ROAD SALT TRANSPORT AT TWO MUNICIPAL WELLFIELDS IN WILMINGTON, MASSACHUSETTS

by
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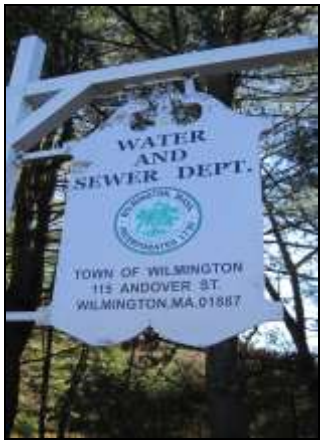


January 31, 2013

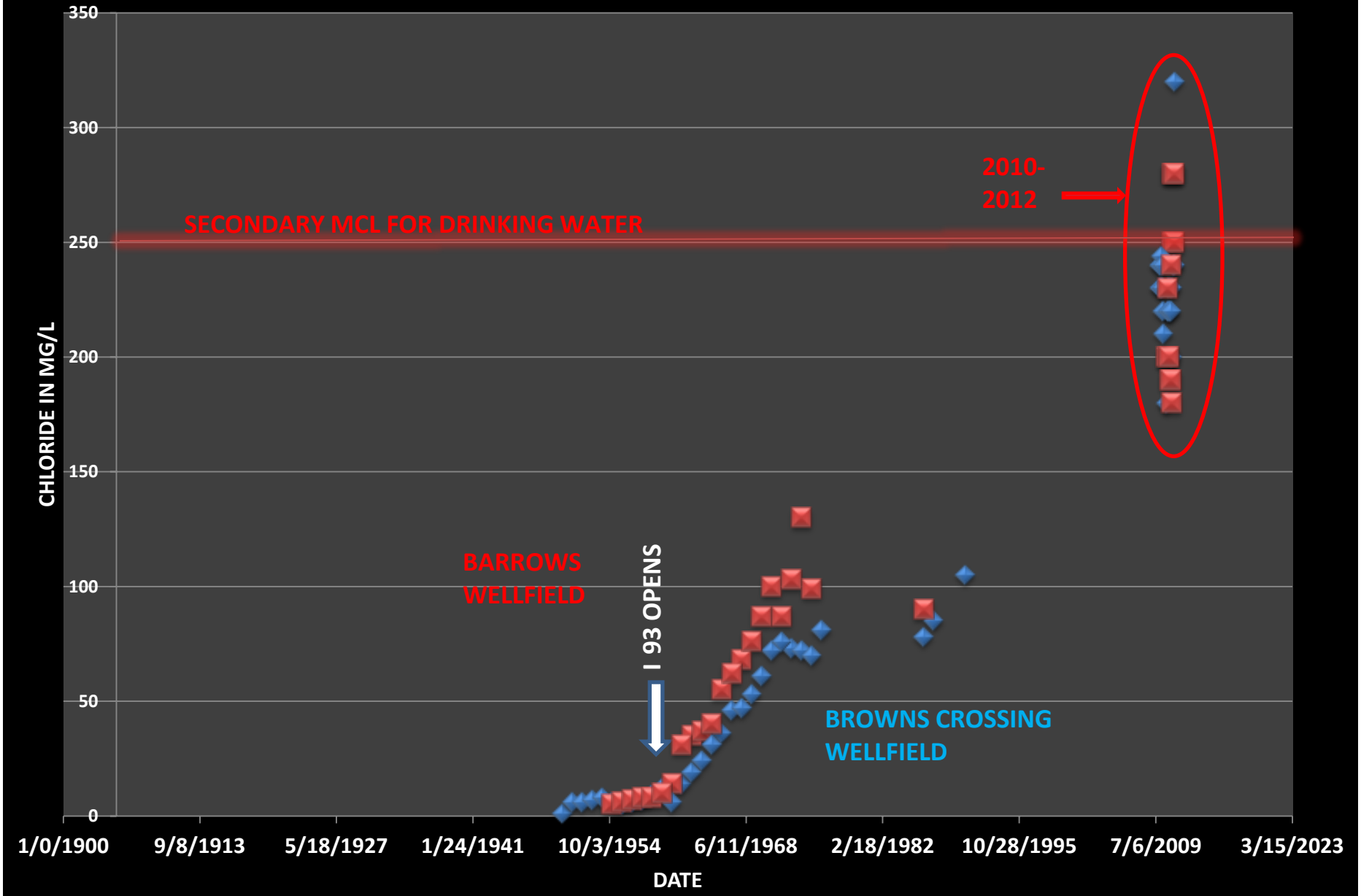
***COMMON SOURCES OF SODIUM CHLORIDE IN WATER SUPPLIES*:**

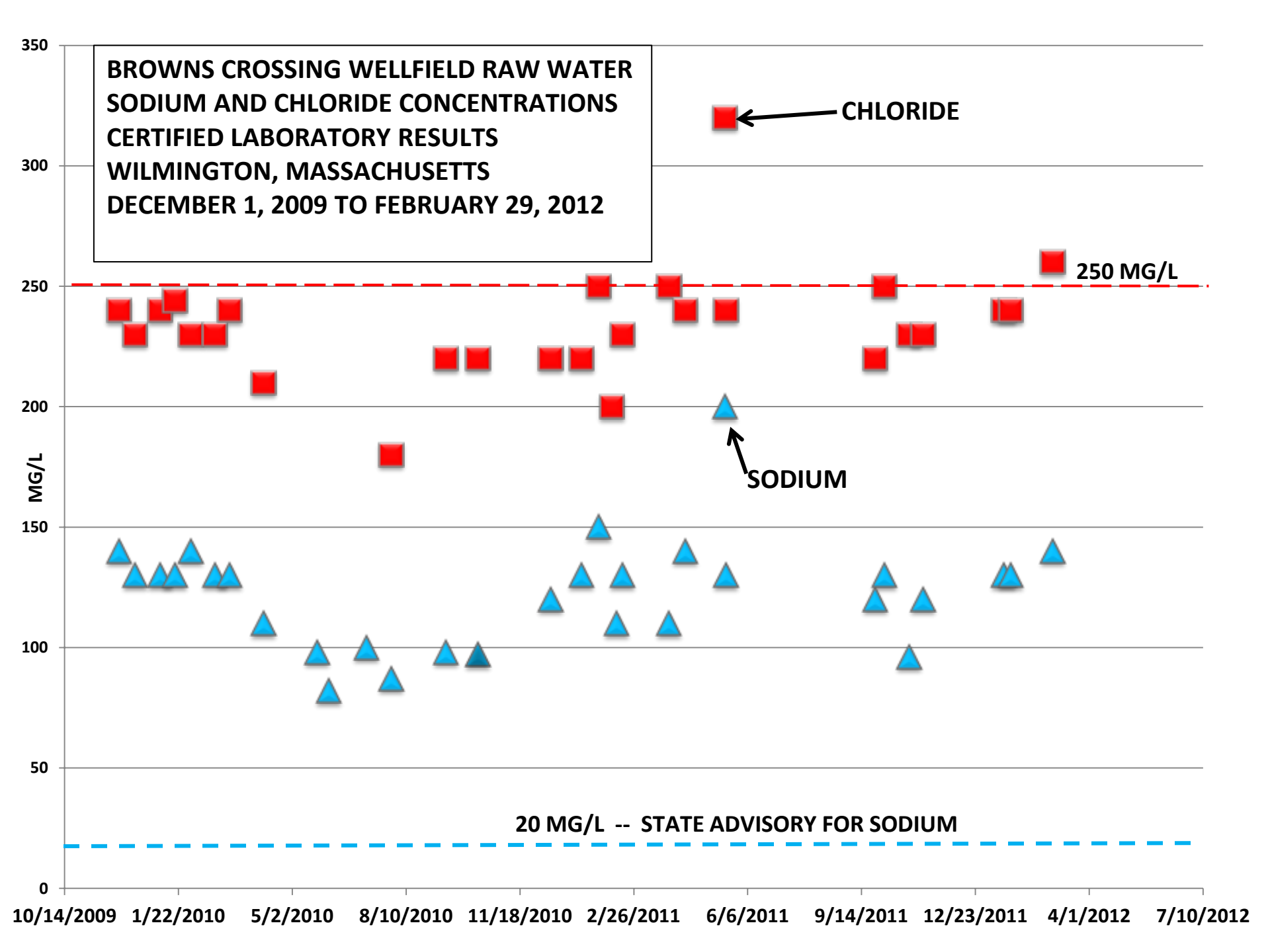
-- ATMOSPHERIC DEPOSITION
-- BEDROCK WEATHERING
-- WASTEWATER (SEPTIC SYSTEMS)
-- WATER SOFTENER DISCHARGE
-- OIL AND GAS DRILLING DISCHARGES
-- MINE DRAINAGE
-- INDUSTRIAL EFFLUENT
-- RESIDENTIAL/COMMERCIAL SIDEWALKS AND DRIVEWAYS
-- PARKING AREA DEICING CHEMICALS
-- ROAD AND HIGHWAY DEICING CHEMICALS


I-93
I-495
WILMINGTON
WELLFIELDS
RT. 128
BOSTON
N
Lowell
North Chelmsford
North Billerica
Pattenville
River Pines
Westlands
Brookside
Station
North Tewksbury
Tewksbury
Junction
Wilmington
Junction
West Andover
Kenwood
Mount Vernon Park
Marble Ridge
Station
Kings Forest
Pinefield
Ipswich
Town of
Boxford
Bradley
Palmer
State
Park
Nancys
Corner
Kinsman
Corner
Asbury Grove
Town of Wenham
North Beverly
Hathorne
Town of
Danvers
Montserrat
Beverly
Peabody
Salem
Curtis
Guild
Town of
Lynnfield
Town of
Reading
Pinehurst
Riverside
Town of
Carlisle
North Acton
East Acton
West Bedford
Havenville
Mishawum
Woburn
Greenwood
Melrose
Lynn
Phillips Point
Nahant
Little Bay
Nahant
Broad Sound
Malden
Linden
Medford
Everett
Revere
Chelsea
Somerville
Winthrop Beach
Point Shirley
Boston
Harbor
Dorchester
Bay
Hull Lagoon
Brookline
Newton
Waltham
Watertown
Lakeview
Hastings
Town of Belmont
Town of
Arlington
South Lincoln
North Sudbury
Nine Acre
Corner
Meriams Corner
West Concord
Tower Hill
Pine Rest
Nobscot
Cochituate
Upper Mystic Lake
Hobbs
Brook
Basin
Walden
Pond
Spot
Pond
Nagog
Pond
Mass Pike
Concord Tpke
Cambridge Tpke
Lowell St
Main St
Andover St
Salem Tpke
By Pass Rd
N Main St
Franklin St
Broadway
Walnut St
Carlisle Rd
Old Sudbury Rd
Boston Post Rd
Glen Rd
Parker St
North Rd
Concord Rd
Great Rd
Salem Rd
Bay Rd
3A
495
38
129
62
114
1
1A
95
128
2A
3
2
4
126
16
60
117
27
90
93
107
9
20


I-93
BROWNS CROSSING WELLFIELD
BARROWS WELLFIELD
WILMINGTON, MA
Ballardvale St
Salem St
Middlesex Ave
Andover St
Ainsworth Rd
Avalon Dr
Franklin Ave
Adams Ave
Ella Ave
Dorothy Ave
Barbara Ave
Catherine Ave
Eagles Row
Fox Run Dr
Woburn St
Sheridan Rd
Carson Ave
Piling Rd
Gunderson Rd
Marie Dr
Charlotte Rd
Draper Dr
Hathaway Rd
Evans Dr
Freeport Dr
Heather Dr
Lucaya Circle
Carriage Way
Cold Spring
Prince St
Greene St
Park St
Glowing Rd
Ridge Circle
Marcus Rd
Kristyn Ln
Nelson Way
High St
Pleasant Rd
Pinewood Rd
North Wilmington
Carolyn Rd
Marcia Rd
Linda Rd
Pineridge Rd
Shady Lane Dr
Birchwood Rd
Oakdale St
Cedarcrest
Lawrence St
125
62
93
1
0
Q

HISTORICAL CHLORIDE CONCENTRATION S AT BROWNS CROSSING AND BARROWS WELLFIELDS, WILMINGTON, MASSACHUSETTS




BROWNS CROSSING WELLFIELD RAW WATER
SODIUM AND CHLORIDE CONCENTRATIONS
CERTIFIED LABORATORY RESULTS
WILMINGTON, MASSACHUSETTS
DECEMBER 1, 2009 TO FEBRUARY 29, 2012
CHLORIDE
250 MG/L
SODIUM
20 MG/L -- STATE ADVISORY FOR SODIUM
MG/L
350
300
250
200
150
100
50
0
10/14/2009
1/22/2010
5/2/2010
8/10/2010
11/18/2010
2/26/2011
6/6/2011
9/14/2011
12/23/2011
4/1/2012
7/10/2012

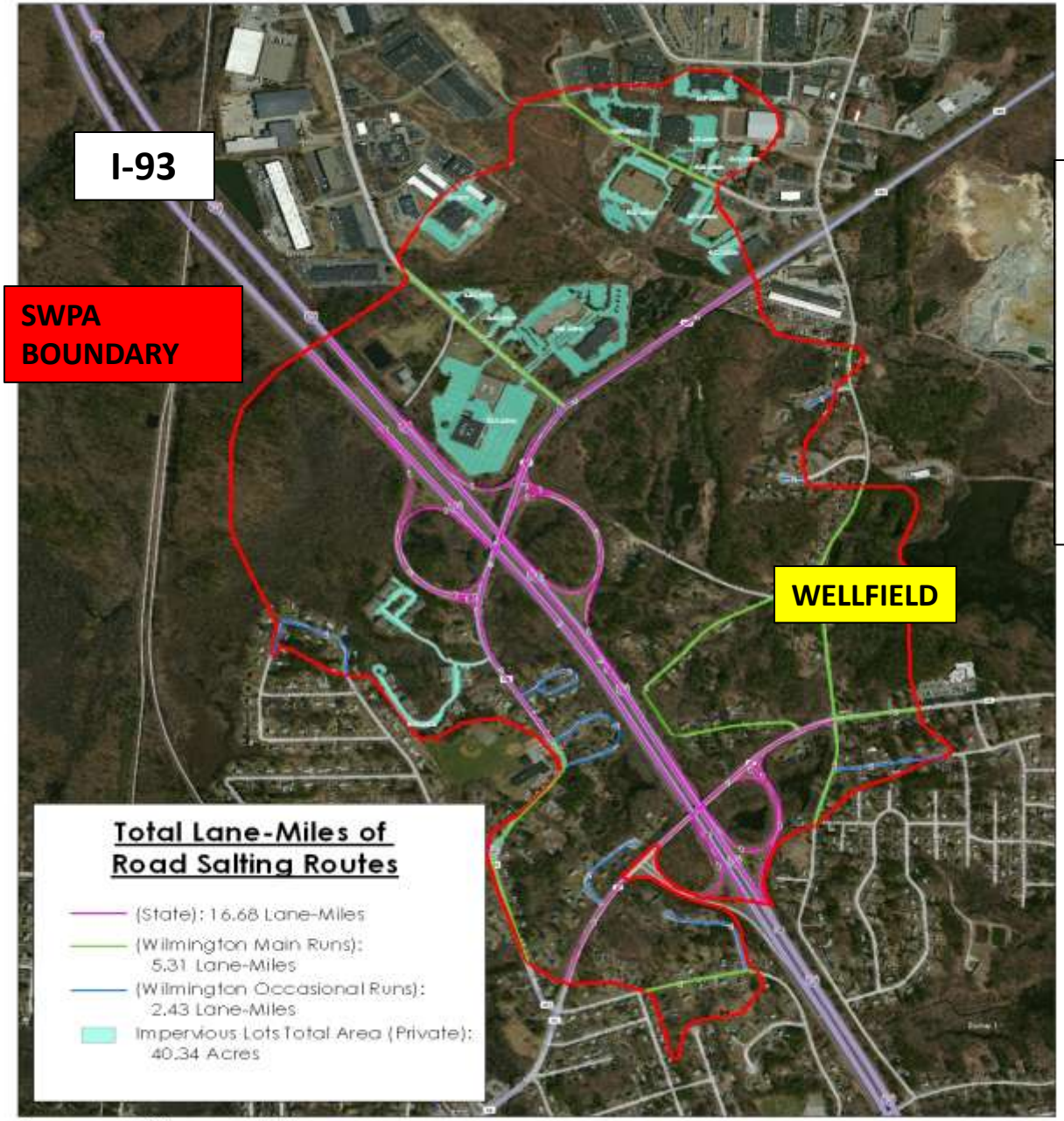

INTERSTATE 93 IN WILMINGTON, MASSACHUSETTS
LOOKING NORTH FROM ROUTE 62 OVERPASS
BROWNS CROSSING
WELLFIELD 2,000' EAST
5 LANES
5 LANES

HUNDREDS OF CATCH BASINS COLLECT STORMWATER FROM PAVED SURFACES

I-93 STORMWATER OUTFALL

PART OF AN 11-ACRE PARKING AREA IN BROWNS CROSSING SWPA MANAGED BY PRIVATE CONTRACTORS WHO APPLIED APPROXIMATELY ONE TON/ACRE CHLORIDE IN 2010-2011

89 STORMDRAINS DISCHARGE INTO STREAMS, WETLANDS AND GROUNDWATER WITHIN THE TWO WELLFIELDS' AREAS OF CONTRIBUTION



BROWNS CROSSING WELLFIELD

ROAD SALT LANE MILES

MASSDOT: 16.68 (68%)

WILMINGTON: 7.74 (32%)

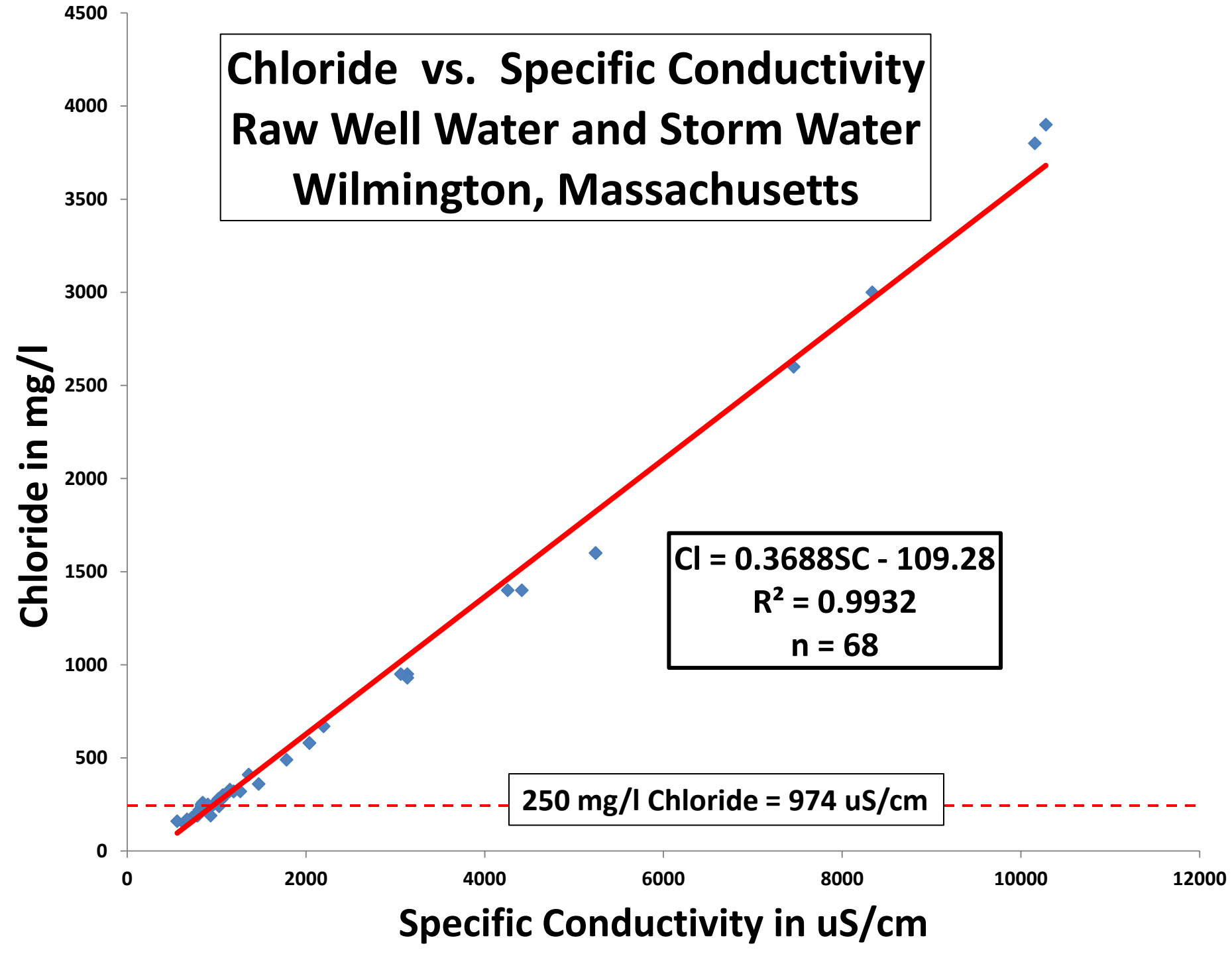
PARKING AREAS: 40.34 AC

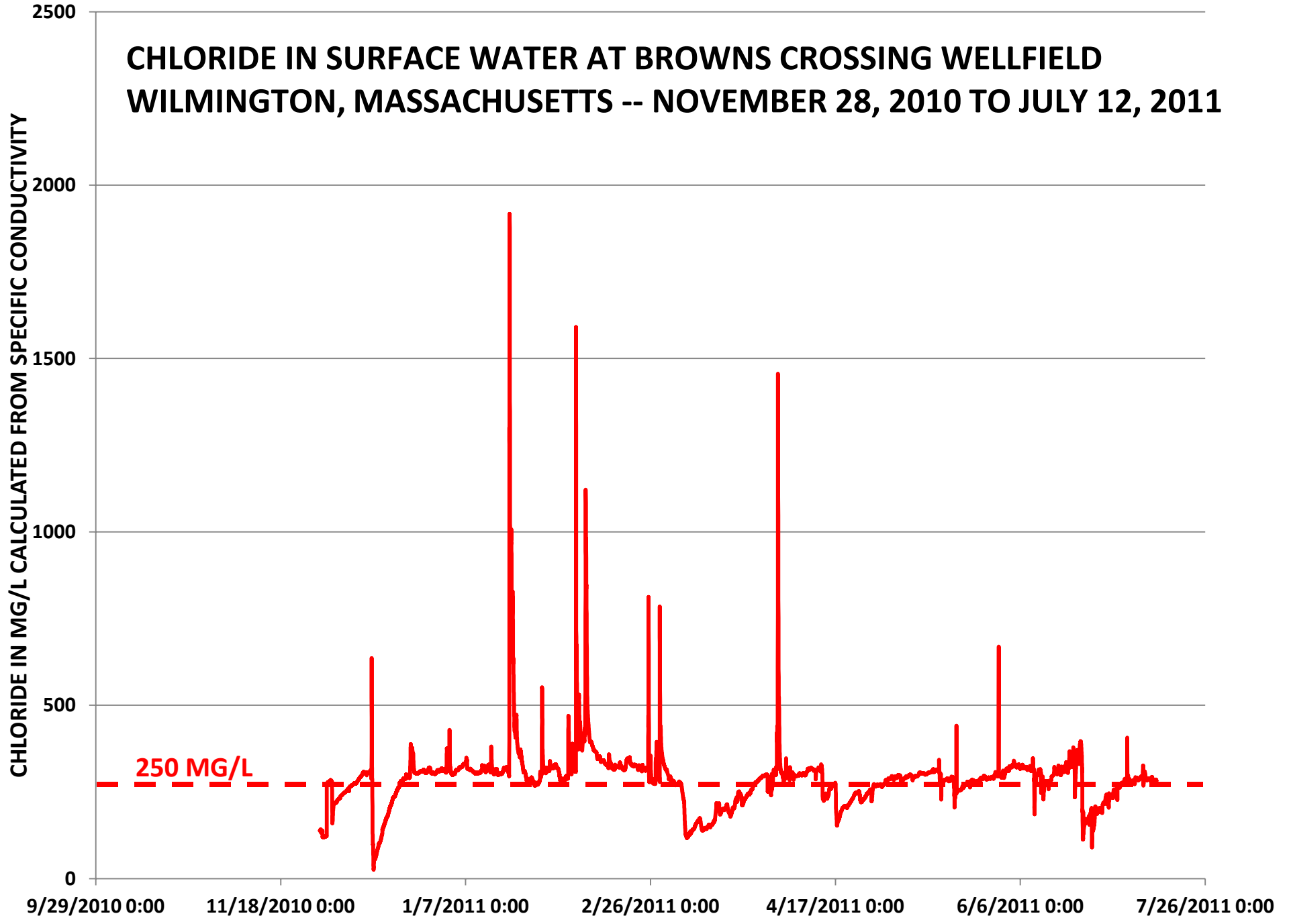

I-93 STORMWATER
CULVERT 2,000 FEET
UPSTREAM OF BROWNS
CROSSING WELLFIELD

DATASONDES MEASURE TEMPERATURE AND SPECIFIC CONDUCTIVITY EVERY 15 MINUTES

CONDUCTIVITY DATASONDE
(15-MINUTE SAMPLE INTERVAL)


G
W
G
W
WINTER SW TOT:
2 TO 6.25 HOURS
BROWNS
CROSSING
WELLFIELD
I-93/ 8 LANES
S
W
G
W
G
W
I-93 CULVERT
Ainsworth Rd
Salem St
Salem St
Salem St


Chloride vs. Specific Conductivity
Raw Well Water and Storm Water
Wilmington, Massachusetts
Cl = 0.3688SC - 109.28
R² = 0.9932
n = 68
250 mg/l Chloride = 974 uS/cm
Chloride in mg/l
Specific Conductivity in uS/cm
0
500
1000
1500
2000
2500
3000
3500
4000
4500
0
2000
4000
6000
8000
10000
12000


CHLORIDE IN SURFACE WATER AT BROWNS CROSSING WELLFIELD
WILMINGTON, MASSACHUSETTS -- NOVEMBER 28, 2010 TO JULY 12, 2011
CHLORIDE IN MG/L CALCULATED FROM SPECIFIC CONDUCTIVITY
2500
2000
1500
1000
500
0
250 MG/L
9/29/2010 0:00
11/18/2010 0:00
1/7/2011 0:00
2/26/2011 0:00
4/17/2011 0:00
6/6/2011 0:00
7/26/2011 0:00

BROWNS CROSSING WELLFIELD

BUILT IN 1928

DESIGN CAPACITY: 1.55 MGD

UNTIL MARCH 2011, 42 FOUR-INCH WELLS IN A WETLAND RANGING FROM 53 TO 83 FEET DEPTH

REPRESENTATIVE GEOLOGY:

3 FEET OF PEAT

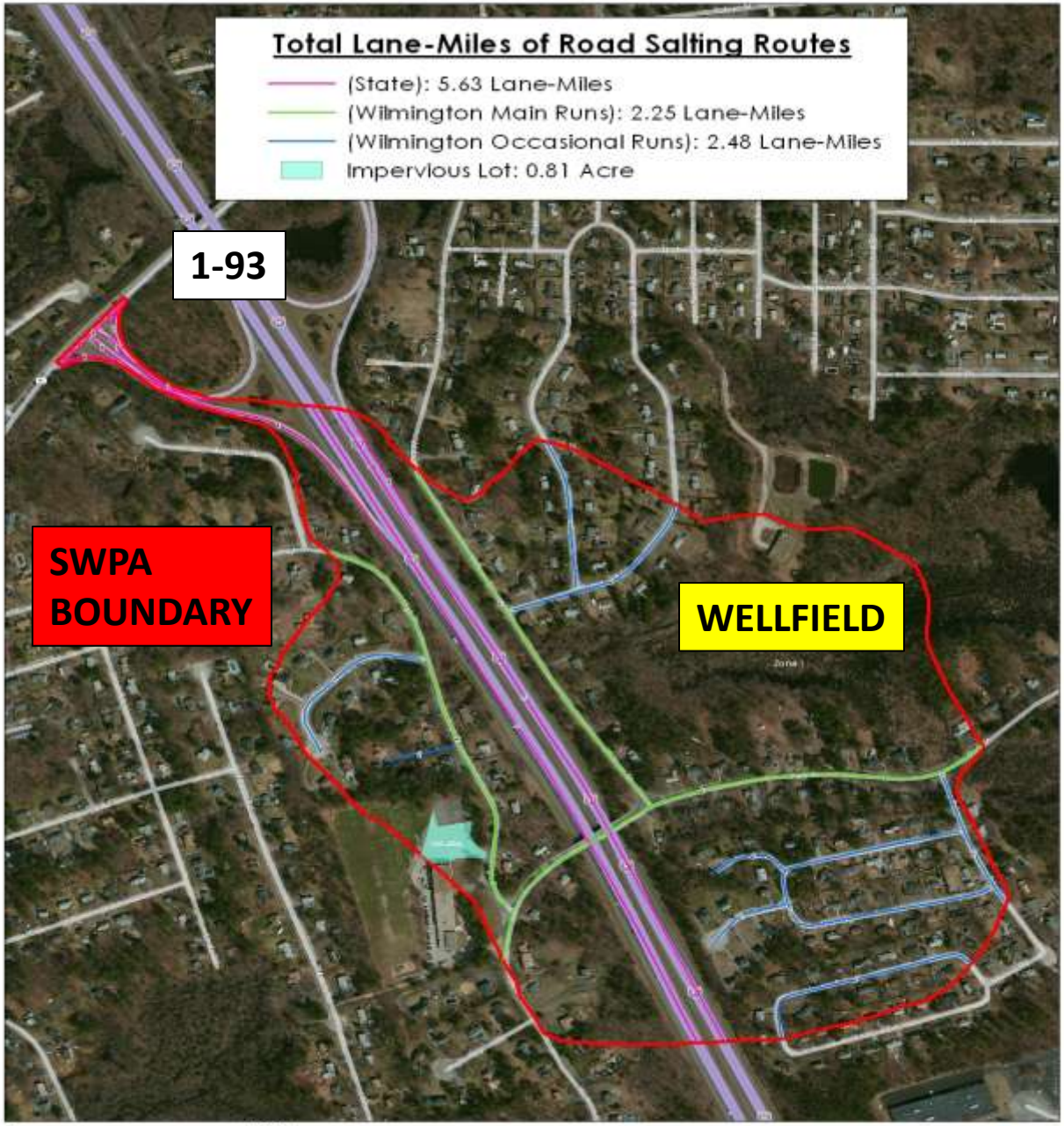
66 FEET COARSE SAND

14 FEET FINE TO COARSE GRAVEL OVER

CAMBRIAN TO SILURIAN AGE METAMORPHIC BEDROCK (499-412 MY)

NEW **BROWNS CROSSING WELLFIELD BEGAN OPERATION IN MARCH 2011**
DESIGN CAPACITY: 1.2 MGD
16 WELLS INSTALLED ON DRY LAND
SCREENED FROM 61 TO 82 FEET DEPTH


NEW BROWNS CROSSING WELLFIELD – MARCH 2011
WILMINGTON, MASS.
GW FLOW
Supply Wells
Monitoring Wells
N
0
50
Feet



BARROWS WELLFIELD

ROAD SALT LANE MILES

STATE: 5.63 (54%)

WILMINGTON: 4.73 (46%)

BARROWS WELLFIELD

BUILT IN 1955

DESIGN CAPACITY: 0.94 MGD

35 FOUR-INCH DIAMETER DRIVEN WELLS

BOOSTED TO 1.0 MGD IN 1960 WITH 20 MORE WELLS

CONNECTED TO SARGENT WTP IN 1989

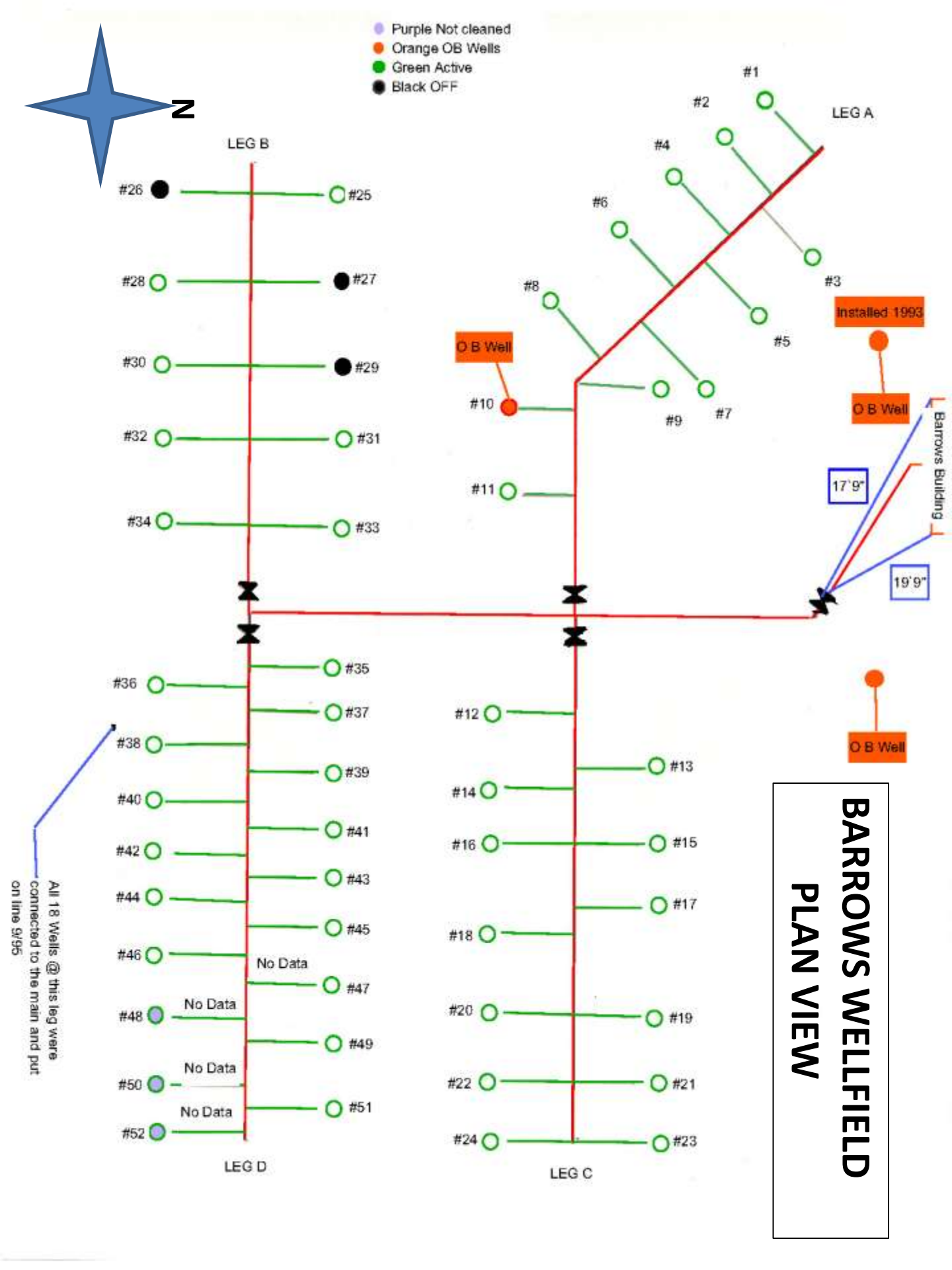
WELLFIELD NOW PUMPING AT 0.36 MGD WITH 45 WELLS

REPRESENTATIVE GEOLOGY

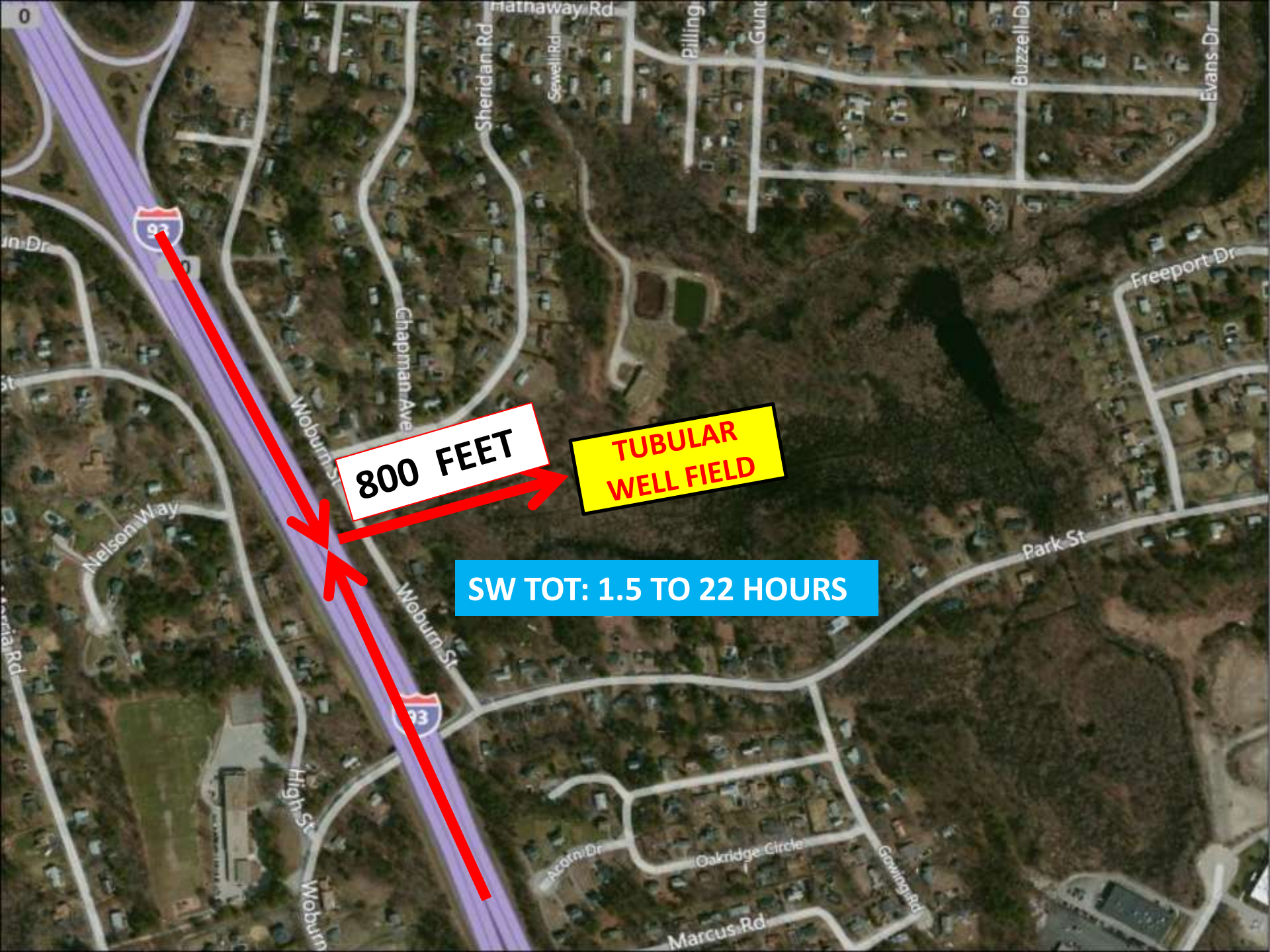
PEAT: 7-13 FEET THICK

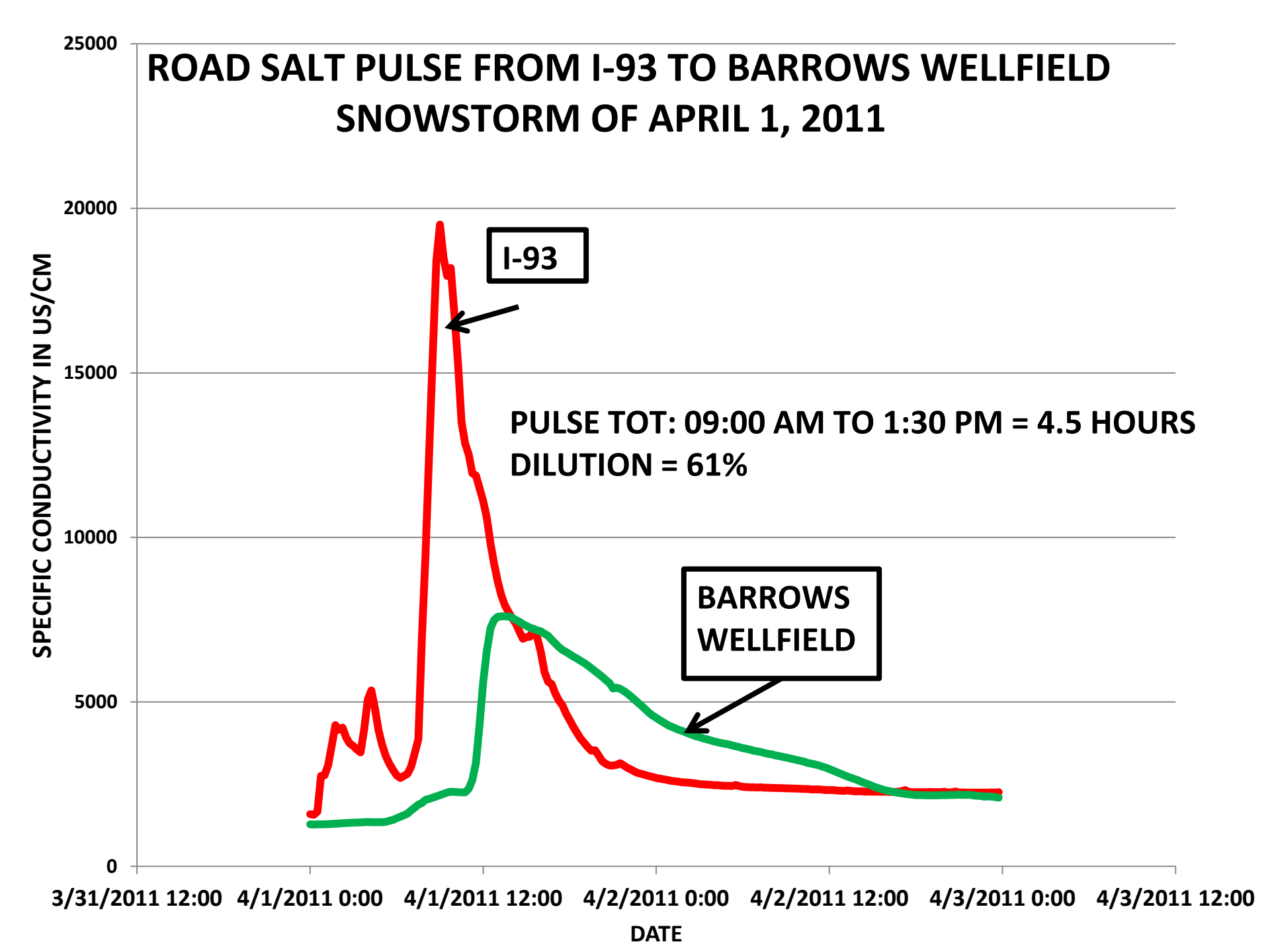
FINE TO COARSE SAND AND GRAVEL

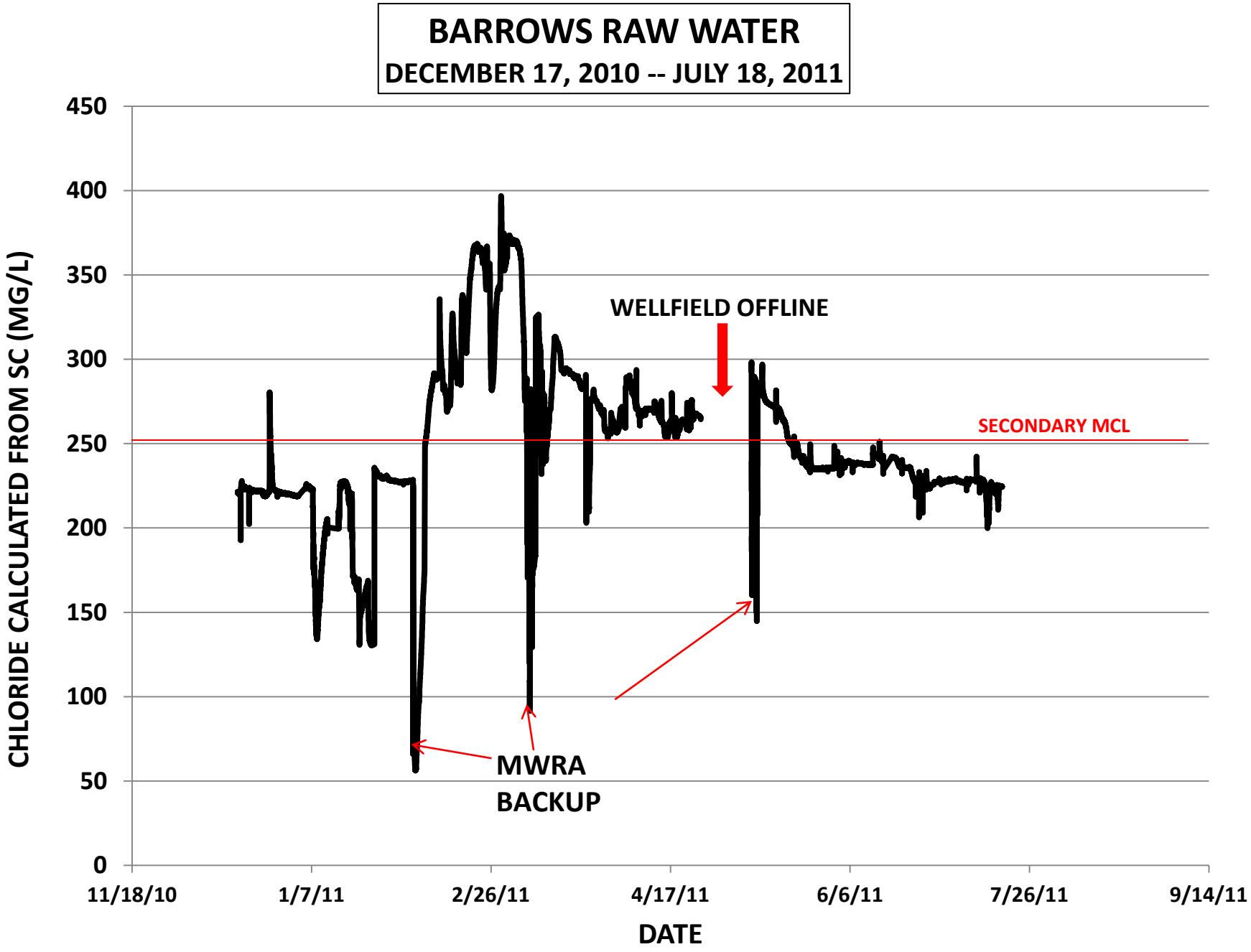
METAMORPHIC FRACTURED ROCK FROM 23 TO 34 FEET DEPTH


Purple Not cleaned
Orange OB Wells
Green Active
Black OFF
N
LEG A
LEG B
LEG C
LEG D
#1
#2
#3
#4
#5
#6
#7
#8
#9
#10
#11
#12
#13
#14
#15
#16
#17
#18
#19
#20
#21
#22
#23
#24
#25
#26
#27
#28
#29
#30
#31
#32
#33
#34
#35
#36
#37
#38
#39
#40
#41
#42
#43
#44
#45
#46
#47
#48
#49
#50
#51
#52
O B Well
Installed 1993
O B Well
O B Well
Barrows Building
17'9"
19'9"
No Data
No Data
No Data
All 18 Wells @ this leg were connected to the main and put on line 9/95
BARROWS WELLFIELD
PLAN VIEW


I-93 STORMWATER CULVERT BUILT IN 1960, JUST 800 FEET UPSTREAM FROM BARROWS WELLFIELD
5 FEET


800 FEET
TUBULAR WELL FIELD
SW TOT: 1.5 TO 22 HOURS
Sheridan Rd
Hathaway Rd
Sewell Rd
Buzzell Dr
Evans Dr
Freeport Dr
Chapman Ave
Woburn St
Nelson Way
Park St
High St
Oakridge Circle
Marcus Rd
93


ROAD SALT PULSE FROM I-93 TO BARROWS WELLFIELD
SNOWSTORM OF APRIL 1, 2011
SPECIFIC CONDUCTIVITY IN US/CM
25000
20000
15000
10000
5000
0
I-93
BARROWS WELLFIELD
PULSE TOT: 09:00 AM TO 1:30 PM = 4.5 HOURS
DILUTION = 61%
3/31/2011 12:00
4/1/2011 0:00
4/1/2011 12:00
4/2/2011 0:00
4/2/2011 12:00
4/3/2011 0:00
4/3/2011 12:00
DATE

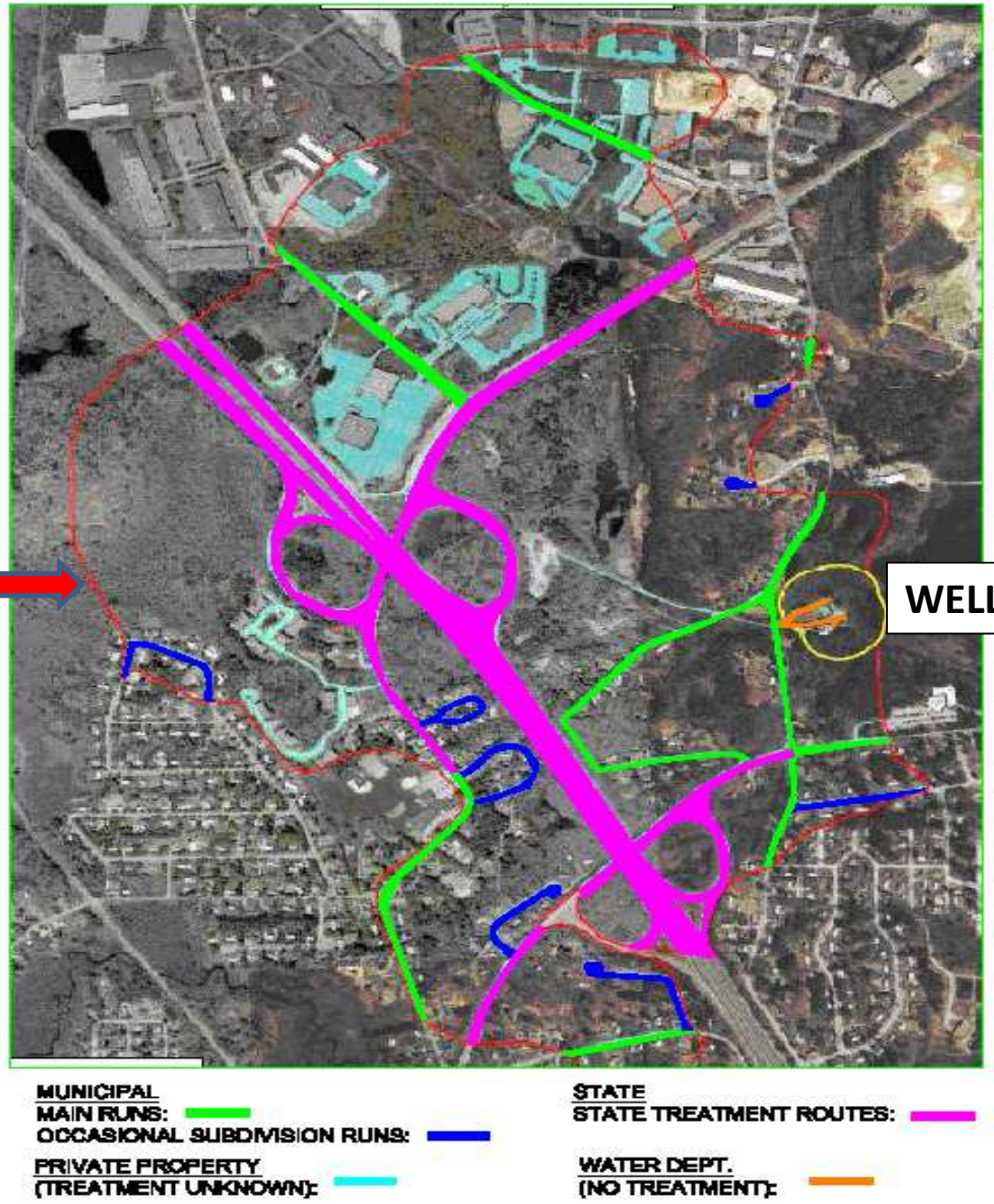

BARROWS RAW WATER
DECEMBER 17, 2010 -- JULY 18, 2011
CHLORIDE CALCULATED FROM SC (MG/L)
450
400
350
300
250
200
150
100
50
0
WELLFIELD OFFLINE
SECONDARY MCL
MWRA
BACKUP
11/18/10
1/7/11
2/26/11
4/17/11
6/6/11
7/26/11
9/14/11
DATE

CALCULATION OF WELLFIELD ROAD SALT BUDGET

1. DELINEATE THE SOURCE WATER PROTECTION AREA.
2. MAP ALL ROADS AND PARKING AREAS.
3. DIFFERENTIATE STATE, LOCAL AND PRIVATE ROADS AND PARKING AREAS.
4. MAP NUMBER OF LANE-MILES/ACRES FOR EACH CATEGORY.
5. DETERMINE WINTER SALT LOADINGS IN TONS PER LANE MILE/ACRE.
6. MULTIPLY LANE-MILES/ACRES BY APPLICATION RATES.
7. CREATE A PIE CHART SHOWING SECTOR PERCENTAGES.
8. GRAPH MULTI-YEAR LOADING HISTORY TO OBSERVE SEASONAL VARIABILITY AND TRENDS OVER TIME.

SALT ROUTE MAP COURTESY OF THE WILMINGTON DPW FOR BROWNS CROSSING SWPA -- WINTER 2010 -2011

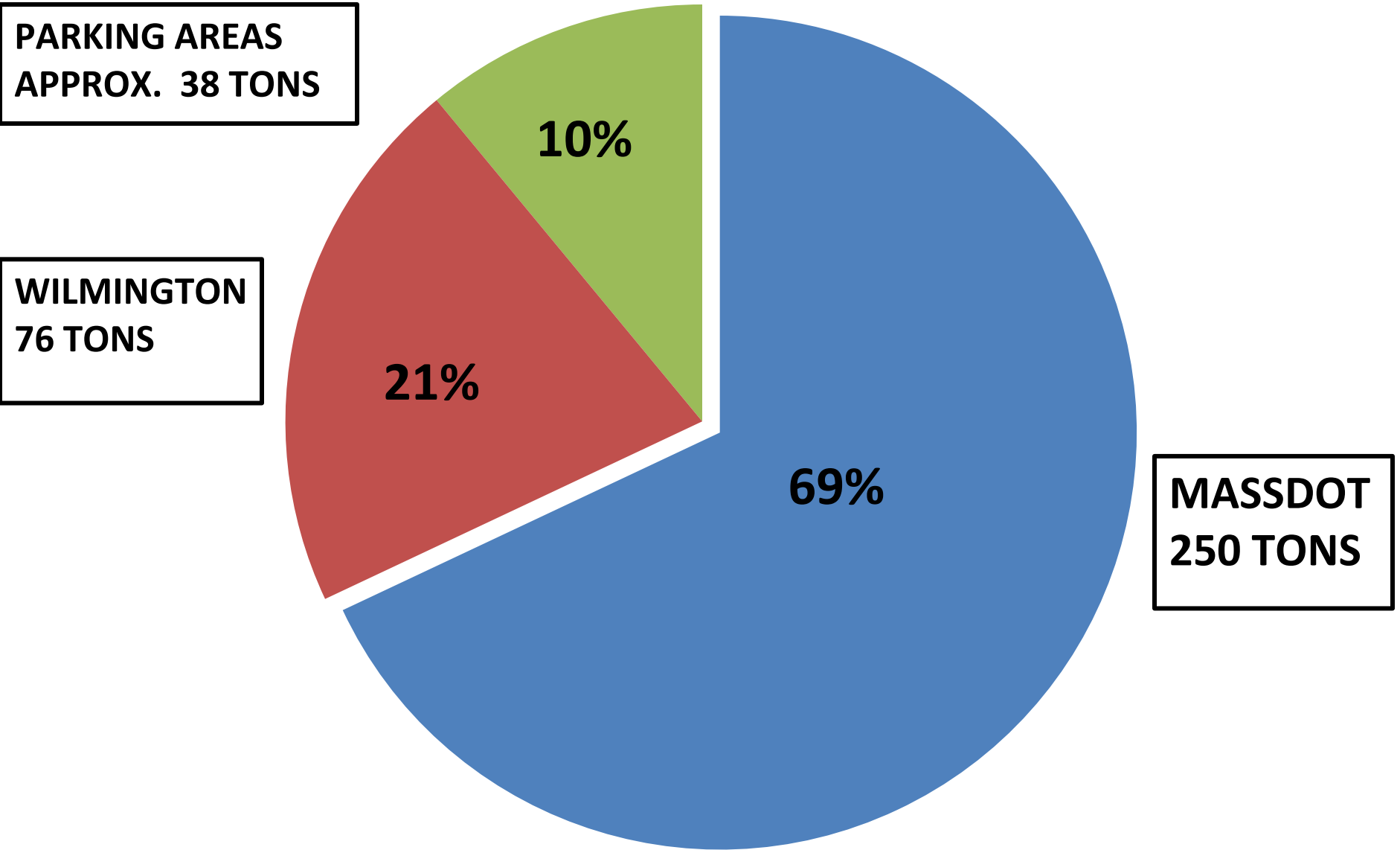
SWPA BOUNDARY



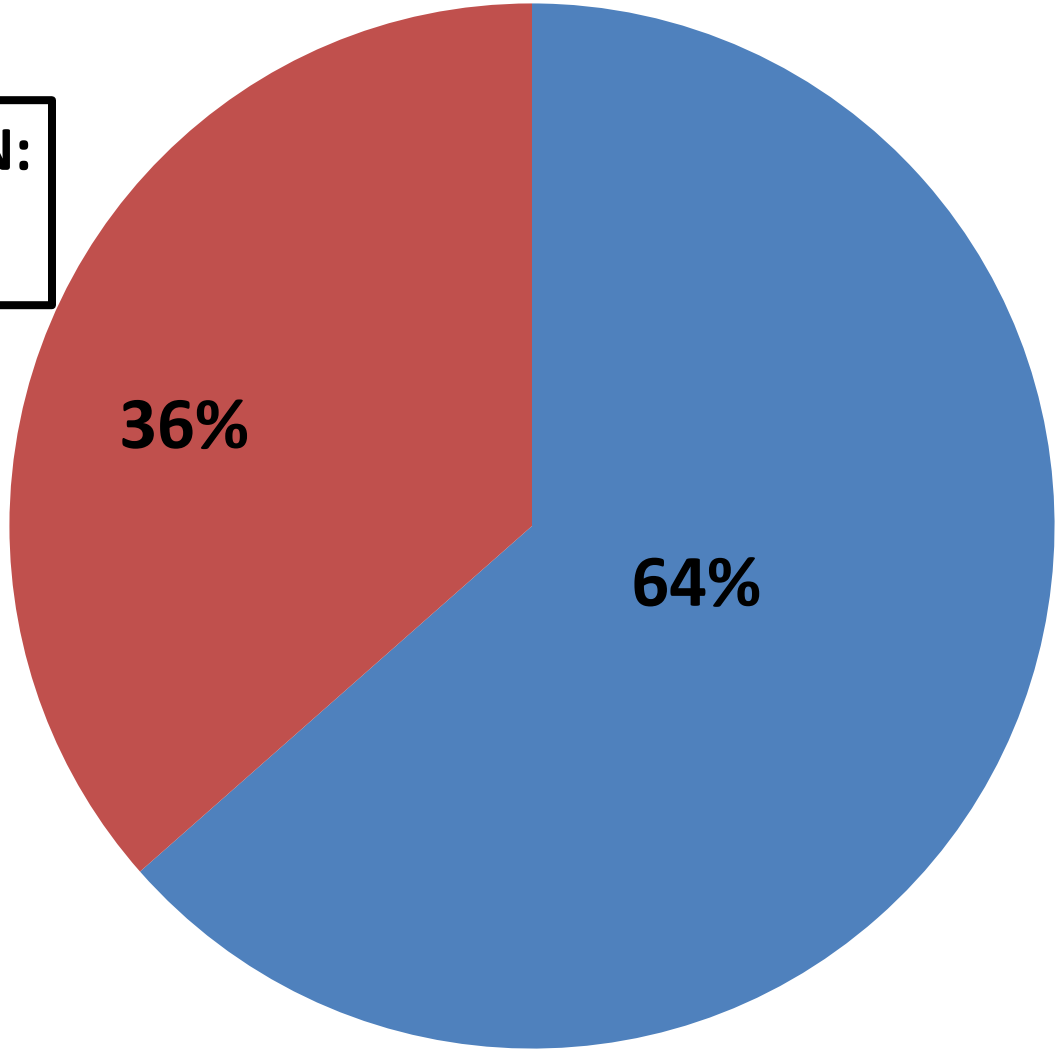
REPORTED ROAD SALT LOADINGS BY SECTOR WINTER OF 2010-2011

SECTOR	WELLFIELD	LOADING RATE (TONS/LANE-MILE)	LANE MILES	ROAD SALT (TONS)	CHLORIDE (TONS)
MASSDOT (I-93):					
	BROWNS CROSSING	24.94	16.68	416	250
	BARROWS	24.94	5.63	140	84
WILMINGTON:					
	BROWNS CROSSING	16.45	7.74	127	76
	BARROWS	16.45	4.73	78	47
PARKING AREAS:	BROWNS CROSSING	1 TON/ACRE	37.6 ACRES	---	37.6
				TOTAL:	495 TONS

SECTOR CHLORIDE LOADINGS IN BROWNS CROSSING SOURCE WATER PROTECTION AREA WINTER OF 2010 – 2011



SECTOR CHLORIDE LOADINGS IN BARROWS SOURCE WATER PROTECTION AREA WINTER OF 2010 – 2011



SUMMARY

- NEARLY 500 TONS OF CHLORIDE WERE APPLIED DURING THE WINTER OF 2010-2011 ON ROADS AND PARKING LOTS IN THE BROWNS CROSSING AND BARROWS SOURCE WATER PROTECTION AREAS:

  MASS. DOT CONTRIBUTION: 69%
  WILMINGTON CONTRIBUTION: 21%
  PRIVATE PARKING AREAS: 10%

-SINCE I-93 OPENED IN 1960, CHLORIDE LEVELS IN WELLFIELD RAW WATER HAVE INCREASED MORE THAN 40 TIMES FROM <10 TO AS MUCH AS 400 MG/L, WELL ABOVE THE SECONDARY MCL OF 250 MG/L.

- CHLORIDE AT BARROWS WELLFIELD INCREASED FROM 250 TO 400 MG/L DURING FEBRUARY, 2011 DUE TO INDUCED INFILTRATION OF SALINE STORMWATER.

- ON FEBRUARY 28, 2011, SODIUM IN BARROWS RAW WATER REACHED A CALCULATED MAXIMUM OF 240 MG/L, OR TWELVE TIMES THE STATE'S ADVISORY LEVEL OF 20 MG/L.

- DATASONDES SHOW THAT SALINE I-93 STORMWATER AVERAGED 3.6 HOURS TO REACH BROWNS CROSSING AND 10.6 HOURS TO REACH BARROWS WELLFIELD.

POTENTIAL REMEDIATION STRATEGIES

STATE DESIGNATES REDUCED-SALT APPLICATION ZONE FOR I-93 IN WELLFIELD RECHARGE AREAS

STATE AND LOCAL SALT-REDUCTION BMPS IMPLEMENTED

STORMWATER DIVERTED BEYOND WELLS

CONNECTION TO ALTERNATIVE WATER SUPPLY

DRINKING WATER TREATMENT

Thank You!

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