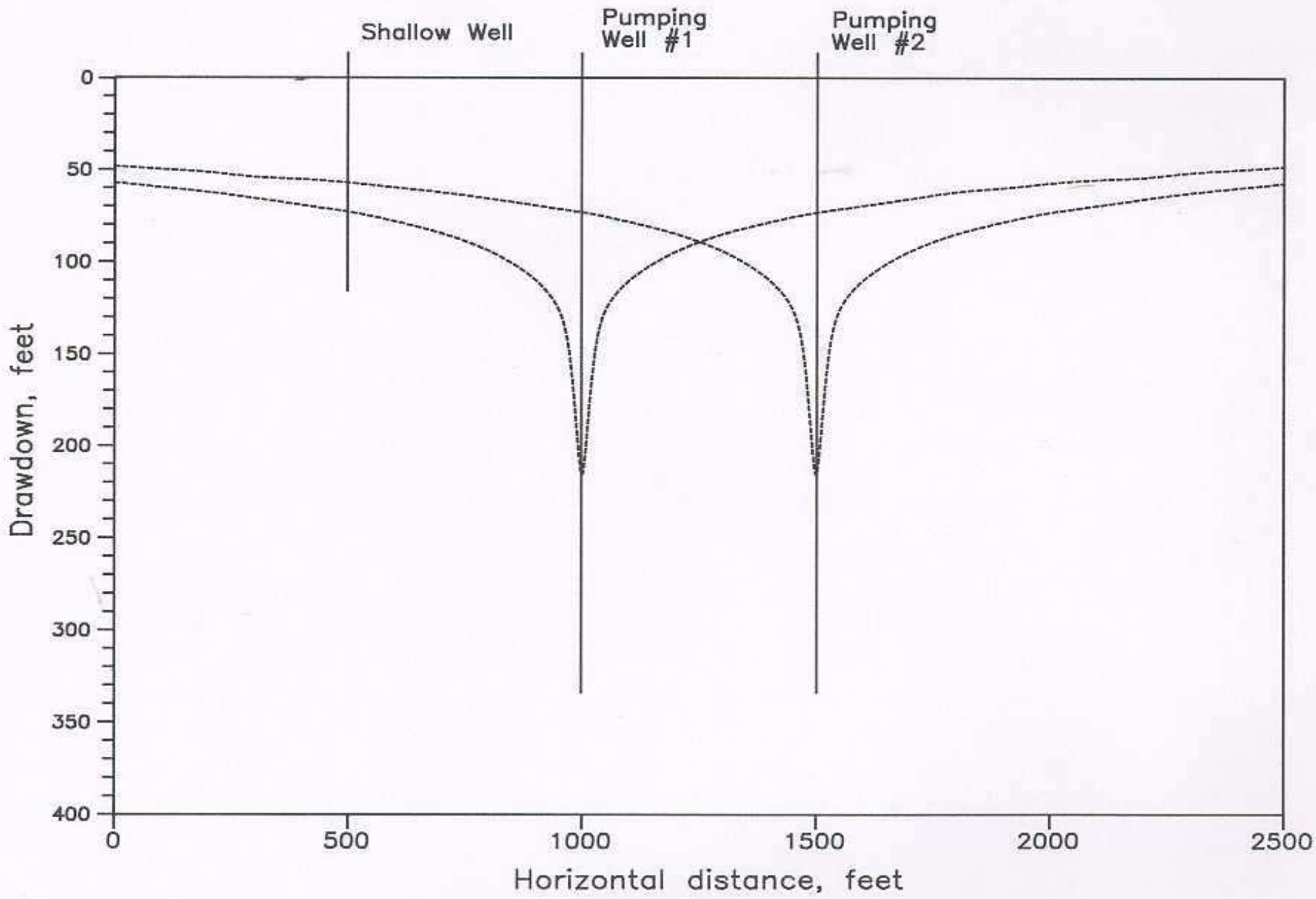
1. Pumping Rate
2. Pumping Period
3. Number of Wells

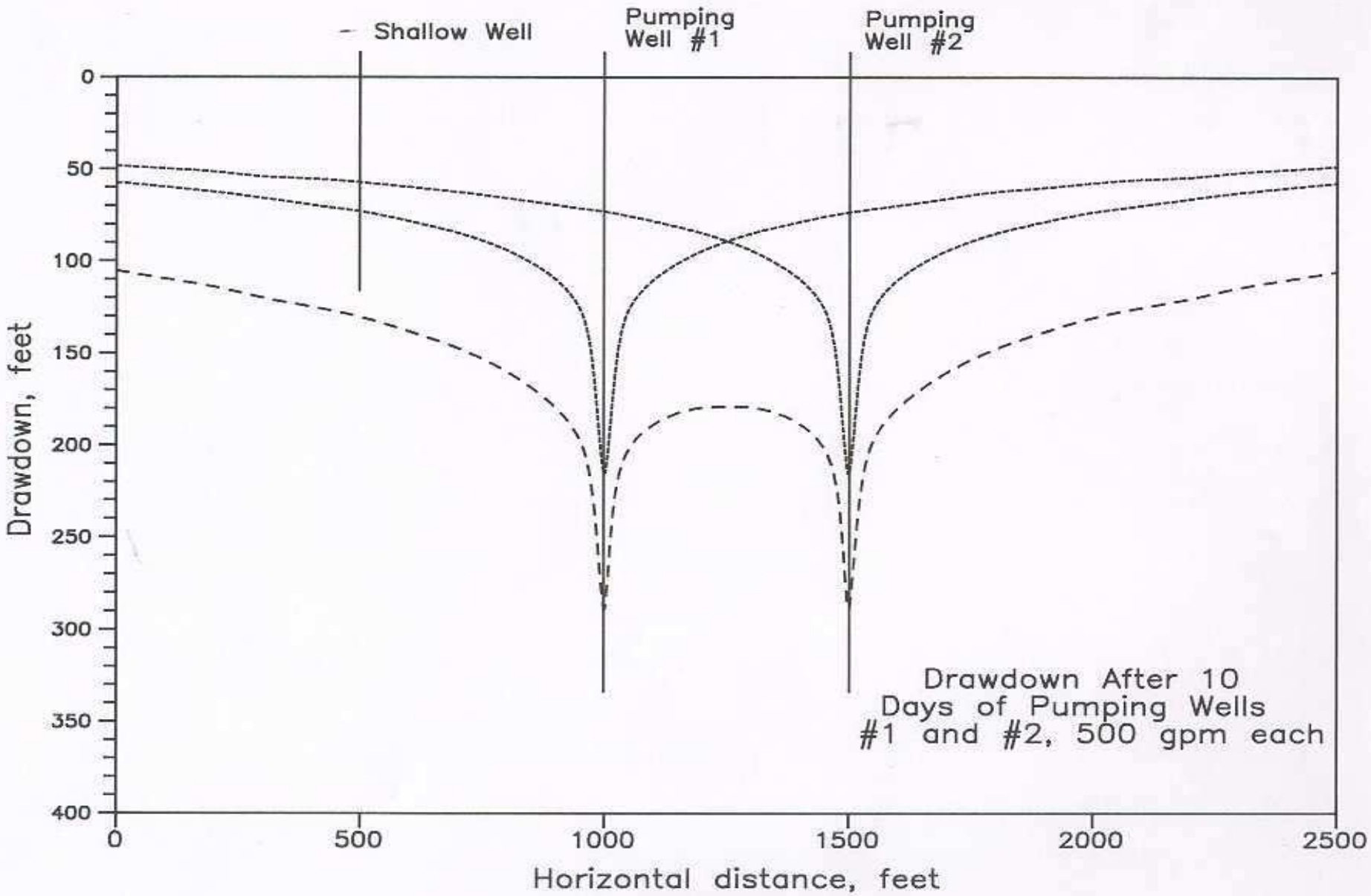
Groundwater-Level Decline is Affected by….

1. Pumping Rate
2. Pumping Period
3. Number of Wells
4. Well Spacing


Shallow Well
Pumping Well #1
Drawdown, feet
0
50
100
150
200
250
300
350
400
0
500
1000
1500
2000
2500
Horizontal distance, feet
Drawdown After 10 Days of Pumping Well #1 at 500 gpm


Shallow Well
Pumping Well #2
Drawdown After 10 Days of Pumping Well #2 at 500 gpm
Drawdown, feet
0
50
100
150
200
250
300
350
400
0
500
1000
1500
2000
2500
Horizontal distance, feet


Shallow Well
Pumping Well #1
Pumping Well #2
0
50
100
150
200
250
300
350
400
Drawdown, feet
0
500
1000
1500
2000
2500
Horizontal distance, feet


Shallow Well
Pumping Well #1
Pumping Well #2
Drawdown, feet
0
50
100
150
200
250
300
350
400
0
500
1000
1500
2000
2500
Horizontal distance, feet
Drawdown After 10 Days of Pumping Wells #1 and #2, 500 gpm each

Summary…

- Pump tests are important to determine…
  - Well performance
  - Aquifer characteristics
- Pump tests may or may not be required depending on the type of well, material the well is constructed in, depth of well, and size of casing
- Different options for pump test
  - Constant rate (most common)
  - Variable rate
  - Step continuous composite
- Very important to follow testing guideline or the data collected is useless

Questions???

MISSOURI
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