

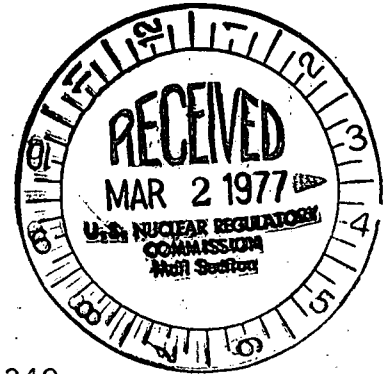


Commonwealth Edison
 One First National Plaza, Chicago, Illinois
 Address Reply to: Post Office Box 767
 Chicago, Illinois 60690

Regulatory Docket File

February 18, 1977

Mr. Dennis L. Ziemann, Chief
 Operating Reactors - Branch 2
 Division of Operating Reactors
 U.S. Nuclear Regulatory Commission
 Washington, D.C. 20555



Subject: Dresden Station Units 2 and 3
 Thermal Plume Studies
NRC Docket Nos. 50-237 and 50-249

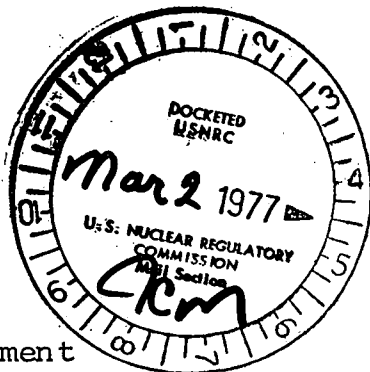
Reference: D. L. Ziemann Letter to R. L. Bolger
 dated January 11, 1977.

Dear Mr. Ziemann:

Attached is Commonwealth Edison's response to Question 1a, "An analysis of the increased blowdown on the thermal characteristics of the Illinois River, in reference to the proposed change from the 50,000 to 500,000 gpm blowdown from Units 2 and 3" of the referenced letter.

Should you have any questions regarding the above, please contact this office.

One (1) signed original and 39 copies are provided for your use.



Very truly yours,

M. S. Turbak

M. S. Turbak
 Nuclear Licensing Administrator
 Boiling Water Reactors

Attachment

2145

An Analysis of the
Increased Blowdown on Thermal
Characteristics of the Illinois River
(50,000 gpm to 500,000 gpm)

Thirty-four (34) thermal plume studies were conducted at Dresden Generating Station by Environmental Affairs Department of Commonwealth Edison Company from 1974 through 1976.

The purpose of the thermal plume studies was to determine the size of the mixing zone to comply with the State of Illinois Pollution Control Board, Water Pollution Rules and Regulation, the National Pollutant Discharge Elimination System and to accumulate field data so a better understanding of the dependent variables that determine the mixing zone at Dresden Station could be obtained.

Sixteen (16) of the thirty-four (34) plume studies were conducted with a Unit 2/3 blowdown rate of 50,000 gpm (111 cfs). The actual size and contour of the mixing zone was determined in ten (10) of the sixteen (16) plume studies (the other six (6) were measured only at the 26 acre isotherm). The flow of the Illinois River ranged from 2,350 to 24,200 cfs for the 50,000 gpm blowdown plume studies. The average size of the mixing zone for the ten (10) plume studies was 1.1 acres, with a maximum of 3.2 acres.

Seven (7) plume studies were conducted with a Unit 2/3 blowdown rate equal to approximately 500,000 gpm (6 at 1115 cfs and 1 at 1135 cfs). Illinois River flows ranged from 5200 to 7050 cfs. The actual size and contour of the mixing zone was determined in five (5) of the seven (7) plume studies. The average size of the mixing zone was 16.9 acres, with a maximum of 24.6 acres.

For more details of the above mentioned plume studies, see the attached "Summary of Dresden Thermal Plume Studies".

Summary of
Dresden Thermal Plume Studies

1974-1976

Purpose:

Determine the size of the mixing zone to comply with the State of Illinois Pollution Control Board, Water Pollution Rules and Regulation, the National Pollutant Discharge Elimination System and to accumulate field data so a better understanding of the dependent variables that determine the mixing zone at Dresden Station could be obtained.

Procedure:

Thirty-four thermal plume studies were conducted by Environmental Affairs Department of Commonwealth Edison Company from August 1974 to August 1976. A Montedoro Whitney DOR-1B, Dissolved Oxygen Meter/Thermometer was used to measure water temperature, and, when necessary to distinguish water source, to measure dissolved oxygen. Temperatures were taken at the station's intake and discharge structure and with the known stations discharge flow the plants' heat rejection rate to the Illinois River was calculated. This amount of rejected heat was subtracted from the downstream mixed temperature at the Dresden Lock and Dam to give the ambient Illinois River temperature that would exist if the station had no heat rejected to the river. See Table 2 of this report. The mixing zone was then determined by trolling back and forth across the river in the vicinity of the discharge plotting the 5°F above ambient Illinois River temperature isotherm. In some studies the actual size of the mixing zone was not determined but was found to be less than 26 acres by trolling various marked section lines that enclosed an area less than 26 acres.

Results:

The measured temperatures and given flows for all of the plume studies are summarized in Table 1. Those plume studies with measured mixing zones (21 of the 34) are shown following Table 2. As can be seen from the plume study mappings, the blowdown flow from Units 2/3 varies from 111 to 2230 cfs with no violations of the 26 acre maximum size mixing zone. The plume studies were conducted over a wide range of Illinois River flows; from 2,350 to 24,200 cubic feet per second.

Table 1 Field Data
for Dresden Thermal Plume Analysis

Study No.	Date of Study	Q _{ILL} cfs	Q ₁ cfs	Q _{2,3} cfs	T _M OF	Intake			Effluent.			$\Delta T_E = T_E - T_I$ OF
						T _{I1} OF	T _{I2,3} OF	T _I OF	T _{E1} OF	T _{E2,3} OF	T _E OF	
1	8/ 9/74	3,800	426	2,230	84.79	81	79.83	80.12	91.40	86.5	87.4	7.23
2	8/10/74	5,700	426	111	83.12	79	79.82	79.70	90.3	86.9	89.6	9.90
3	10/17/74	3,650	426	111	67.64	62.28	61.7	61.9	68.9	69.62	69.05	7.15
4	10/21/74	3,650	291	111	61.83	51.98	51.98	51.98	63.5	65.84	64.1	12.15
5	4/10/75	12,425	426	111	43.3	40.43	40.12	40.30	47	43.7	46.32	6.02
6	6/19/75	24,200	426	111	73	72.5	71.25	71.5	81.25	76.6	80.3	8.80
7	7/ 8/75	8,650	426	111	83.39	76.5	76.6	76.6	89	86.13	88.4	11.81
8	8/15/75	2,350	426	111	83.5	82.1	81.6	81.7	94	85.5	92.2	10.5
9	9/10/75	3,800	426 ¹	111	74.02	68.07	68.68	68.36	N/A	74.7	74.7	6.34
10	9/18/75	3,050	426 ¹	111	73.8	66.2	68.96	68.00	N/A	74.75	74.75	6.75
11	11/ 7/75	4,300	291 ¹	111	67.17	59.6	59.71	59.67	N/A	77.13	77.13	17.46
12	2/ 9/76	8,900	291	111	40.5	*	*	32.00	46.3	46.6	46.38	14.28
13	2/10/76	8,350	291	111	41.77	*	*	32.40	40	47.67	42.12	9.72
14	2/11/76	13,250	291 ¹	111	35.98	*	*	30.00	32	49.1	36.72	6.72
15	3/ 1/76	20,650	291	111	47.5	*	*	45.50	56	60.25	57.17	12.17
16	3/11/76	22,650	291	111	43.8	*	*	41.50	55.4	59	56.39	14.80
17	4/15/76	8,150	426 ¹	780 ²	66.82	58.93	59.28	59.17	60	81	73.34	14.17
18	5/21/76	9,350	426	1,561 ²	70	64.36	64.5	64.5	79	76.44	76.95	12.45
19	5/25/76	10,450	426	1,561 ²	68.5	61.44	61.74	61.65	75	72.5	73.40	11.75
20	5/27/76	5,750	426	1,561	73	64.29	64.73	64.58	79	79	79.0	14.42
21	6/ 3/76	10,850	426	2,230	70.7	64	64	64	80	76.29	77.06	13.06
22	6/11/76	7,150	426	1,561	83.57	75.59	75.74	75.7	88.5	87.6	87.80	12.1
23	7/ 8/76	7,050	426	1,115	79.12	74.55	75.21	75.07	86.54	87.13	86.97	11.9
24	7/15/76	4,050	426	668	86.36	83.48	84.38	84.02	96.98	89.42	92.36	8.33
25	7/28/76 (AM)	5,750	426	804.4	86.5	80.7	80.65	80.69	94.2	90	91.45	10.76
26	7/28/76 (PM)	5,750	426	1,135	87.28	82.75	83.63	83.33	96	90	91.64	8.31
27	7/29/76 (AM)	8,350	426	867	85.2	81	82.35	81.9	94	88	89.98	8.08
28	7/29/76 (PM)	8,350	426	571	85.2	81	81.38	81.19	94	88.5	90.85	9.66
29	8/13/76	3,800	426	111	82.4	74.2	74.57	74.4	88.5	85	87.78	13.38
30	8/17/76 (AM)	5,200	426	1,115	81.74	76.7	77.5	77.1	88	85	85.65	8.55
31	8/17/76 (PM)	5,200	426	1,115	81.9	78.8	79	78.9	88.5	86.5	87.01	8.11
32	8/18/76 (AM)	7,000	426	1,115	81.7	76.14	76.56	76.44	89	86.1	86.9	10.46
33	8/18/76 (PM)	7,000	426	1,115	82.5	76.8	77.1	76.95	88	87.91	87.93	10.98
34	8/19/76	5,850	426	1,115	83.6	77.8	76.8	77.2	91	87.5	88.6	11.4

* No data available or inconclusive

1 Flow neglectable, Unit off-line

2 Lake bypass.

MAC 1/20/77

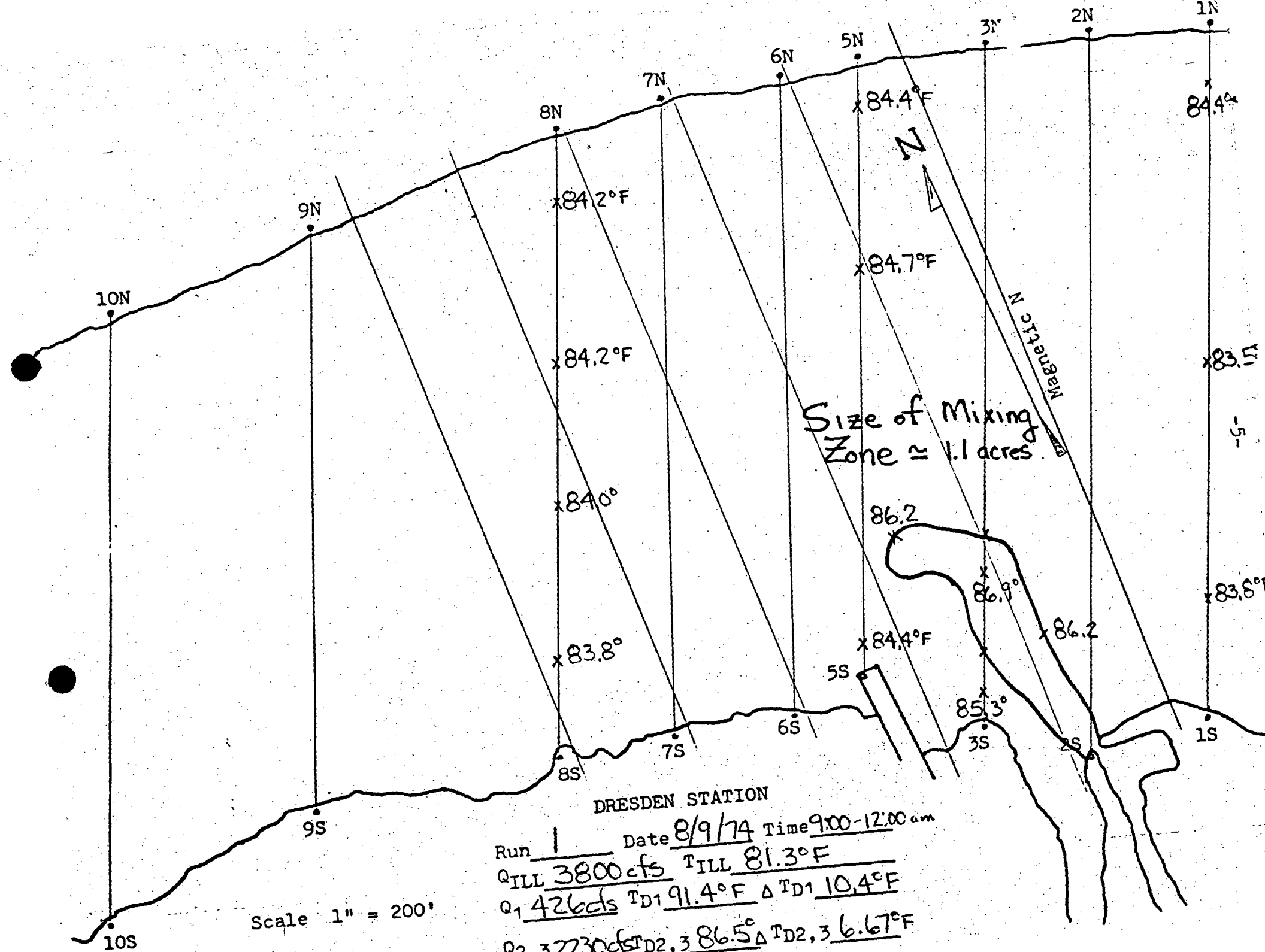
Table 2
 Calculated Ambient
 Illinois River Temperature

<u>Study No.</u>	<u>Date of Study</u>	<u>Qk cfs</u>	<u>QDP cfs</u>	<u>TK °F</u>	<u>TDP °F</u>	<u>TILL °F</u>
1	8/09/74	963	2,837	77.0	83.7	79.65
2	8/10/74	960	4,740	75.92	83.66	82.14
3	10/17/74	820	2,830	55.76	70.88	66.64
4	10/21/74	817	2,833	50.84	62.60	60.49
5	4/10/75	6,725	5,700	40.1	48.0	43.04
6	6/19/75	17,400	6,800	70.0	76.70	72.82
7	7/08/75	4,150	4,500	76.0	86.0	82.65
8	8/15/75	1,120	1,230	77.5	85.0	81.16
9	9/10/75	2,200	1,600	69.0	79.12	73.84
10	9/18/75	1,250	1,800	65.0	79.5	73.49
11	11/07/75	1,300	3,000	59.5	71.0	66.72
12	2/09/76	2,950	5,950	32.0	42.0	38.68*
13	2/10/76	2,700	5,650	32.4	44.0	40.25*
14	2/11/76	6,200	7,050	30.0	41.0	35.85*
15	3/01/76	12,200	8,450	45.0	50.0	47.05*
16	3/11/76	14,450	8,200	41.9	45.5	43.2 *
17	4/15/76	4,880	3,270	59.4	68.6	64.64
18	5/21/76	3,934	5,416	64.7	70	67.34
19	5/25/76	4,340	6,110	60.4	68	66.34
20	5/27/76	4,230	1,520	63.75	74.14	68.09
21	6/03/76	7,310	3,540	64	70	67.55
22	6/11/76	3,240	3,910	74.79	80.5	80.21
23	7/08/76	3,980	3,070	74.22	81.02	76.51
24	7/15/76	2,070	1,980	81.26	87.76	84.11
25	7/28/76(AM)	1,600	4,150	80.56	86.5	84.19
26	7/28/76(PM)	1,630	4,120	81.69	86.19	85.04
27	7/29/76(AM)	3,020	5,330	78.86	86	83.95
28	7/29/76(PM)	2,840	5,510	77.72	85.58	84.05
29	8/13/76	1,780	2,020	74.79	82	80.49
30	8/17/76(AM)	1,410	3,790	73	80.5	79.22
31	8/17/76(PM)	1,410	3,790	74.25	81.64	79.5
32	8/18/76(AM)	1,370	5,630	73.17	82	79.4
33	8/18/76(PM)	1,370	5,630	74.5	83.13	80.10
34	8/19/76	1,210	4,640	74.13	82.63	80.6

*Calculated as TILL not TILL, due to unavailable individual unit data.

Nomenclature Used

- Q_{ILL} - Illinois River flow
Data obtained from Dresden Lock and Dam
- Q_1 - Unit 1 flow
Data obtained from Dresden Station
- $Q_{2,3}$ - Units 2 & 3 flow to river (blowdown)
Data obtained from Dresden Station
- T_M - Illinois River Mixed Temperature
Measured Average at Dresden Lock and Dam
- T_{I1} - Unit 1 Intake Temperature
Measured Average at Intake Structure South
- $T_{I2,3}$ - Unit 2 & 3 Make-up Intake Temperature
Measured Average at Intake Structure Center and North
- T_I - Average Intake Temperature of all Units
- T_{E1} - Unit 1 Effluent Temperature
Measured Maximum at Slot Jet
- $T_{E2,3}$ - Unit 2 & 3 Effluent Temperature
Measured Maximum of Blowdown
- T_E - Average Maximum Effluent Temperature of all Units
- ΔT_E - Temperature change of cooling water = $T_E - T_I$
- Q_K - Kankakee River flow at Wilmington
Data obtained from USGS
- Q_{DP} - Des Plaines River flow = $Q_{ILL} - Q_K$
- T_K - Ambient Kankakee River Temperature
Measured at Transmission Lines upstream of Dresden Station
- T_{DP} - Ambient Des Plaines River Temperature
Measured at Joliet Yacht Club upstream of Dresden Station
- T_{ILL} - Ambient Illinois River Temperature at Dresden Station
= $\frac{Q_K (T_K) + Q_{DP} (T_{DP})}{Q_{ILL}}$
- T''_{ILL} - Ambient Illinois River Temperature at Dresden Station
= $\frac{T_M - Q_1 (T_{E1} - T_{I1}) + Q_{2,3} (T_{E2,3} - T_{I2,3})}{Q_{ILL}}$
- ΔT_D - Temperature difference between Effluent and Ambient Illinois
River = $T_E - T_{ILL}$
- ΔT_{26} - Temperature at the edge of 26 acres



10N

9N

8N

7N

6N

5N

3N

2N

1N

10S

9S

8S

7S

6S

5S

3S

2S

1S

x 84.2°F

x 84.2°F

x 84.0°

x 83.8°

x 84.4°F

x 84.7°F

86.2

x 86.9°

x 86.2

x 84.4°F

85.3°

84.4°

x 83.5°

x 83.8°



Size of Mixing Zone ≈ 1.1 acres

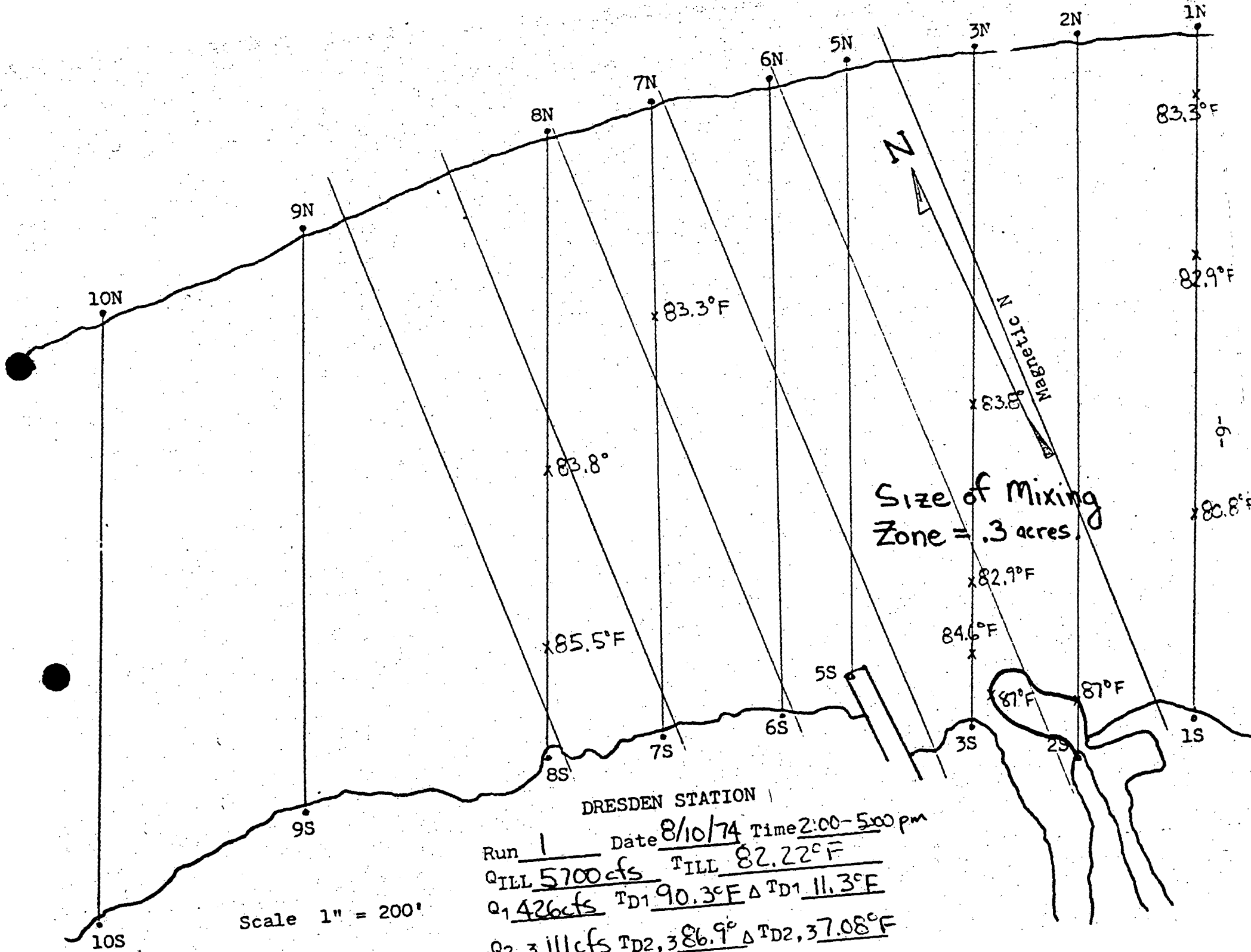
Magnetic N

DRESDEN STATION

Run 1 Date 8/9/74 Time 9:00-12:00 am
 Q TILL 3800 cfs T TILL 81.3°F
 Q₁ 426 cfs TD₁ 91.4°F ΔTD₁ 10.4°F
 Q₂ 3223 cfs TD_{2,3} 86.5° ΔTD_{2,3} 6.6°F

Scale 1" = 200'

All temperatures shown

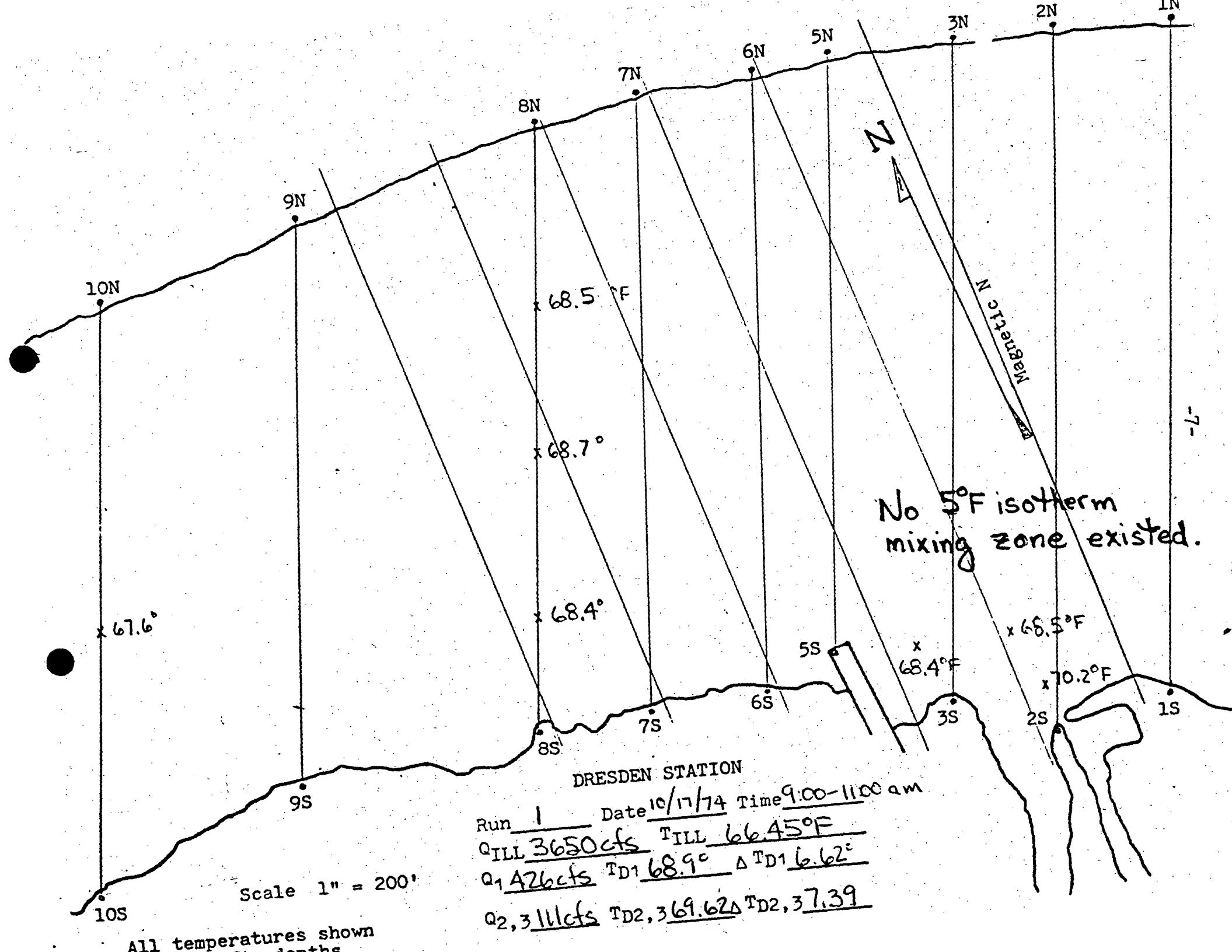


Scale 1" = 200'

DRESDEN STATION

Run 1 Date 8/10/74 Time 2:00-5:00 pm
 Q_{TILL} 5700 cfs T_{TILL} 82.22°F
 Q₁ 426 cfs T_{D1} 90.3°F Δ T_{D1} 11.3°F
 Q_{2,3} 111 cfs T_{D2,3} 86.9°F Δ T_{D2,3} 37.08°F

All temperatures shown



10N

9N

8N

7N

6N

5N

3N

2N

1N

x 67.6°

x 68.5 °F

x 68.7°

x 68.4°

5S

x 68.4°F

x 66.5°F

x 70.2°F

9S

8S

7S

6S

3S

2S

1S

10S

Scale 1" = 200'

DRESDEN STATION

Run 1 Date 10/17/74 Time 9:00-11:00 am

Q_{TILL} 3650 cfs T_{TILL} 66.45°F

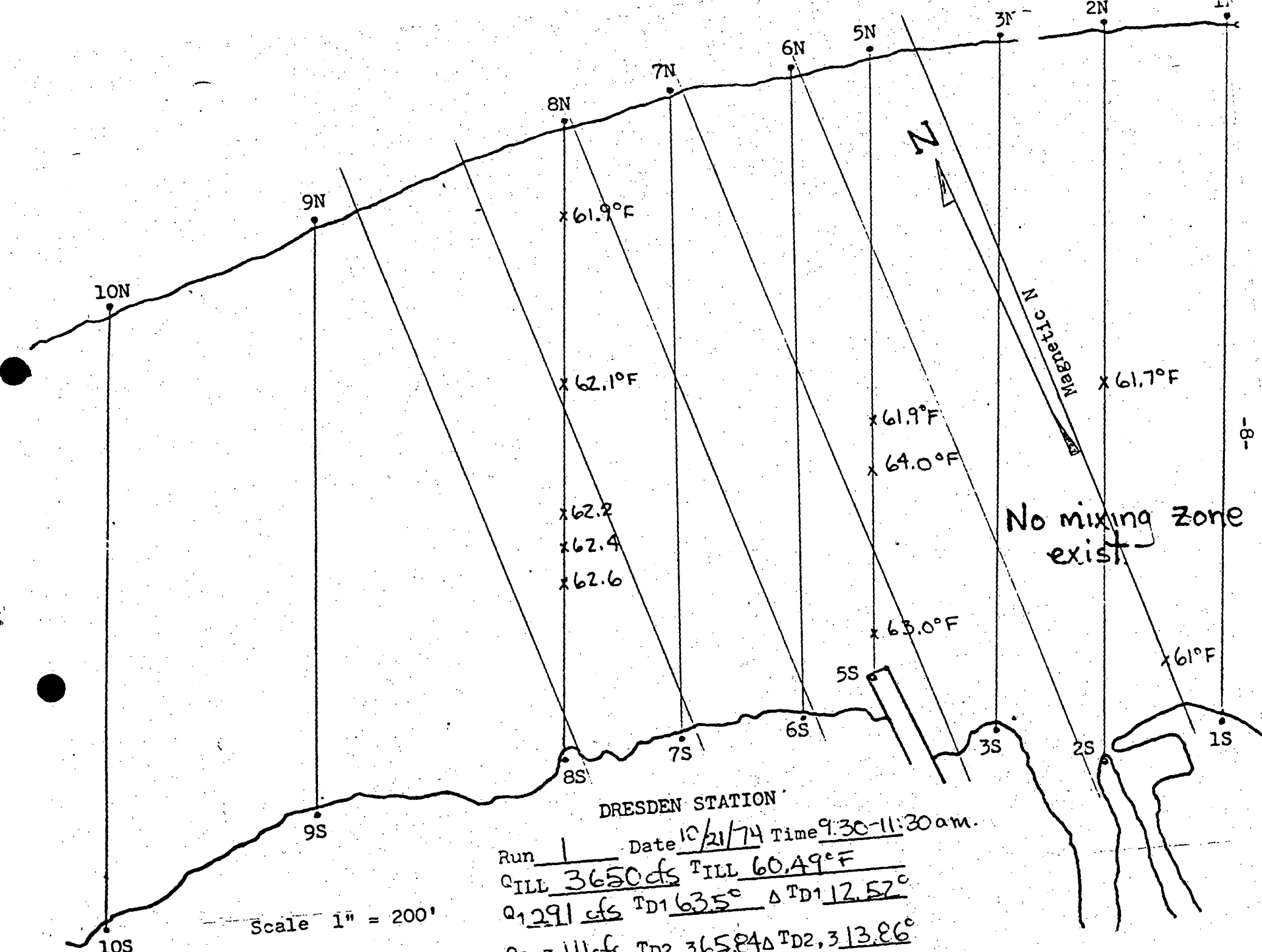
Q₁ 426 cfs TD₁ 68.9° ΔTD₁ 6.62°

Q₂ 311 cfs TD₂ 369.62 ΔTD₂ 37.39

No 5°F isotherm mixing zone existed.

All temperatures shown

-7-



10N

9N

8N

7N

6N

5N

3N

2N

1N

10S

9S

8S

7S

6S

5S

3S

2S

1S

x 61.9°F

x 62.1°F

x 62.2

x 62.4

x 62.6

x 61.9°F

x 64.0°F

x 63.0°F

x 61.7°F

x 61°F

N

Magnetic N

No mixing zone exist

DRESDEN STATION

Run Date 10/21/74 Time 9:30-11:30 am.

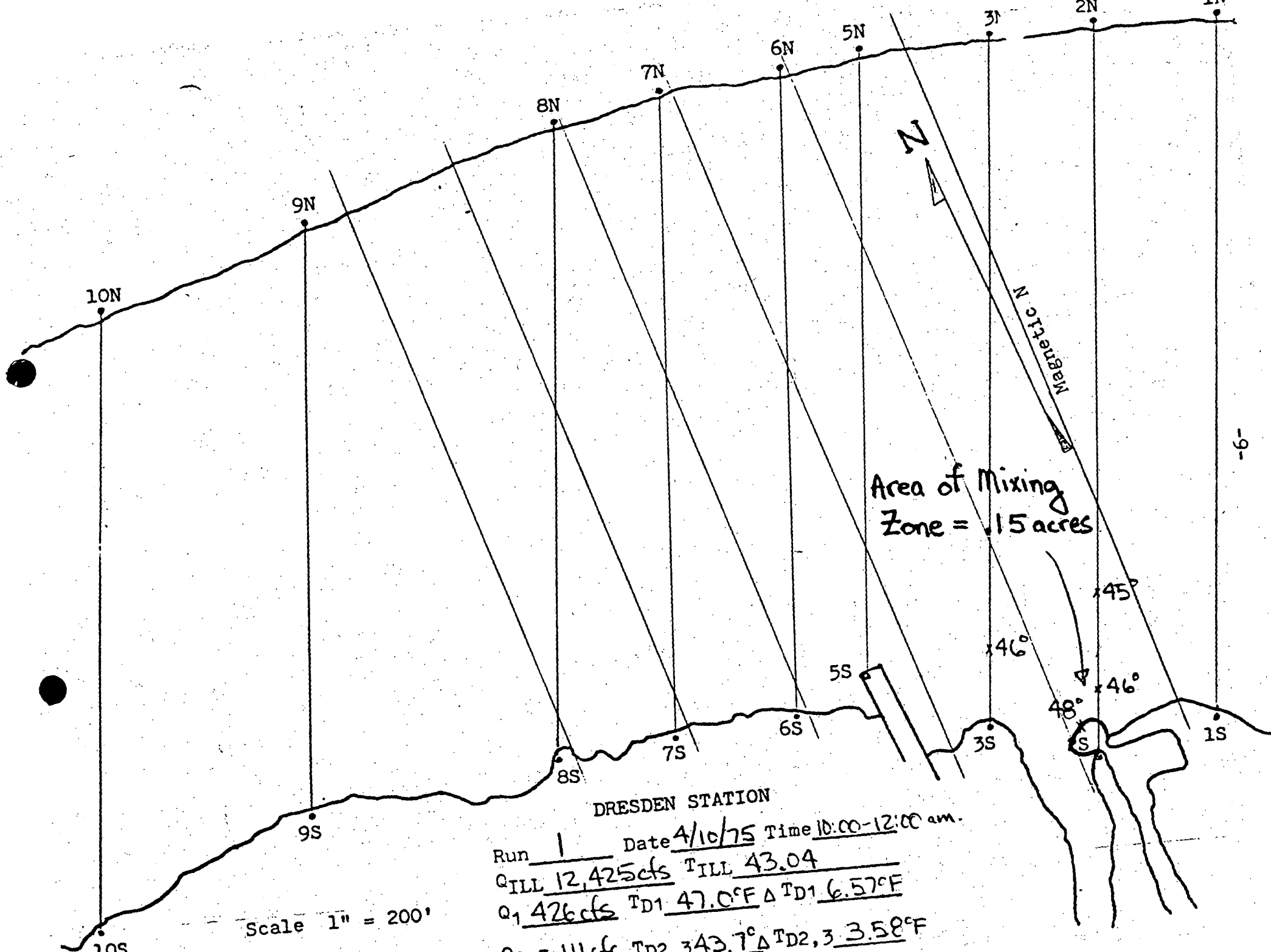
Q 1291 cfs TILL 60.49°F

Q 1291 cfs TD1 63.5° ΔTD1 12.52°

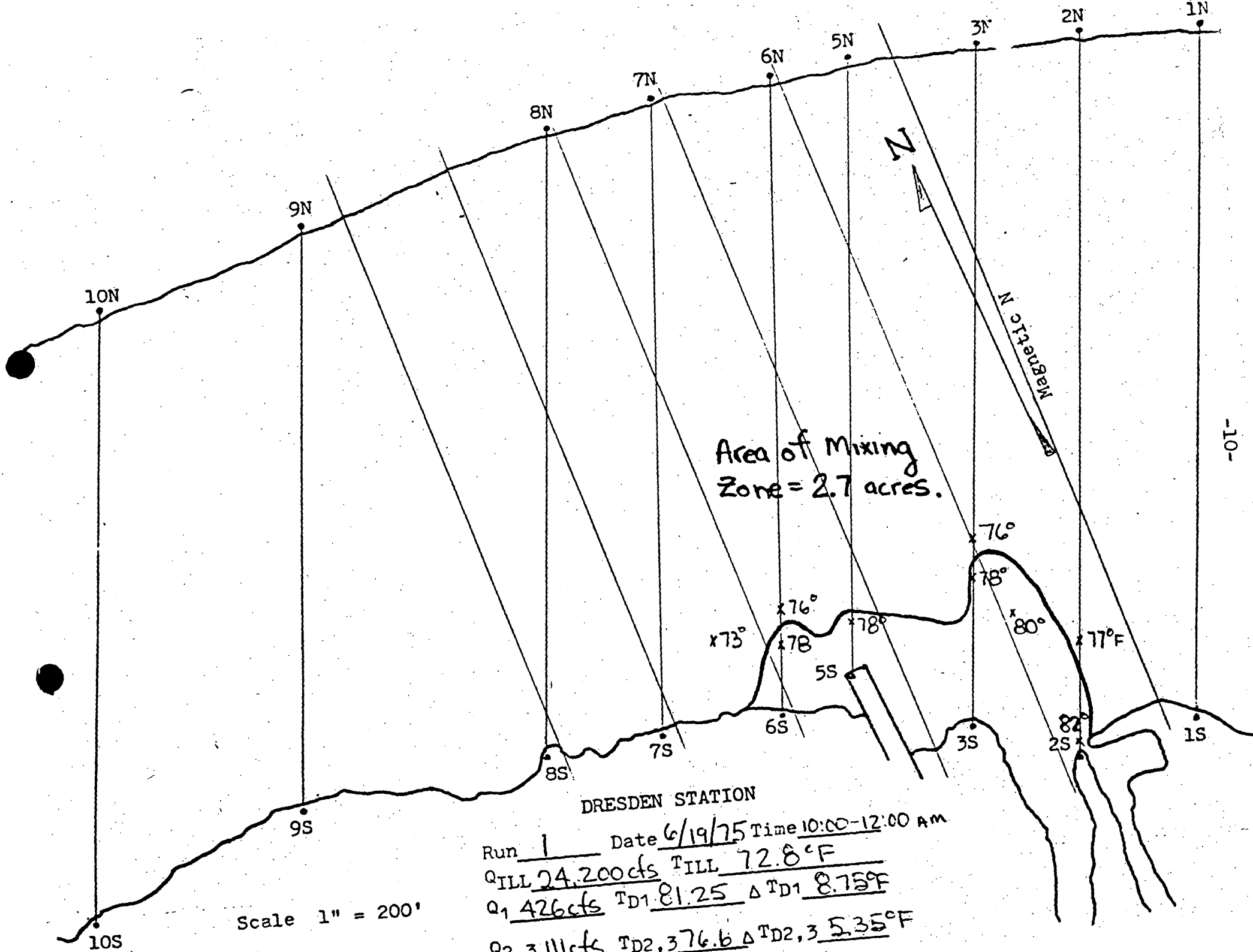
Q 2,3 111 cfs TD2, 365.84 ΔTD2, 313.86°

Scale 1" = 200'

All temperatures shown
at 2 ft depths



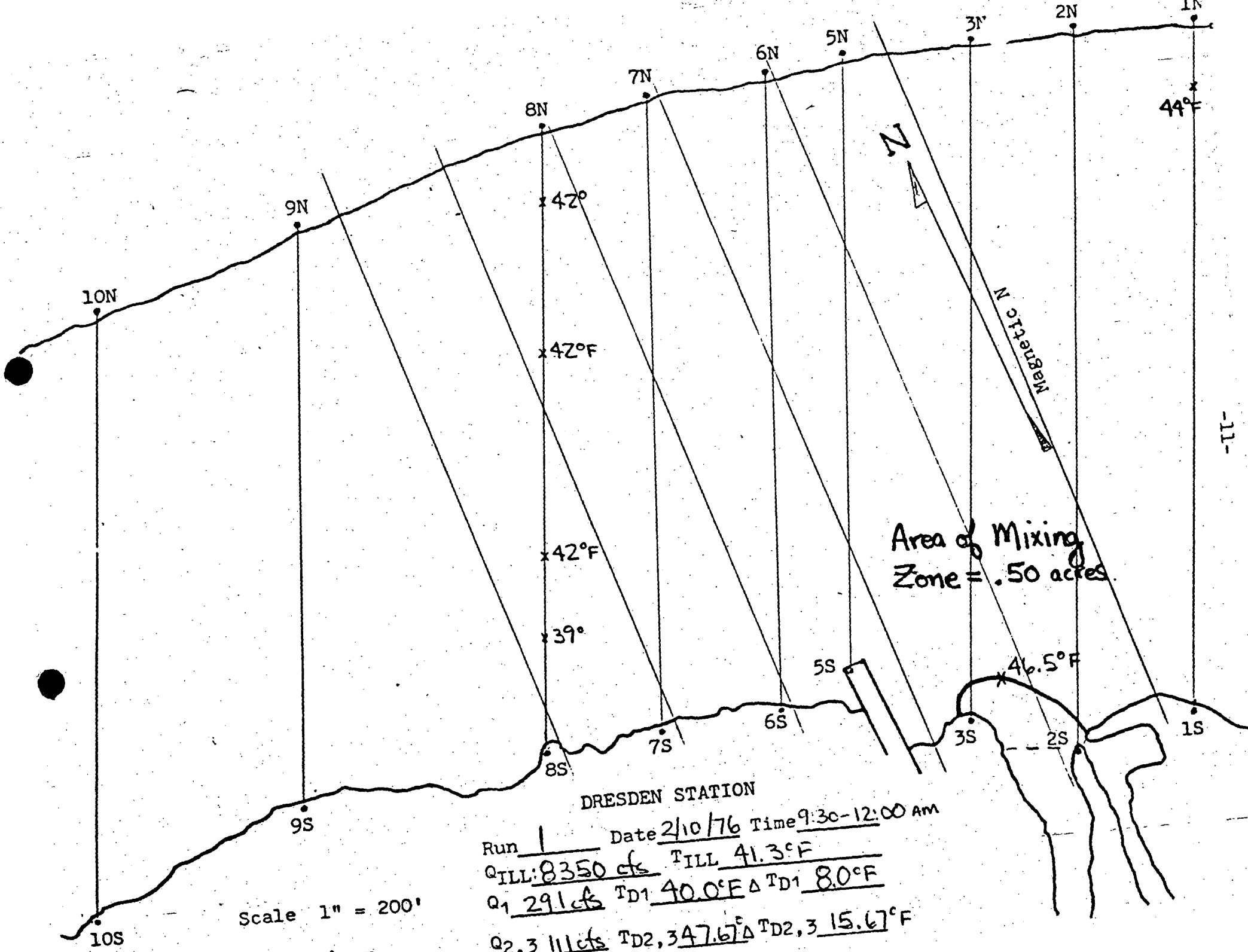
All temperatures shown at depths



Scale 1" = 200'

Run 1 Date 6/19/75 Time 10:00-12:00 AM
 Q TILL 24.200 cfs TILL 72.8°F
 Q₁ 426 cfs TD₁ 81.25 ΔTD₁ 8.75°F
 Q_{2,3} 111 cfs TD_{2,3} 76.6 ΔTD_{2,3} 5.35°F

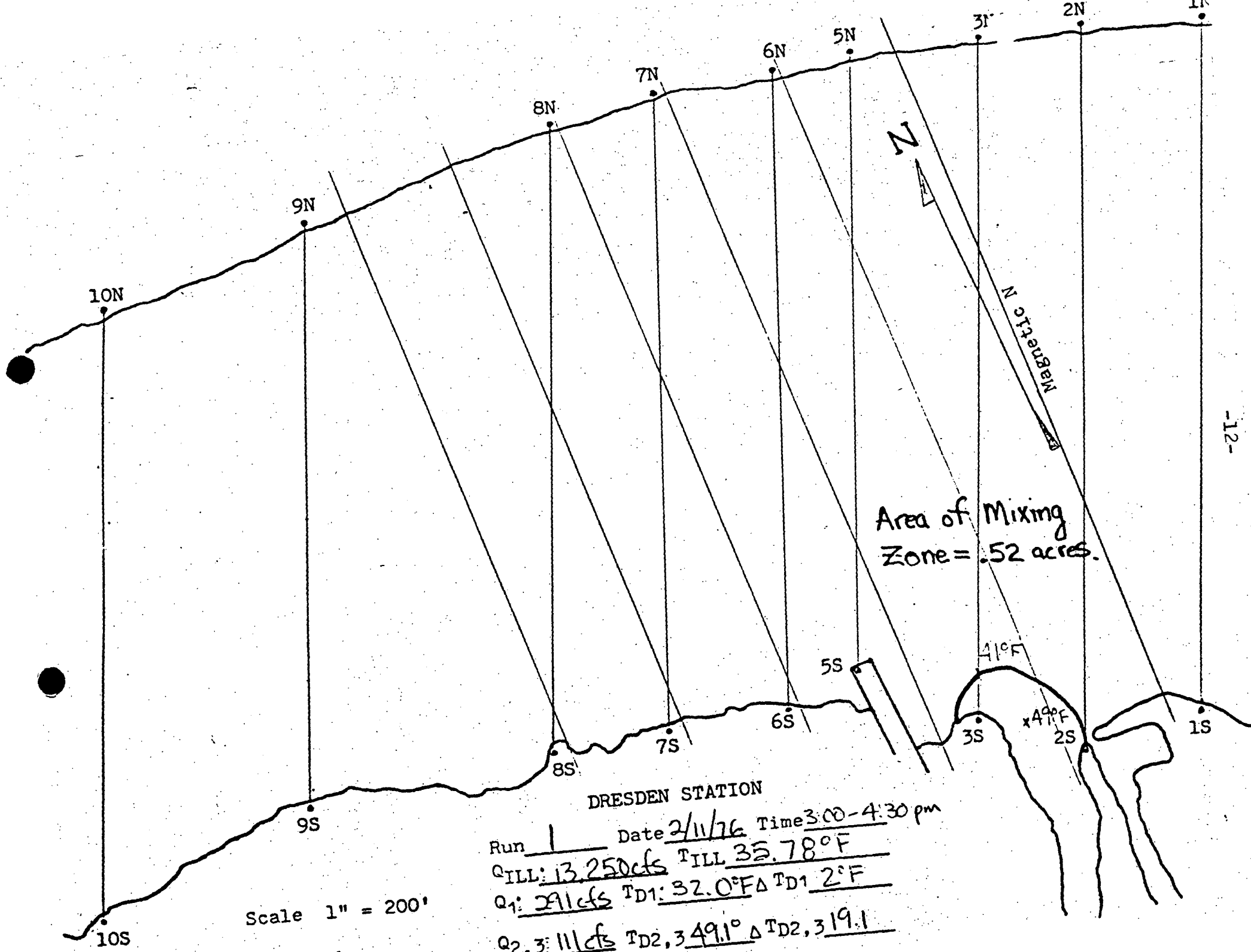
All temperatures shown



All temperatures shown
in this

Scale 1" = 200'

DRESDEN STATION
 Run 1 Date 2/10/76 Time 9:30-12:00 AM
 Q TILL: 8350 cfs TILL 41.3°F
 Q1 291 cfs TD1 40.0°F Δ TD1 8.0°F
 Q2,3 111 cfs TD2,3 47.67°F Δ TD2,3 15.67°F



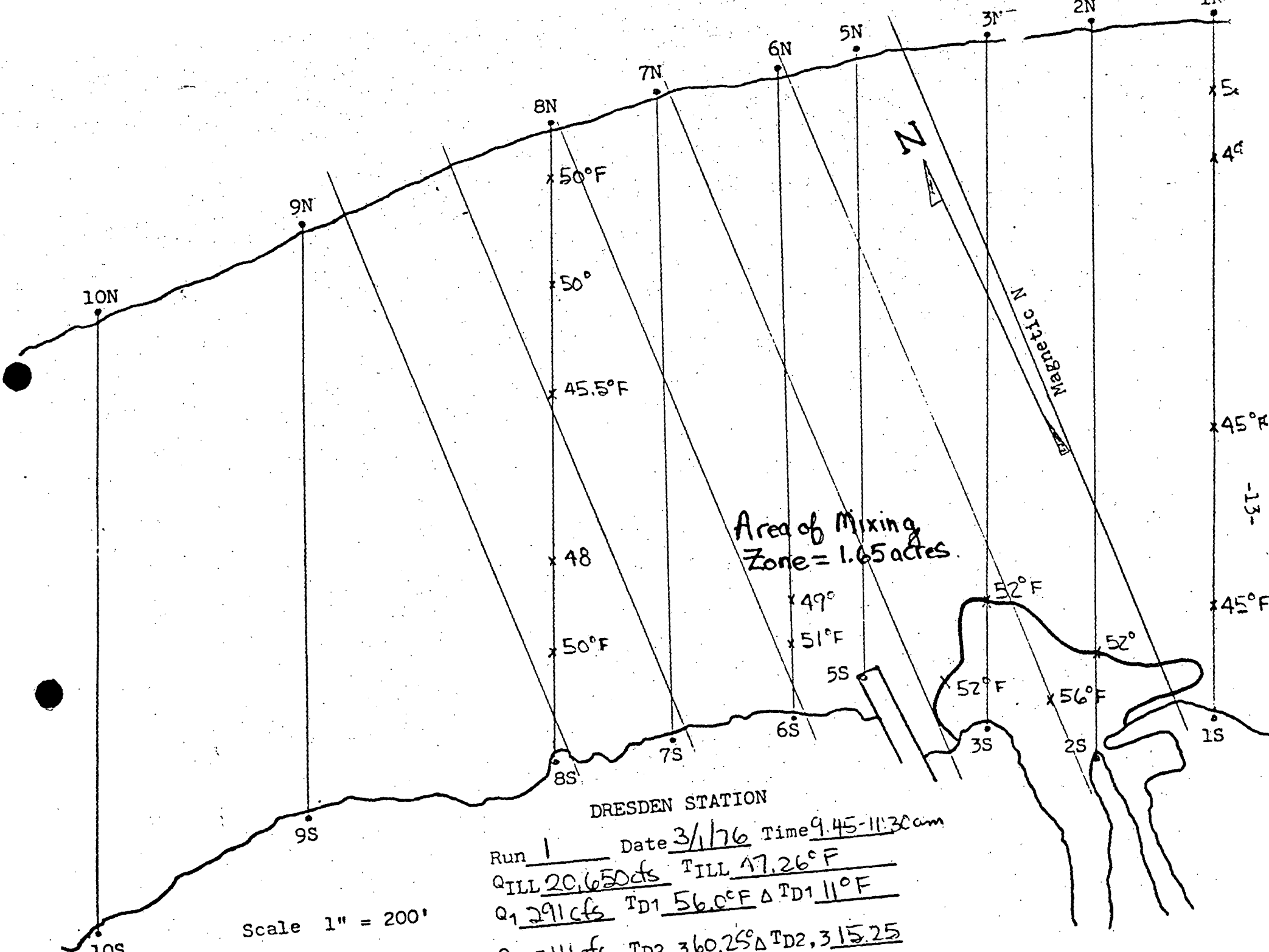
Area of Mixing
Zone = .52 acres.

DRESDEN STATION

Run 1 Date 2/11/76 Time 3:00-4:30 pm
 Q_{TILL}: 13,250 cfs T_{TILL}: 35.78°F
 Q₁: 291 cfs TD₁: 32.0°F ΔTD₁: 2°F
 Q_{2,3}: 111 cfs TD_{2,3}: 349.1° ΔTD_{2,3}: 319.1

Scale 1" = 200'

All temperatures shown
in feet



Scale 1" = 200'

All temperatures shown at depths

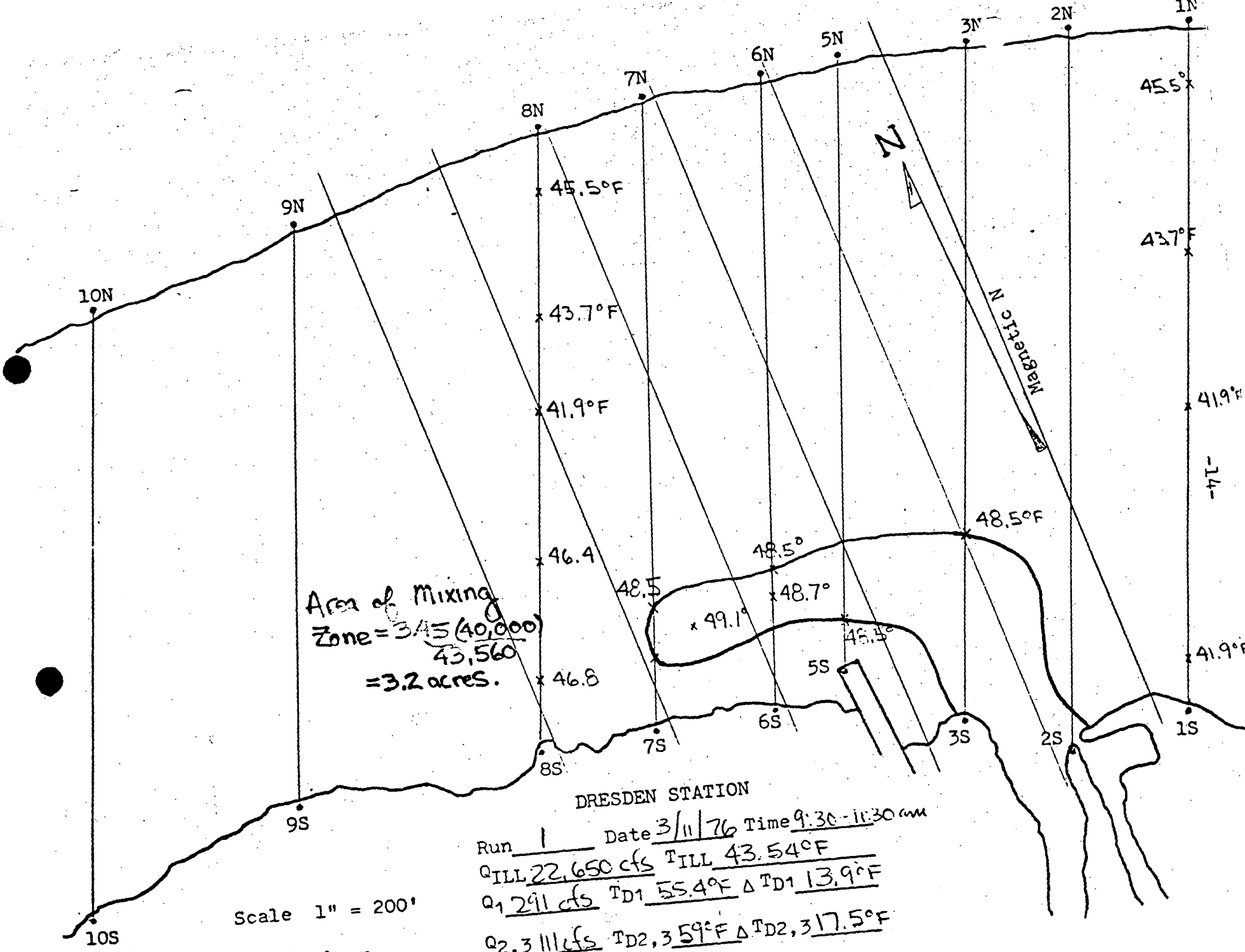
Run 1 Date 3/1/76 Time 9:45-11:30 am
 Q TILL 20.650 cfs TILL 47.26° F
 Q₁ 291 cfs TD₁ 56.0° F Δ TD₁ 11° F
 Q₂ 3111 cfs TD₂ 360.25° Δ TD₂ 315.25

Area of Mixing Zone = 1.65 acres.

DRESDEN STATION



Magnetic N



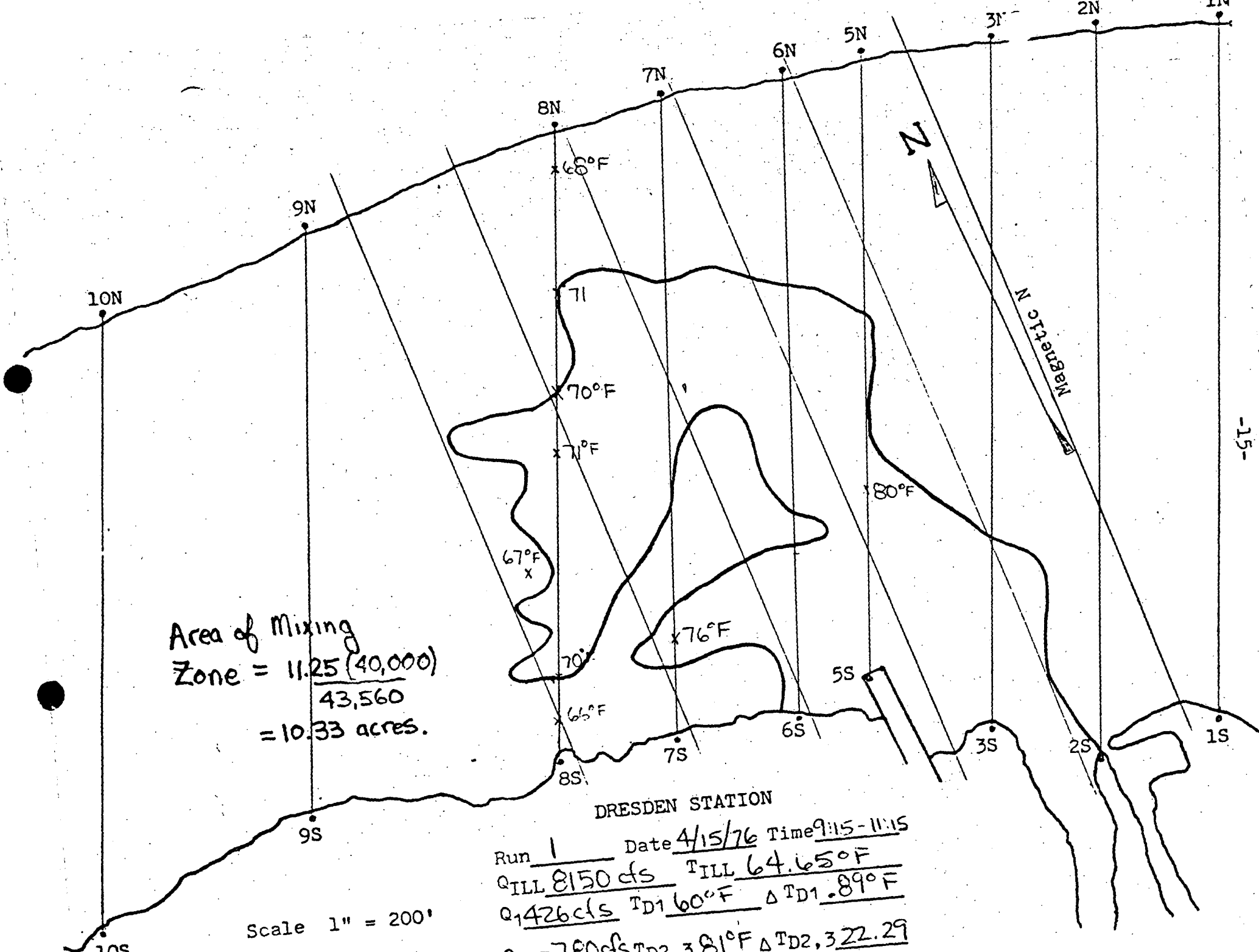
Area of Mixing
 Zone = $\frac{345 (40,000)}{43,560}$
 = 3.2 acres.

DRESDEN STATION

Run 1 Date 3/11/76 Time 9:30-11:30 am
 QILL 22,650 cfs TILL 43.54°F
 Q1 291 cfs TD1 55.4°F ΔTD1 13.9°F
 Q2 3111 cfs TD2 35.9°F ΔTD2 317.5°F

Scale 1" = 200'

All temperatures shown



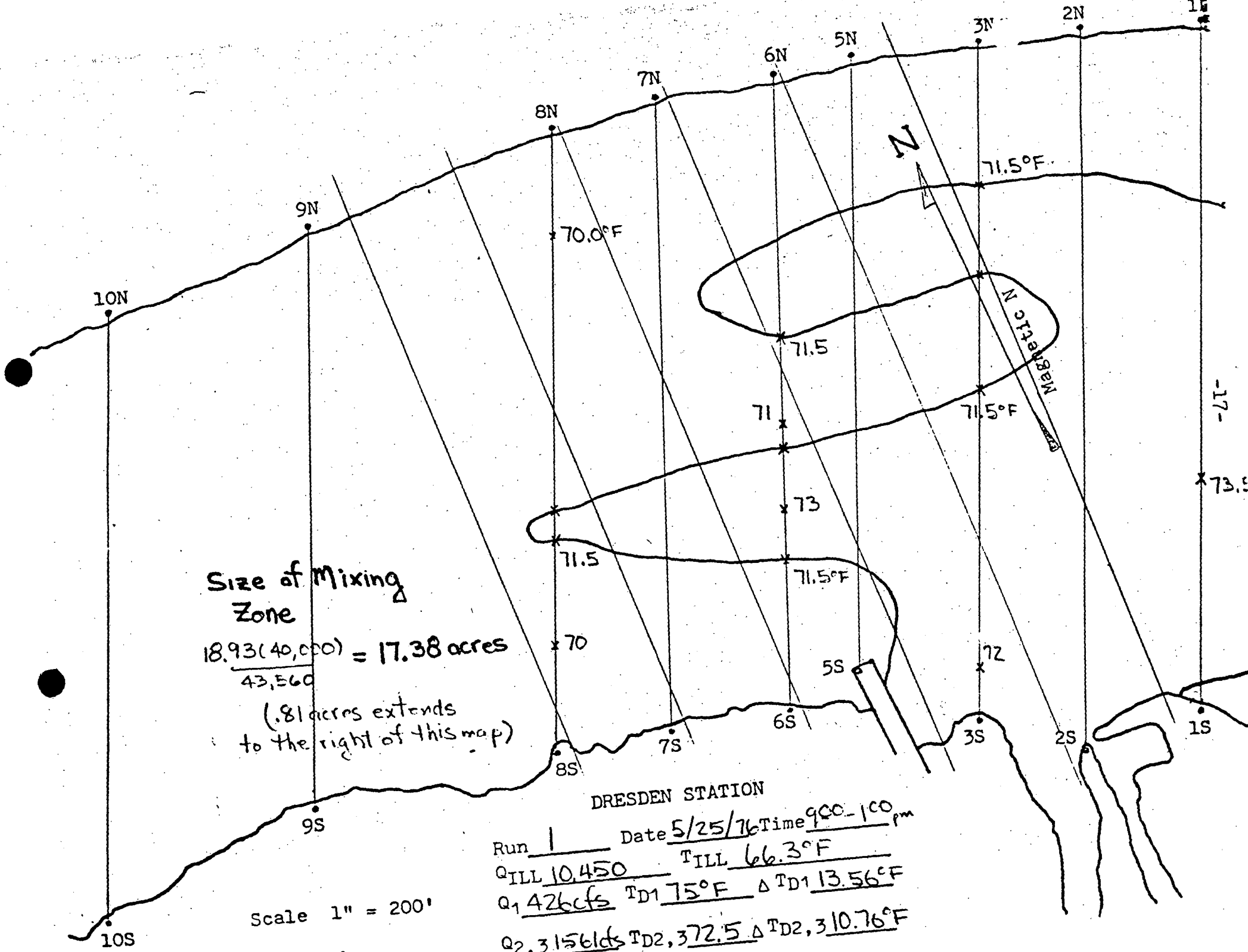
Area of Mixing
 Zone = $\frac{11.25 (40,000)}{43,560}$
 = 10.33 acres.

DRESDEN STATION

Run 1 Date 4/15/76 Time 9:15-11:15
 Q TILL 8150 cfs TILL 64.65°F
 Q 1426 cfs TD1 60°F Δ TD1 1.89°F
 Q 2,378 cfs TD2 381°F Δ TD2 322.29

Scale 1" = 200'

All temperatures shown
 depths



Size of Mixing Zone

$$\frac{18.93(40,000)}{43,560} = 17.38 \text{ acres}$$

(.81 acres extends to the right of this map)

DRESDEN STATION

Run 1 Date 5/25/76 Time 9:00-1:00 pm

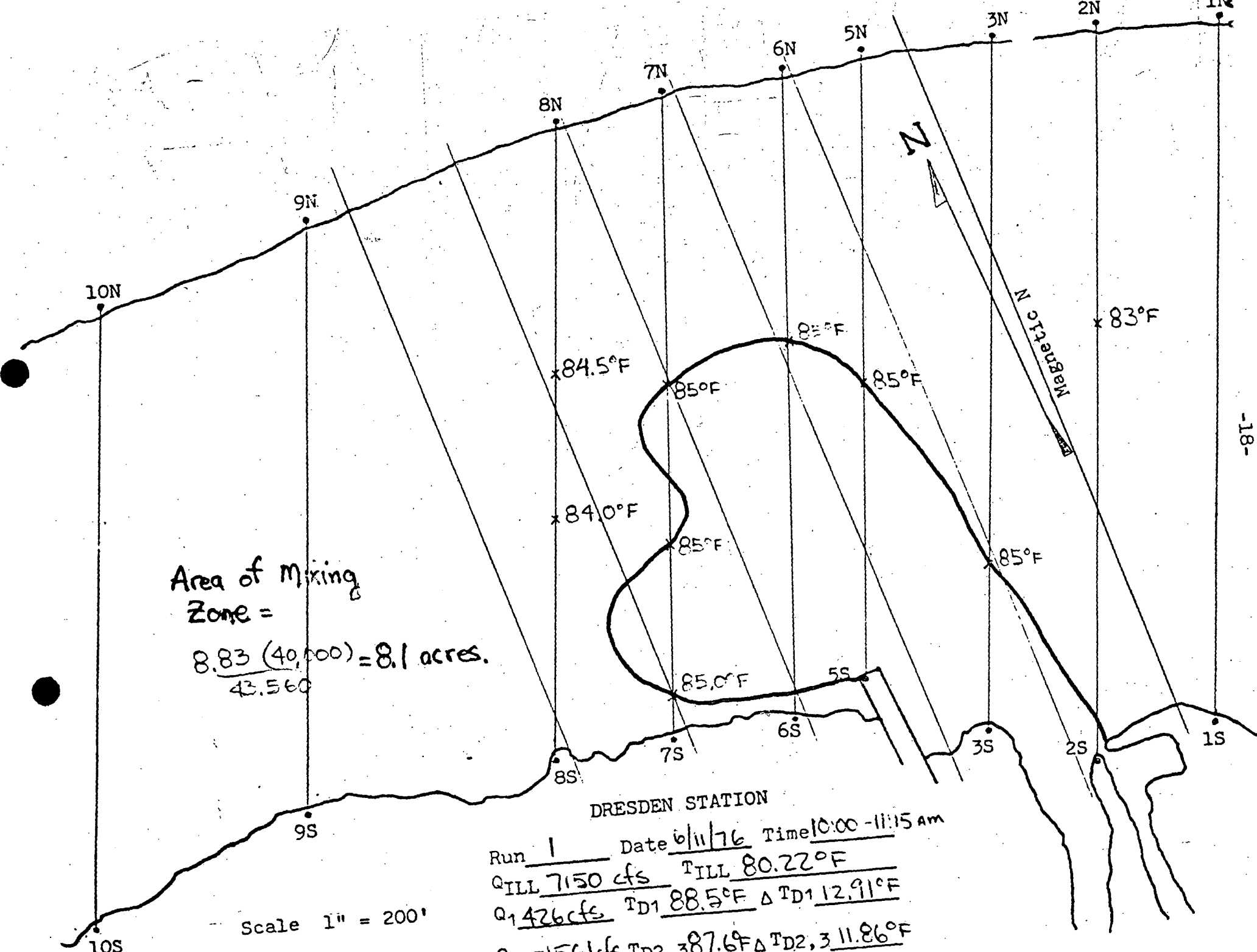
Q TILL 10.450 TILL 66.3°F

Q₁ 426 cfs TD₁ 75°F ΔTD₁ 13.56°F

Q₂ 3,156 cfs TD₂ 372.5 ΔTD₂ 310.76°F

Scale 1" = 200'

All temperatures shown



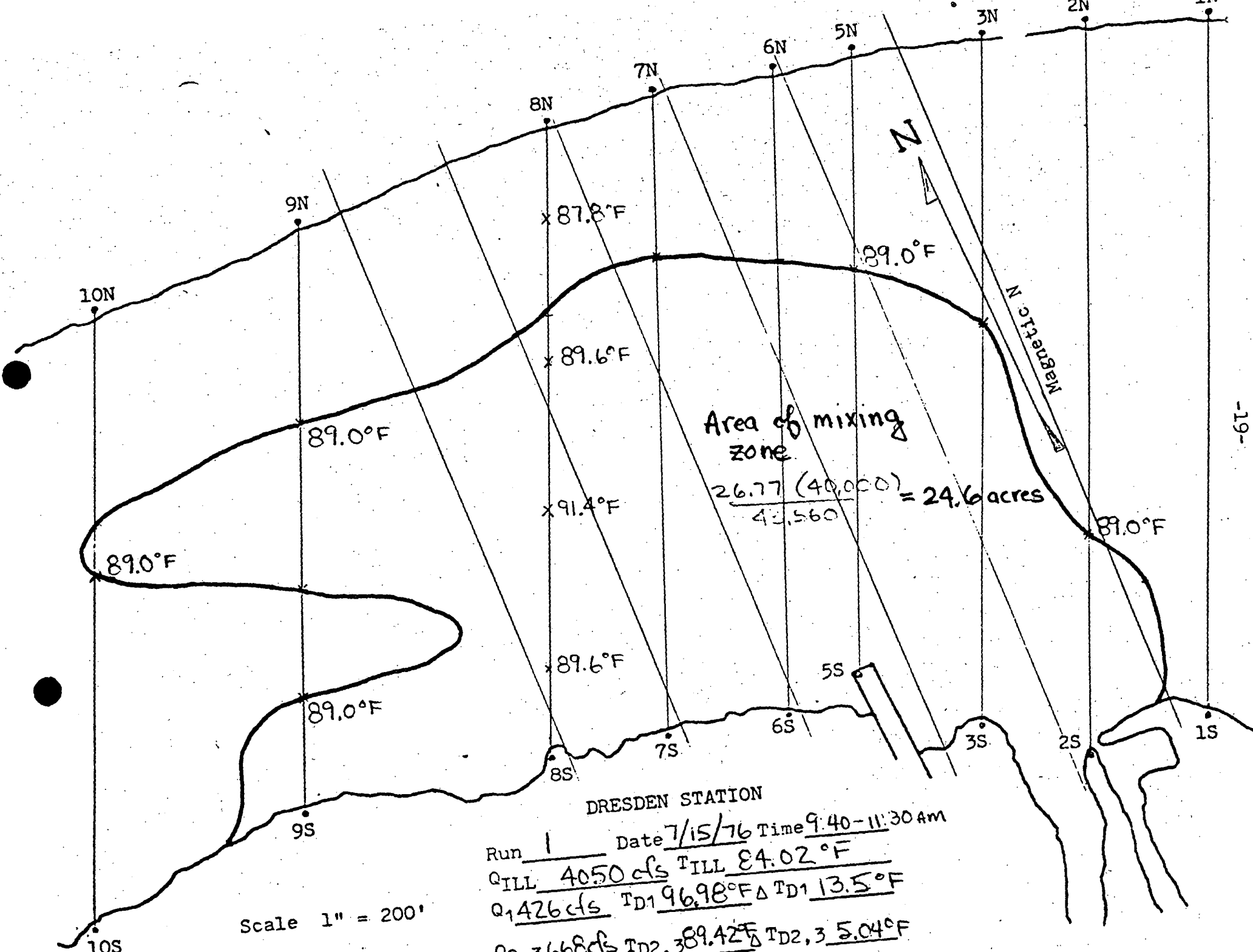
Area of Mixing Zone =
 $\frac{8.83 (40,000)}{43,560} = 8.1 \text{ acres.}$

DRESDEN STATION

Run 1 Date 6/11/76 Time 10:00 - 11:15 am
 QILL 7150 cfs TILL 80.22°F
 Q1 426 cfs TD1 88.5°F Δ TD1 12.91°F
 Q2, 3156 cfs TD2, 87.6°F Δ TD2, 311.86°F

Scale 1" = 200'

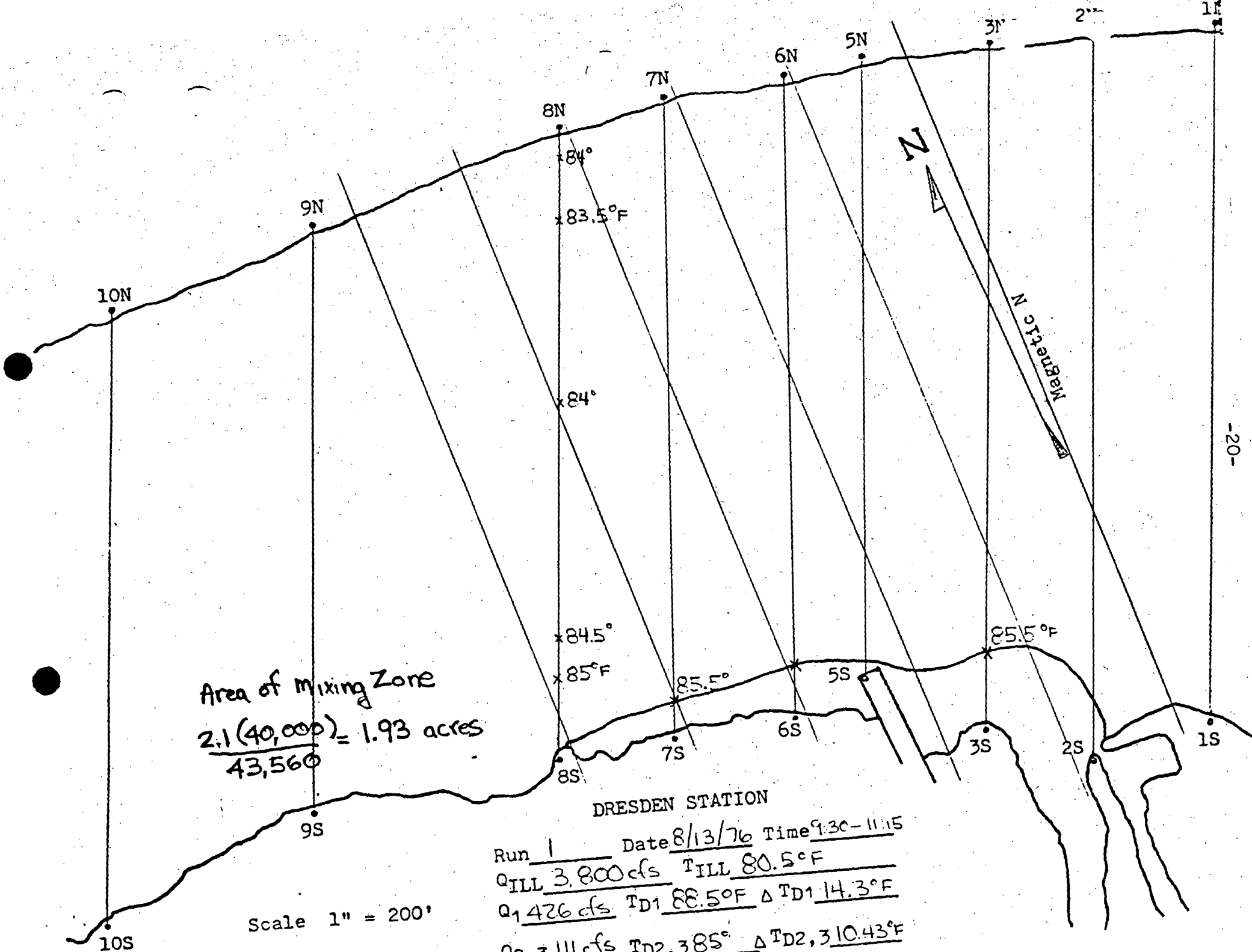
All temperatures shown
 at 5 ft depths



Scale 1" = 200'

Run 1 Date 7/15/76 Time 9:40-11:30 AM
 QILL 4050 cfs TILL 84.02 °F
 Q₁ 426 cfs TD₁ 96.98 °F Δ TD₁ 13.5 °F
 Q₂ 3668 cfs TD₂ 89.42 °F Δ TD_{2,3} 5.04 °F

All temperatures shown
 at 5 ft depths



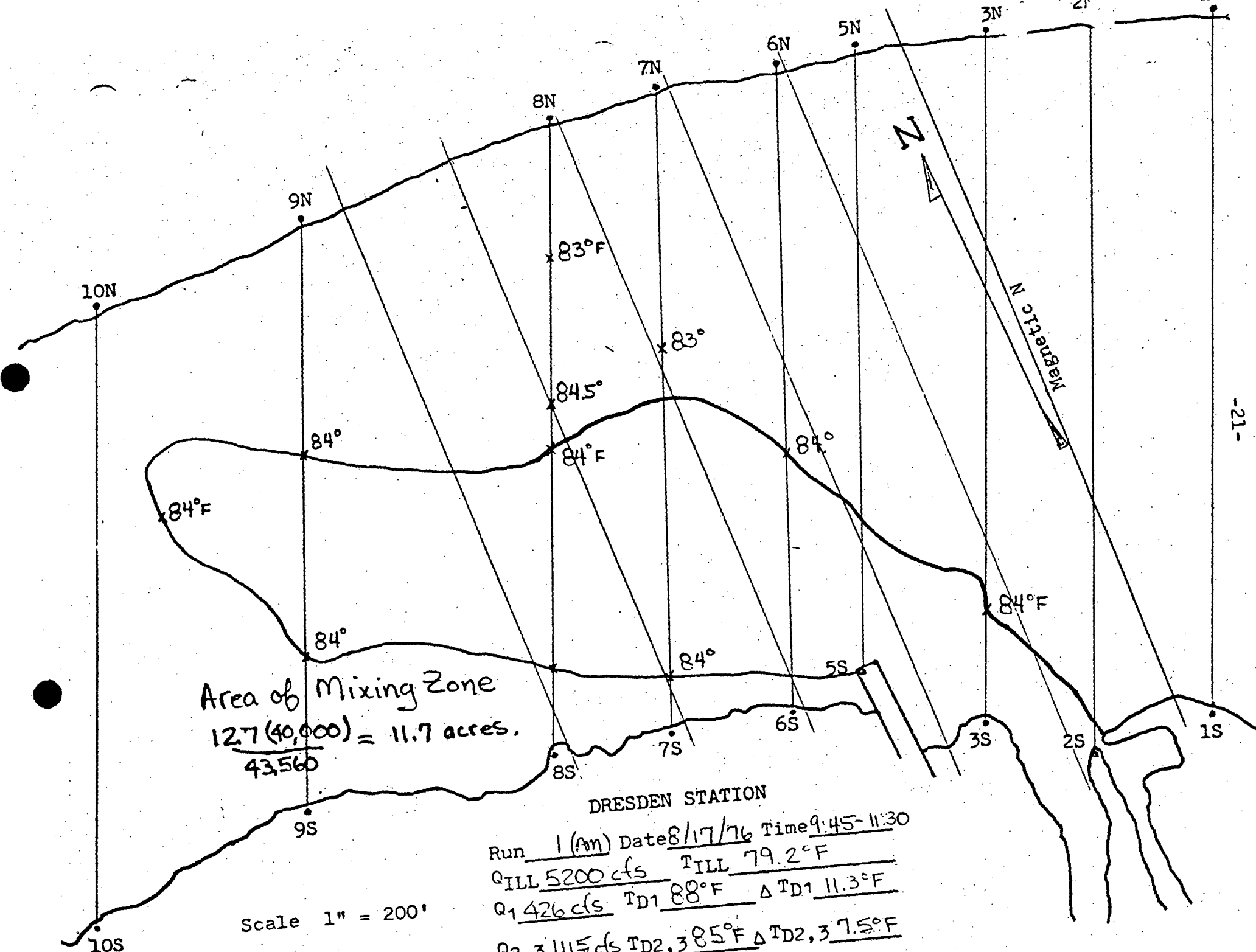
Area of Mixing Zone
 $\frac{2.1(40,000)}{43,560} = 1.93$ acres

DRESDEN STATION

Run 1 Date 8/13/76 Time 9:30-11:15
 Q_{ILL} 3,800 cfs T_{ILL} 80.5°F
 Q_1 426 cfs T_{D1} 88.5°F ΔT_{D1} 14.3°F
 Q_2 3,111 cfs T_{D2} 385° ΔT_{D2} 310.43°F

Scale 1" = 200'

All temperatures shown
 in degrees Fahrenheit



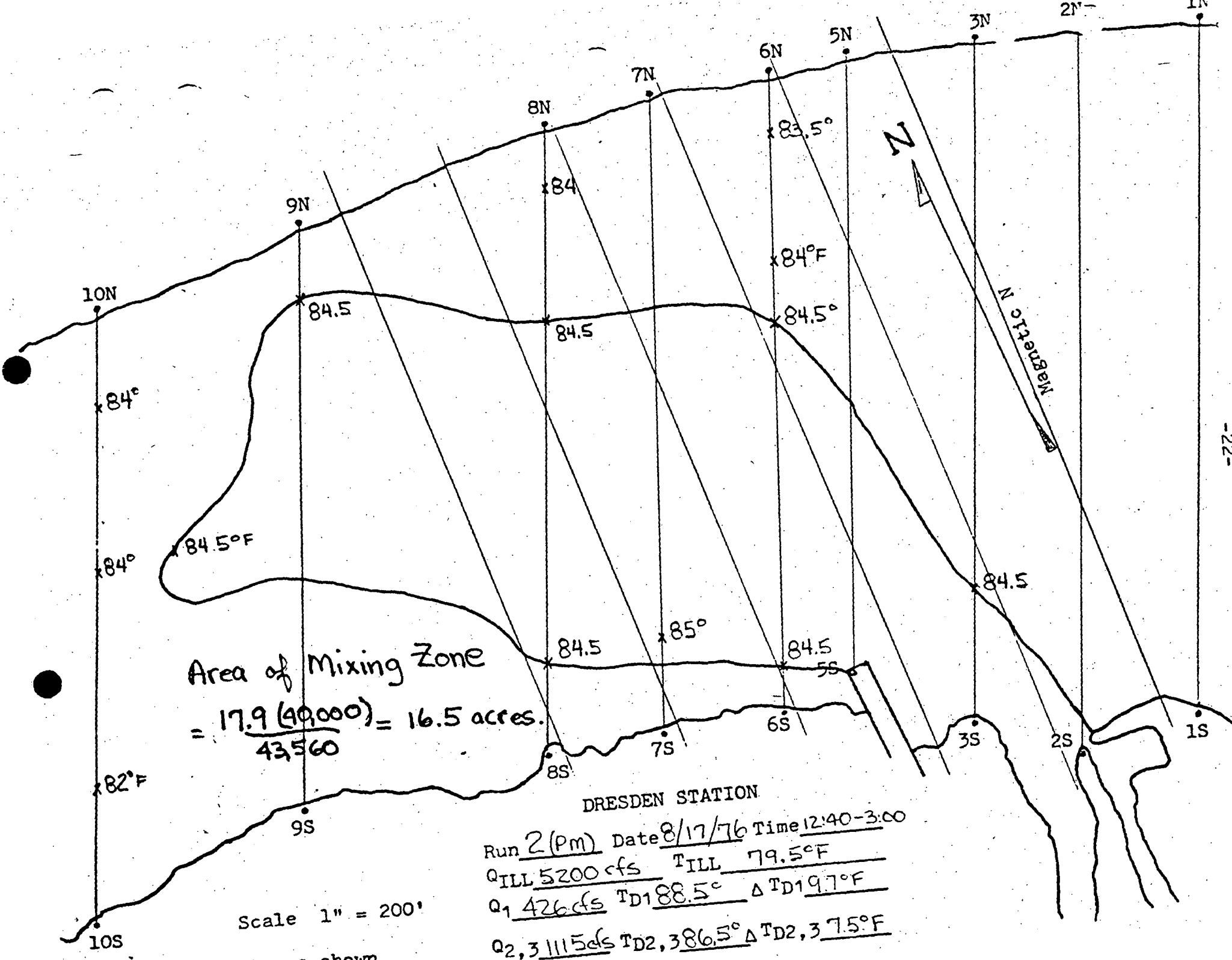
Area of Mixing Zone
 $12.7 (40,000) = 11.7 \text{ acres.}$
 $\frac{43,560}{}$

DRESDEN STATION

Run 1 (Am) Date 8/17/76 Time 9:45-11:30
 Q ILL 5200 cfs TILL 79.2°F
 Q 1 426 cfs TD1 88°F ΔTD1 11.3°F
 Q 2,3 1115 cfs TD2,3 85°F ΔTD2,3 7.5°F

Scale 1" = 200'

All temperatures shown
 of 3 ft. depths



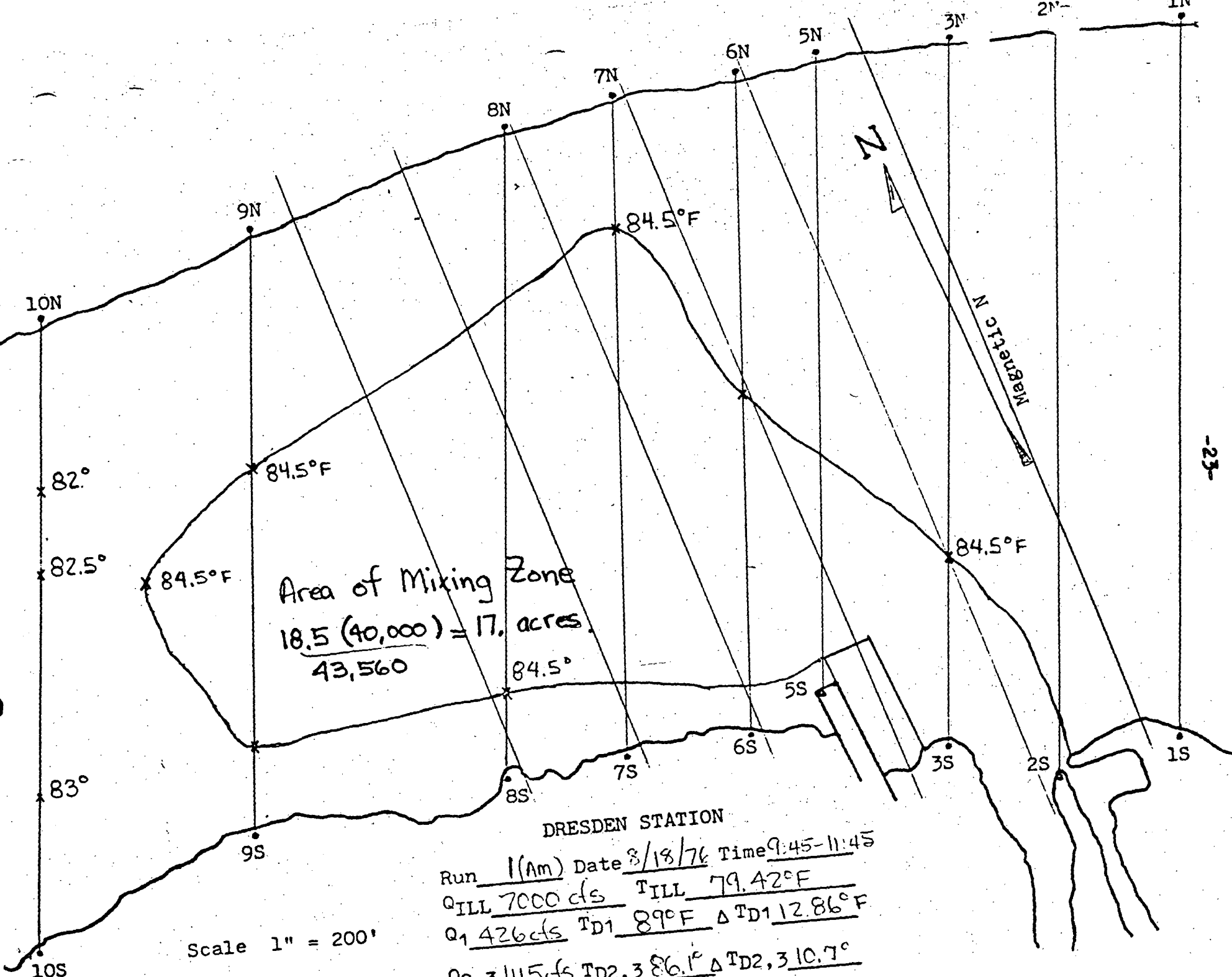
Area of Mixing Zone
 $= \frac{17.9 (40,000)}{43,560} = 16.5 \text{ acres.}$

DRESDEN STATION

Run 2 (pm) Date 8/17/76 Time 12:40-3:00
 Q TILL 5200 cfs TILL 79.5°F
 Q₁ 426 cfs TD 188.5° ΔTD 19.7°F
 Q₂ 3,111.5 cfs TD 2,386.5° ΔTD 2,375°F

Scale 1" = 200'

All temperatures shown



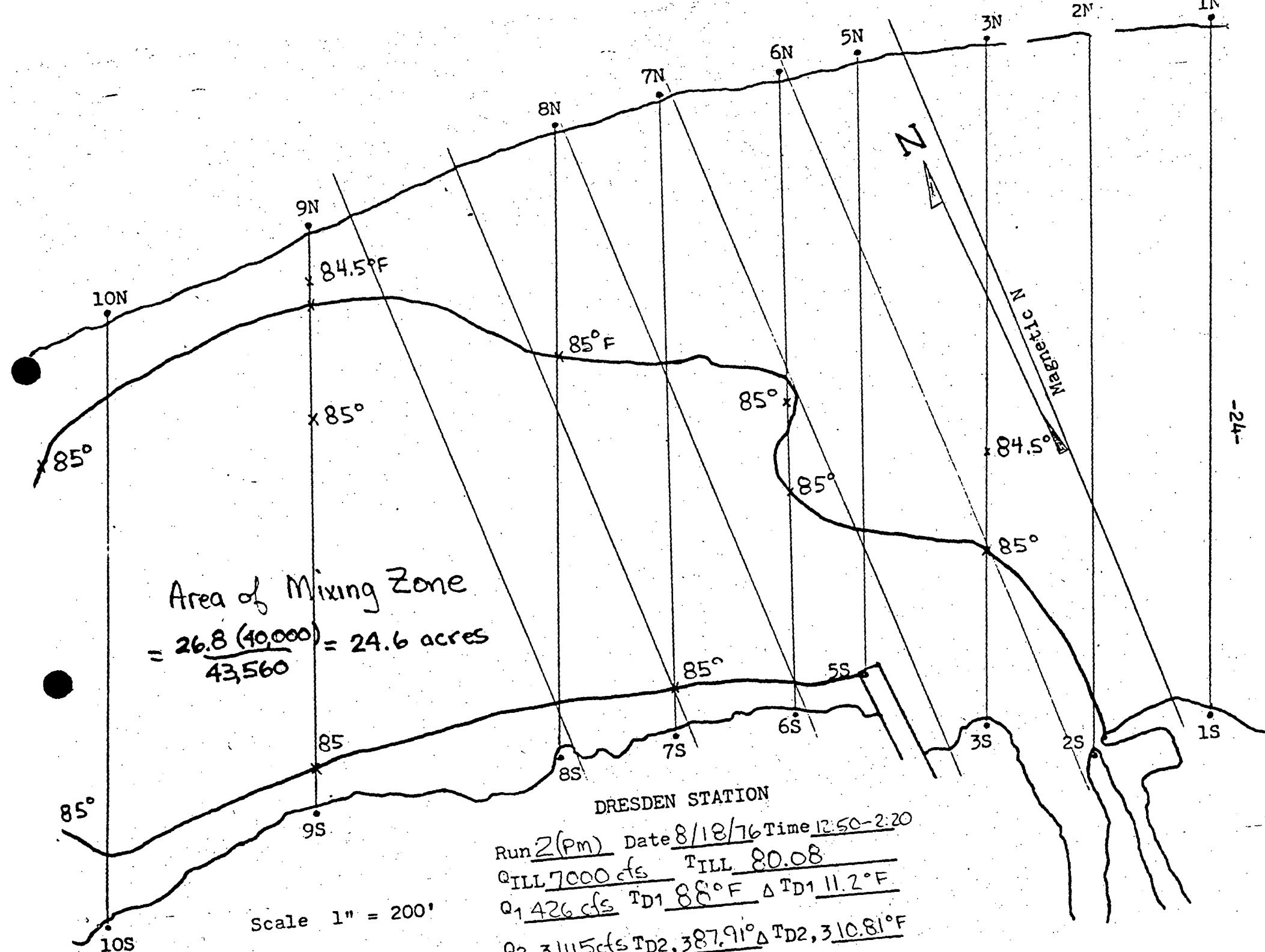
Area of Mixing Zone
 $18.5 (40,000) = 17. \text{ acres.}$
 $43,560$

DRESDEN STATION

Run 1 (Am) Date 8/18/76 Time 9:45-11:45
 Q_{ILL} 7000 cfs T_{ILL} 79.42°F
 Q_1 426 cfs TD_1 89°F ΔTD_1 12.86°F
 Q_2 3115 cfs TD_2 386.1° ΔTD_2 310.7°

Scale 1" = 200'

All temperatures shown
 at depths



All temperatures shown

Scale 1" = 200'

DRESDEN STATION

Run 2 (PM) Date 8/18/76 Time 12:50-2:20
 Q TILL 7000 cfs TILL 80.08
 Q₁ 426 cfs T_{D1} 88°F ΔT_{D1} 11.2°F
 Q₂ 3115 cfs T_{D2} 387.91° ΔT_{D2} 310.81°F

