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Stressed Stream Analysis of Deep Run and Gage Gully in the Canandaigua Lake Watershed

Joseph C. Makarewicz

The College at Brockport, jmakarew@brockport.edu

Theodore W. Lewis

The College at Brockport, tlewis@brockport.edu

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STRESSED STREAM ANALYSIS OF

Deep Run and Gage Gully In the Canandaigua Lake Watershed



**Joseph C. Makarewicz and Theodore W. Lewis
Center for Applied Aquatic Science and Aquaculture
Department of Biological Sciences, SUNY Brockport**

Funded by the Canandaigua Lake Watershed Task Force

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Cover Photo: Turbid and silt laden waters of Deep Run (forefront) entering Canandaigua Lake (blue water) during a precipitation event.

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SUMMARY

1. Deep Run and Gage Gully subwatersheds are located at Canandaigua Lake's northeast corner. Both subwatersheds are relatively small in size but a three-year monitoring program has identified them as contributing disproportionately high loads of nutrients and suspended solids (soils) to Canandaigua Lake. Within the entire Canandaigua Lake watershed, Deep Run lost the most phosphorus and nitrate per unit area of watershed to Canandaigua Lake (January 1997 to January 2000), while Gage Gully ranked third. Also, the Deep Run and Gage Gully subwatersheds ranked 3rd and 5th for total Kjeldahl nitrogen (TKN) loss and 2nd and 3rd for total suspended solids loss per unit area, respectively in the Canandaigua Lake watershed.
2. Because these two subwatersheds were contributing more nutrients and suspended solids than most subwatersheds of Canandaigua Lake, they have the potential to adversely affect the lake. The policy of maintaining the current high water quality of Canandaigua Lake suggested that the sources of pollution in Gage Gully and Deep Run be identified. With this report, we provide evidence suggesting the location and the intensity of pollution sources in the Deep Run and Gage Gully watersheds.

3. **Deep Run**

Figure 2 provides the location of sampling sites while Figure 50 is a visual summary of the results. Nitrate was extremely high throughout the entire watershed except for a small rivulet (Station DR3) near the mouth of the stream. The high levels within the entire subwatershed reflect the fact that the source of nitrate is at the top of the watershed. Two areas were especially high in nitrate concentrations.

Site 6 Series, Kipp Road:

The Station 6 series in the upper reaches of the Deep Run watershed contained the highest nitrate concentrations observed in all of the events sampled. Nitrate levels often exceeded EPA Guidelines for drinking water. The agricultural fields on the north and south side of Kipp Road (sometimes called Powell Road on maps) adjacent to Sites 6A1 and 6B appear to be one source of nitrate within the Deep Run subwatershed. Concentrations of total phosphorus and total suspended solids were also exceedingly high in this area during some of the events.

Site 10 Series Route 247 and Lake to Lake Road:

- a. The second major source of nitrate appears to be the cornfield on the North side of Lake to Lake Road adjacent to Site 10C1. Site 10C1 had very high nitrate concentrations (max = 13.4 mg N/L) indicating that the upstream cornfield is contributing nutrients to downstream systems. Subsequent events also had high concentrations of the soluble form

of the nutrient phosphorus (soluble reactive phosphorus –SRP).

- b. Total phosphorus (TP), SRP and TKN concentrations were generally higher at Site10C compared to Site 10C1. This suggests that a source of these nutrients exist in the 10C branch between Lake to Lake Road and Route 247. A livestock operation exists between these two sites. The stream segment that branched off to the south and east between Sites 10C and 10C1 was not sampled due to inaccessibility but the majority of the watershed in that area appeared to be part of the same livestock operation.
- c. Site 10A is a roadside ditch along the west side of Route 247. Site 10A had high concentrations of total phosphorus, soluble reactive phosphorus, total suspended solids (TSS) and chloride but the flow was estimated to be only about 10% of the discharge observed at either 10B or 10C. During one event the tributary did not even flow. The source appeared to be runoff from an agricultural field up the hill on the west side of Route 247 and road runoff and seepage into the ditch. Although concentrations are high at Site 10A, the impact on downstream systems is probably minimal.
- d. Site 10A1 was sampled during the last event and represents the overland runoff from a tilled agricultural field. Site 10A1 is a source of phosphorus, solids and TKN.

Site 7 and 7a:

Elevated levels of several analytes (TP, nitrate, TSS and TKN) were observed during the January and February events. In subsequent events, although elevated levels of nutrients and solids were observed, their magnitude was not as high as in previous events.

4. Gage Gully

Figure 3 provides the location of sampling sites while Figure 51 is a visual summary of the results.

Sites 1, 1A, 2, 3 and 10

Nitrate, TP, SRP, TKN and TSS were generally high at these stations on all events. The entire headwater area near the intersection of Arnold Road and Green Road is contributing nutrients and soil to downstream systems and eventually Canandaigua Lake. High nitrate concentrations, often exceeding 10 mg N/L, were observed in the headwaters of Gage Gully. Much of this area is in agricultural use.

Site 5B:

Site 5B was under snow for the first two events in January and February and therefore was not

sampled until April. Site 5B runs along the west side of Route 364 but also receives flow from an agricultural field adjacent to Route 364. High losses of phosphorus, organic and inorganic nitrogen and soil occur from this site. The highest TKN concentration in the watershed was measured at Site 5B during the 18 May 2000 event.

Sites 4, 5 and 5A:

In the April event, the area between Sites 4 and 5 showed an increase in total phosphorus, TKN and total suspended solids. Site 5A was sampled between Sites 4 and 5. The majority of the increase was observed between site 4 and Site 5A. The land use was agriculture in this area and there was evidence of some ‘ditching’ (small drainage furrow in the field) of the agricultural fields in this area. The high levels of soils in the stream during the event may be associated with that practice. Although phosphorus increased between Sites 4 and 5 in each subsequent event, the magnitude of the increase was reduced.

Site 7:

Site 7, a tributary to the main branch of Gage Gully that drains two adjacent agricultural fields separated by a hedgerow, had moderately high levels of total phosphorus, total Kjeldahl nitrogen and nitrate during the January and February events.

Sites 1 to 8:

An increase of TSS, TP and TKN were observed within this field that was in agriculture.

Site 11:

Site 11 is a roadside ditch flowing eastward along Green Road and joins the main tributary at Site 4. Site 11 had high phosphorus and TKN both times it was sampled. There was some road construction near Route 364, which could a cause of the high values.

RECOMMENDATIONS AND BEST MANAGEMENT PRACTICES

Most of the sources discovered during this Stressed Stream Analysis are agricultural in nature. In general, a review of the agricultural practices in the targeted areas is warranted. Recommendations and Best Management Practices are discussed in detail in the text.

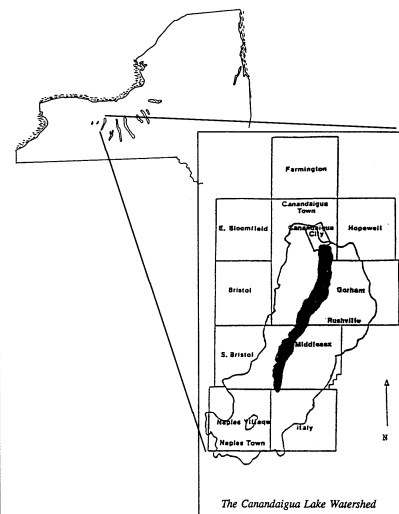
INTRODUCTION

Although relatively small in size, the Deep Run (2193 acres) and Gage Gully (732 acres) subwatersheds located at Canandaigua Lake's northeast corner (Fig. 1) contributed disproportionately high loads of nutrients and soil to Canandaigua Lake. For three consecutive years, SUNY Brockport monitored the major tributaries of Canandaigua Lake. A prioritization based on loading of nutrients and soil to Canandaigua Lake revealed that Deep Run and Gage Gully were two of six sub-watersheds identified as contributing the largest amount of nutrients and soil to Canandaigua Lake per unit area. Of the entire Canandaigua Lake watershed, the Deep Run subwatershed contributed the most phosphorus and nitrate per unit area of watershed to Canandaigua Lake for the January 1997 to January 2000 period, while Gage Gully ranked third (1,2,3). Deep Run and Gage Gully ranked 3rd and 5th for total Kjeldahl nitrogen loss and 2nd and 3rd for total suspended solids loss, respectively, in the Canandaigua Lake watershed. Clearly these two watersheds were contributing more nutrients and suspended solids than most subwatersheds of Canandaigua Lake and have the potential to adversely affect the lake. The policy of maintaining the current high water quality of Canandaigua Lake suggested that the sources of pollution in Gage Gully and Deep Run be identified and abated. With this report, we provide evidence suggesting the location and the intensity of pollution sources in the Deep Run and Gage Gully watersheds.

The Approach:

Point and non-point sources of nutrients, soils and salts were identified through a process called stressed stream analysis or segment analysis (4). For an entire watershed such as Canandaigua Lake, this approach identifies impacted sub-watersheds and their associated streams (4,5,6,7,8). Within a subwatershed, stressed stream analysis is an approach for determining how and where a stream and its ecological community are adversely affected by a pollution source or other disturbances. Stressed stream analysis is an integrative, comprehensive approach for determining the environmental health of a watershed and its constituent streams. It is a technique that identifies the sources, extent, effects and severity of pollution in a watershed. In

Location Map



Canandaigua Lake Watershed in the
Finger Lakes Region of New York State

its fullest use, it combines elements of the sciences of hydrology, limnology, ecology, organismal biology and genetics in an integrated approach to analyze cause and affect relationships in disturbed stream ecosystems.

Within a sub-watershed, the stream(s) is used to monitor the "health" of the watershed. Because nutrients are easily transported by water, they can be traced to their source by systematic geographic monitoring of the stream. Stressed stream analysis is a technique that divides the impacted sub-watershed into small distinct geographical units – segment analysis. Samples are taken at the beginning and end of each unit of the stream to determine if a nutrient source occurs within that reach. At completion, the cause and extent of pollution have been identified. If needed, the severity of the pollution within the impacted sub-watershed and or the entire watershed can then be evaluated by spatial analysis of the quantity and quality of biological indicators, such as fish and invertebrates, and by biological examination of structural and functional changes in individual organisms and populations in affected communities. Once identified, sources of chemical pollutants, may be corrected using "Best Management Practices" (BMP). In this report, stressed stream analysis is limited to a spatial analysis of chemical sources in two previously identified impacted subwatersheds, Gage Gully and Deep Run.

DEFINITIONS

Total Phosphorus- A measure of all forms of the element phosphorus. Phosphorus is an element required for plant growth on land or in water. In lakes, phosphorus is often the limiting factor of phytoplankton growth and is the cause of eutrophication, or overproduction, of lakes. Phosphorus may enter a watershed in soluble or organic form from several sources including sewage, heavy-duty detergents, fertilizer and agricultural waste. Some forms of phosphorus are more available to, and cause more immediate activity in, plants.

Soluble Reactive Phosphorus- A measure of the most available and active form of phosphorus.

Nitrate + Nitrite- A measure of the soluble forms of nitrogen used readily by plants for growth. Sources of nitrates in the environment are many and include barnyard waste and fertilizer.

Total Kjeldahl Nitrogen- The Kjeldahl method is a convenient method of analysis for nitrogen but cannot be used for all types of nitrogen compounds. It is, however, a good measure of organic nitrogen, including ammonia. Manure, for example, contains a large amount of organic nitrogen.

Sodium and Chloride- A measure of the mineral, most commonly found as sodium chloride

(NaCl), dissolved in water. NaCl naturally occurs in deep layers of local bedrock. Mined, it is stored and spread as a de-icing agent on roads and other pavements.

Total Suspended Solids - A measure of the loss of soil and other materials suspended in the water from a watershed. Water-borne sediments act as an indicator, facilitator and agent of pollution. As an indicator, they add color to the water. As a facilitator, sediments often carry other pollutants, such as nutrients and toxic substances. As an agent, sediments smother organisms and clog pore spaces used by some species for spawning.

Drainage Tile - In moderately and poorly drained soils, “tiles” or drains are subsurface drainage systems designed to improve subsurface drainage and lower the water table in a field improving the ability to plant and grow crops. Tile drainage systems collect seepage water and discharge it at a point in a ditch, stream, or road ditch. Unless a surface water discharge has been added to the drain tile system, the water the drain tile carries is water that has percolated through the soil. Thus the possibility exists that excess nutrients from excessive fertilization or other sources (e.g., septic system) could be transported by the ground water draining from the field into a stream.

SAMPLING AND ANALYTICAL METHODS

Segment analysis was performed on four dates each on Deep Run (4 January, 24 February, 4 April and 18 May 2000) and Gage Gully (4 January, 24 February, 21 April and 18 May 2000). Sampling locations are shown on Figures 2 and 3. A total of 122 samples were analyzed for nitrate, soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, chloride, and total suspended solids with the exception of chloride which was dropped from the 18 May event. All samples were taken under hydrometeorological event conditions.

Initially, 12 sites on Deep Run and nine sites at Gage Gully were sampled. At Deep Run, three areas of pollution sources were identified and subsequently additional sites were sampled to further pinpoint those sources. The areas that were expanded were Site DR6, Site DR7 and Site DR10. At Gage Gully, the same stations were sampled during each event with the addition of a total of eleven sites to pinpoint sources within the watershed.

All samples were generally taken within 180 minutes at each watershed. Specific locations of all sampling sites are shown in Figures 2 and 3. All sampling bottles were routinely cleaned with phosphate free RBS between sampling dates and pre-coded to ensure exact identification of the particular sample. Containers were rinsed prior to sample collection with the water being collected. In general, all procedures followed EPA standard methods (9) or Standard Methods for the Analysis of Water and Wastewater (10). Sample water for dissolved nutrient analyses (SRP, nitrate + nitrite) was filtered immediately with 0.45- μm MCI Magna Nylon 66 membrane

and either frozen or analyzed within 24 hours of collection.

Nitrate+Nitrite: Dissolved nitrate+nitrite nitrogen was performed by the automated (Technicon autoanalyser) cadmium reduction method (10).

Soluble Reactive Phosphorus: Sample water was filtered through a 0.45- μm membrane filter. The filtrate was analyzed for orthophosphate using the automated (Technicon) colorimetric ascorbic acid method (10). The formation of the phosphomolybdeum blue complex was read colorimetrically at 880nm.

Total Phosphorus: The persulfate digestion procedure was used prior to analysis by the automated (Technicon autoanalyser) colorimetric ascorbic acid method (10).

Total Kjeldahl Nitrogen: Analysis was performed using a modification of the Technicon Industrial Method 329-74W/B. The following modifications were made:

- In the sodium salicylate-sodium nitroprusside solution, sodium nitroprusside was increased to 0.4 gm/L.
- The reservoir of the autoanalyser was filled with 2M H_2SO_4 instead of distilled water.
- Other reagents were made fresh prior to analysis.

Chloride: The mercuric nitrate titration method was utilized for analysis of chloride (10).

Total Suspended Solids: APHA (10) Method 2540D was employed for this analysis.

QUALITY CONTROL

The Water Chemistry Laboratory at SUNY Brockport is certified through the New York State Department of Health's Environmental Laboratory Approval Program (ELAP - # 11439). This program includes bi-annual proficiency audits, annual inspections and good laboratory practices documentation of all samples, reagents and equipment (Table 1).

RESULTS

Deep Run - Chronological Account of Stressed Stream Analysis

4 January 2000 (Figures 4-9, Table 2)

The initial sampling event occurred during event conditions caused by a combination of rain (nearly 0.5 inches) and snowmelt. The goal of this sampling was to initiate the program and to determine the variability of nutrient concentrations along sections of Deep Run. Twelve stations were sampled in the Deep Run sub-watershed and results are presented in Table 2 and Figures 4-

9 (See Figure 2 for a Sampling Site Map). Several potential sources of nutrient loss from the watershed were identified. Station 10 had the highest total phosphorus (TP), total Kjeldahl nitrogen (TKN), soluble reactive phosphorus (SRP) and total suspended solids (TSS) concentrations observed along with the third highest nitrate concentration. Site 10's concentrations of TP and TSS were more than twice that of the next highest concentrations found within the watershed.

Nitrate was elevated in the entire watershed with the exception of Site 3, a small rivulet near the mouth of Deep Run. Nitrate concentrations at the rest of the stations ranged from 4 to 15 mg N/L, with seven of the twelve sites registering a concentration over 10 mg N/L. Ten mg N/L is a significant threshold in that it is the maximum contaminant level for nitrate in drinking water set by the U.S. Environmental Protection Agency in the Safe Drinking Water Act. Site 6 had the highest concentration of nitrate (15.30 mg N/L) followed closely by Sites 7 (15.00 mg N/L), 10 (14.70 mg N/L), 8 (12.60 mg N/L), 11 (10.92 mg N/L), 12 (10.80 mg N/L) and 4 (10.25 mg N/L), respectively.

Elevated levels of TP, nitrate, TSS and TKN were also found at Site 7. At Site 11, the highest concentration of chloride was found, as well as an elevated level of TP. Soluble nutrients (SRP and nitrate) were high at Site 6.

Several areas of concern were identified during the first sampling event. For the next hydrometeorological event (i.e., rain event), the number of sampling stations was expanded at Sites 6, 7 and 10.

24 February 2000 (Figures 10-15, Table 2)

A snowmelt event was sampled on 24 February 2000. The stream was very turbid. Besides the twelve stations sampled on 4 January 2000, an additional seven sites were sampled to further investigate pollution sources identified during the first sampling event.

Station 10 Series: As observed in January, concentrations were generally high at Station 10. The sub-watersheds that make up the discharge at Station 10 were sampled at three locations just upstream from Site 10 (Sites 10A, 10B and 10C). The branch above Site 10C was further sampled at Lake to Lake Road (Site 10C1). Site 10A had the highest TP, SRP, TSS and chloride concentrations in the entire watershed. Site 10A is a roadside ditch along the west side of Route 247. Although the concentrations observed at Station 10A were substantially higher than those observed at Site 10B and 10C, the discharge at Site 10A was estimated to be only about 10% of the discharge observed at either 10B or 10C. This means that the impact of the higher concentrations at Site 10A may not be as important as those observed at Sites with higher flow rates. Phosphorus concentrations were high at Sites 10B and 10C but dropped off significantly at Site 10C1, suggesting that the phosphorus source in the 10C branch is between Lake to Lake Road and Route 247. TKN concentrations were highest at Site 10C indicating that the source of pollution in this area is at least partially organic in origin. Site 10C1 was very high in nitrate concentration (13.4 mg N/L) indicating that the cornfield it drains is losing this nutrient to the watershed.

Station 6 Series: The results of the 4 January 2000 sampling demonstrated that nitrate concentrations were high in the Station 6 branch of Deep Run. Consequently, additional sites were sampled upstream from Site 6 to help identify the source of nitrate. On 24 February 2000, the Station 6 branch of Deep Run contained the highest nitrate concentrations observed in the entire subwatershed. Nitrate concentrations increased upstream to 16.8 mg N/L at Site 6A and to 17.8 mg N/L at Site 6B. Site 6B is a drain tile pipe outlet from a tilled field on the south side of Kipp Road. This field and its drainage system is an obvious source of nitrate to Deep Run. Site 6B also had a high concentration of total phosphorus.

Stations 7 and 7A: Nitrate was again high in the Station 7 branch of Deep Run. Site 7A was added for this event. Site 7A was sampled by walking in from Lake to Lake Road. The nitrate concentration at Site 7 was 12.0 mg N/L and at Site 7A the concentration was 10.5 mg N/L. TP and SPR were slightly higher at Site 7A than at Site 7. Compared to the first event, Station 7 was not a major source of contaminants during the 24 February event.

4 April 2000***(Figures 16-21, Table 2)***

A stressed stream analysis performed on 4 April 2000 confirmed the sources identified during the previous sampling event. A general rain, measuring 0.81 inches at the City of Canandaigua Water Treatment Plant, occurred within the Canandaigua Lake watershed from 3 to 4 April. Station 6A1 was added at very top of that branch of the watershed.

Station 10 Series: At Station 10C1, high concentrations of the soluble nutrients SRP and nitrate were observed. This result suggests that the cornfield that drains into Site 10C1 is a source of soluble nutrients to Deep Run. The elevated chloride levels at this site are likely deicing salt runoff from Lake to Lake Road.

Station 6 Series: As on previous occasions, Site 6B had the highest nitrate levels within the subwatershed (15.62 mg N/L) closely followed by Site 6A1 (15.10 mg N/L). During this event, Site 6B also had the highest concentration of total phosphorus. Sites 6B and 6A1 are right across Kipp Road from each other. These data suggest that the two fields in agriculture above these sites are the source of the elevated nitrate levels observed. Agricultural practices should be reviewed for both these fields.

Station 7: The nitrate concentration at Station 7 was a relatively high 9.53 mg N/L, but SRP, TP and TKN concentrations were not elevated during this event.

18 May 2000***(Figure 22-26, Table 2)***

Saturated soils were present in the subwatershed during the heavy rain (0.92 inches in the 24 hour period ending the morning of 19 May 2000) of 18 May 2000. This event was characterized by heavy erosion into the creek with resultant increases in the chemical forms containing particulate forms (TP, TKN and TSS).

Station 10 Series: Site 10C had high levels of SRP, TP and TKN. Upstream of Site 10C, at Site 10C1 the concentrations of all of these parameters were substantially lower. A source of these nutrients in this reach is suggested. A livestock operation exists between these two sites and is

the likely source of phosphorus and total Kjeldahl nitrogen. The stream segment that branches off to the south and east between Sites 10C and 10C1 was not sampled due to inaccessibility but the majority of the watershed in that area appeared to be part of the same livestock operation.

Station 6 Series: The Station 6 series were all extremely high in TP, TKN, nitrate and TSS. Again, at the very top of the watershed, agricultural fields on either side of Kipp Road appear to be the sources of nutrients and suspended solids to Deep Run. The concentrations at Station 6 (the confluence of 6A1 and 6B) were exceedingly high, with a TP concentration of 3600 $\mu\text{g P/L}$ and a TSS concentration of 1956 mg/L.

Station 7: Increased levels of nutrients and solids were not observed at Station 7 in the same proportion as other polluted sites during this event. It appears that the nutrient source observed during the January and February 2000 events was no longer present.

Chronological Account of Stressed Stream Analysis – Gage Gully:

4 January 2000 (Figure 27-32, Table 3)

Nine sites were sampled during the initial event on 4 January 2000 (Refer to Figure 3 for Sampling Site Map). Similar to Deep Run, nitrate was extremely high at all stations sampled in the Gage Gully watershed. Every station's nitrate concentration was over 10 mg/L, the cutoff for safe drinking water. Highest concentrations were observed in the headwaters of this watershed. The highest nitrate value found in Gage Gully on 4 January 2000 was 27.0 mg N/L at Station 2 on the north side of Green Road in the upper reaches of the watershed. TSS, TKN and TP were also high at Station 2. Total phosphorus was high at Station 7 with a concentration of 204 $\mu\text{g P/L}$. Site 5 was also high in TP at 103 $\mu\text{g P/L}$, TSS (139 mg/L) as well as SRP at 31 $\mu\text{g P/L}$. An increase in TP and TSS were observed from Station 4 to Station 5. The high chloride concentrations at Stations 8 and 4 reflect their location near Green Road.

24 February 2000 (Figure 33-38, Table 3)

The initial sampling sites along with six additional sites to further pinpoint sources of pollution were sampled on 24 February 2000. A major source of nutrients and suspended solids in Gage Gully is between Sites 4 and 5A. Total phosphorus increased from 239 to 639 $\mu\text{g P/L}$, TSS increased from 180 to 627 mg/L, and TKN increased from 1110 to 2200 $\mu\text{g N/L}$ from Site 4 to

Site 5A. The source appears to be particulate and perhaps organic in nature, since SRP did not increase significantly between the two stations and nitrate actually decreased in concentration. Land use included agriculture and there was evidence of 'ditching' of fields. The high levels of soils in the stream during the event may be associated with this practice.

High nitrate concentrations were observed in the headwaters of Gage Gully in the Green and Arnold Road areas. Site 2, which is a tile drain outlet from the tilled cornfield on the north side of Green Road, had the highest nitrate concentration at 22.9 mg N/L. There was no evidence of surface water intrusion from our vantage point. However, we did not walk the field. Sites 3, 1 and 1A in this area all had nitrate concentrations over 14 mg N/L. Site 3 is a combination of runoff from the same cornfield that drains into Site 2 along with ditch runoff from Green Road. Site 1 is where Gage Gully crosses under Arnold Road and Site 1A is another drain tile outlet from the non-tilled agricultural field on the east side on Arnold Road. Since TP, SRP, TKN and TSS were also high at many of these stations, this entire area is contributing nutrients and soil to downstream systems and eventually Canandaigua Lake.

The agricultural field between Sites 1 and 8 was a source of TSS, TP and TKN of 24 February 2000: TSS increased from 96 to 231 mg/L; TP increased from 161 to 299 $\mu\text{g P/L}$; and TKN increased from 890 to 1320 $\mu\text{g N/L}$ between Site 1 and Site 8.

Within the Site 7 segment, the small tributary at site 7B appeared to be the source of high levels of TP, SRP, TSS and TKN observed. This area was planted in winter wheat.

21 April 2000 (Figure 39-44, Table 3)

Five additional sites were added to the sampling regime during the event on 21 April 2000. Drain tile pipe outlets continued to be point sources of nitrate to Gage Gully. Site 1A, a drain tile outlet pipe on the east side of Arnold Road, had the highest concentration of nitrate measured in the watershed at 15.07 mg N/L. High concentrations of nitrate, total phosphorus and soluble reactive phosphorus were also observed at the drain tile outlet at Site 2. Sites 1A and 2 drain agricultural fields near the headwaters of Gage Gully. We did not walk the field to determine if there were any breaches of the tile system allowing surface water to enter the tile drainage system.

Site 5B runs along the west side of Route 364 but also receives flow from an agricultural field

adjacent to Route 364. Site 5B was high in TSS, TKN, TP, SRP, and nitrate. Clearly, a source exists in this segment.

An increase in total phosphorus was observed between Sites 4 and 5. The majority of the increase was observed between site 4 and Site 5A. Land use included agriculture and there was evidence of some 'ditching' of fields.

Another source of nutrients to Gage Gully is Site 11, the road ditch flowing east from Route 364 to Site 4. High concentrations of both forms of phosphorus along with high TKN levels were observed. Although additions from highway construction can not be ruled out, losses from a tilled agricultural field on the west side of Route 364 appeared to be the most likely source.

18 May 2000 (Figure 45-49, Table 3)

Similar to April, Site 5B had extremely high concentrations of TKN (6480 $\mu\text{g N/L}$) and nitrate (6.25 mg N/L). TP was also elevated at 227 $\mu\text{g P/L}$. Again the tilled agricultural field on the west side of Route 364 appears to be the likely source.

The tile drain at Site 2 again was high in nitrate, TP and TSS. The same cornfield that drains into Site 2 is also partially drained by the ditch along the west side of Arnold Road and sampled at Site 10. Site 10 was also high in both forms of phosphorus. Site 13, upstream of that cornfield in the watershed was low in all parameters, confirming that the cornfield is the source.

As in previous events, TSS, TKN and TP increased from Station 1 to Station 8, an area in agriculture.

It should be noted that heavy rains falling on already saturated soils characterized this event. The result was heavy soil loss from the watershed as depicted by the high TSS concentrations at many sites (Sites 2, 5, 4, 8, 12, 14 and 1). In general, this translated to high TP and TKN concentrations at the same locations.

DISCUSSION

People influence the quality and quantity of runoff from a watershed into a stream. The amount of runoff is determined by the amount of excess precipitation, that which neither sinks into the ground nor is stored at the surface. Precipitation excess is determined primarily by climate,

vegetation, infiltration capacity, surface storage and land use by people. Impervious landscapes (e.g., parking lots), removal of wetlands and vegetation in general, storm sewers, blockage of streams by debris, etc., all contribute to rapid rises in stream level and potential flooding. Similarly, land usage contributes to the quality of the water in the stream and ultimately Canandaigua Lake. For example the spreading of manure on the land, if done properly, can be a reasonable practice to enrich the soil. If not done properly, the result may be elevated levels of fecal coliform bacteria and increased levels of phosphorus, organic nitrogen and nitrates that cause health concerns or cause eutrophication of down stream systems. Land use practices initiated by people can and do affect stream water quality and stream discharge. If we can identify the sources of pollution, best management plans and improved practices can be initiated that mitigate downstream and lake effects.

Agricultural Environmental Management

AEM was developed by farmers, state, federal and local governments and farm conservation professionals to enhance the protection of important environmental resources, such as the state's rivers, lakes and streams, while maintaining a healthy agricultural economy. Agricultural land makes an important contribution to the economy, diversity and beauty of the Canandaigua Lake watershed. Over one hundred farmers conduct diverse agricultural operations on over thirty thousand acres of watershed land.

In 1996, the Watershed Council (formerly known as the Local Government Watershed Policy Committee) asked that an Agricultural Advisory Committee made up of farmers be formed to provide solutions to agriculture-based water pollution problems. In four years and over forty meetings, the committee has grown from the original five to eleven members, and their role has changed from advisory to leadership. In its expansion, the Agricultural Program Committee (APC) has not only solicited participation but has encouraged diversity, so that the committee will include young and old farmers, specialists in various agricultural products, and farmers from all parts of the watershed.

The Canandaigua Lake Agricultural Program Committee uses the AEM process to prioritize projects that will be funded, and through peer communication, encourages participation by the farming community. Agricultural Environmental Management calls for a tiered approach to implement Best Management Practices (BMPs) on watershed farms. The tiered approach begins

with the farmer's self-assessment, followed by a technical assessment by program personnel and implementation. The effort is farmer led, entirely voluntary and will be guided by the decisions of farmers at every stage.

Approximately 95% of watershed farmers are participating in this program. Over \$747,000 in state and federal funds have been obtained to install conservation practices on watershed farms. Nearly \$100,000 in the farmers' own funds has been applied to conservation practices to match grant funding. The APC has also chosen to provide Lake Friendly Farmer signs that will announce cooperation with the program to the outside world. Farmers participating in the AEM program have and will continue to be issued a 18" X 24" sign to hang at their farm gates.

Sources of Nutrient, Soil and Chloride Loss in the Gage Gully and Deep Run Watersheds

Chloride (Deicing salt) in the Deep Run and Gage Gully Watersheds

Environmental concerns revolving around elevated levels of deicing salt include: damage to vegetation, affects on fish spawning in streams, pollution of ground water making well water undrinkable, disintegration of pavement and metal corrosion. Elevated levels of chloride (>200 mg/L) were observed at Site 10A in Deep Run on 24 February 2000 and at Site 4 and Site 8 in Gage Gully on 4 January 2000. In Gage Gully, there were five other samples that had chloride concentrations over 100 mg/L on 4 January, but after that date there were no readings that high. Elevated chloride readings can be attributed to de-icing salt applied to the nearby roads. Similarly, in Deep Run there are no apparent sources of high chloride in the watershed. The overall concentrations seem to be slightly higher than in Gage Gully, but that can be attributed to the larger linear mileage of roads in the Deep Run watershed.

Recommendation:

There seem to be no alarming or persistent levels of chloride in either watershed. All elevated concentrations of chloride can readily be explained by de-icing salt applications to roads within the watershed. Reduction of de-icing salt usage would decrease levels in the adjacent streams. However, concentrations in streams did not appear to be excessive and any reduction would have to consider public safety issues in this hilly area.

Major Sources of Nutrients in the Deep Run and Gage Gully Watersheds

Deep Run:

Site 6 Series, Kipp Road:

Please refer to Figure 50 while reading this section. This figure provides a visual overview of sources within the Gage Gully watershed discussed below. Nitrate concentrations were generally high throughout the entire watershed. The high levels within the entire subwatershed reflect the fact that the source of nitrate is at the top of the watershed. Two areas were especially high in nitrate concentrations. The Station 6 Series in the upper reaches of the watershed contained the highest nitrate concentrations observed in all of the event samples taken from Deep Run. Nitrate levels often exceeded EPA Guidelines for drinking water. The agricultural fields on the north and south side of Kipp Road (sometimes called Powell Road on maps) adjacent to Sites 6A1 and 6B appear to be one source of nitrate within the Deep Run subwatershed. Concentrations of total phosphorus and total suspended solids were also exceedingly high in this area during some of the events. The same agricultural fields were tilled in the autumn and are the likely source of the losses of soil observed. The amount being lost will vary from event as a function of rain fall, snow melt, snow cover, and the degree to which the soil is frozen.

Site 10 Series - Route 247 and Lake to Lake Road:

Site 10C1: The second major source of nitrate appeared to be the cornfield on the North side of Lake to Lake Road adjacent to Site 10C1. Site 10C1 had very high nitrate concentration (max = 13.4 mg N/L) indicating that the upstream cornfield is contributing nutrients to downstream systems. Subsequent events also showed high concentrations of the soluble nutrient SRP.

Site 10C: Total phosphorus, SRP and TKN concentrations were generally higher at Site 10C compared to Site 10C1. This suggests that a source of these nutrients exists in the 10C branch between Lake to Lake Road and Route 247. A livestock operation is present between these two sites (10C and 10C1). The stream segment that branches off to the south and east between Sites 10C and 10C1 was not sampled due to inaccessibility but the majority of the watershed in that area appeared to be part of the same livestock operation.

Site 10A: Site 10A is a roadside ditch along the west side of Route 247. Site 10A had high concentrations of total phosphorus, soluble reactive phosphorus, total suspended solids and chloride but the flow was estimated to be only about 10% of the discharge observed at either 10B or 10C; the tributary did not flow during one event. Although concentrations are high at Site

10A, the impact on downstream systems is probably minimal. The source of nutrients and suspended solids at this site is a combination of runoff from an agricultural field on the west side of Route 247 (Site 10A1), runoff from Route 247 itself and from seepage from agricultural fields that abut the ditch running to Site 10A.

Site 10A1: The overland flow from this tilled agricultural field was a source of phosphorus, solids and TKN. Although the concentrations of these chemicals at Station 10A were substantially higher than other sites in the watershed, the discharge was relatively low. Impact from this site on lower reaches of the watershed may not be as high as other sites with higher discharges.

Site 7: Elevated levels of TP, nitrate, TSS and TKN were observed at Site 7 during the 4 January 2000 event. Nitrate was again high during the 24 February event as was Site 7A which was added upstream for this event. TP and SPR were slightly higher at Site 7A than at Site 7. During the subsequent two events, increased levels of nutrients and solids were not observed Station 7 in the same proportion as other impacted sites; that is the source was no longer present.

Recommendations:

1. A review of the agricultural practices in the Deep Run watershed should be undertaken. In cooperation with the Ontario County Soil and Water Conservation District, soil testing should be instituted at the sites in agriculture to evaluate fertilizer application rates and timing. This would be analogous to a Tier Three evaluation in the Agricultural Environment Management Program (AEM) process. It is possible that a reduction in fertilizer application rates is possible that would reduce costs and maintain yields to the agriculture community while reducing nitrate losses to downstream systems.
2. The high TKN concentrations at Site 10C suggest that that the livestock operation may be a source. There are several small, but economical practices, such as barnyard runoff management and manure storage facilities that may reduce the loss of nitrogenous compounds.
3. Wells used for human water supply in the Deep Run watershed should be tested for nitrate. Nitrate concentrations above 10 mg N/L in drinking water can cause a disease called methemoglobinemia in infants.

Gage Gully:

Please refer to Figure 51 while reading this section. This figure provides a visual overview of sources within the Gage Gully watershed discussed below.

Sites 1, 1A, 2, 3 and 10:

Nitrate, TP, SRP, TKN and TSS were generally high at these stations on all events. The entire headwater area near the intersection of Arnold Road and Green Road are contributing nutrients and soil to downstream systems and eventually Canandaigua Lake. High nitrate concentrations, often exceeding 10 mg/L, were observed in the headwaters of Gage Gully. Much of this area is in agriculture. The tile drainage system may facilitate the transport of nutrients to the stream.

Site 5B:

Site 5B was under snow for the first two events in January and February and therefore was not sampled until April. Site 5B runs along the west side of Route 364 but also receives flow from an agricultural field adjacent to Route 364. High losses of phosphorus, organic and inorganic nitrogen and soil occur from this site. The highest TKN concentration in the watershed was measured at Site 5B during the 18 May 2000 event.

Sites 4, 5 and 5A:

In the early events, the area between Sites 4 and 5 showed an increase in total phosphorus and total suspended solids. During subsequent events, Site 5A was sampled between Sites 4 and 5. The majority of the increase was observed between site 4 and Site 5A. There was agriculture in this area and there was evidence of some ‘ditching’ of the agricultural fields in this area. The high levels of soils in the stream during the event may be associated with that practice. Although phosphorus increased between Sites 4 and 5 in each subsequent event, the magnitude of the source was reduced.

Site 7:

Site 7, a tributary to the main branch of Gage Gully that drains two adjacent agricultural fields separated by a hedgerow, had moderately high levels of total phosphorus, total Kjeldahl nitrogen and nitrate during the January and February events.

Sites 1 to 8:

An increase of TSS, TP and TKN were observed within this field that was in agriculture.

Site 11:

Site 11 is a roadside ditch flowing eastward along Green Road and joins the main tributary at Site 4. Site 11 had high phosphorus and TKN both times it was sampled. There was some road construction near Route 364, which could be the cause of the high values.

Recommendations:

1. A review of the agricultural practices within the Gage Gully subwatershed are warranted, especially in the headwaters area of Green and Arnold Roads. The nutrient lost at the highest rate is the soluble form of nitrogen suggesting that inorganic forms of fertilizer may be the cause. In cooperation with the Ontario County Soil and Water Conservation District, soil testing should be instituted and fertilizer application rates and timing should be reviewed.
2. The losses in particulate forms (soil, total suspended solids, total Kjeldahl nitrogen) from fields are most likely related to soil loss. Modifications in tillage practices and / or buffer strips between the agricultural field and the stream should be reviewed with the land owner or group renting the land for cash crops.
3. Wells used for human water supply in the Gage Gully watershed should be tested for nitrate. Nitrate concentrations above 10 mg N/L in drinking water can cause a disease called methemoglobinemia in infants.
4. The water from the tile drains should be tested for fecal coliforms.

Best Management Practices:

In general, the primary pollutants to Canandaigua Lake to be addressed through AEM (Agricultural Environmental Management) are nutrients, sediments/soils, and pathogens. Agricultural sources/activities identified as potential sources of nutrients, sediments/soils and pathogens are barnyards, lack of proper manure storage, fall plowing, silage and milking parlor waste. The Ontario Soil and Water Conservation District suggest the following Best Management Practices to mitigate various sources of pollution:

- Comprehensive nutrient management plan (CNMP) implementation;
- Soil testing
- Fencing off streams and other environmentally sensitive areas;
- Filter strips;
- Access road improvement;
- Pasture management;
- Barnyard runoff management;
- Streambank protection;
- Manure storage system;
- Short duration grazing system;
- Alternative water supply;

- Pesticide management;
- Diversion systems;
- Fuel storage containment;
- Silage leachate management.

For more information regarding AEM in the Canandaigua Lake watershed contact Robert Stryker at (716) 396-3478.

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Table 1. Results of the semi-annual New York State Environmental Laboratory Assurance Program (ELAP Lab # 11439, SUNY Brockport) Non-Potable Water Chemistry Proficiency Test, January 2000. Score Definition: Satisfactory or Unsatisfactory

**WADSWORTH CENTER
NEW YORK STATE DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY APPROVAL PROGRAM**

Proficiency Test Report

Lab 11439 SUNY Brockport
Shipment 223 Non Potable Water Chemistry
Shipment Date: 24-Jan-2000

EPA Lab Id NY01449

Page 1 of 1

<u>Analyte</u>	<u>Sample ID</u>	<u>Result</u>	<u>Mean/Target</u>	<u>Satisfactory Limits</u>	<u>Method</u>	<u>Score</u>
Approval Category : Non Potable Water						
Sample: Residue						
Solids, Total Suspended	2302	29.3	26.7287	22-31	SM18 2540D (TOTAL SUSPENDED)	Satisfactory
353 passed out of 374 reported results.						
Sample: Organic Nutrients						
Kjeldahl Nitrogen, Total	2304	1.46	1.538204	1-2	EPA 351.3	Satisfactory
119 passed out of 134 reported results.						
Phosphorus, Total	2304	4.52	4.339982	4 - 5	SM18 4500-PB,5	Satisfactory
149 passed out of 157 reported results.						
Sample: Inorganic Nutrients						
Nitrate (as N)	2307	1.86	1.88194	2 - 2	SM18 4500-NO3-F	Satisfactory
121 passed out of 127 reported results.						
Orthophosphate (as P)	2307	5.12	4.731237	5 - 5	SM18 4500-PF	Satisfactory
103 passed out of 112 reported results.						
Sample: Metals I and II						
Sodium, Total	2311	11.44	12.07362	11 - 13	ASTM D-1688-95C	Satisfactory
129 passed out of 139 reported results.						

Table 2. Stressed stream analysis results for Deep Run for samples taken on 4 January, 24 February, 4 April and 18 May 2000. SRP = soluble reactive phosphorus, TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and NA = not analyzed.

01/04/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)	02/24/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)
DR1	8.1	30.7	8.85	113.3	7.7	500	D1	7.4	135.6	5.54	85.3	130.3	710
DR2	9.9	32.9	4.01	58.1	6.9	340	D2	9.9	114.7	4.17	43.4	71.4	530
DR3	30.5	92.6	0.33	11.2	70.0	420	D3	12.4	102.8	1.00	6.1	31.1	290
DR4	7.4	72.3	10.25	110.5	53.3	570	D4	14.9	147.5	5.82	85.8	98.3	760
DR5	28.4	152.3	6.90	110.4	97.4	520	D5	12.4	102.8	4.90	38.4	23.8	500
DR6	63.1	150.1	15.3	49.5	53.3	470	D6	24.9	114.7	13.83	42.9	34.5	500
DR7	25.2	408.9	15.00	89.2	233	1670	D6A	41.2	263.7	16.75	18.7	71.4	670
DR8	27.6	136.5	12.6	98.1	79.5	640	D6B	33.7	153.4	17.81	13.6	43.3	510
DR9	32.3	53.2	9.12	70.8	14.1	520	D7	18.7	131.1	12.04	76.7	59.3	680
DR10	92.4	931.1	14.7	52.9	503.0	2730	D7A	19.9	168.3	10.50	107.0	13.6	450
DR11	26.2	301.5	10.92	115.7	174.1	850	D8	19.9	186.2	6.68	86.8	162.2	1170
DR12	15.9	67.8	10.80	98.4	58.2	570	D9	31.2	59.6	6.02	44.4	85.5	400
							D10	63.7	211.6	6.56	133.8	109.6	1010
							D10A	214.8	524.3	5.38	405.4	164.5	1100
							D10B	129.9	214.5	6.26	102.0	120.3	970
							D10C	84.9	250.3	6.67	35.8	35.8	2790
							D10C1	7.4	50.6	13.44	153.0	38.0	410
							D11	6.2	122.2	7.31	43.9	29.0	770
							D12	16.2	147.5	6.22	37.9	112.7	810
04/04/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)	05/18/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)
DR1	4.3	32.0	3.81	78.8	9.8	880	DR2	25.4	181.7	1.05	NA	192.0	1450
DR2	4.6	25.6	2.03	48.0	5.2	1080	DR3	27.6	613.0	0.67	NA	620.0	2560
DR3	7.5	46.7	0.35	7.6	9.1	1280	DR4	16.4	151.4	2.12	NA	118.5	1270
DR4	3.6	32.0	4.89	91.2	5.4	610	DR5	5.5	177.2	3.36	NA	218.0	1400
DR5	9.2	56.7	5.04	90.7	9.3	660	DR6	59.7	3600.0	3.43	NA	1956.0	2880
DR6	21.9	38.5	11.76	55.5	6.8	500	DR6A	57.6	2145.0	5.10	NA	1760.0	5520
DR6A1	8.5	55.5	15.10	54.0	7.4	610	DR6A1	46.3	2003.9	5.08	NA	1675.0	3960
DR6B	13.8	90.1	15.62	20.9	22.1	620	DR6B	50.3	1176.5	6.05	NA	1795.0	3640
DR7	7.8	37.3	9.53	108.0	5.5	600	DR7	44.5	235.2	2.63	NA	223.0	1780
DR8	7.8	46.1	6.66	101.5	8.2	560	DR8	34.1	227.3	2.54	NA	472.0	2040
DR9	3.6	6.2	4.94	71.2	4.8	230	DR9	30.4	980.0	2.87	NA	826.0	3840
DR10B	5.3	38.5	8.94	101.0	3.7	490	DR10	463.1	747.5	4.58	NA	113.0	4280
DR10C	8.2	15.6	9.49	49.5	10.6	700	DR10A	195.7	234.6	1.86	NA	39.0	1210
DR10C1	35.0	35.0	11.19	127.2	11.8	480	DR10A1	10.9	378.8	6.70	NA	339.0	2380
DR11	6.8	15.0	9.49	137.0	3.2	440	DR10B	39.1	67.7	5.25	NA	10.0	1520
DR12	6.8	29.7	5.60	86.8	5.0	480	DR10C	720.5	1029.7	3.46	NA	180.7	5920
							DR10C1	20.7	189.6	5.08	NA	87.5	1450
							DR11	4.1	112.7	2.19	NA	62.0	1060
							DR12	64.8	176.3	2.24	NA	182.5	1620

Table 3. Stressed stream analysis results for Gage Gully for samples taken on 4 January, 24 February, 21 April and 18 May 2000. SRP = soluble reactive phosphorus, TP = total phosphorus, TSS = total suspended solids, TKN = total Kjeldahl nitrogen and NA = not analyzed.

01/04/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)	02/24/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)
GG1	23.4	46.9	15.36	111.2	28.9	570	G1	29.9	161.0	14.89	43.4	95.8	890
GG2	20.2	95.3	27.18	16.9	95.8	720	G1A	17.4	82.8	14.28	13.1	13.2	480
GG3	29.4	57.6	15.42	121.2	33.2	480	G2	37.4	172.6	22.90	17.2	77.5	660
GG4	55.7	86.9	11.94	243.3	48.0	870	G3	34.9	263.9	14.89	32.3	205.6	1290
GG5	30.8	102.6	11.22	168.1	139.3	750	G4	32.4	239.3	11.09	55.0	180.8	1110
GG6	20.5	231.5	10.08	123.2	184.2	670	G5	34.9	671.4	7.15	75.7	406.0	1630
GG7	8.8	204.1	10.62	36.9	87.9	680	G5A	41.2	639.4	7.27	75.2	627.0	2200
GG8	3.9	66.7	13.80	237.9	33.6	420	G6	32.4	616.4	7.01	69.2	749.0	2060
GG9	19.5	57.7	14.76	129.8	21.6	480	G7	17.4	172.6	5.16	29.8	138.0	610
							G7A	11.2	150.9	4.46	12.6	122.5	460
							G7B	14.9	208.9	5.03	35.8	199.4	1320
							G8	28.7	298.7	7.59	44.4	230.9	1320
							G9	22.4	97.3	5.31	37.4	15.6	460
							G9A	27.4	92.9	6.71	38.9	11.6	440
							G10	66.2	150.9	7.00	84.3	29.1	820
04/21/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)	05/18/00	SRP (µg P/L)	TP (µg P/L)	NITRATE (mg N/L)	Chloride (mg/L)	TSS (mg/L)	TKN (µg N/L)
GG1	18.0	66.3	8.36	38.6	197.5	990	GG1	152.3	328.4	3.44	NA	109.5	1940
GG1A	11.0	41.6	15.07	9.6	14.2	630	GG2	26.5	278.8	8.87	NA	488.0	1490
GG2	68.2	186.2	12.54	10.6	55.3	810	GG3	40.9	109.4	1.12	NA	43.7	1110
GG3	15.2	18.1	3.40	40.9	157.2	970	GG4	150.2	239.0	3.20	NA	378.0	2640
GG4	30.6	29.6	5.70	52.0	90.9	1250	GG5	59.0	328.4	2.75	NA	390.0	2040
GG5	10.7	82.4	5.00	54.7	76.1	1100	GG5B	68.8	226.7	6.25	NA	111.5	6480
GG5A	22.5	87.5	5.70	52.2	60.5	1130	GG7A	11.3	196.0	1.27	NA	88.7	1150
GG5B	73.1	241.3	6.40	40.4	220.9	1420	GG8	88.1	352.5	3.43	NA	248.5	2370
GG7	7.6	73.8	1.52	22.2	223.6	1090	GG9	26.1	66.3	6.36	NA	5.0	1020
GG8	57.7	65.1	7.75	48.8	112.1	1080	GG9A	<1.2	35.9	7.40	NA	20.0	830
GG9	24.6	61.1	0.83	93.9	14.3	1360	GG10	502.9	517.5	0.64	NA	75.0	1980
GG9A	13.8	46.2	5.65	20.7	6.8	550	GG11	396.4	396.4	2.45	NA	98.8	3120
GG10	36.1	116.2	2.20	17.9	47.5	1050	GG12	16.4	217.4	0.20	NA	154.0	1240
GG11	120.6	405.5	0.97	65.1	34.6	2130	GG13	77.3	83.5	0.02	NA	6.2	1260
GG12	29.2	62.3	1.43	48.0	32.4	520	GG14	29.0	151.2	2.98	NA	112.0	1430
GG13	19.4	42.8	1.63	35.8	5.3	640							
GG14	15.2	84.1	4.80	42.4	47.6	850							

Canandaigua Lake - Subwatershed & Direct Drainage Basins

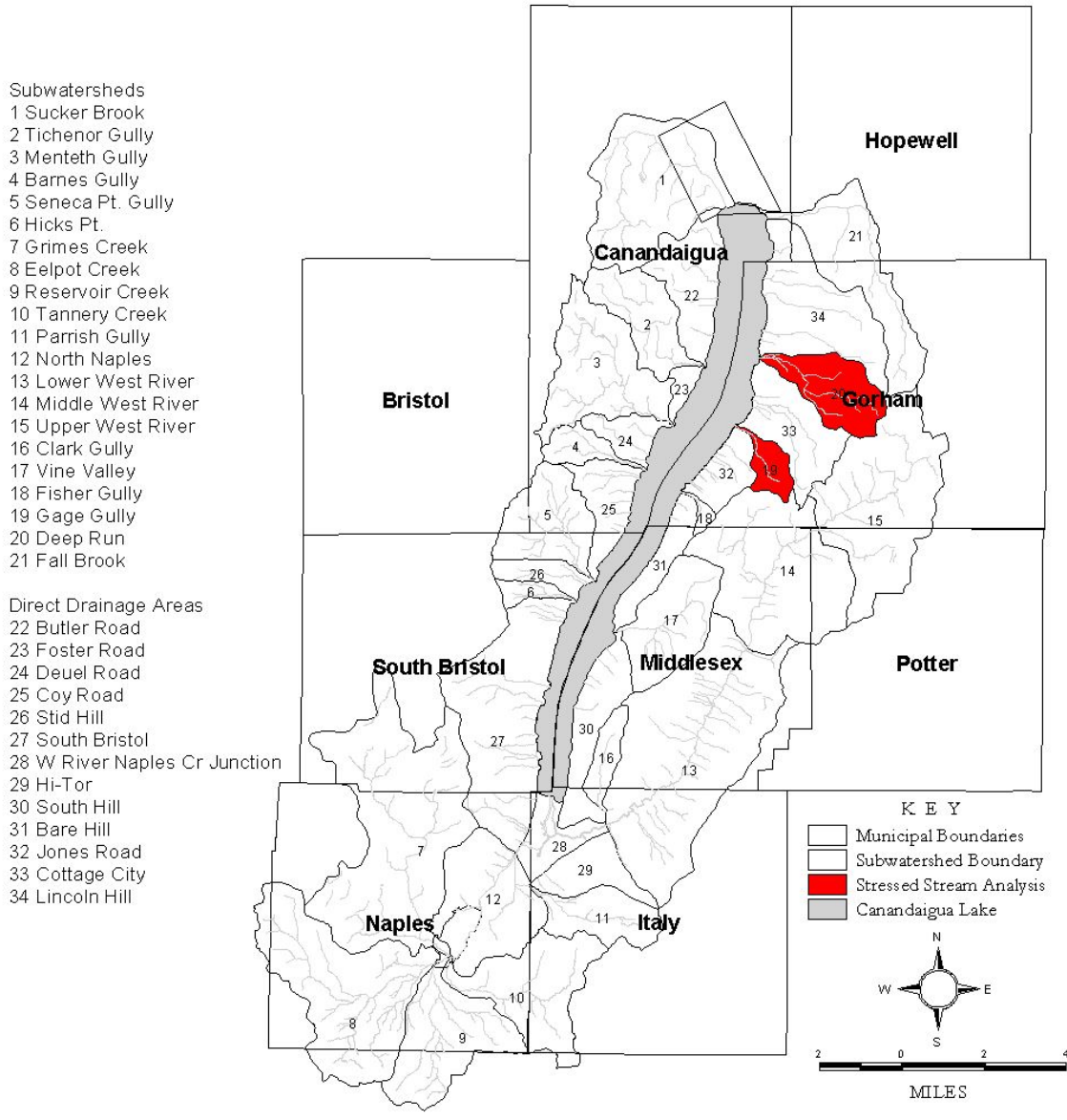


Figure 1. Map of the Canandaigua Lake watershed. The Deep Run and Gage Gully sub-watersheds are shown in red.

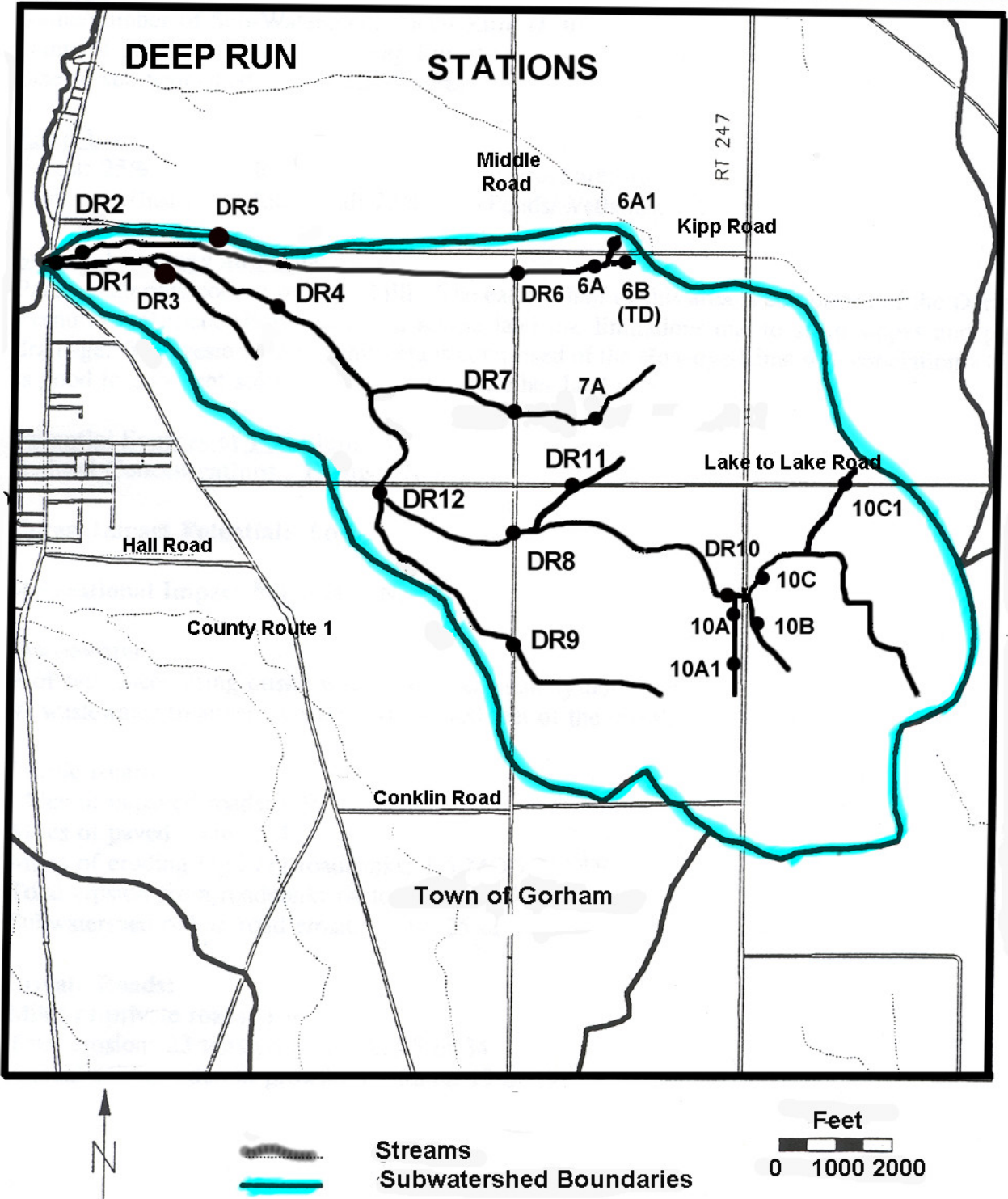


Figure 2. Stressed stream sampling stations in the Deep Run sub-watershed. TD refers to the location of a tile drain.

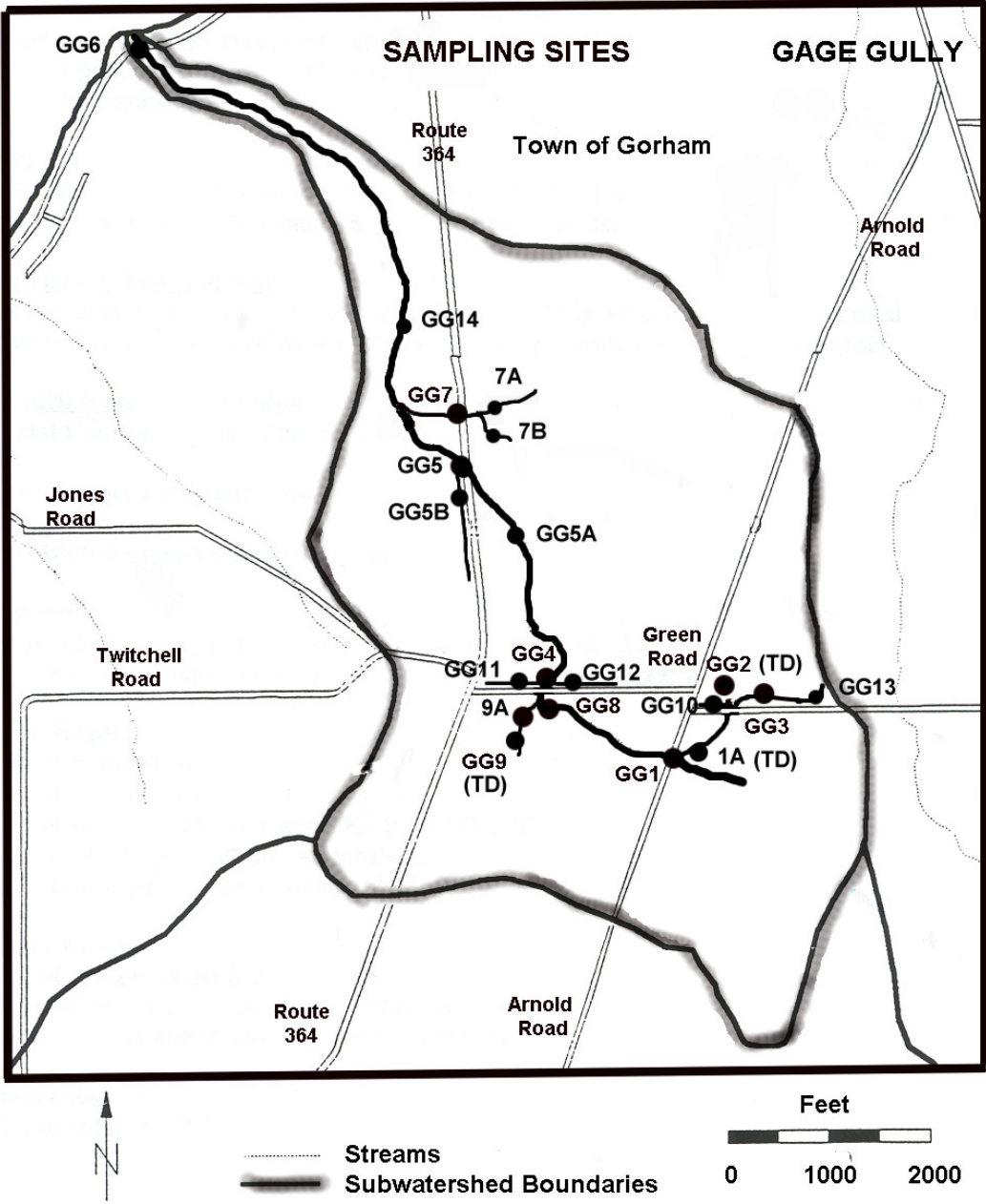


Figure 3. Stressed stream sampling stations in the Gage Gully sub-watershed. TD refers to the location of a tile drain.

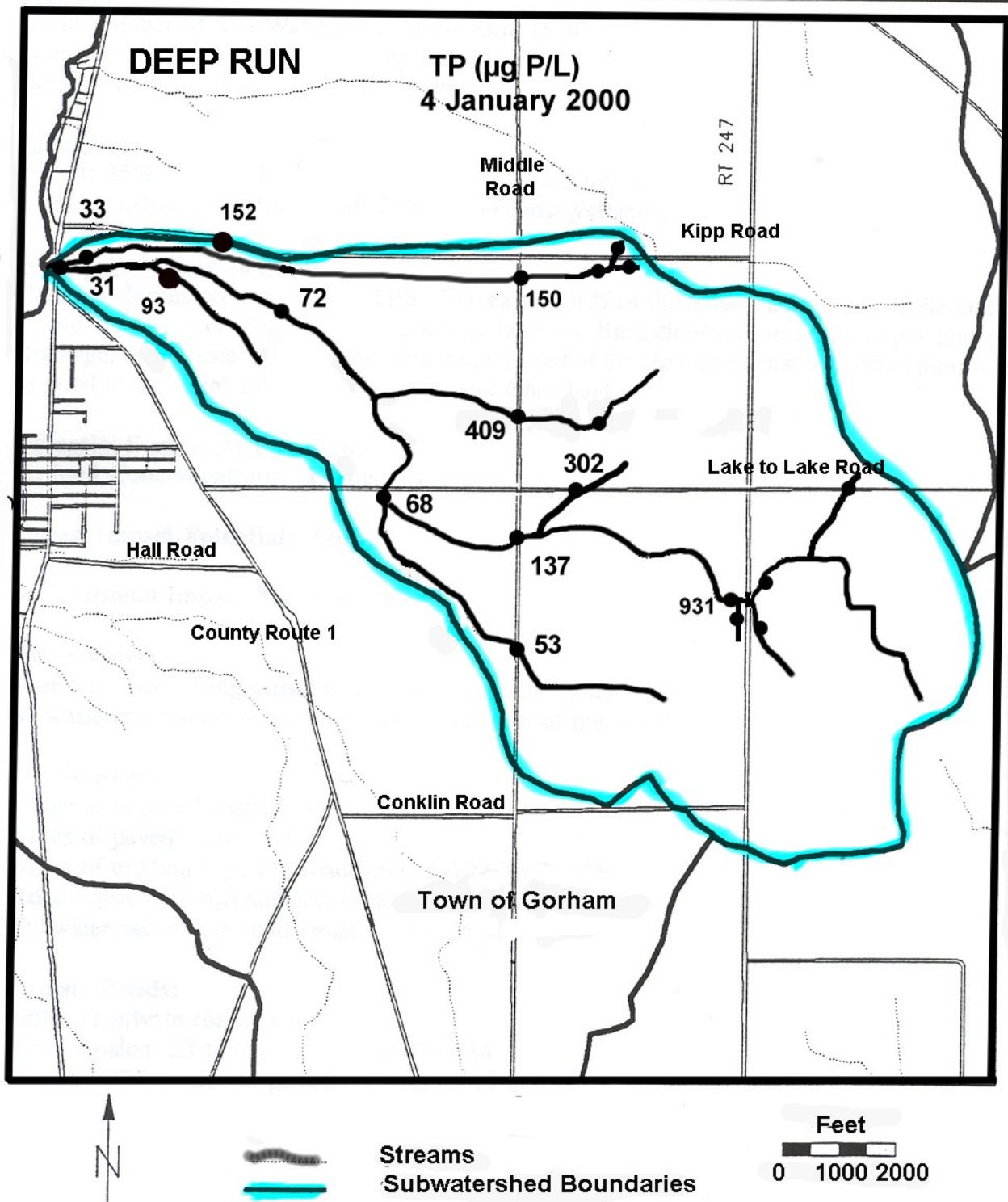


Figure 4. Total phosphorus (TP) concentrations from Deep Run Stressed Stream Analysis on 4 January 2000.

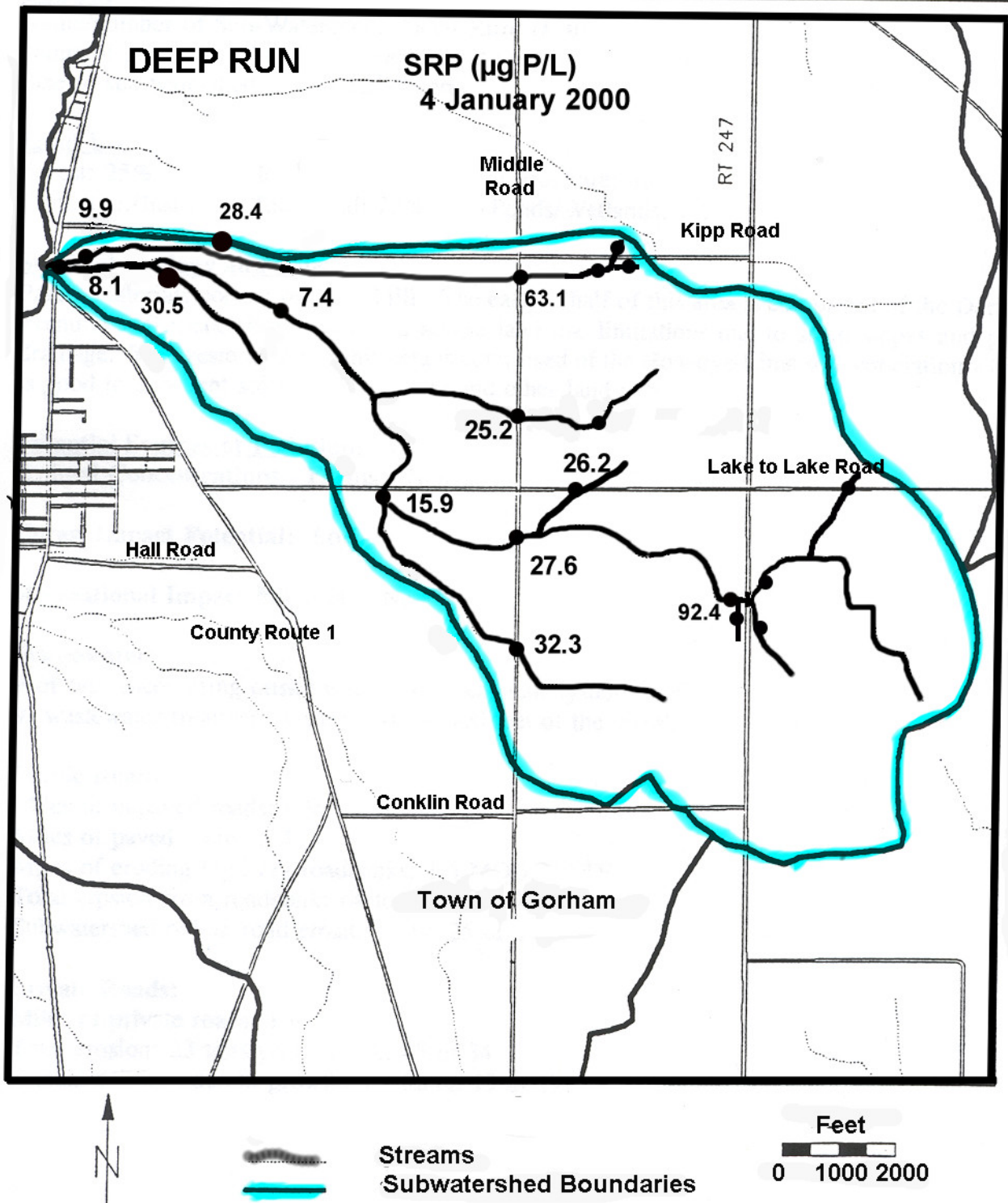


Figure 5. Soluble reactive phosphorus (SRP) concentrations from Deep Run Stressed Stream Analysis on 4 January 2000.

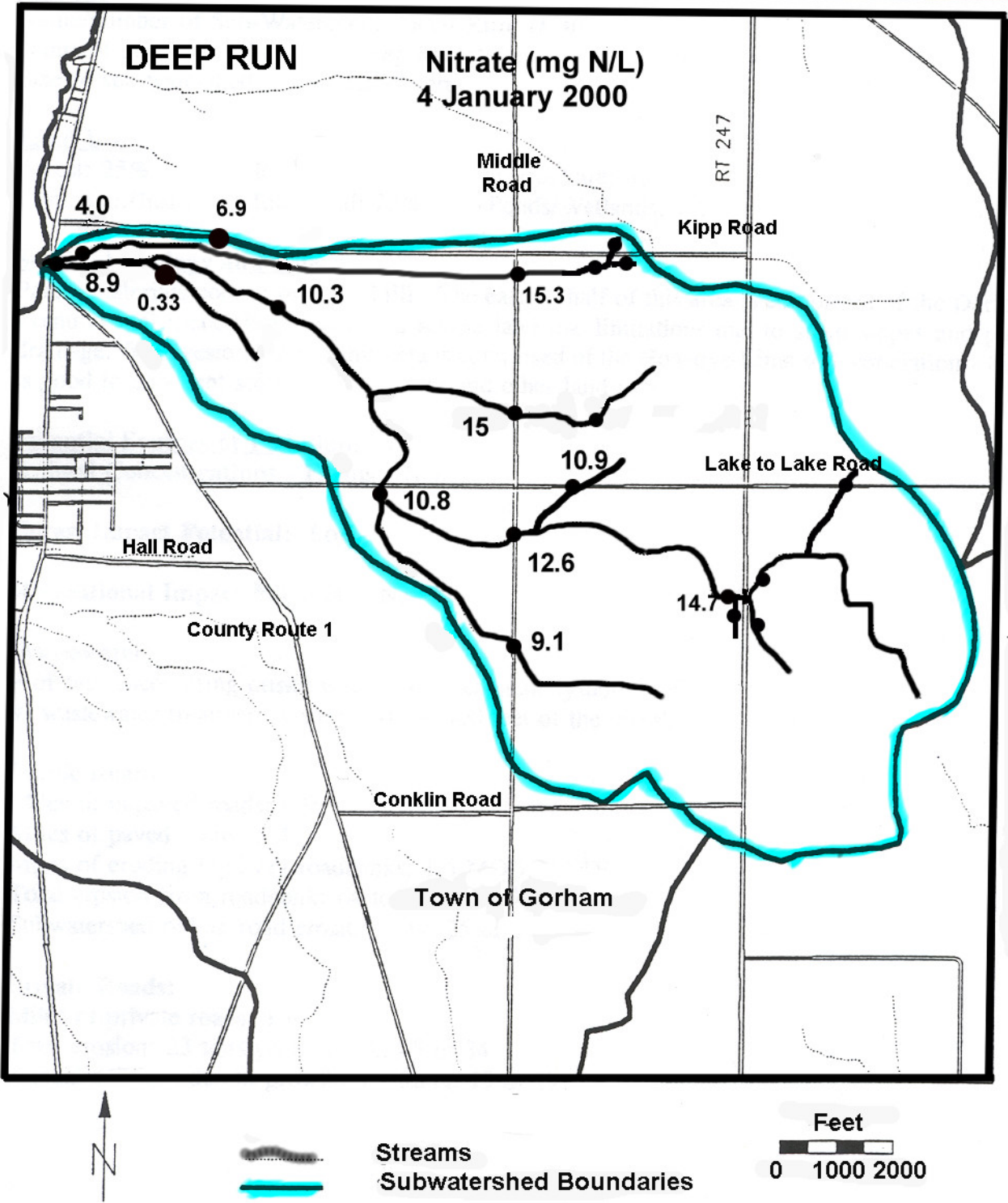


Figure 6. Nitrate concentrations from Deep Run Stressed Stream Analysis on 4 January 2000.

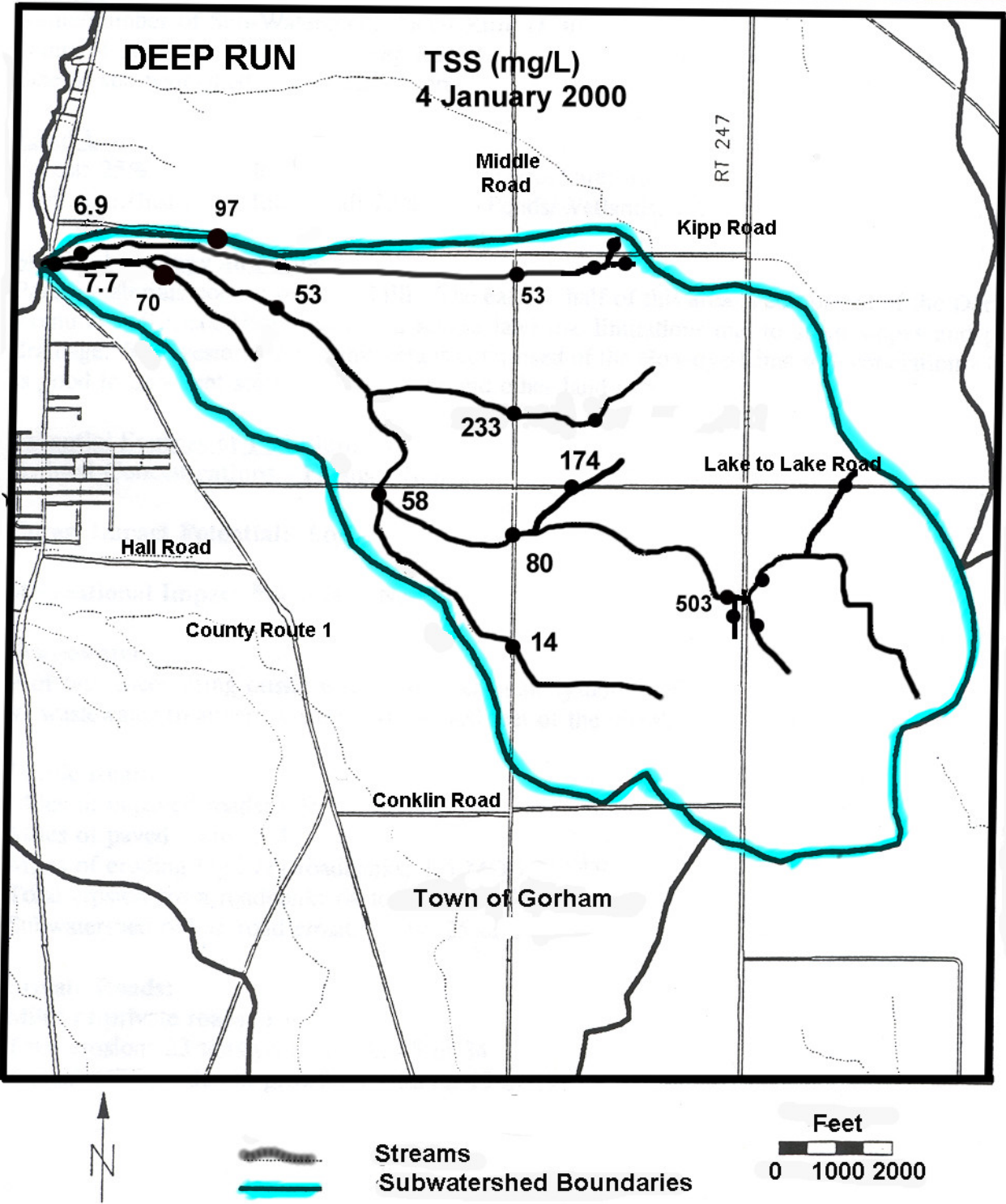


Figure 7. Total suspended solids (TSS) concentrations from Deep Run Stressed Stream Analysis on 4 January 2000.

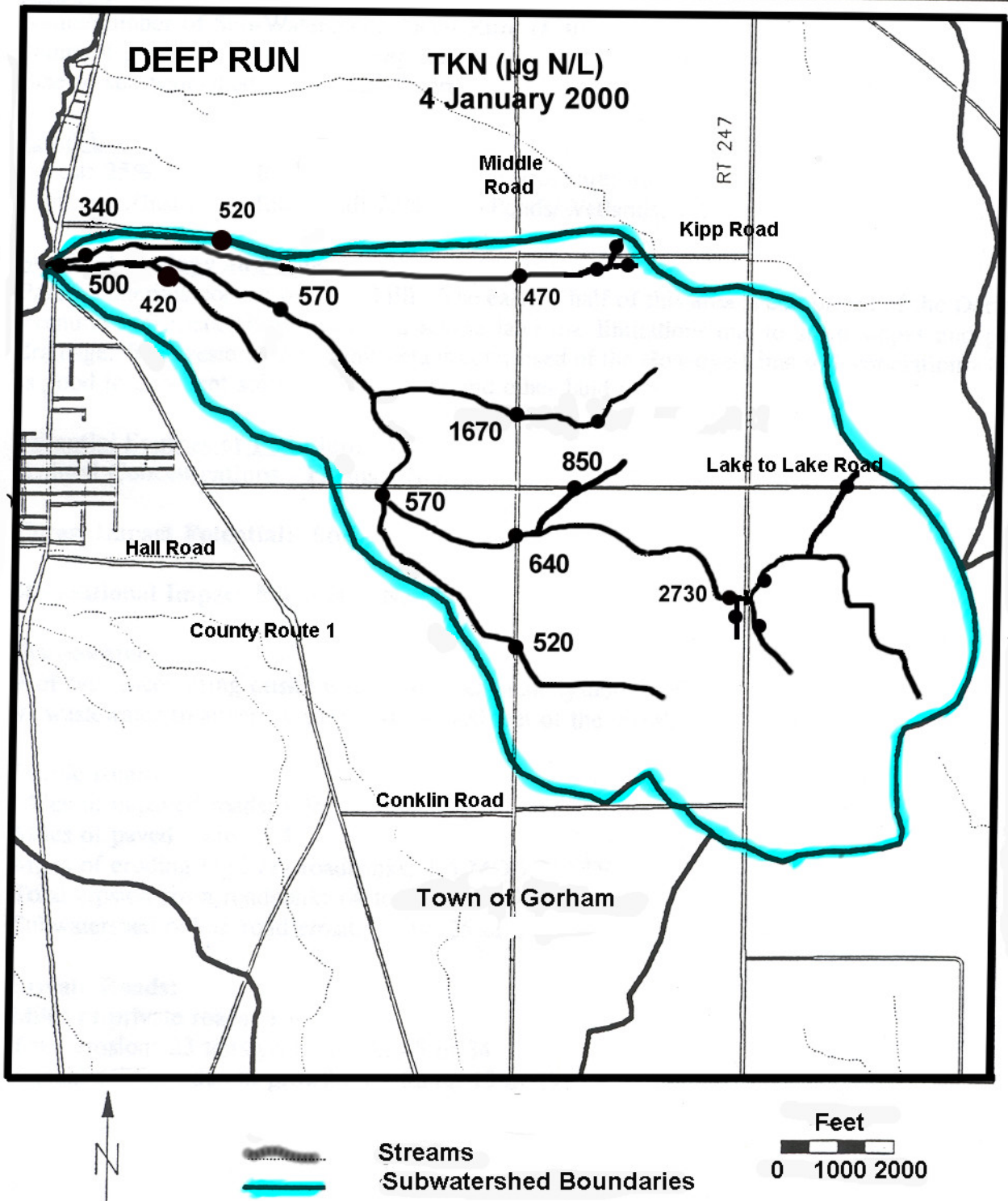


Figure 8. Total Kjeldahl nitrogen (TKN) concentrations from Deep Run Stressed Stream Analysis on 4 January 2000.

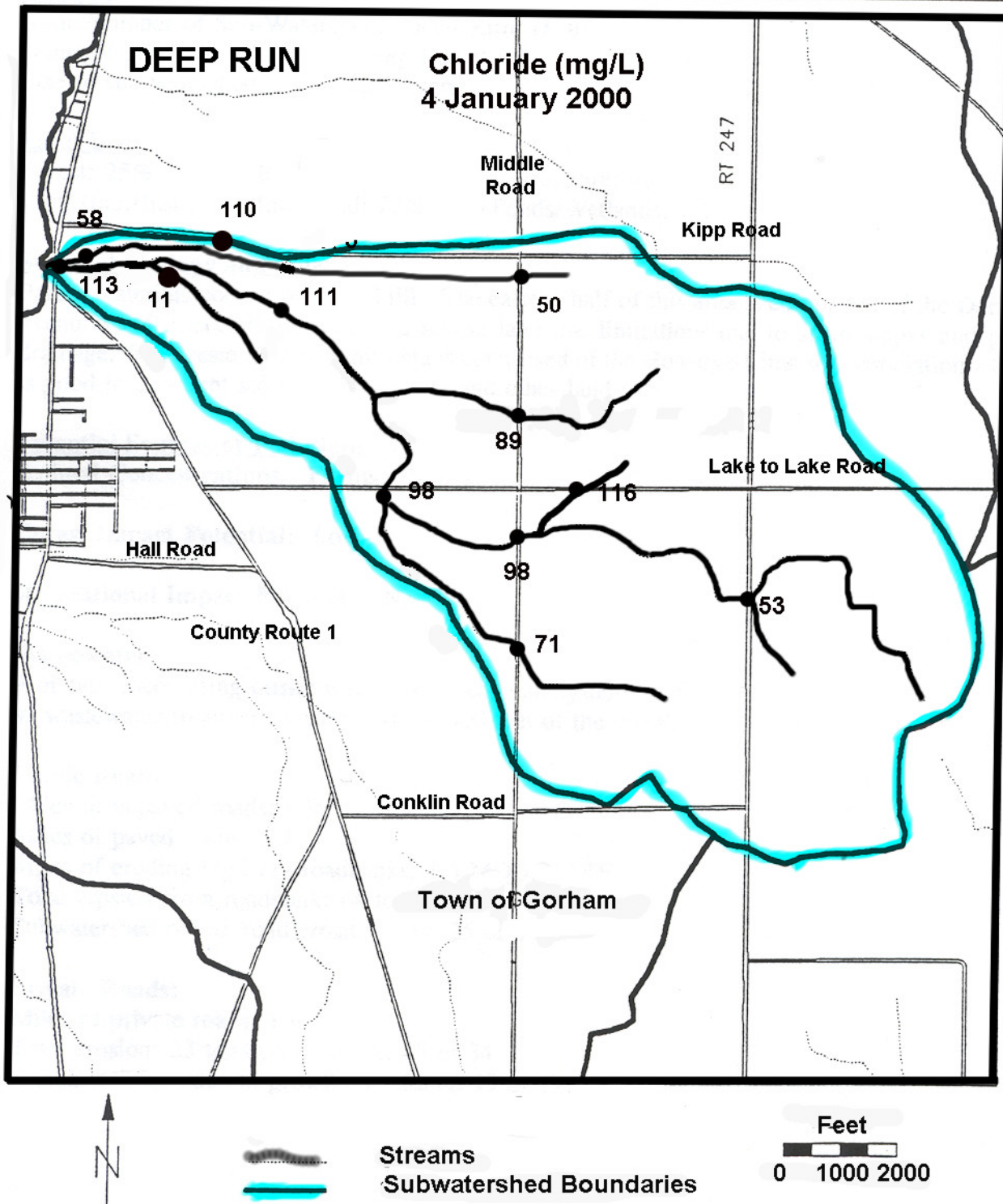


Figure 9. Chloride concentrations from Deep Run Stressed Stream Analysis on 4 January 2000.

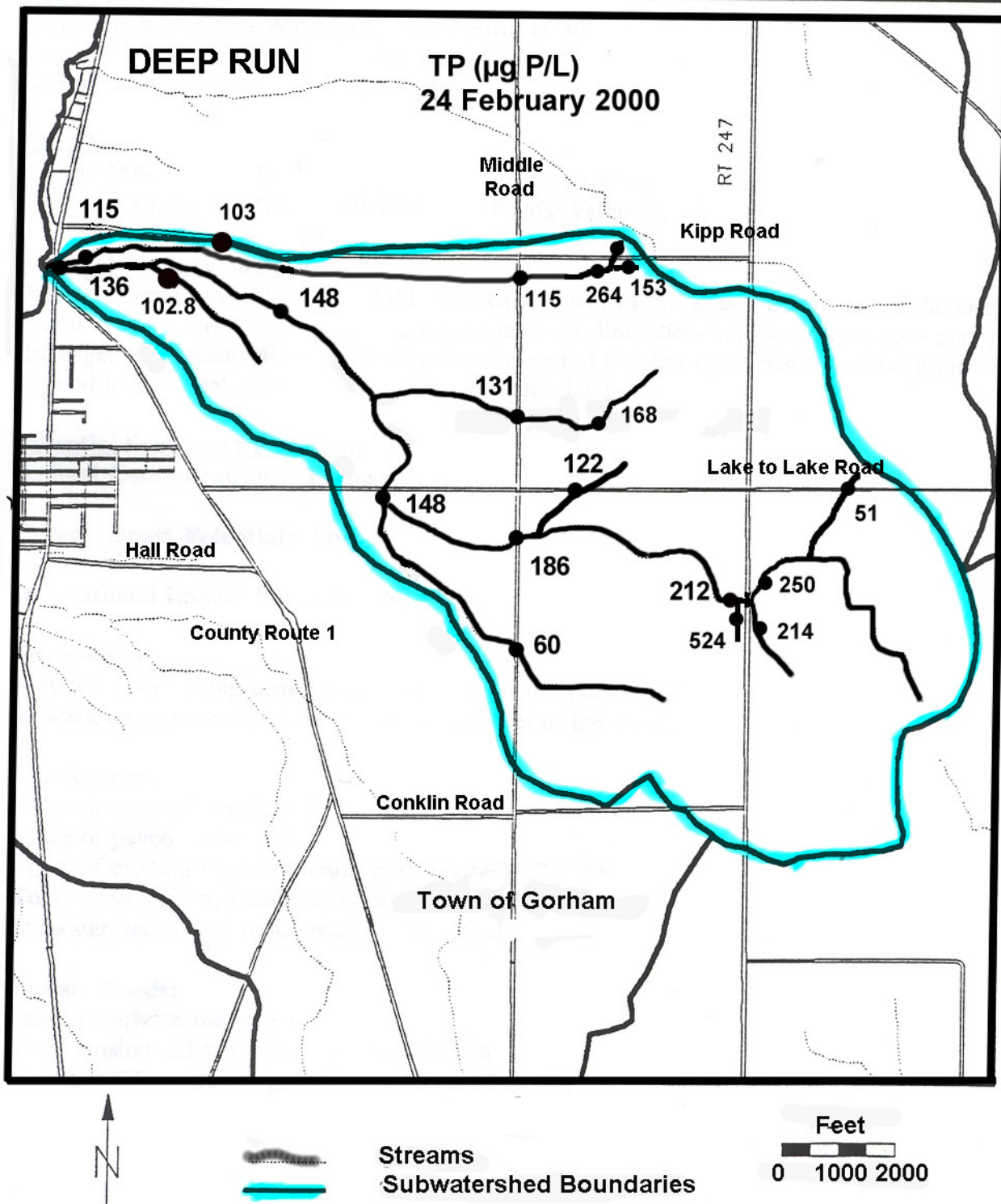


Figure 10. Total phosphorus (TP) concentrations from Deep Run Stressed Stream Analysis on 24 February 2000.

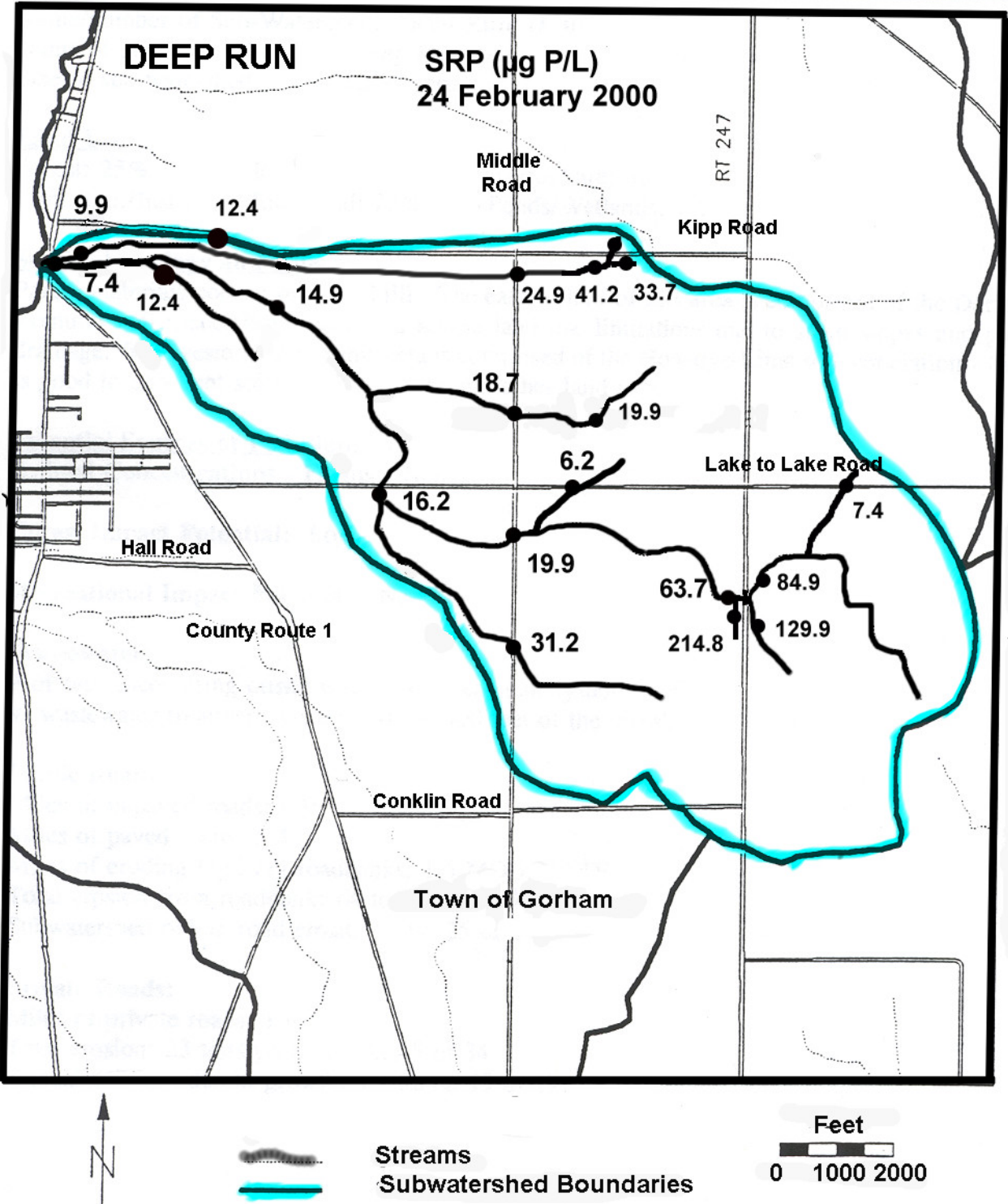


Figure 11. Soluble reactive phosphorus (SRP) concentrations from Deep Run Stressed Stream Analysis on 24 February 2000.

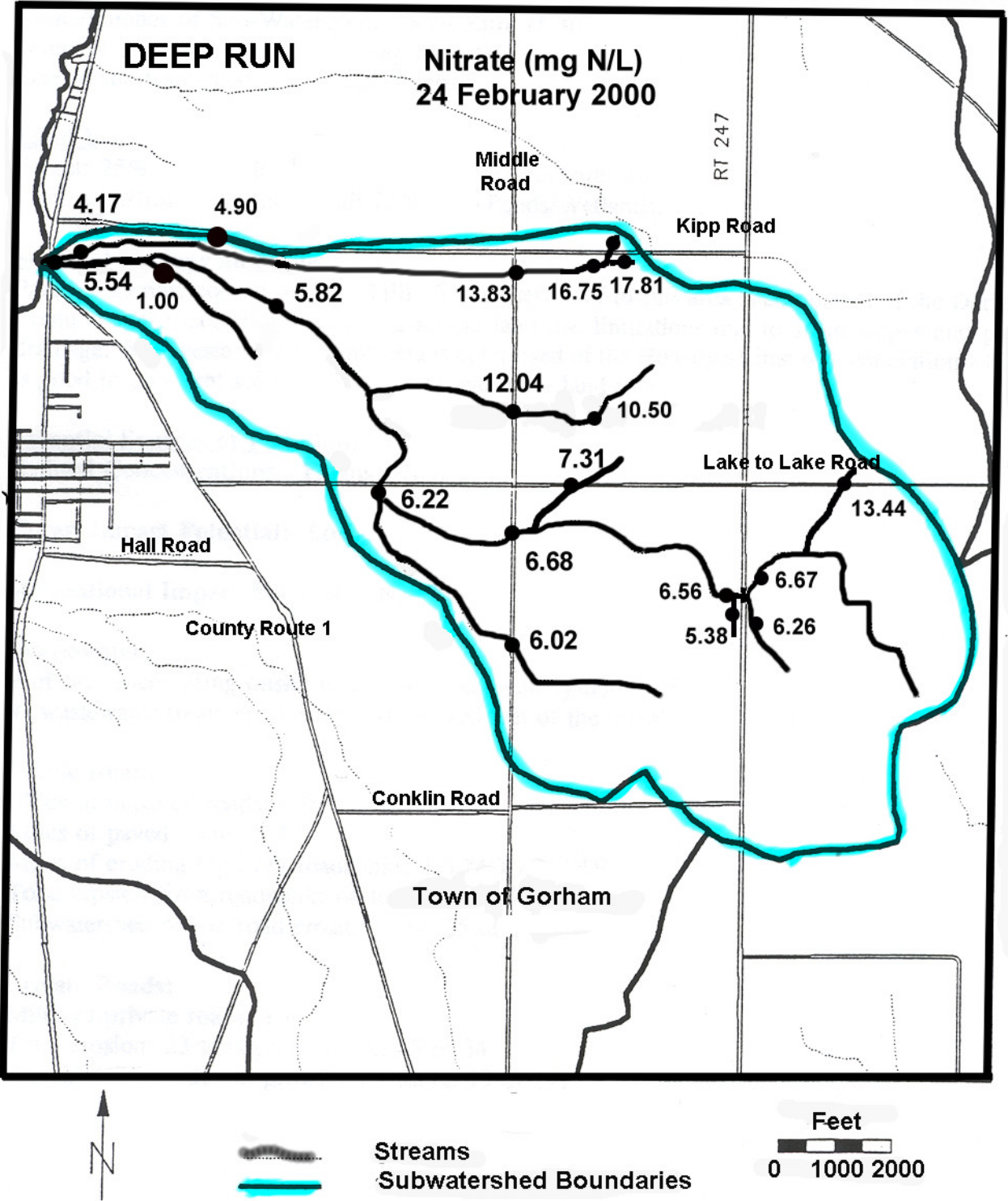


Figure 12. Nitrate concentrations from Deep Run Stressed Stream Analysis on 24 February 2000.

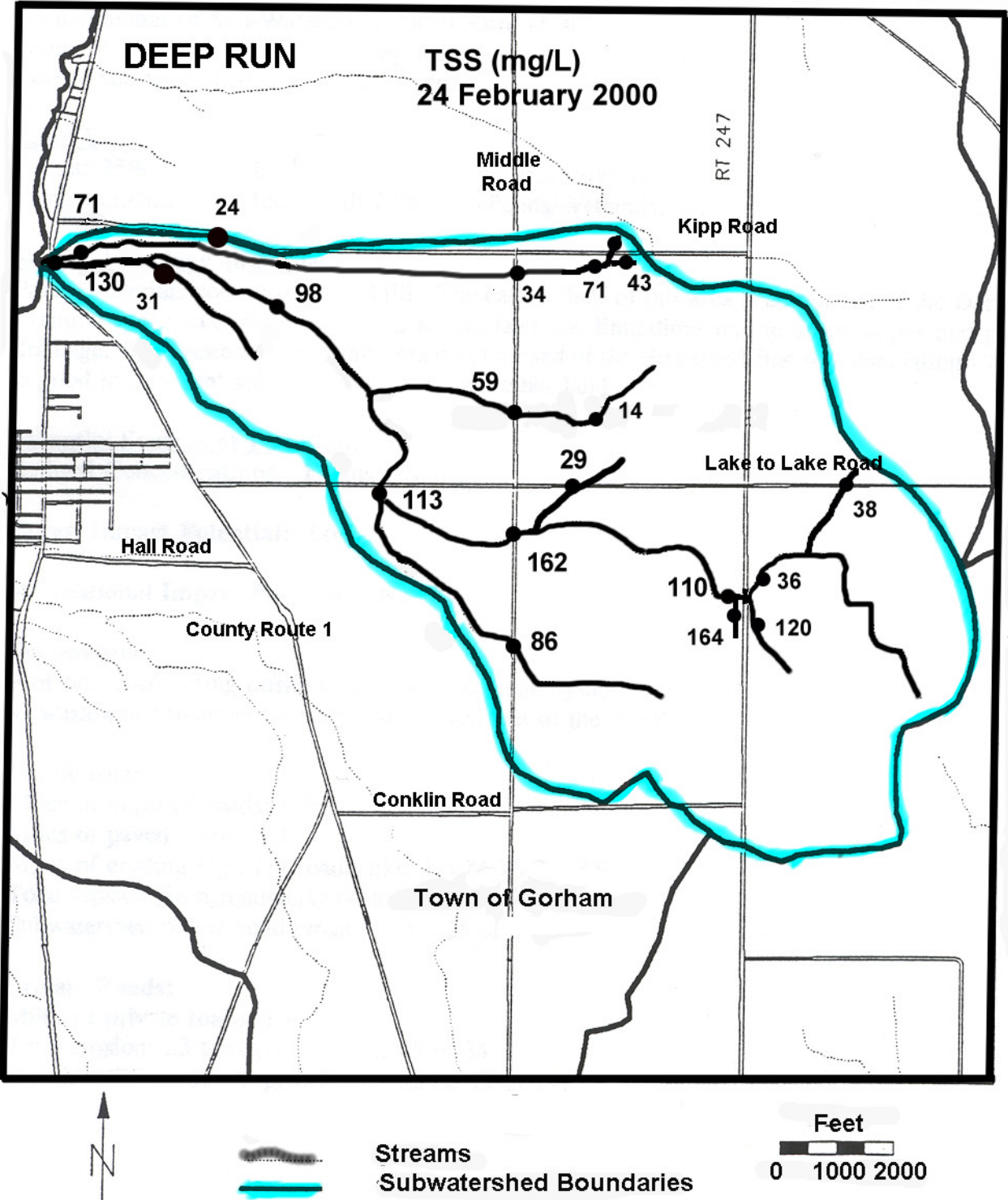


Figure 13. Total suspended solids (TSS) concentrations from Deep Run Stressed Stream Analysis on 24 February 2000.

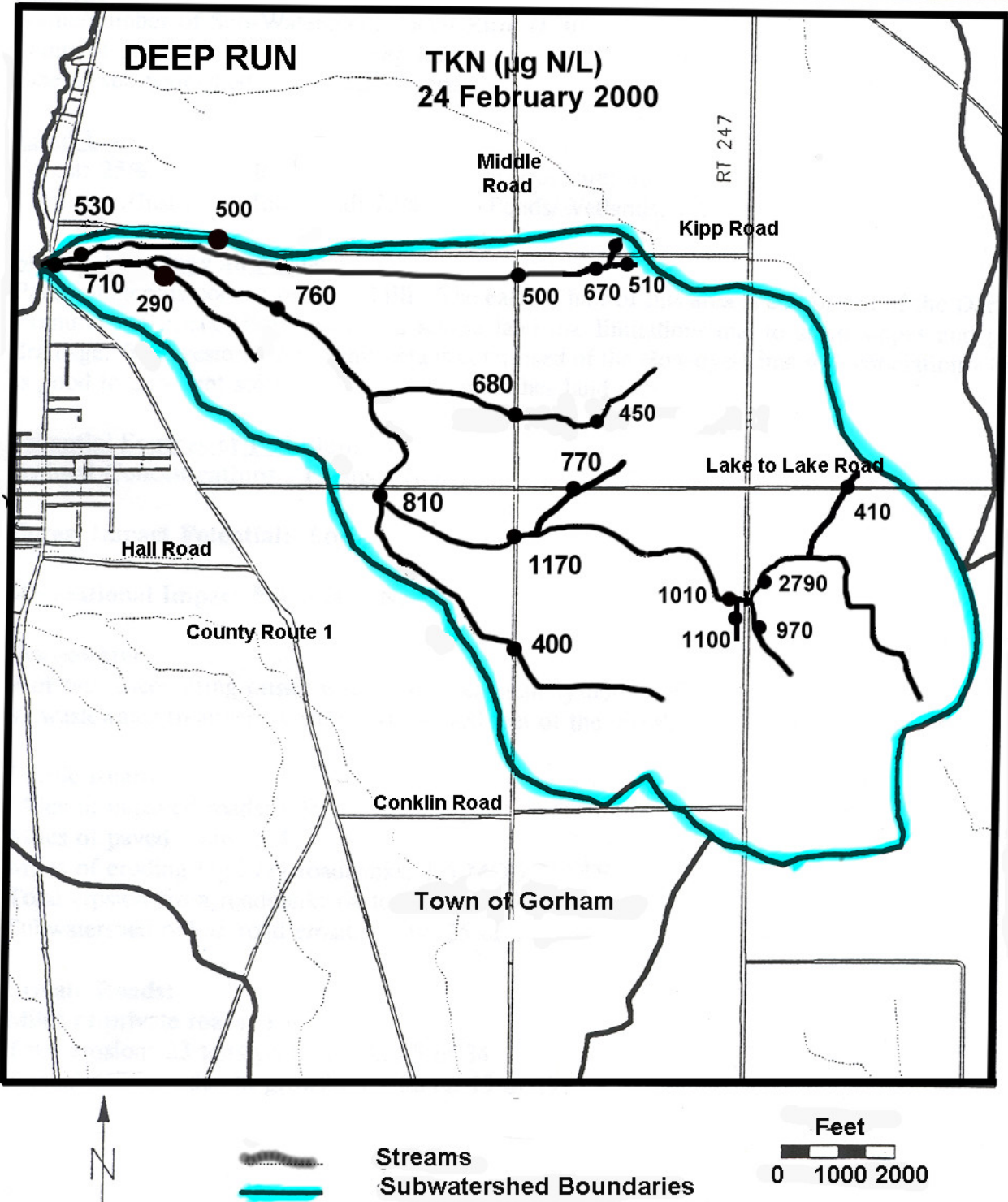


Figure 14. Total Kjeldahl nitrogen (TKN) concentrations from Deep Run Stressed Stream Analysis on 24 February 2000.

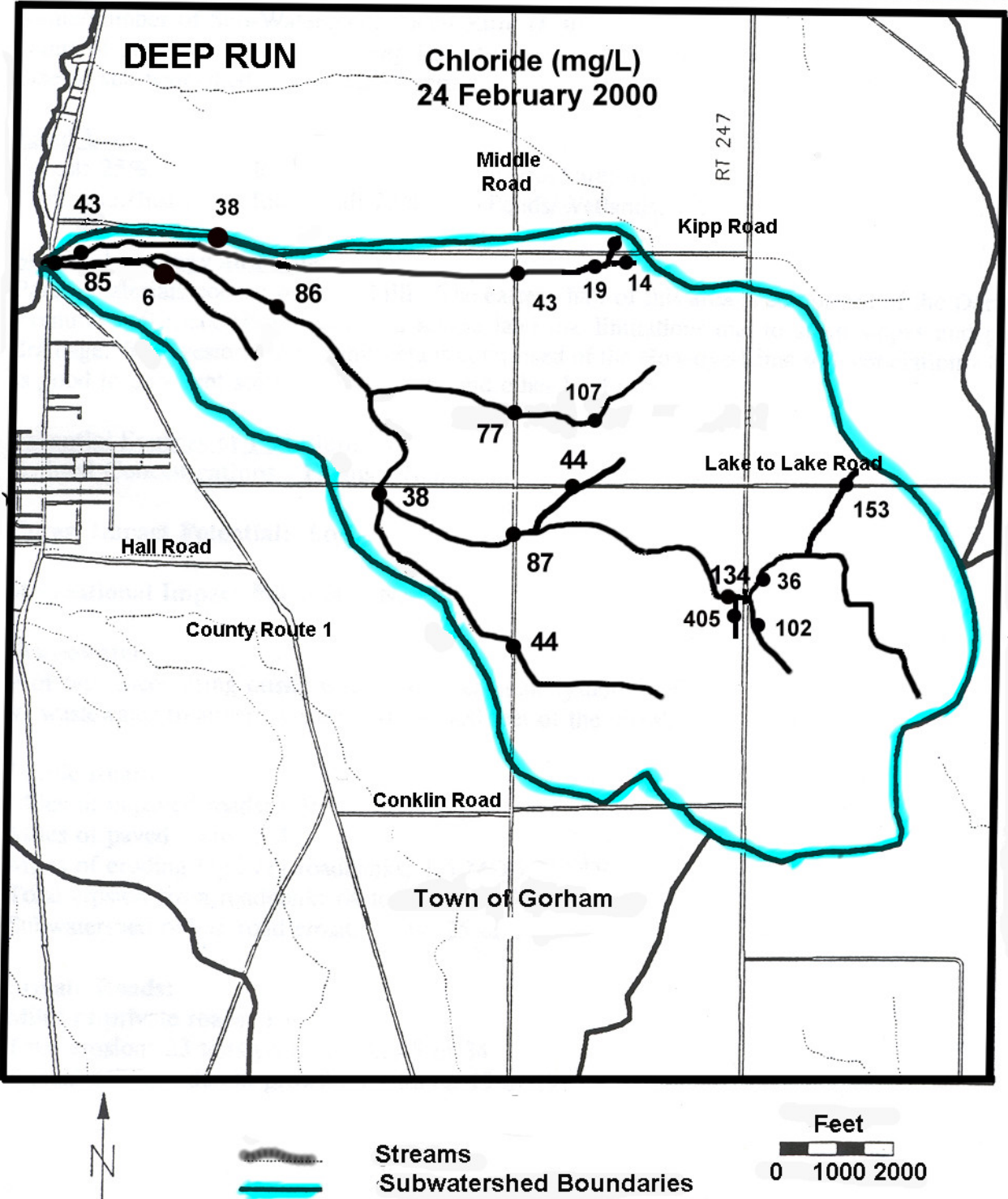


Figure 15. Chloride concentrations from Deep Run Stressed Stream Analysis on 24 February 2000.

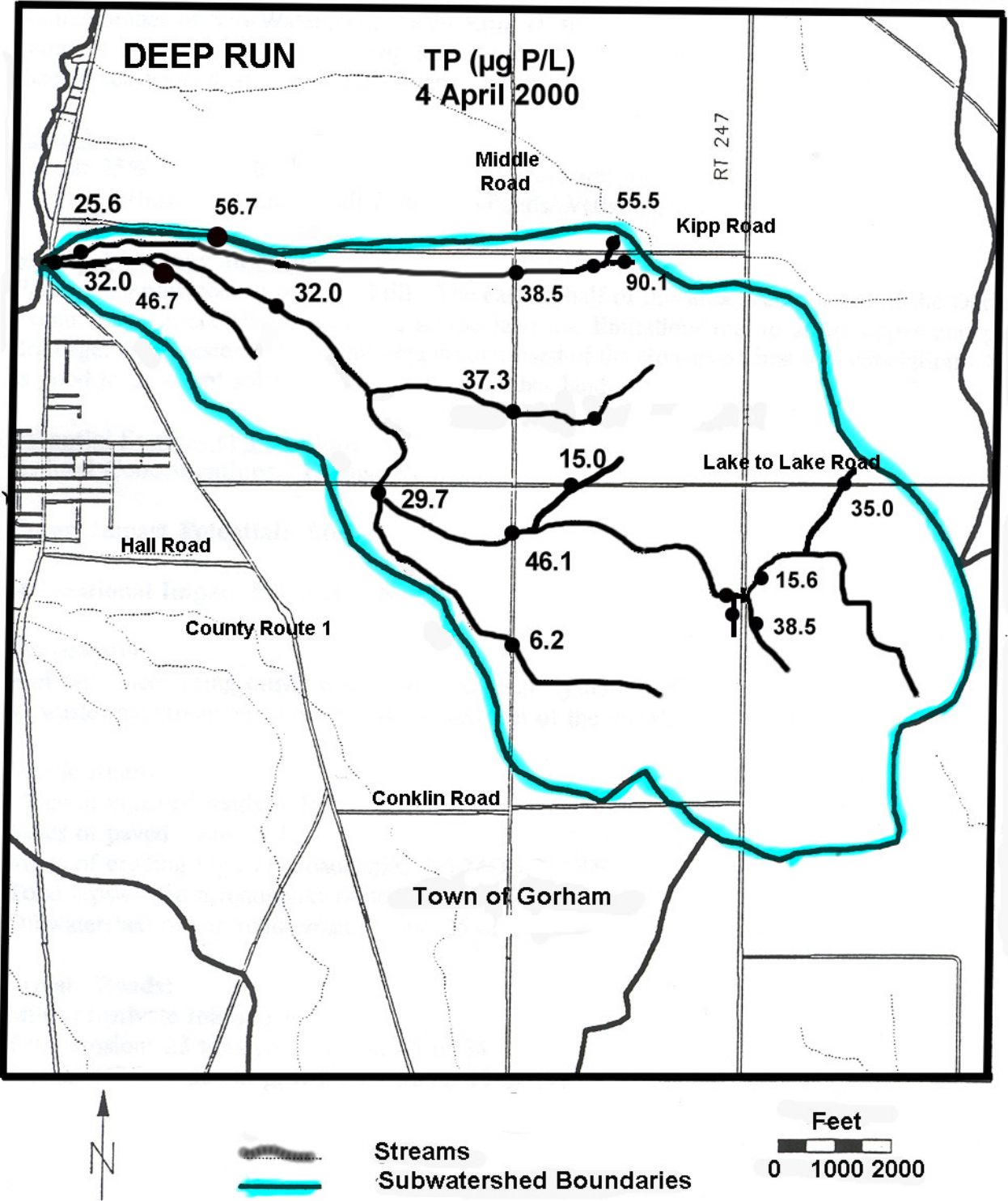


Figure 16. Total phosphorus (TP) concentrations from Deep Run Stressed Stream Analysis on 4 April 2000.

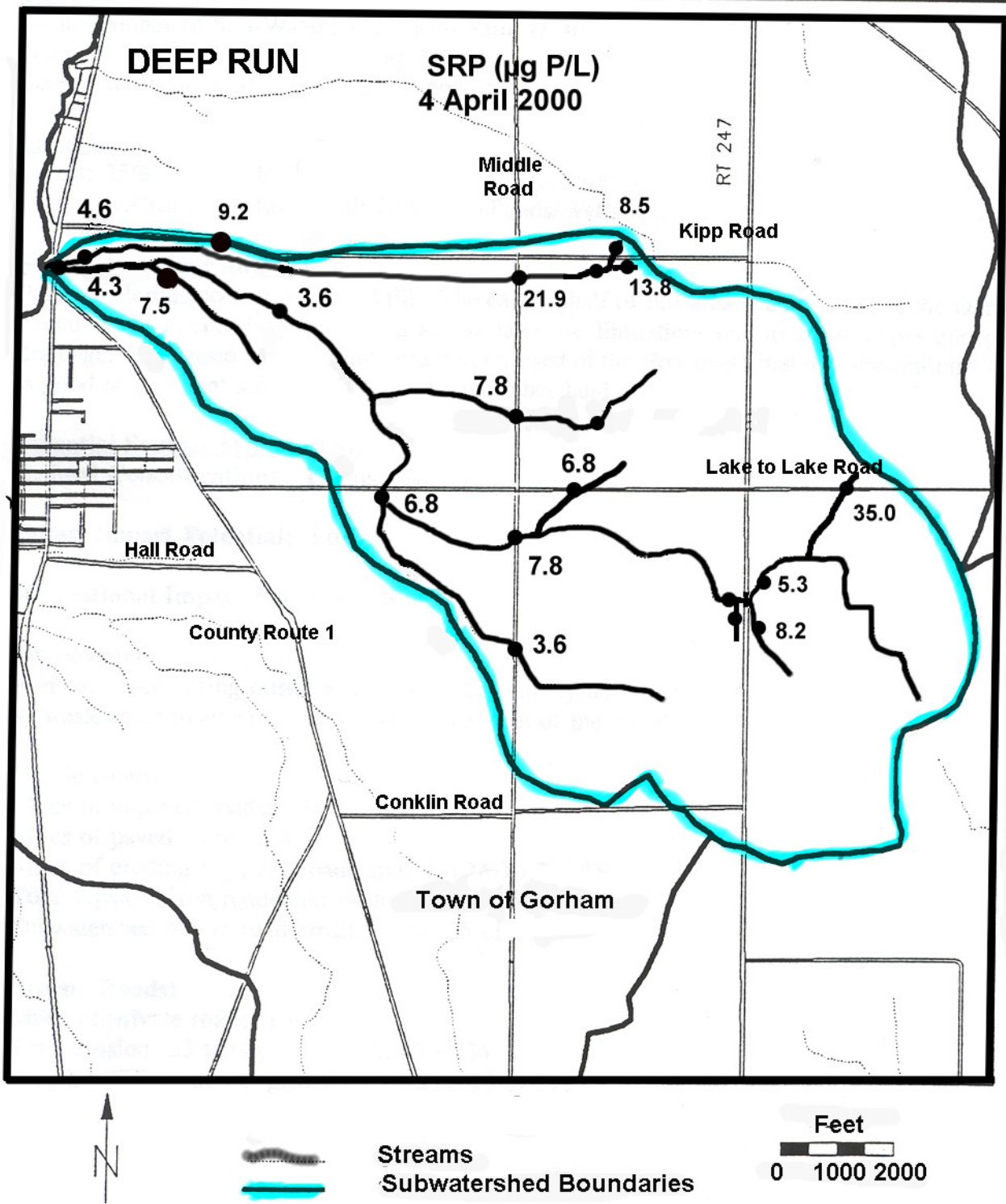


Figure 17. Soluble reactive phosphorus (SRP) concentrations from Deep Run Stressed Stream Analysis on 4 April 2000.

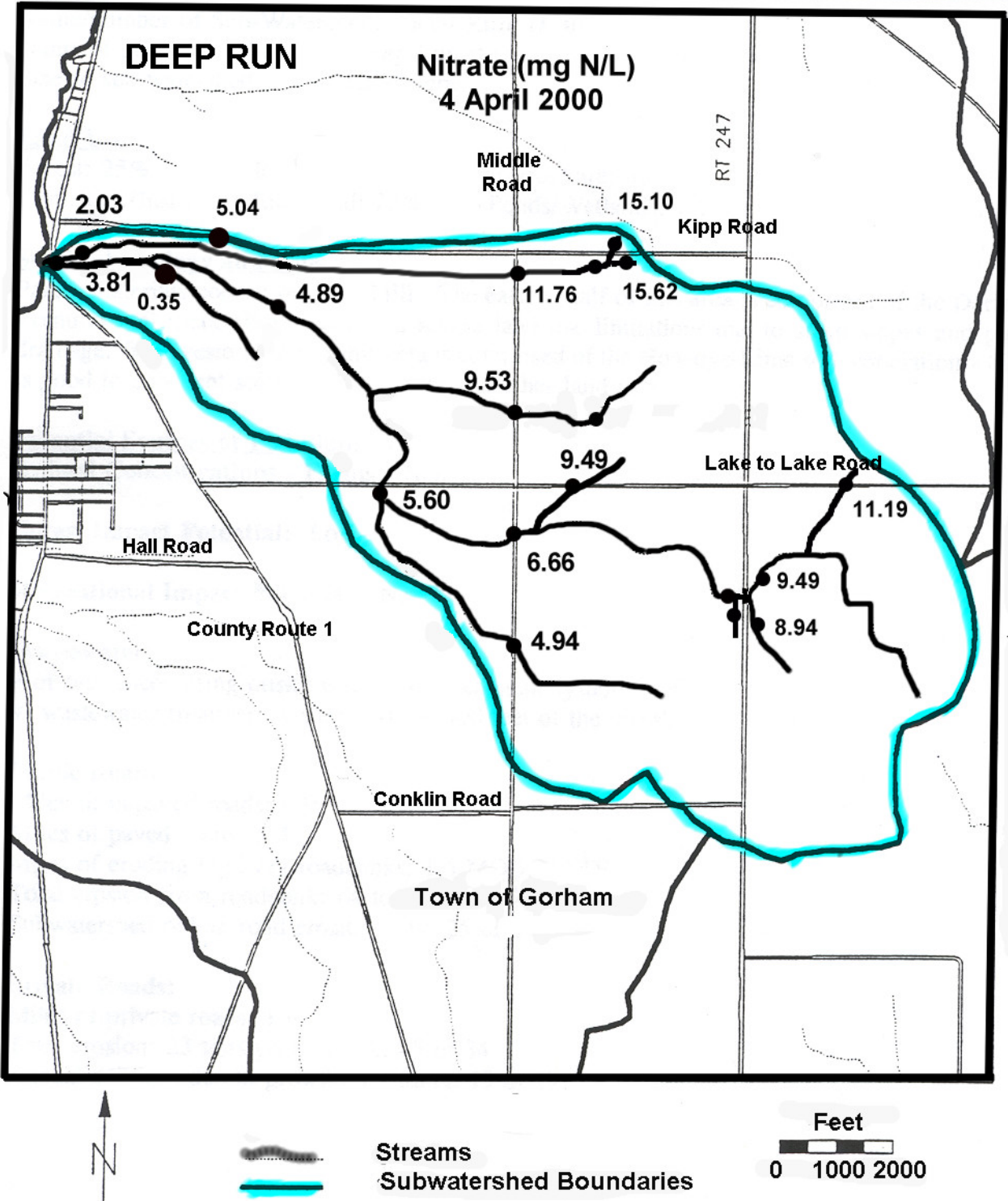


Figure 18. Nitrate concentrations from Deep Run Stressed Stream Analysis on 4 April 2000.

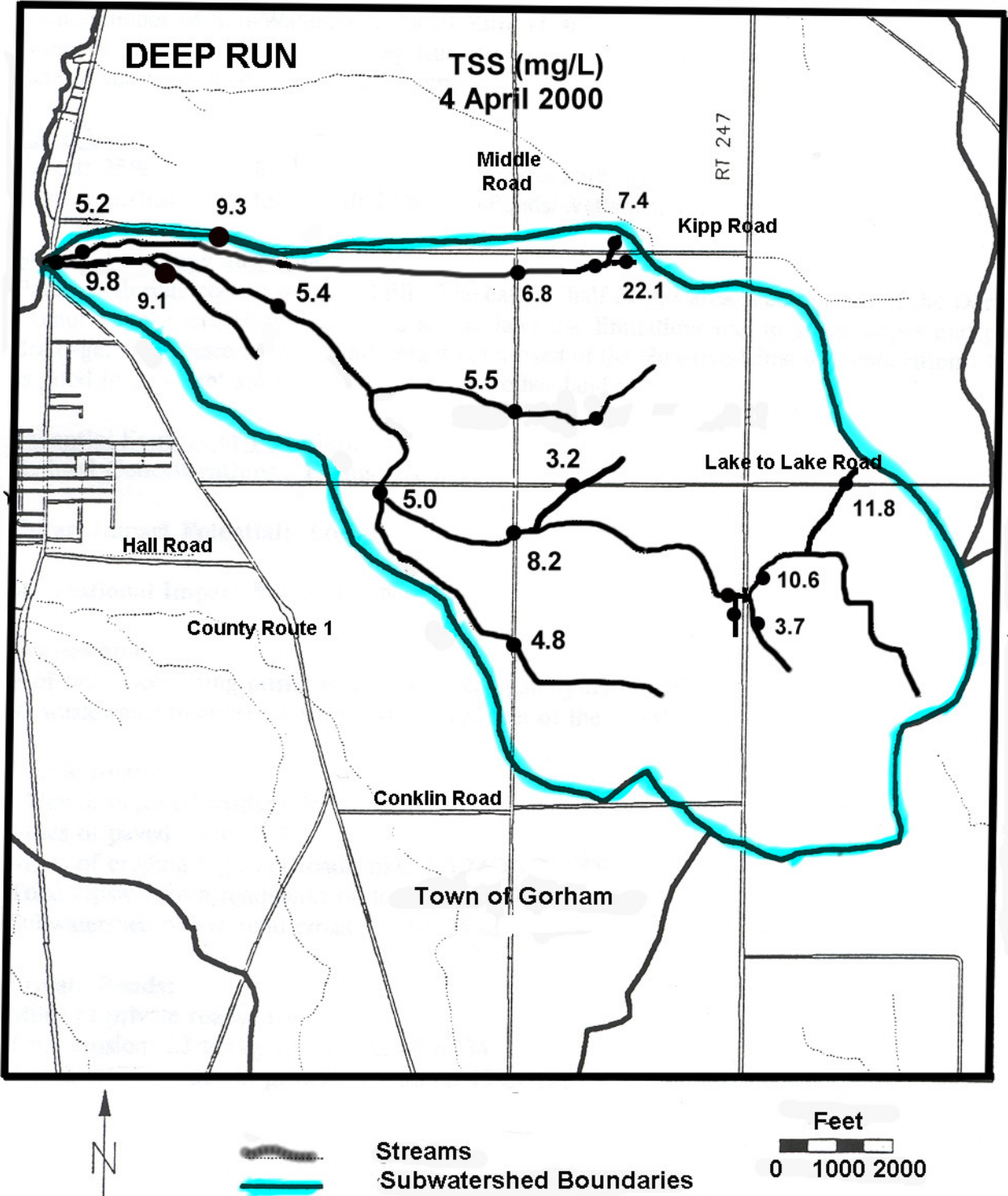


Figure 19. Total suspended solids (TSS) concentrations from Deep Run Stressed Stream Analysis on 4 April 2000.

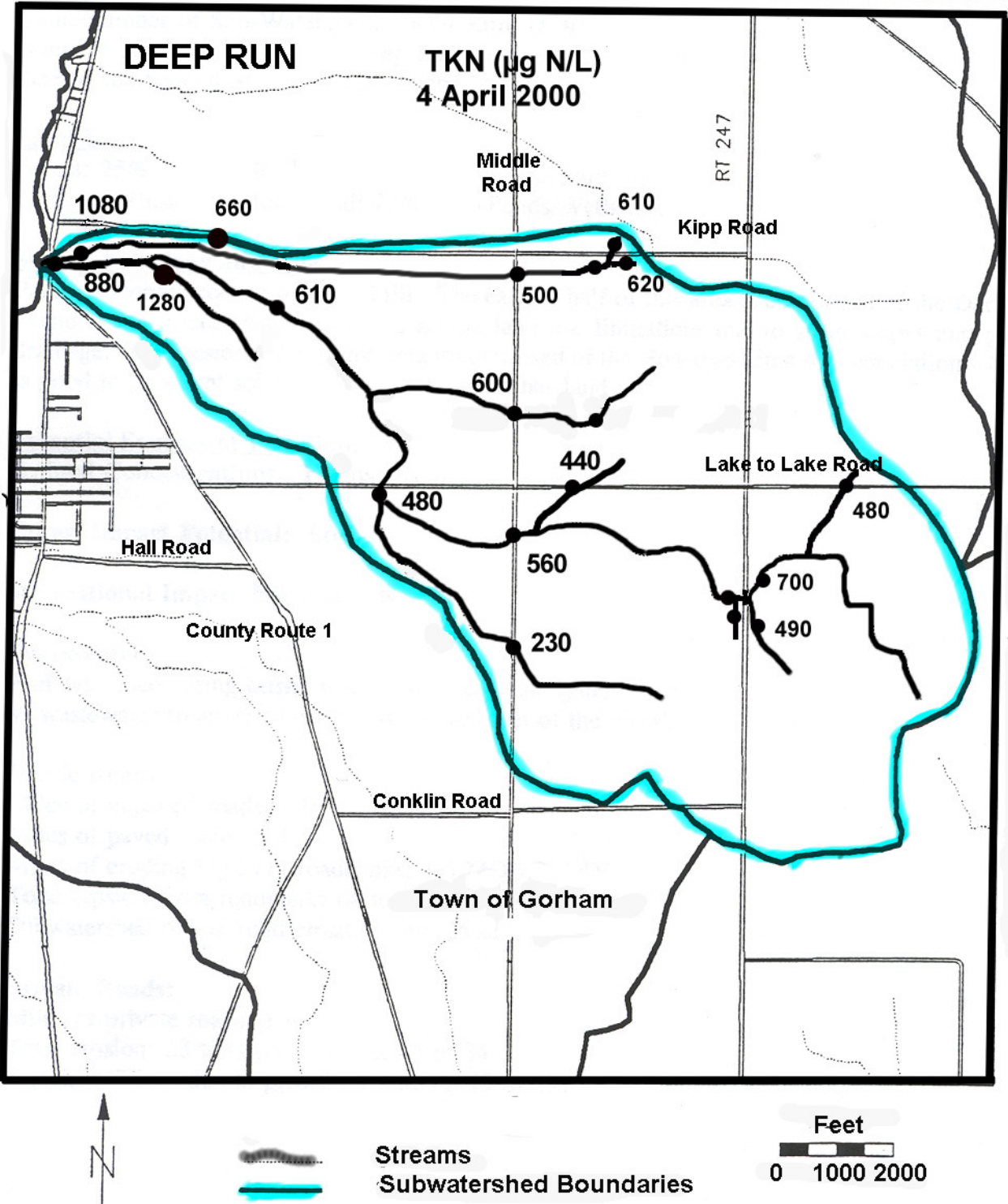


Figure 20. Total Kjeldahl nitrogen (TKN) concentrations from Deep Run Stressed Stream Analysis on 4 April 2000.

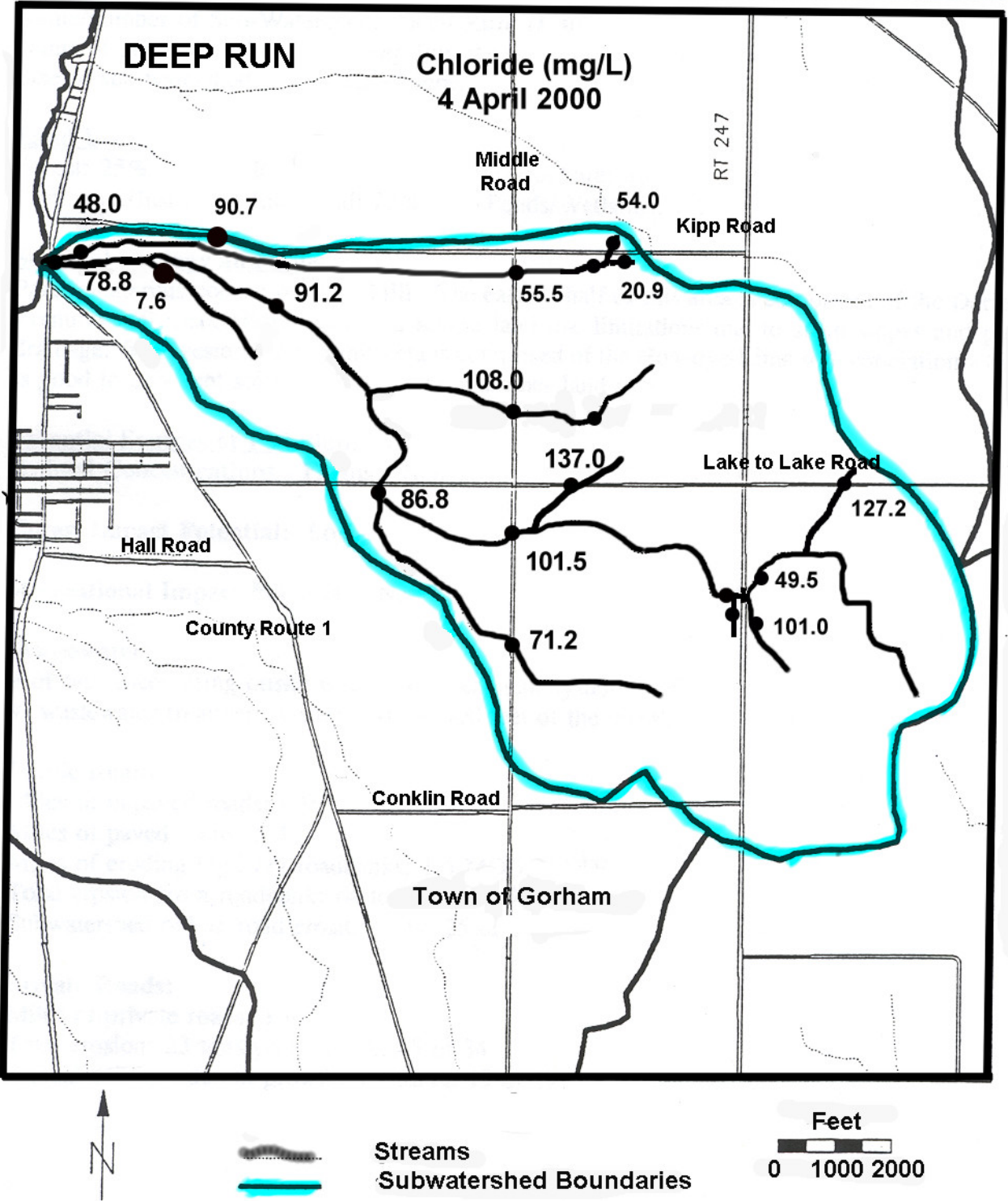


Figure 21. Chloride concentrations from Deep Run Stressed Stream Analysis on 4 April 2000.

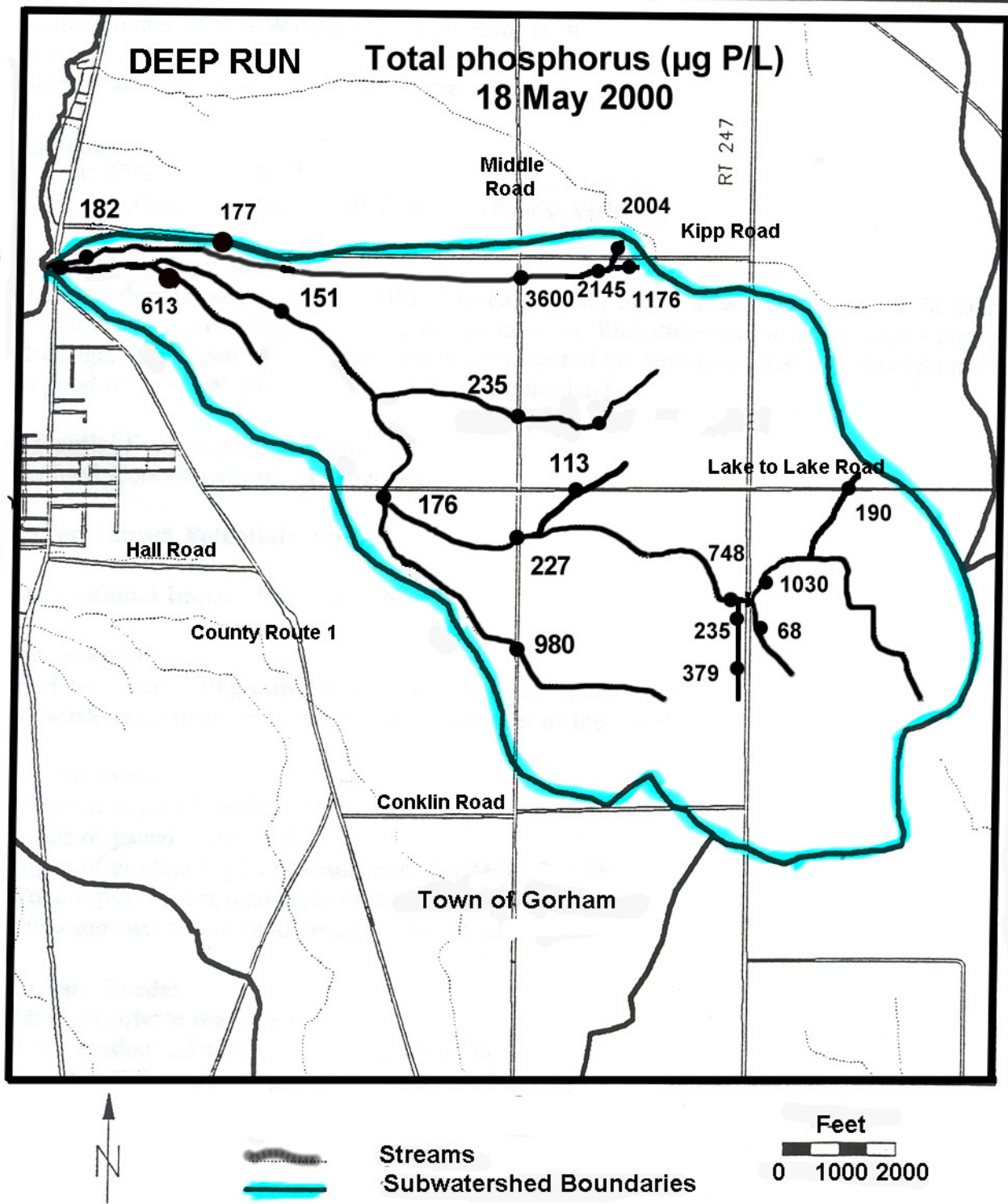


Figure 22. Total phosphorus (TP) concentrations from Deep Run Stressed Stream Analysis on 18 May 2000.

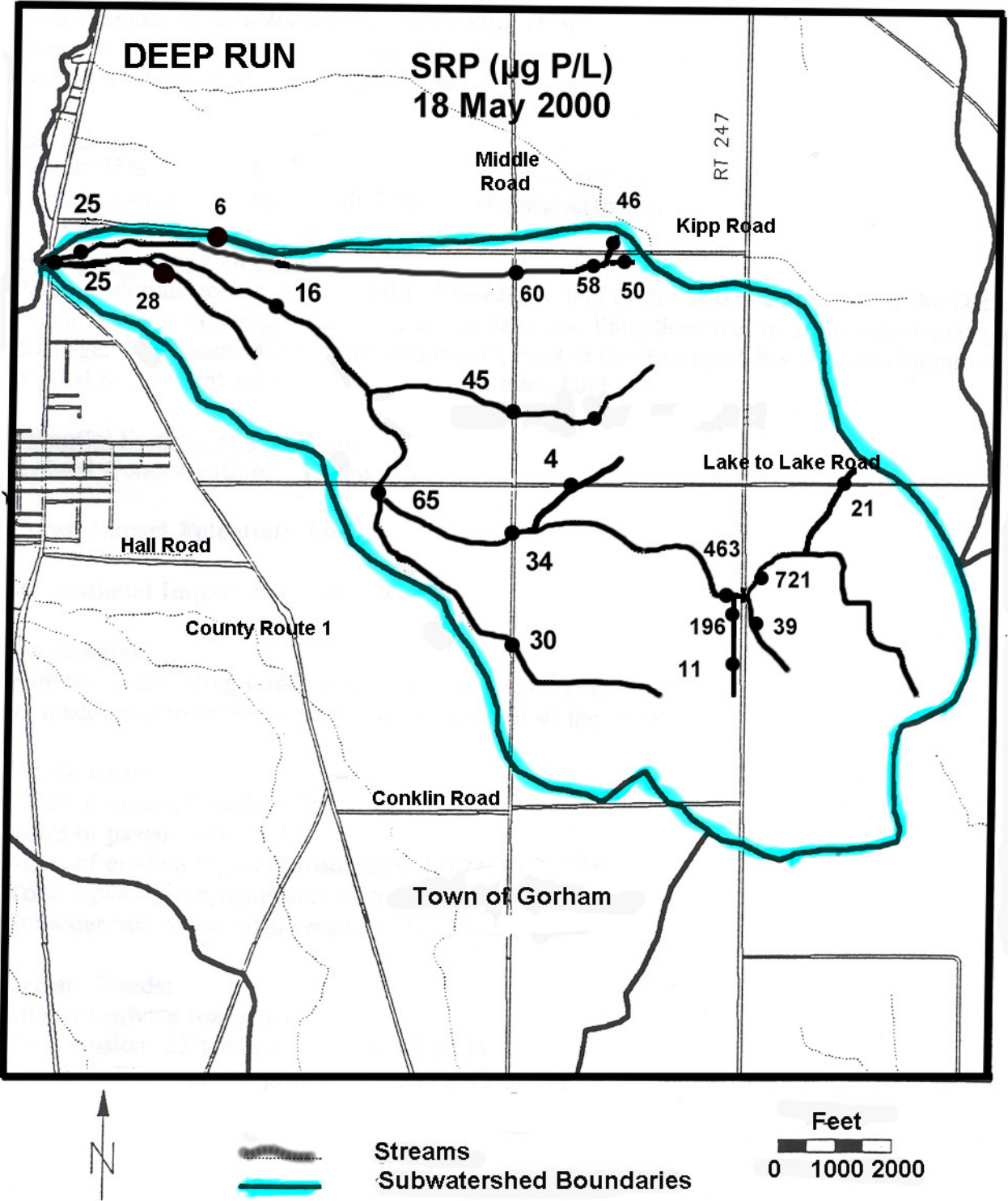


Figure 23. Soluble reactive phosphorus (SRP) concentrations from Deep Run Stressed Stream Analysis on 18 May 2000.

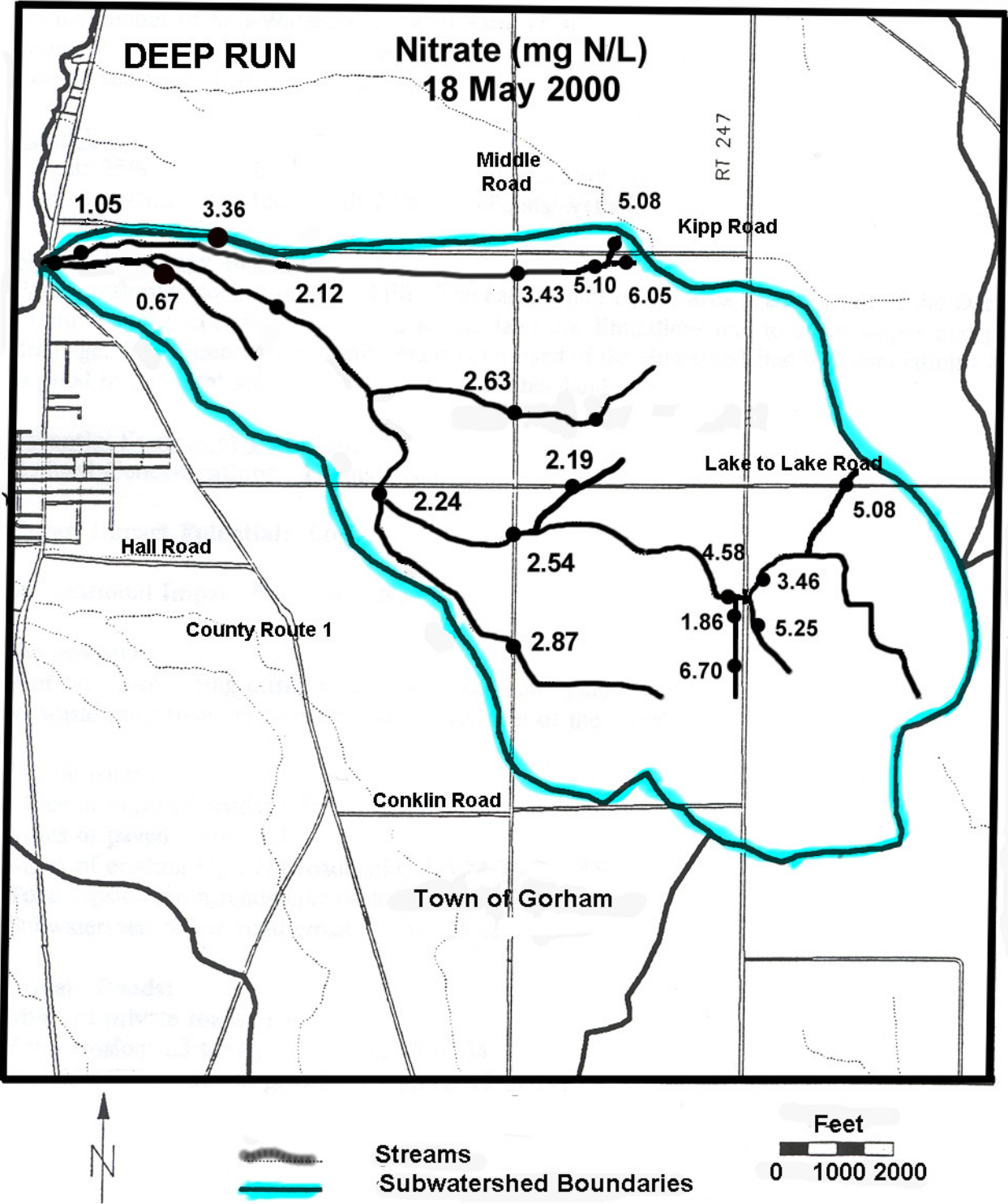


Figure 24. Nitrate concentrations from Deep Run Stressed Stream Analysis on 18 May 2000.

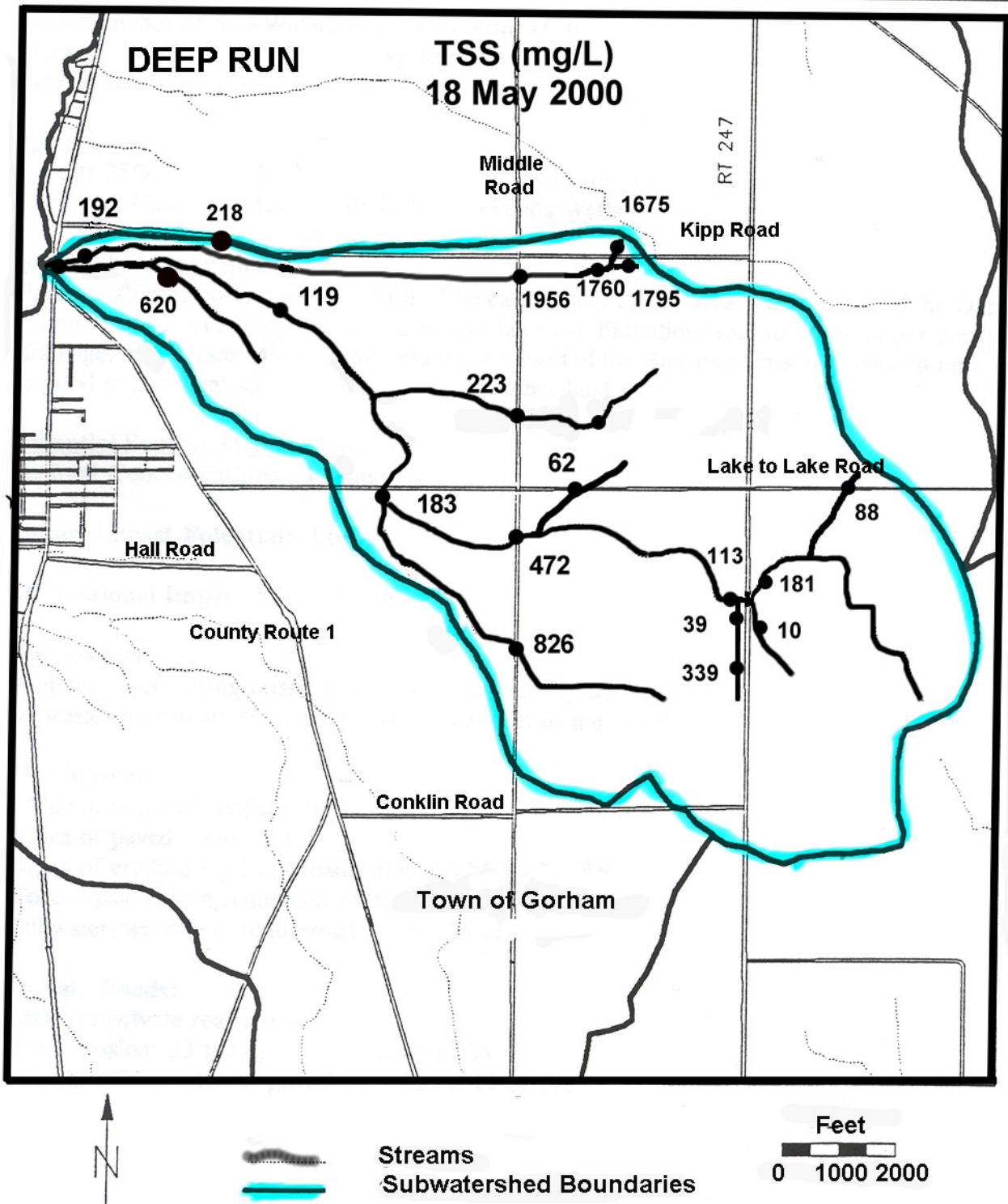


Figure 25. Total suspended solids (TSS) concentrations from Deep Run Stressed Stream Analysis on 18 May 2000.

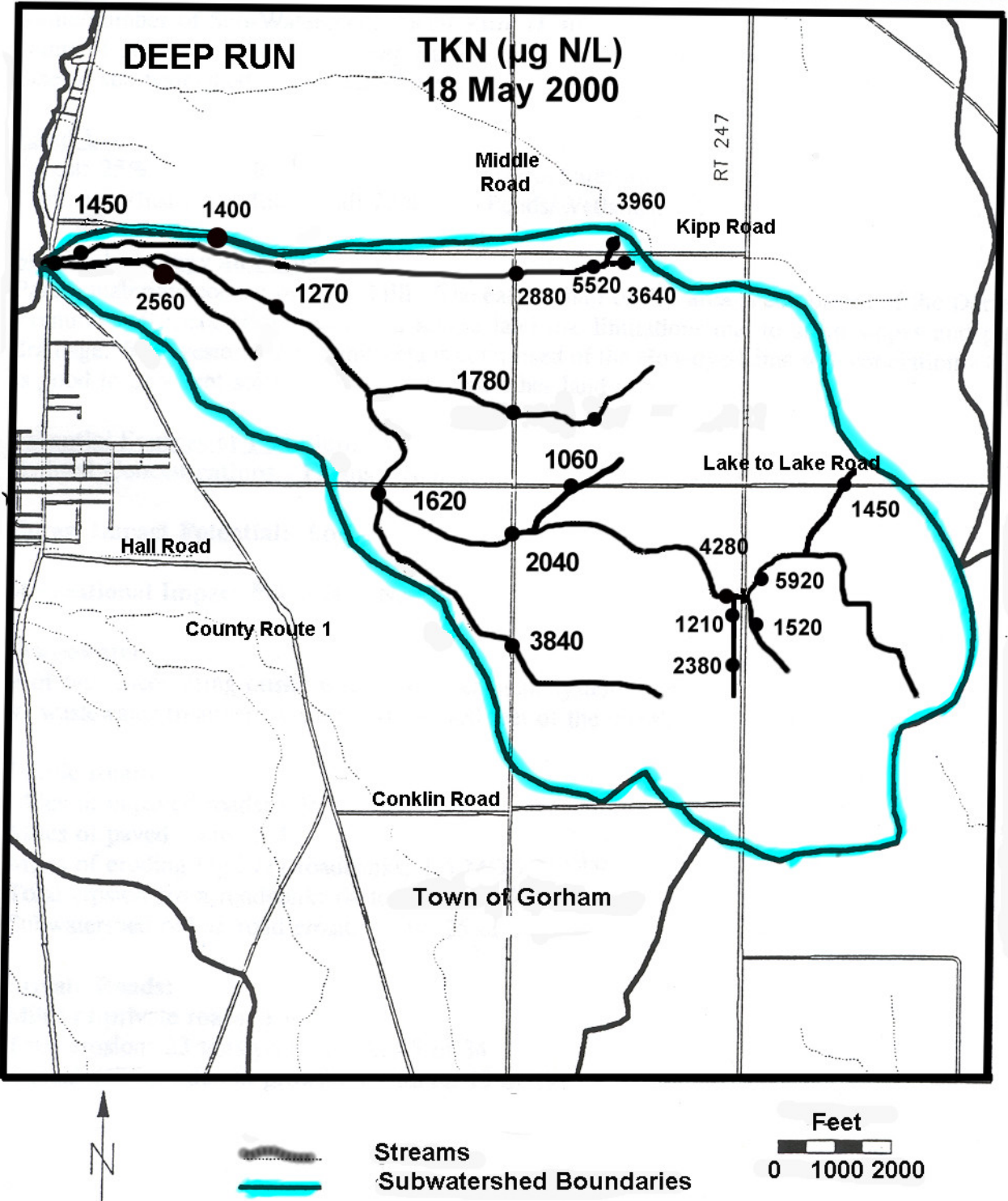


Figure 26. Total Kjeldahl nitrogen (TKN) concentrations from Deep Run Stressed Stream Analysis on 18 May 2000.

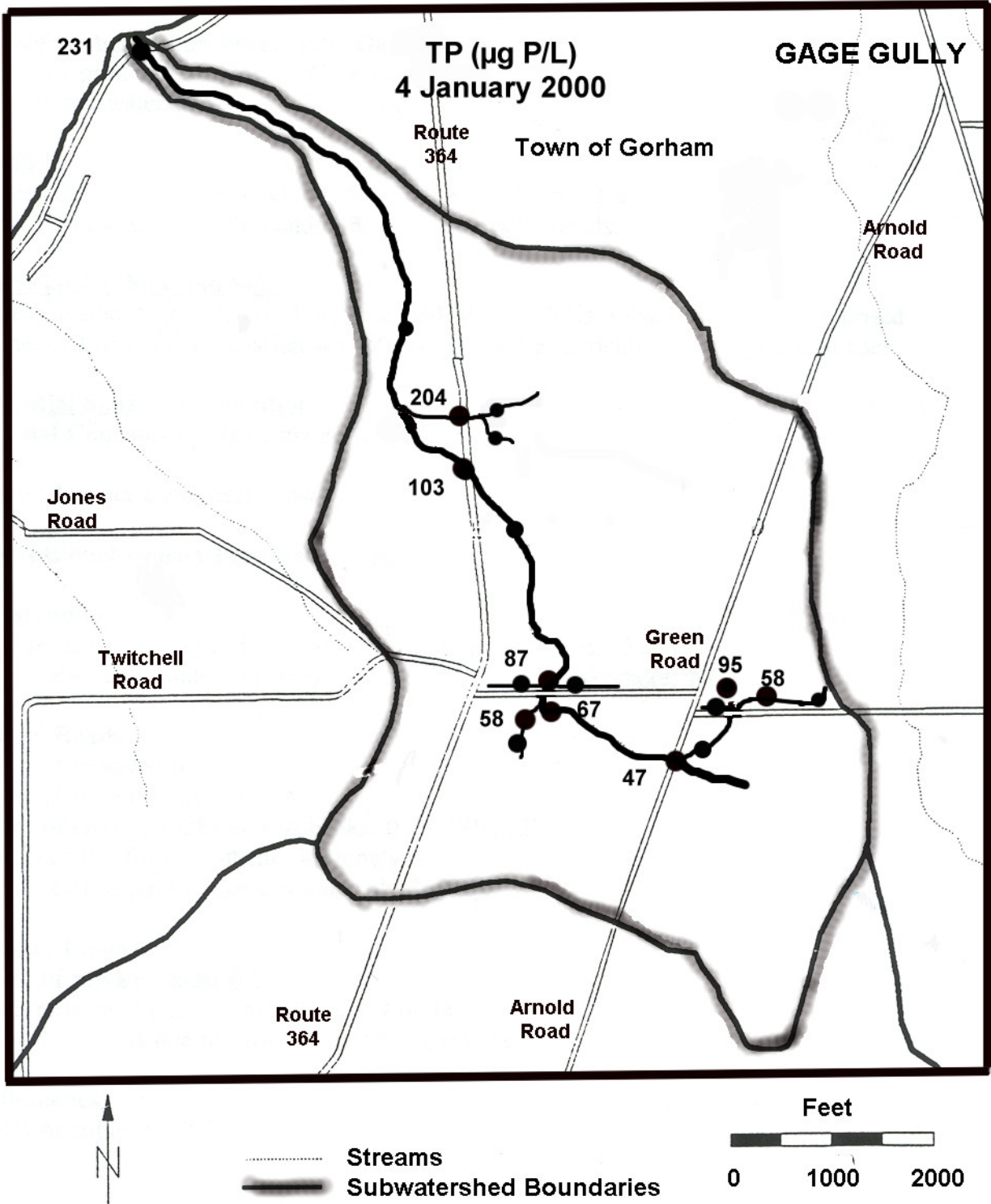


Figure 27. Total phosphorus (TP) concentrations from Gage Gully Stressed Stream Analysis on 4 January 2000.

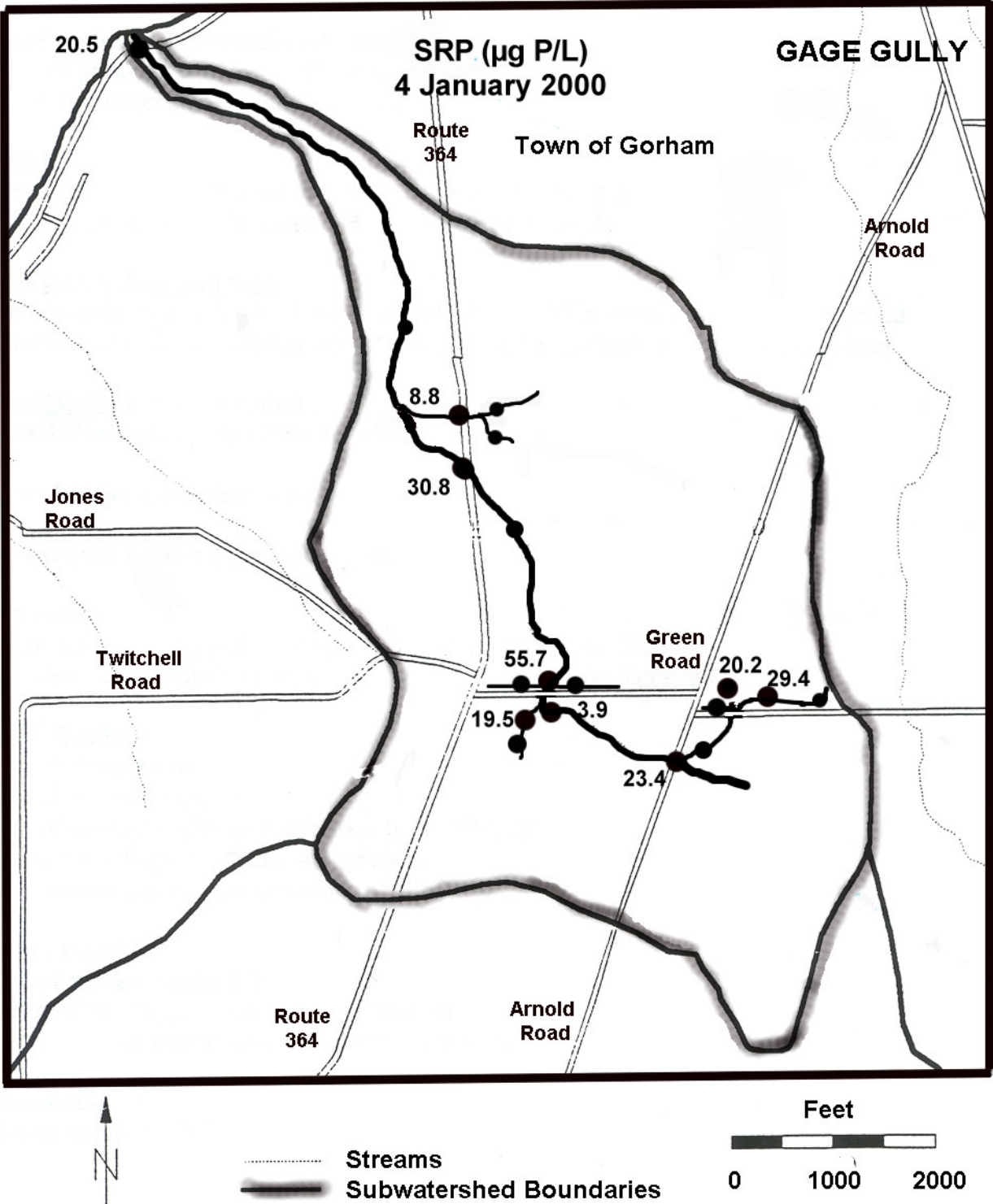


Figure 28. Soluble reactive phosphorus (SRP) concentrations from Gage Gully Stressed Stream Analysis on 4 January 2000.

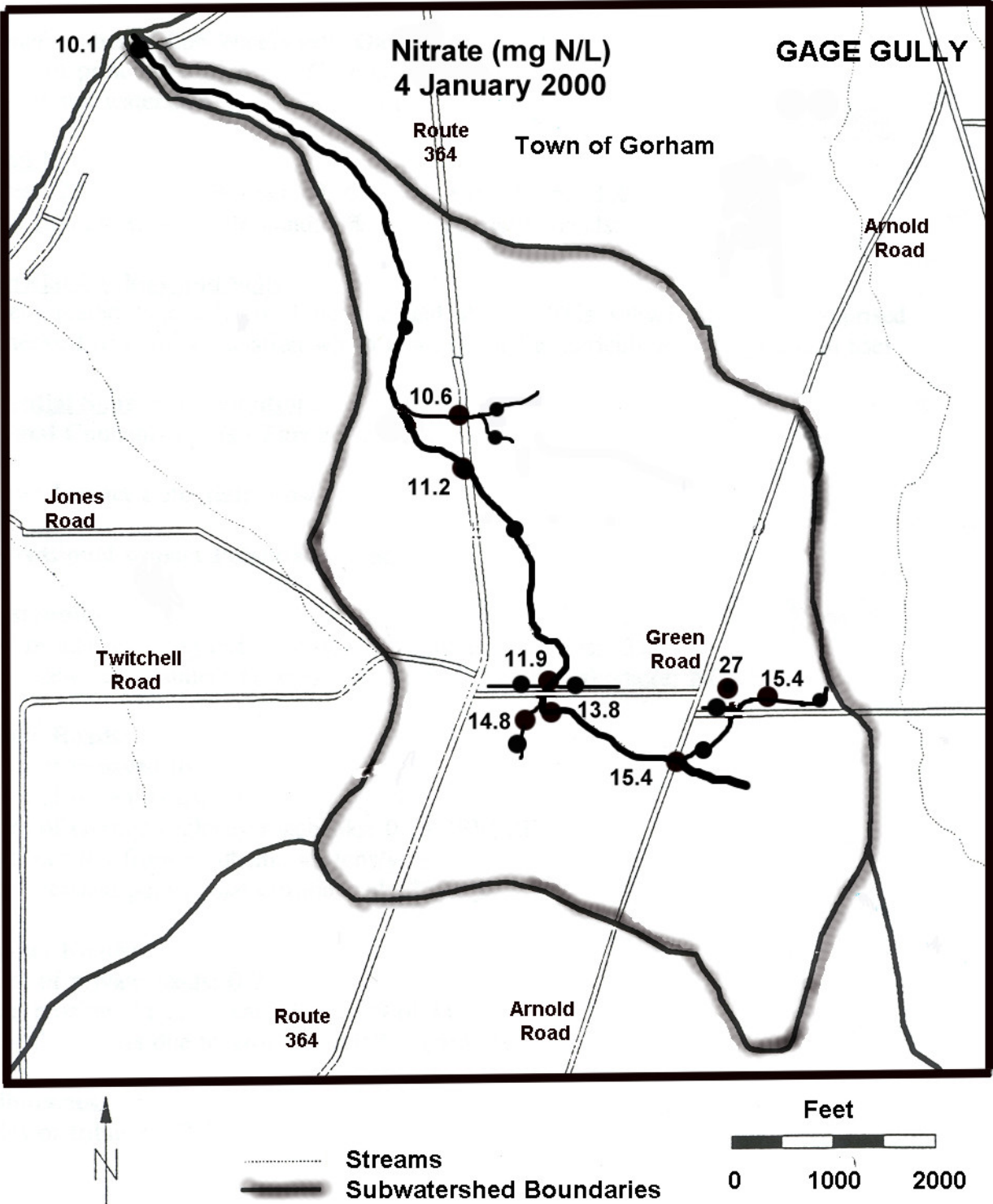


Figure 29. Nitrate concentrations from Gage Gully Stressed Stream Analysis on 4 January 2000.

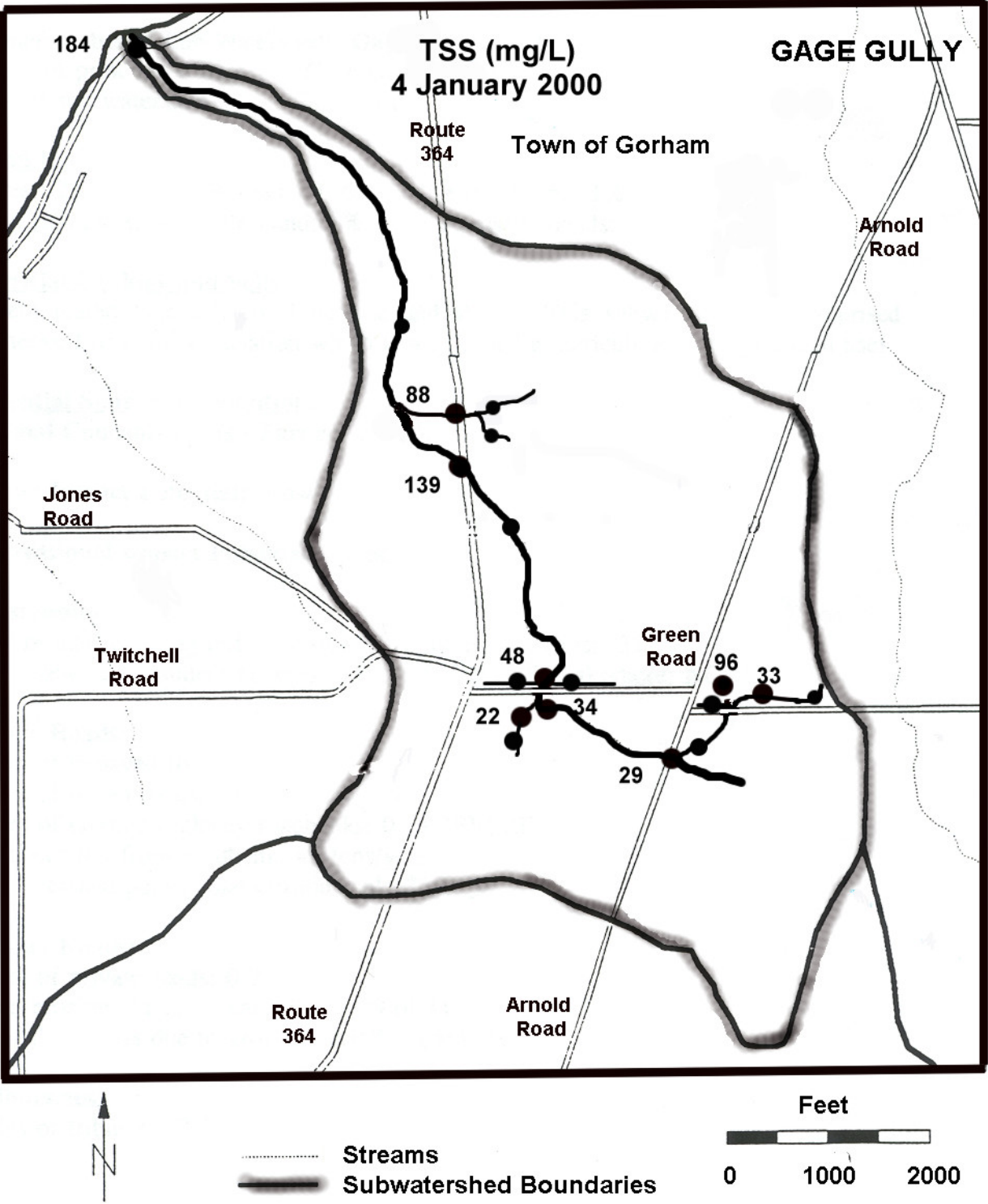


Figure 30. Total suspended solids (TSS) concentrations from Gage Gully Stressed Stream Analysis on 4 January 2000.

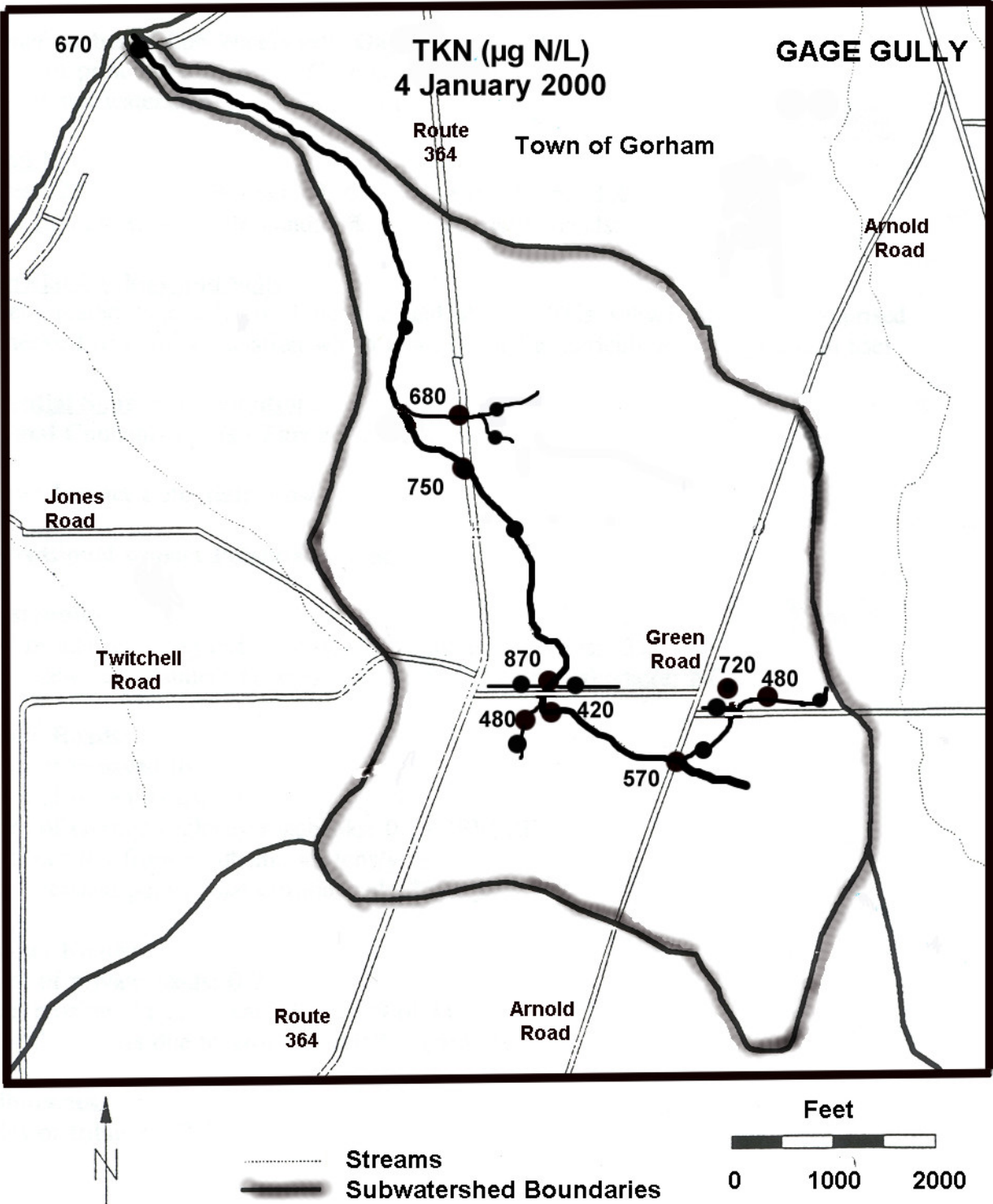


Figure 31. Total Kjeldahl nitrogen (TKN concentrations from Gage Gully Stressed Stream Analysis on 4 January 2000.

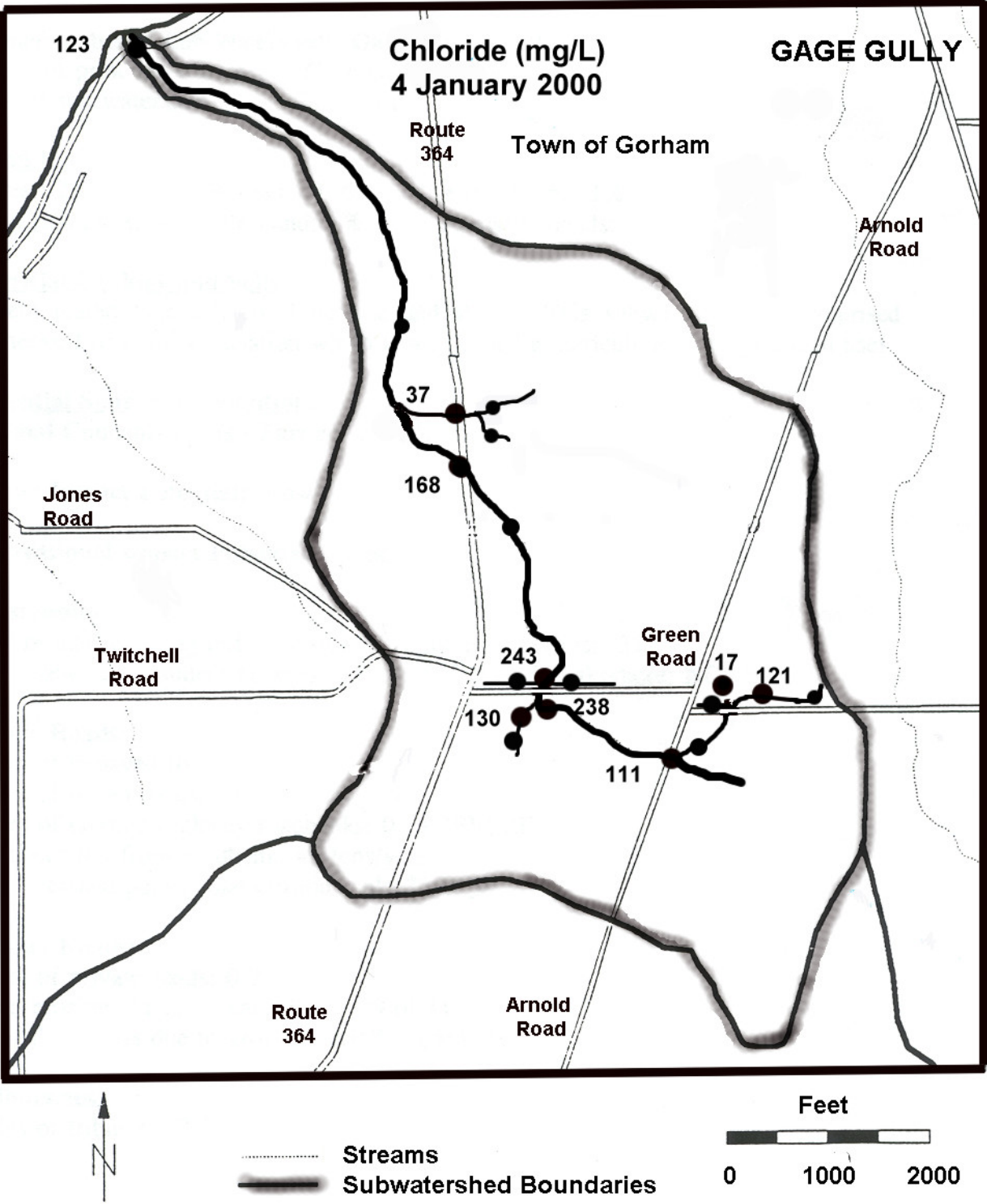


Figure 32. Chloride concentrations from Gage Gully Stressed Stream Analysis on 4 January 2000.

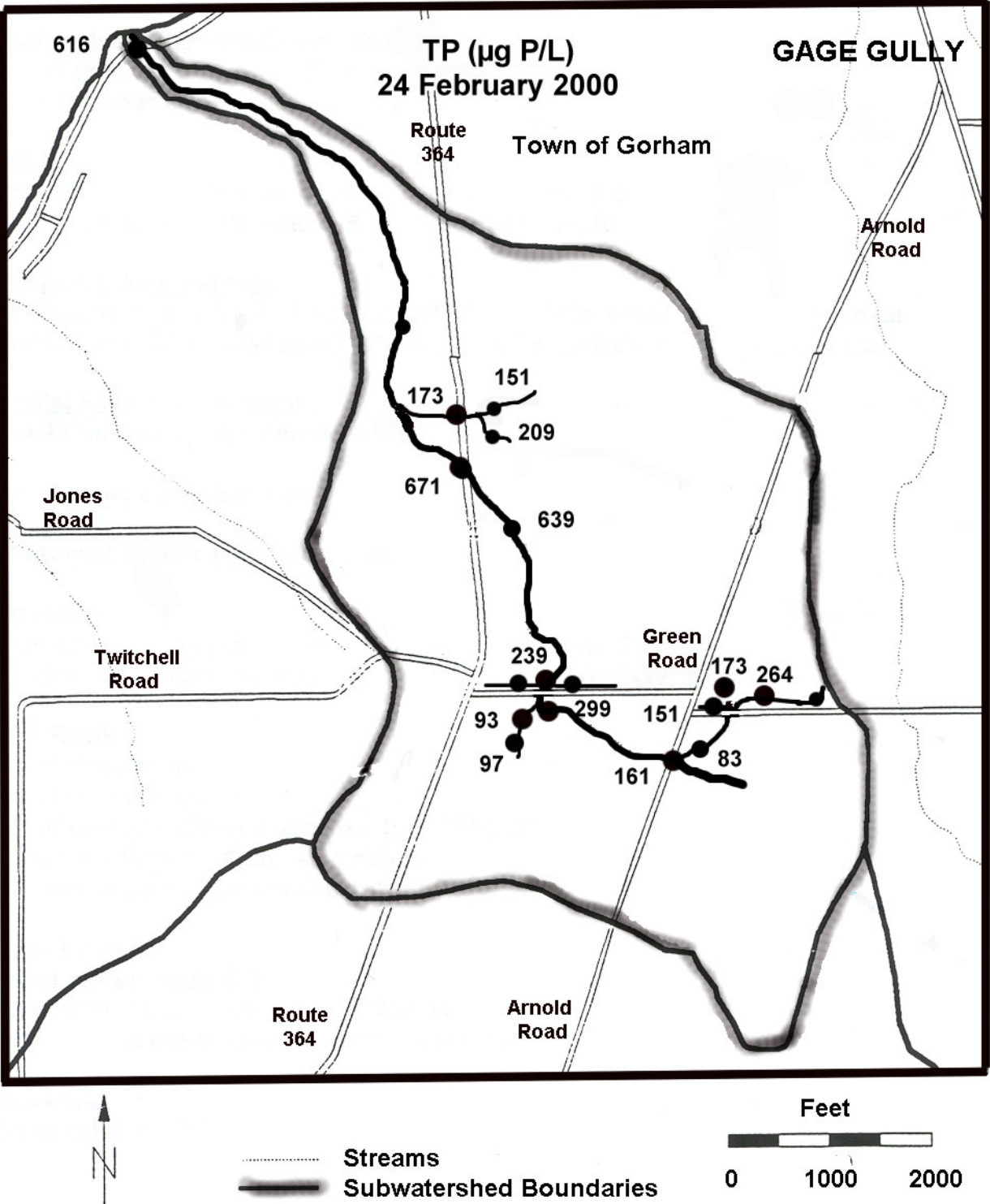


Figure 33. Total phosphorus (TP) concentrations from Gage Gully Stressed Stream Analysis on 24 February 2000.

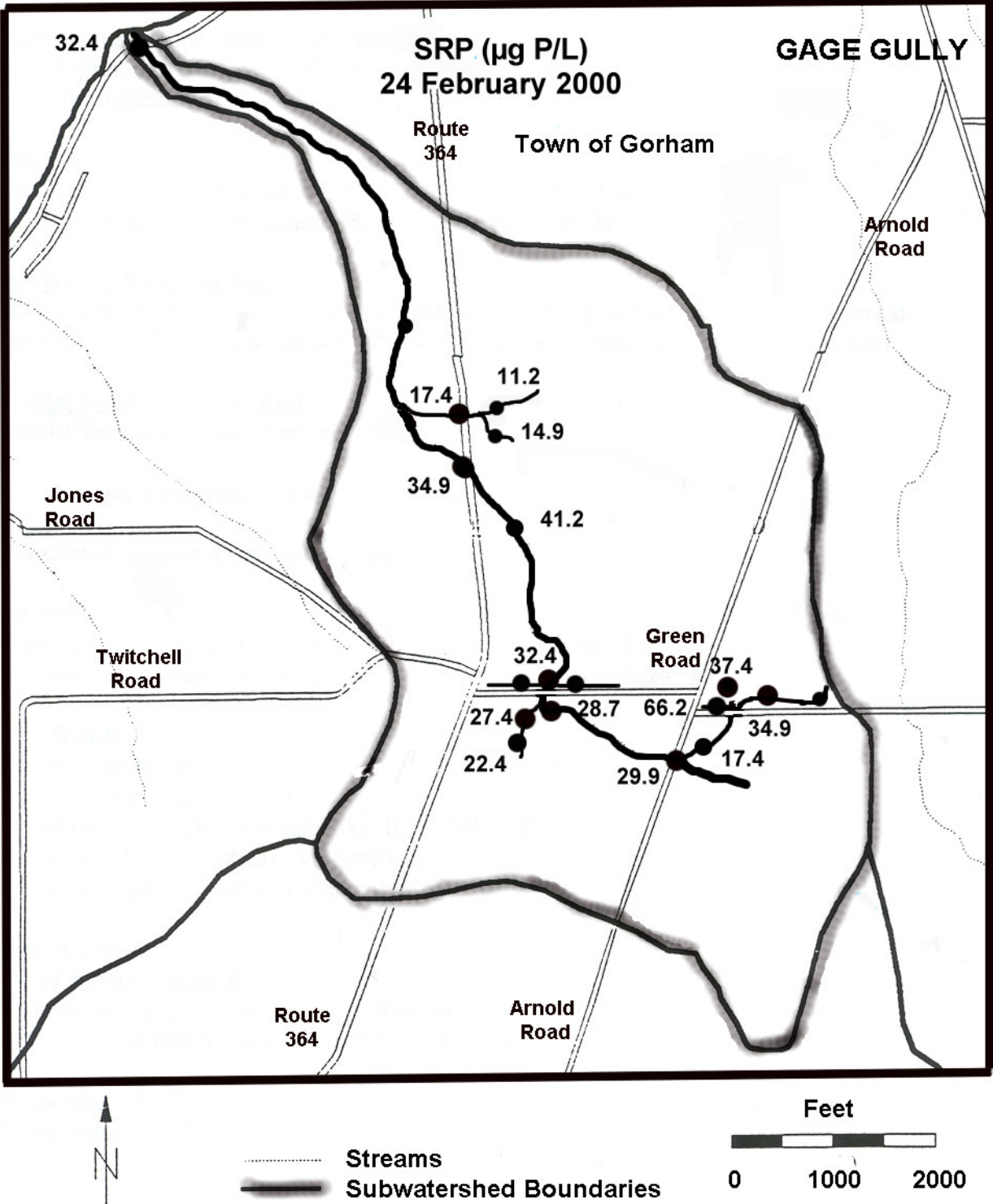


Figure 34. Soluble reactive phosphorus (SRP) concentrations from Gage Gully Stressed Stream Analysis on 24 February 2000.

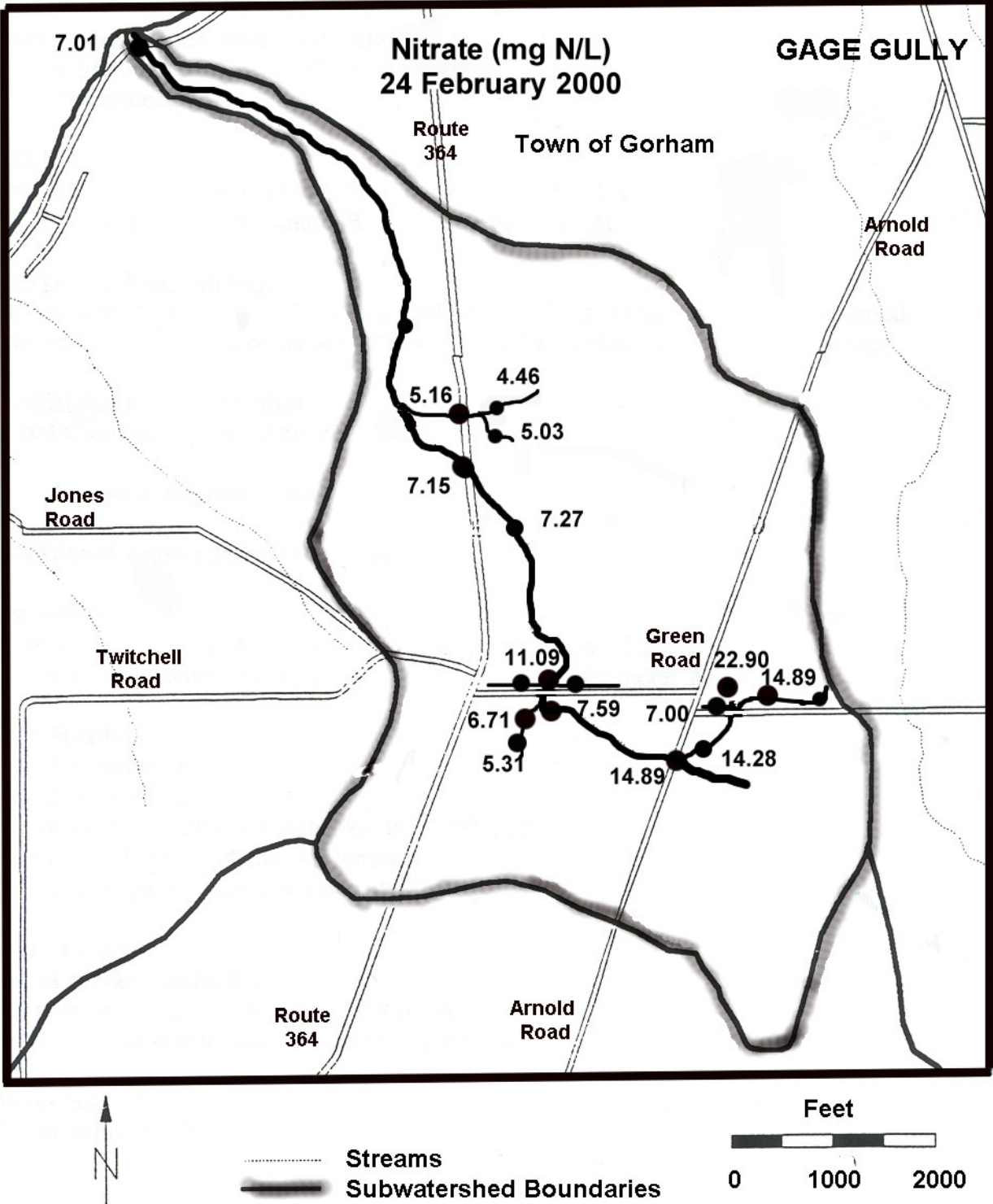


Figure 35. Nitrate concentrations from Gage Gully Stressed Stream Analysis on 24 February 2000.

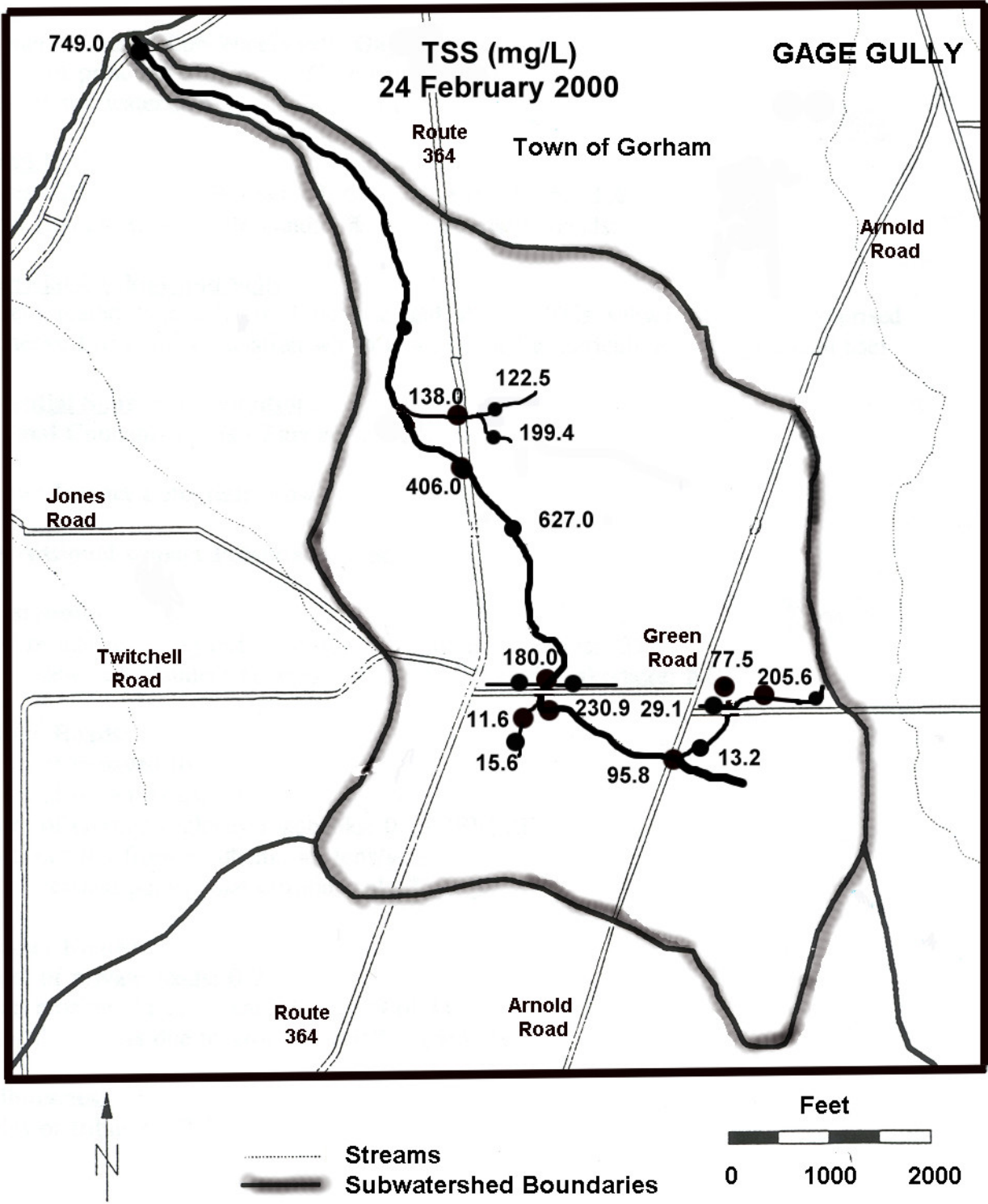


Figure 36. Total suspended solids (TSS) concentrations from Gage Gully Stressed Stream Analysis on 24 February 2000.

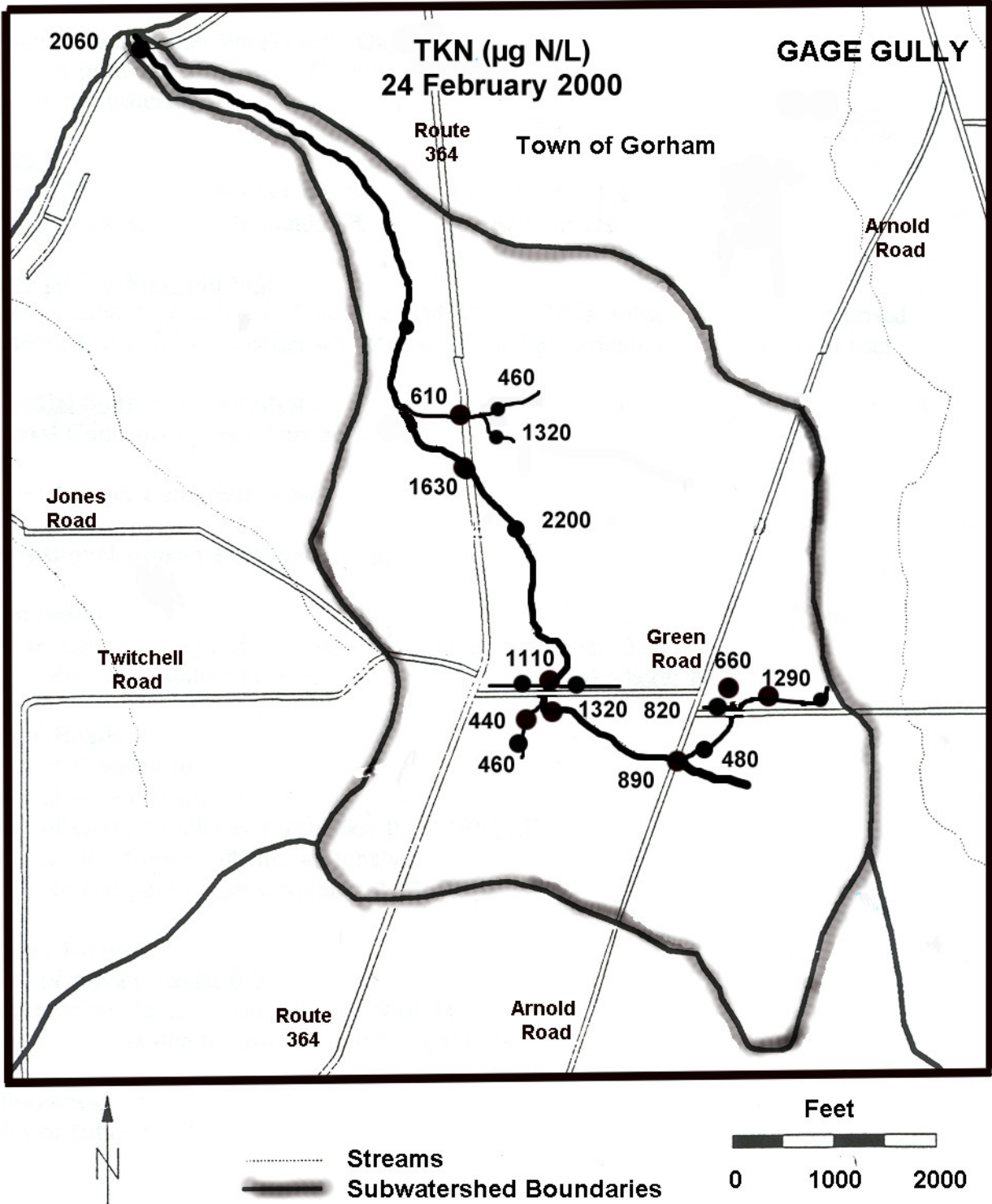


Figure 37. Total Kjeldahl nitrogen (TKN) concentrations from Gage Gully Stressed Stream Analysis on 24 February 2000.

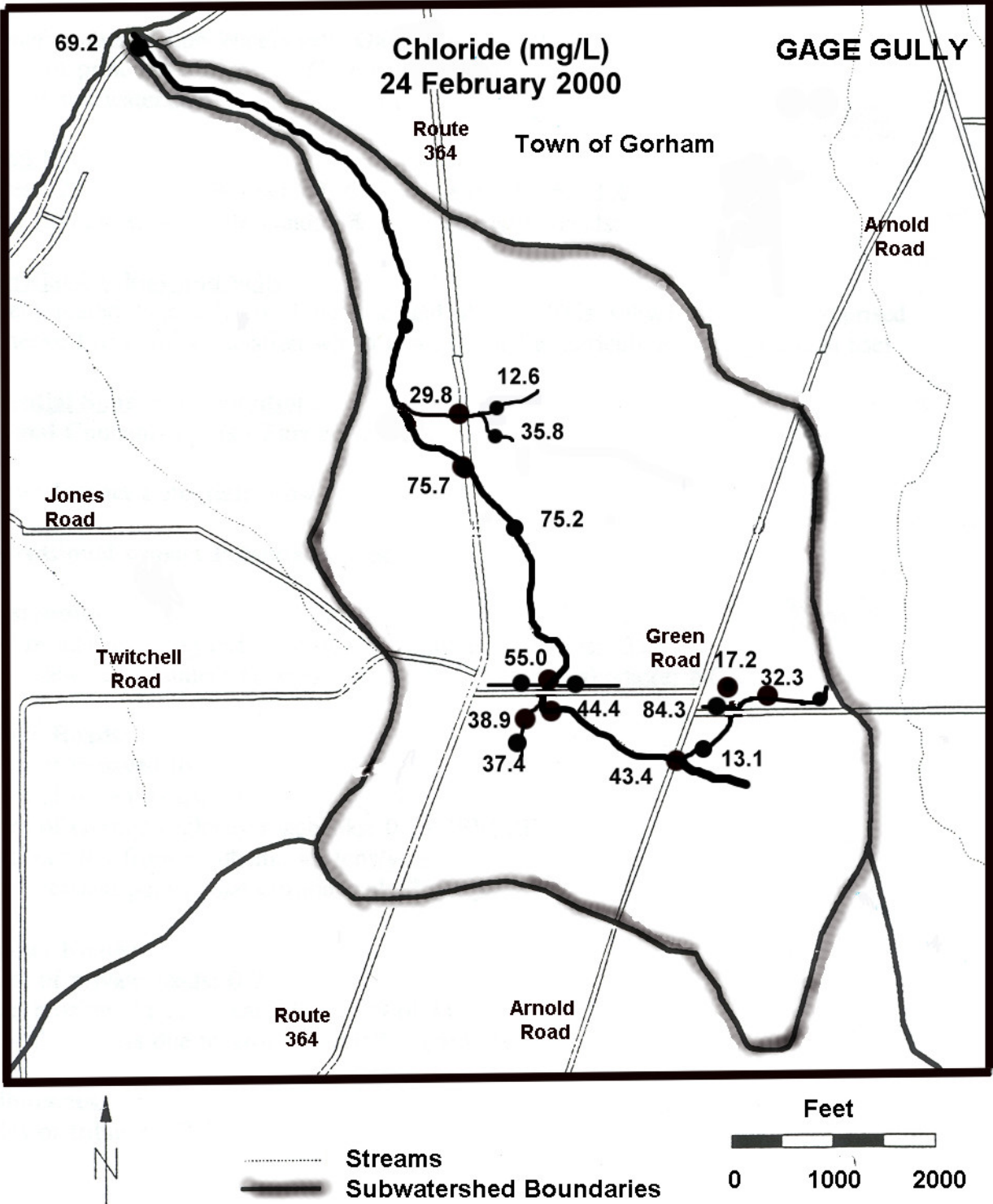


Figure 38. Chloride concentrations from Gage Gully Stressed Stream Analysis on 24 February 2000.

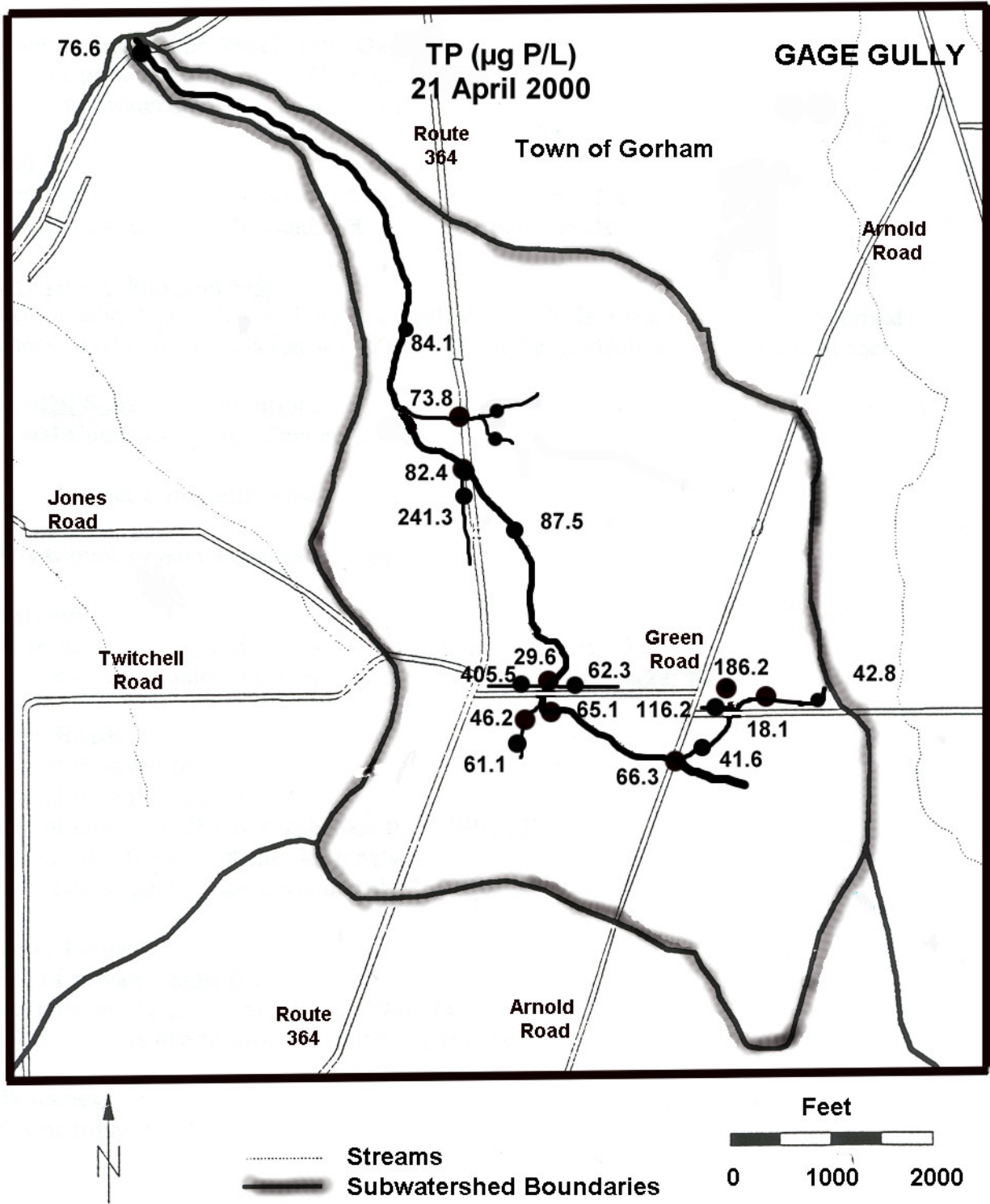


Figure 39. Total phosphorus (TP) concentrations from Gage Gully Stressed Stream Analysis on 21 April 2000.

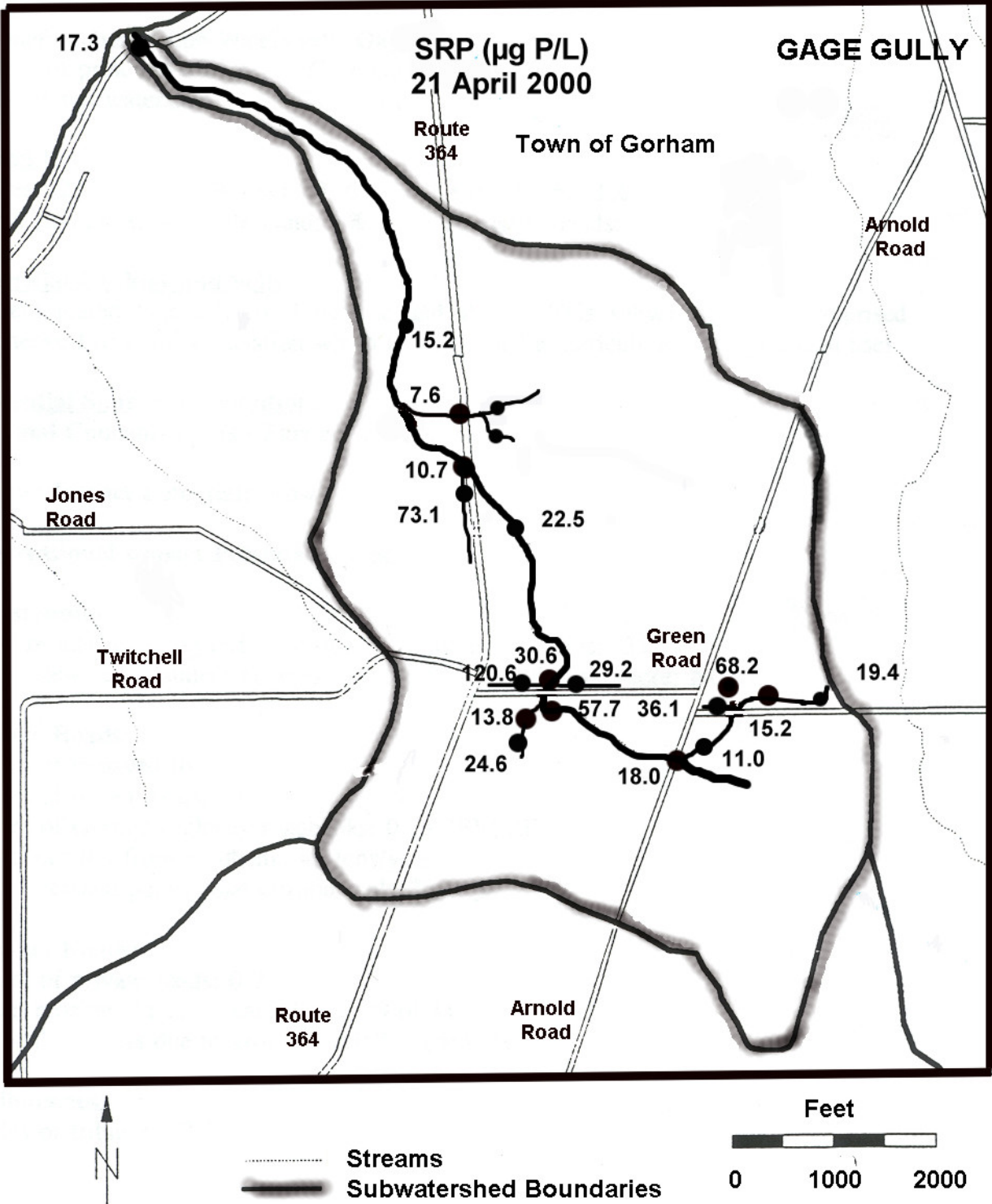


Figure 40. Soluble reactive phosphorus (SRP) concentrations from Gage Gully Stressed Stream Analysis on 21 April 2000.

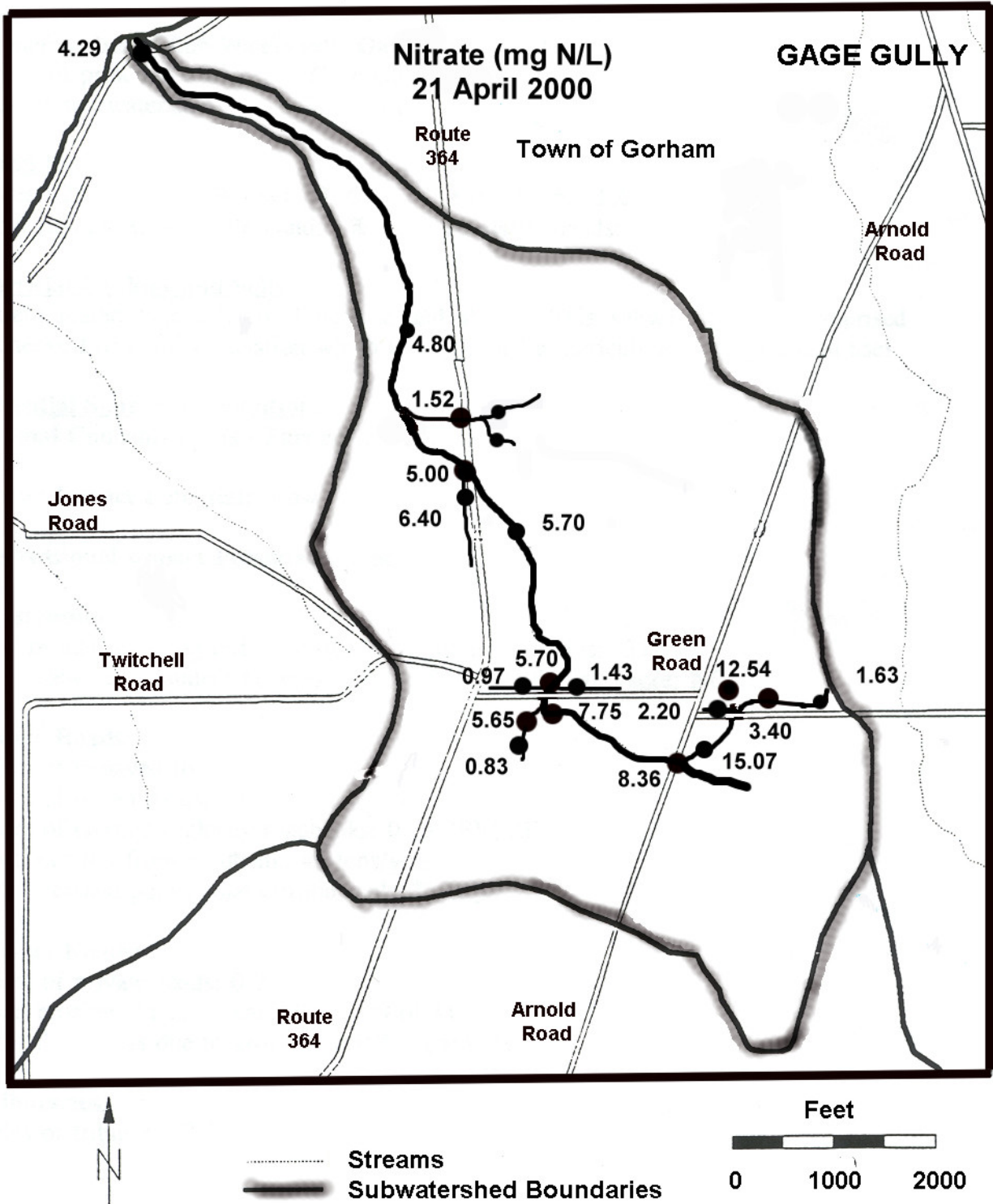


Figure 41. Nitrate concentrations from Gage Gully Stressed Stream Analysis on 21 April 2000.

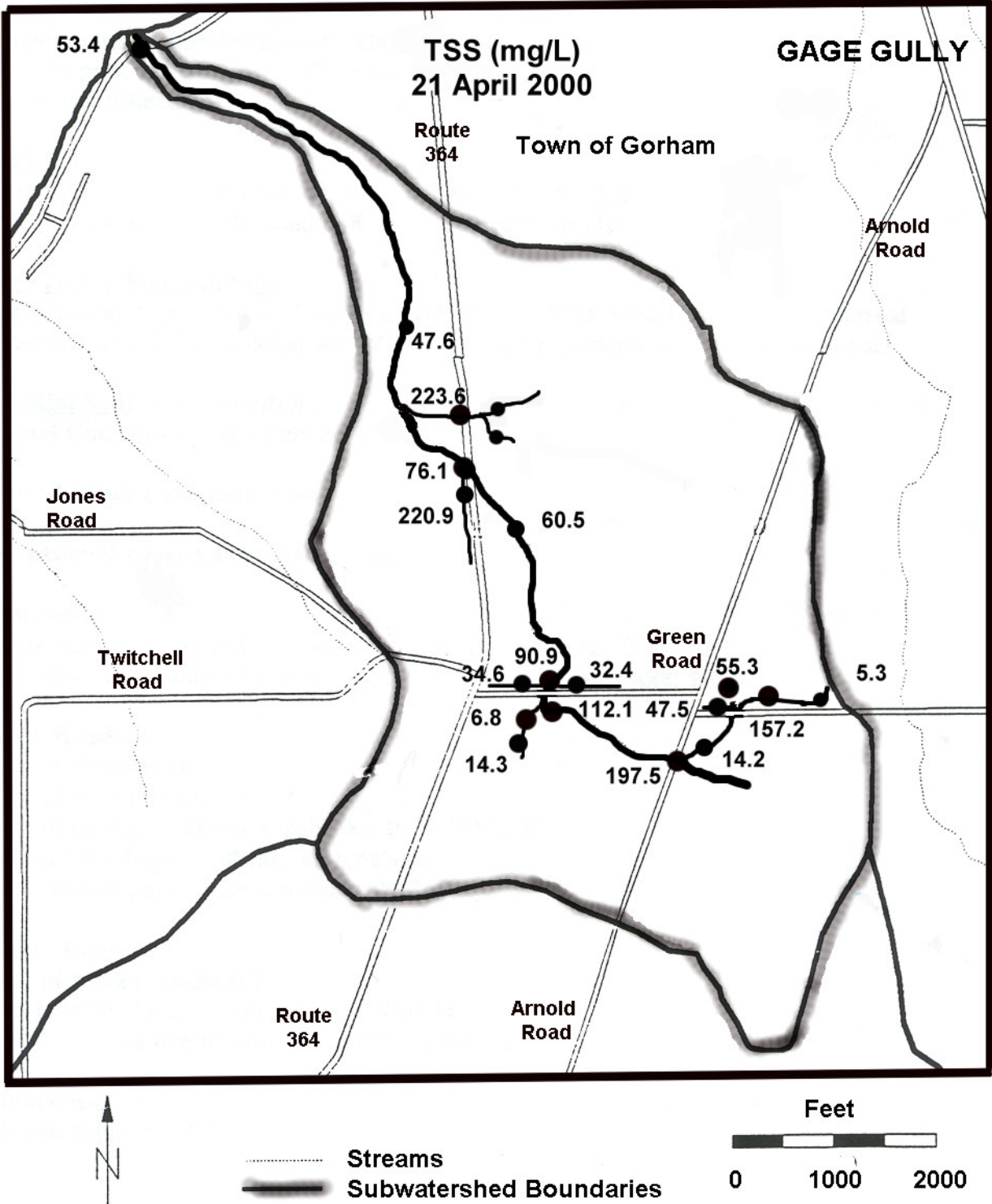


Figure 42. Total suspended solids (TSS) concentrations from Gage Gully Stressed Stream Analysis on 21 April 2000.

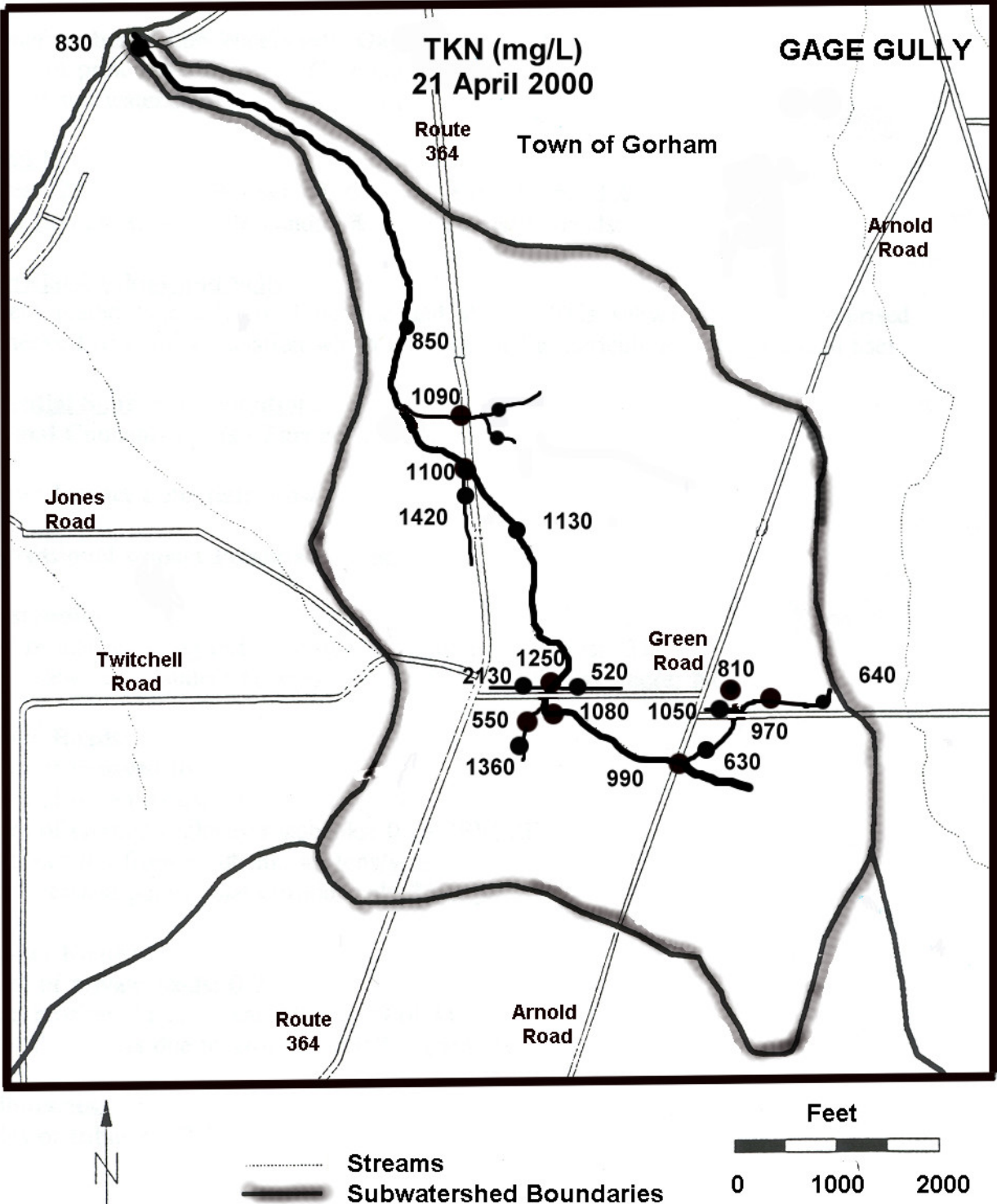


Figure 43. Total Kjeldahl nitrogen (TKN) concentrations from Gage Gully Stressed Stream Analysis on 21 April 2000.

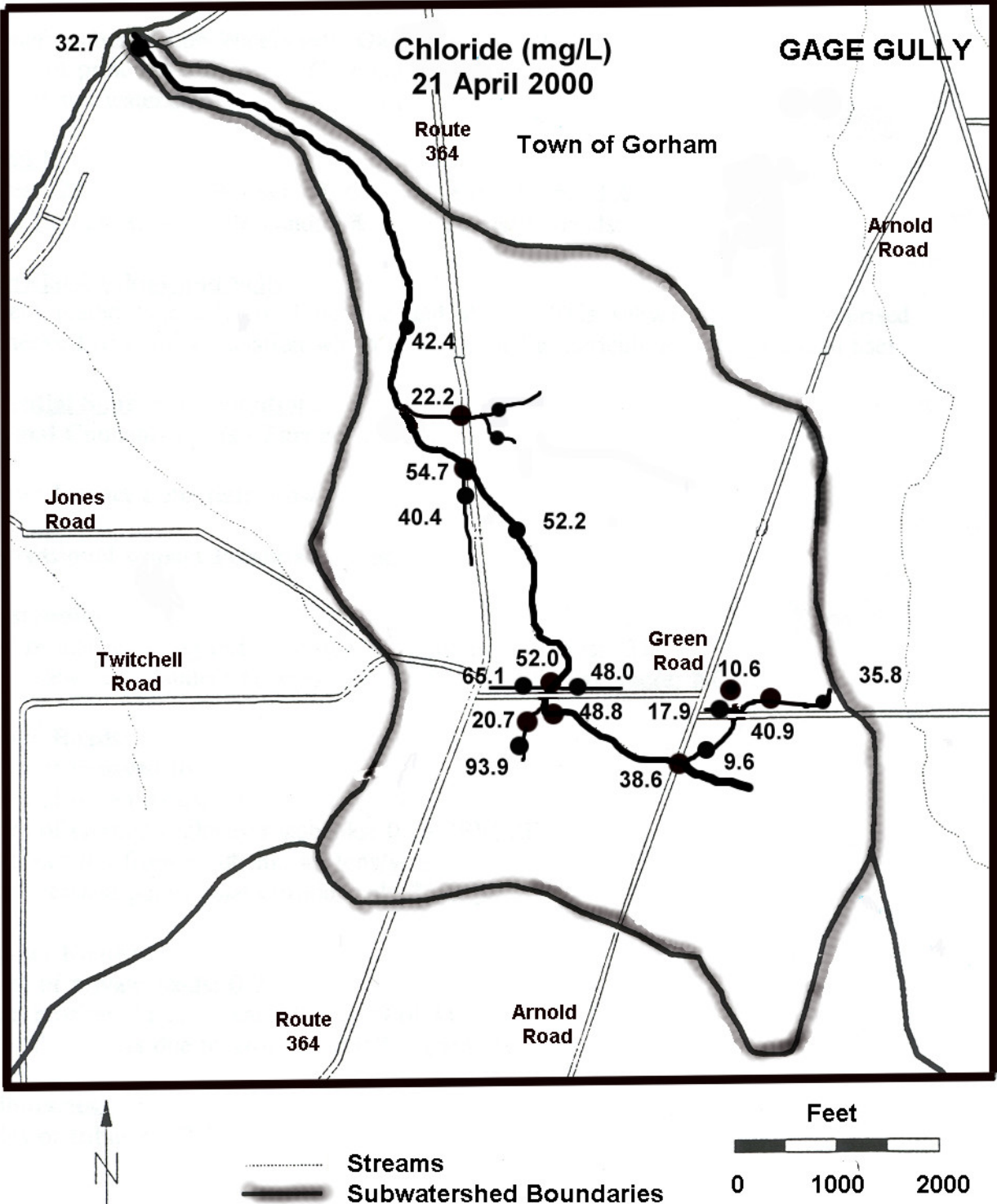


Figure 44. Chloride concentrations from Gage Gully Stressed Stream Analysis on 21 April 2000.

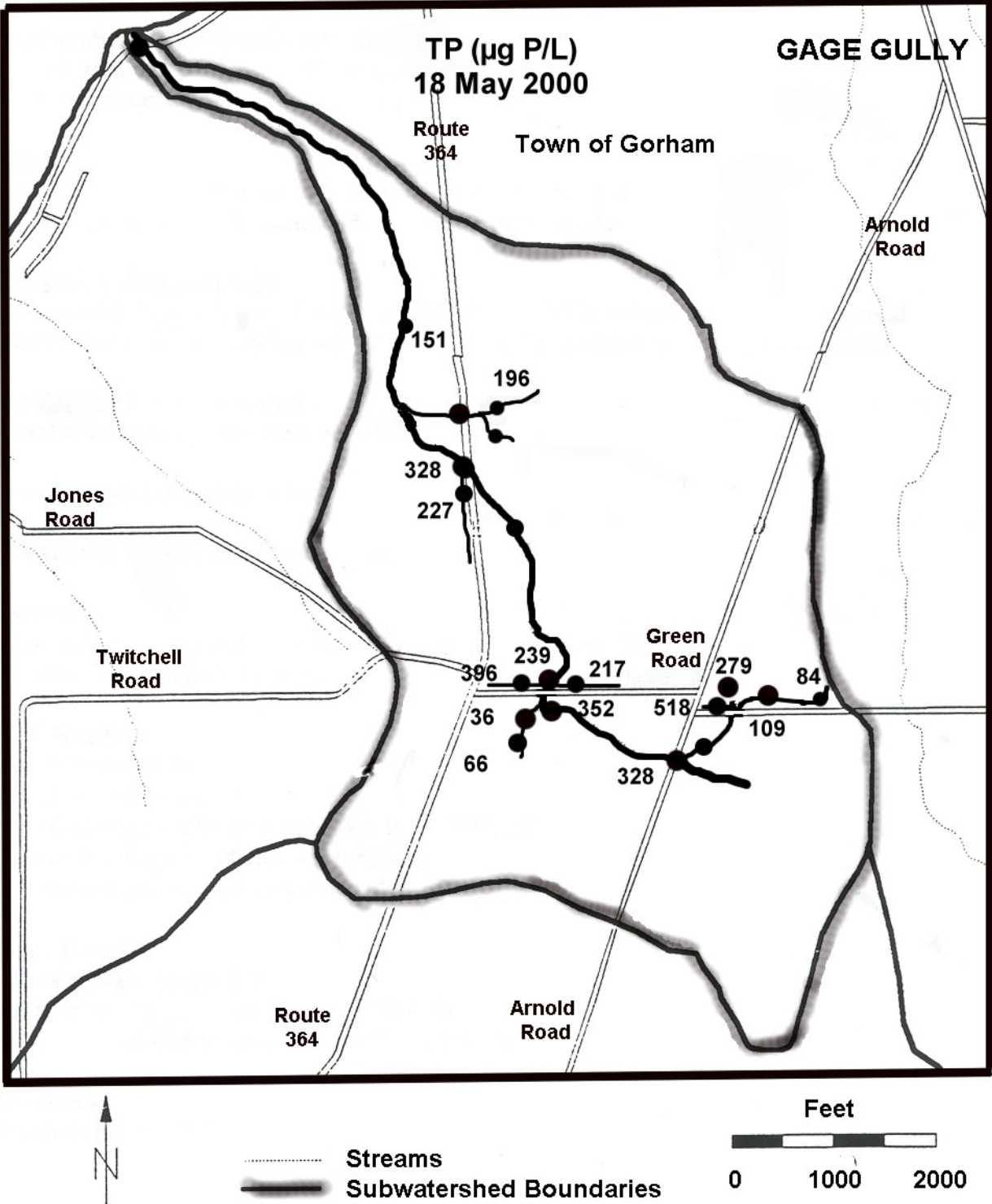


Figure 45. Total phosphorus (TP) concentrations from Gage Gully Stressed Stream Analysis on 18 May 2000.

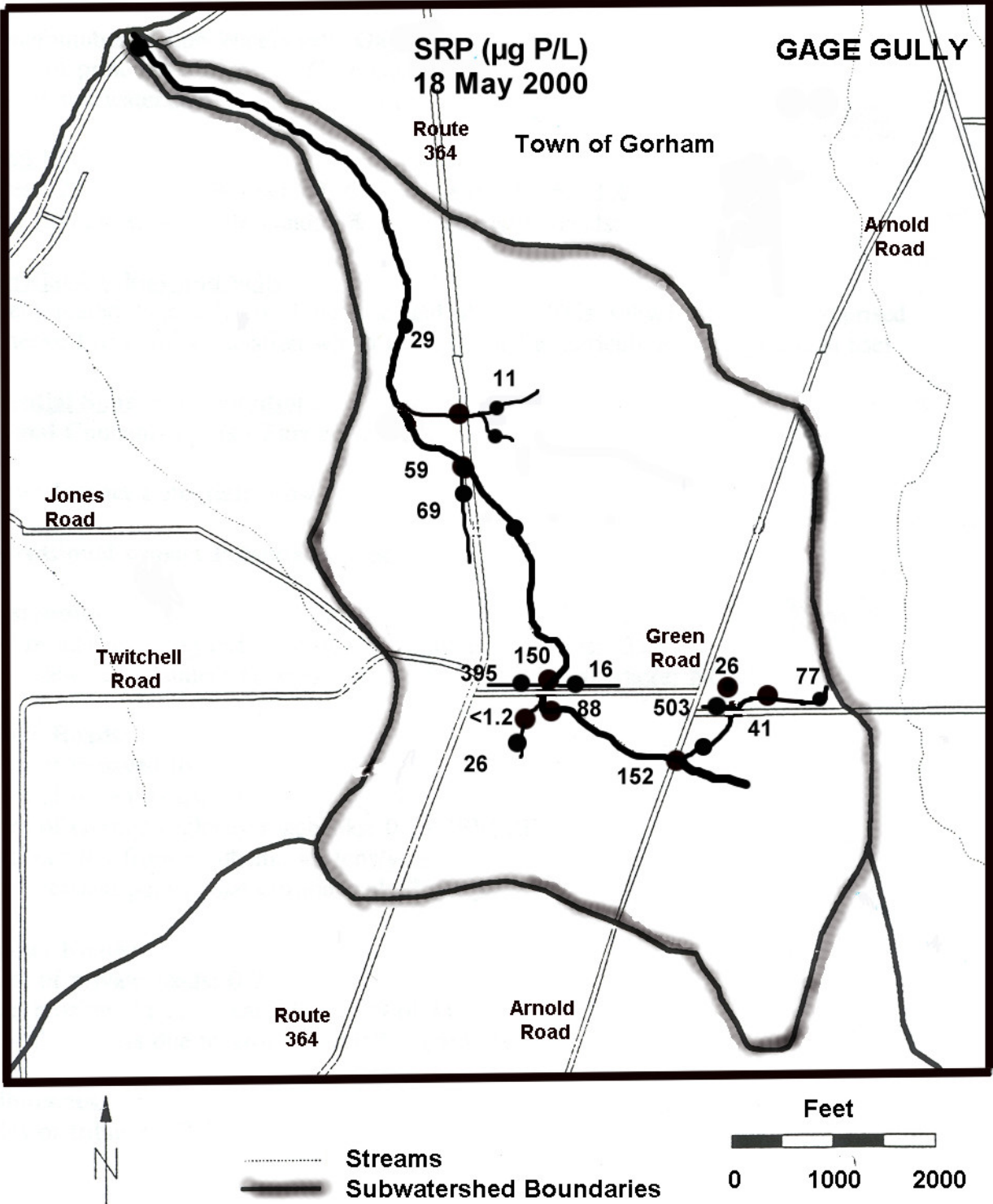


Figure 46. Soluble reactive phosphorus (SRP) concentrations from Gage Gully Stressed Stream Analysis on 18 May 2000.

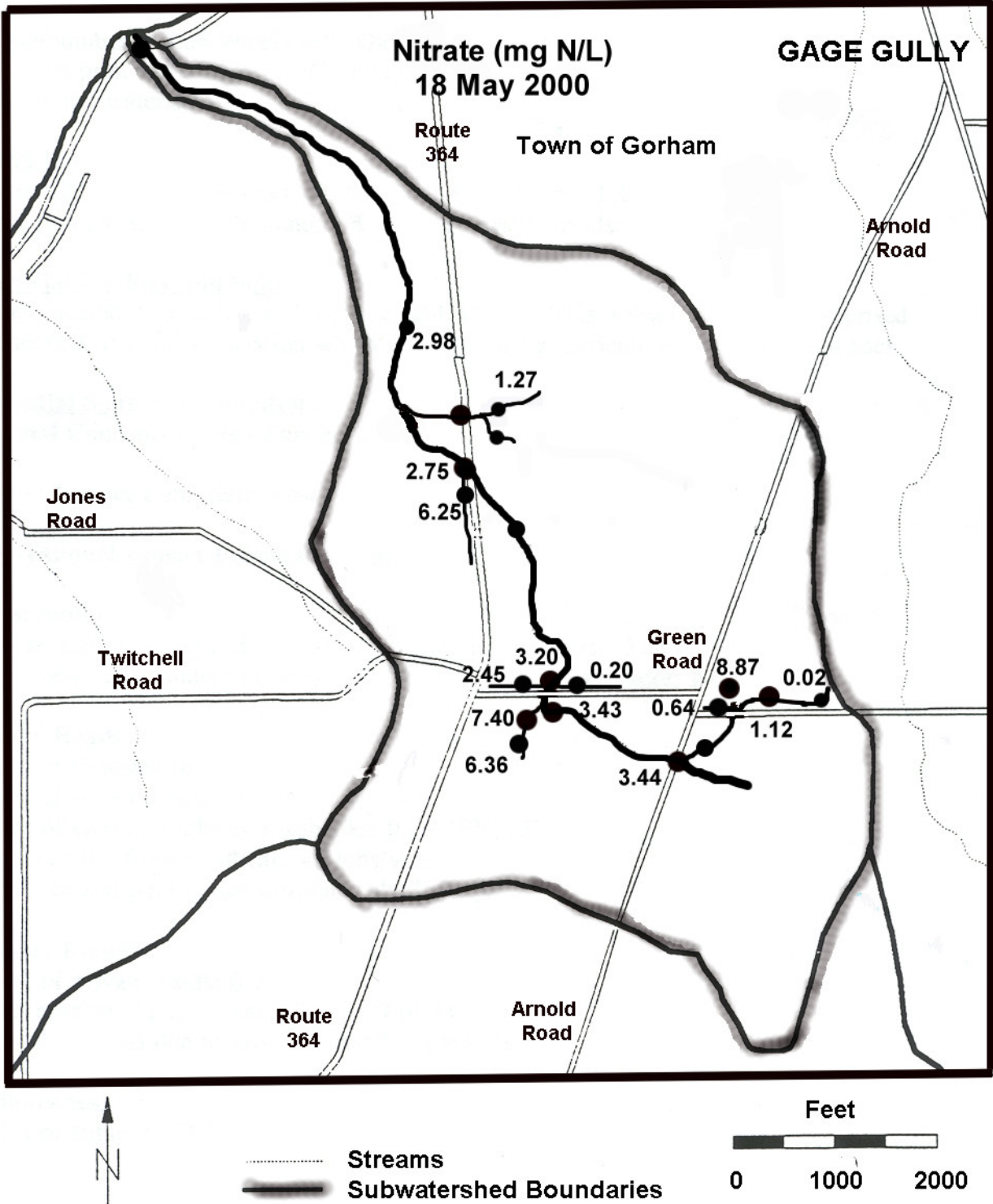


Figure 47. Nitrate concentrations from Gage Gully Stressed Stream Analysis on 18 May 2000.

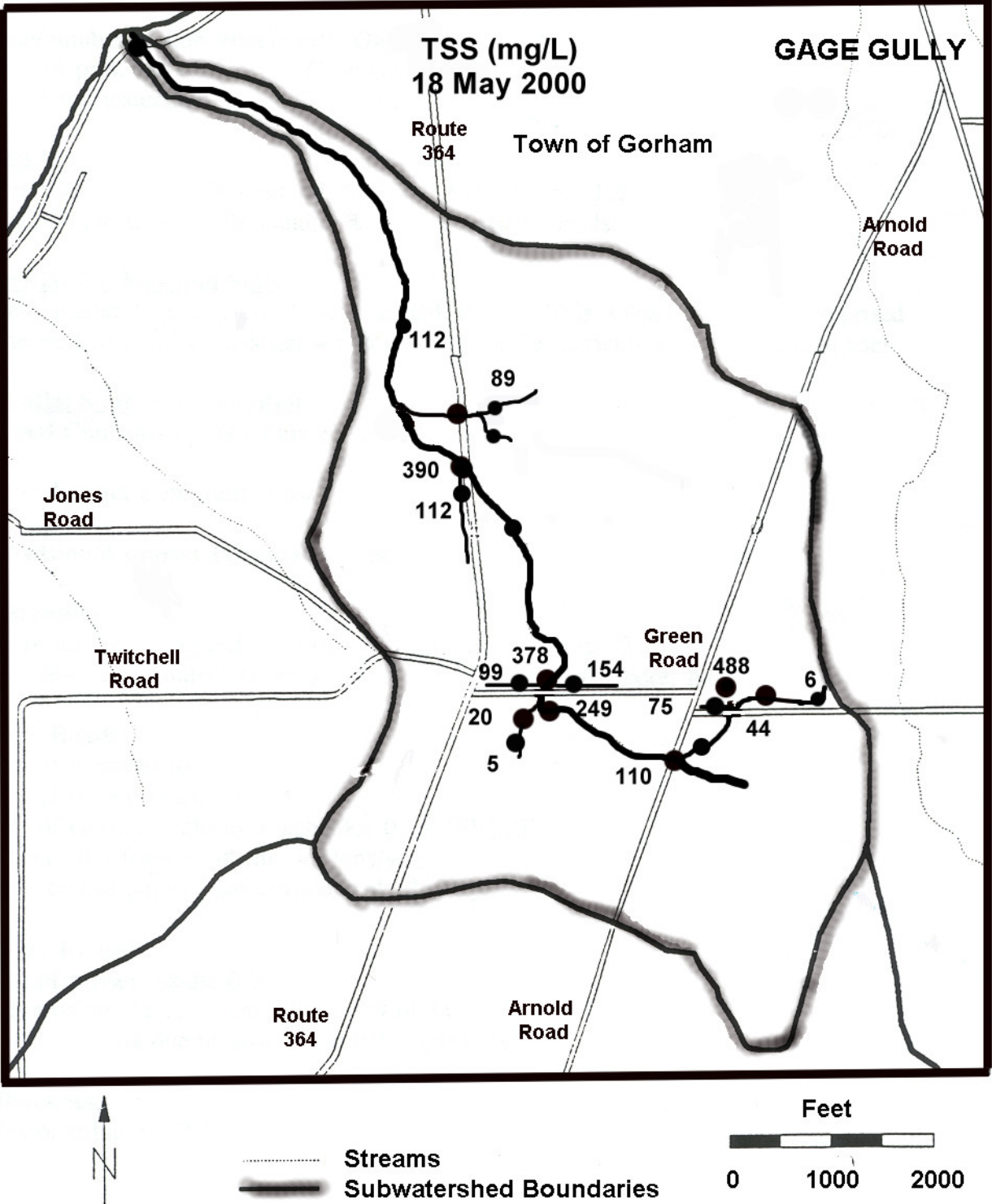


Figure 48. Total suspended solids (TSS) concentrations from Gage Gully Stressed Stream Analysis on 18 May 2000.

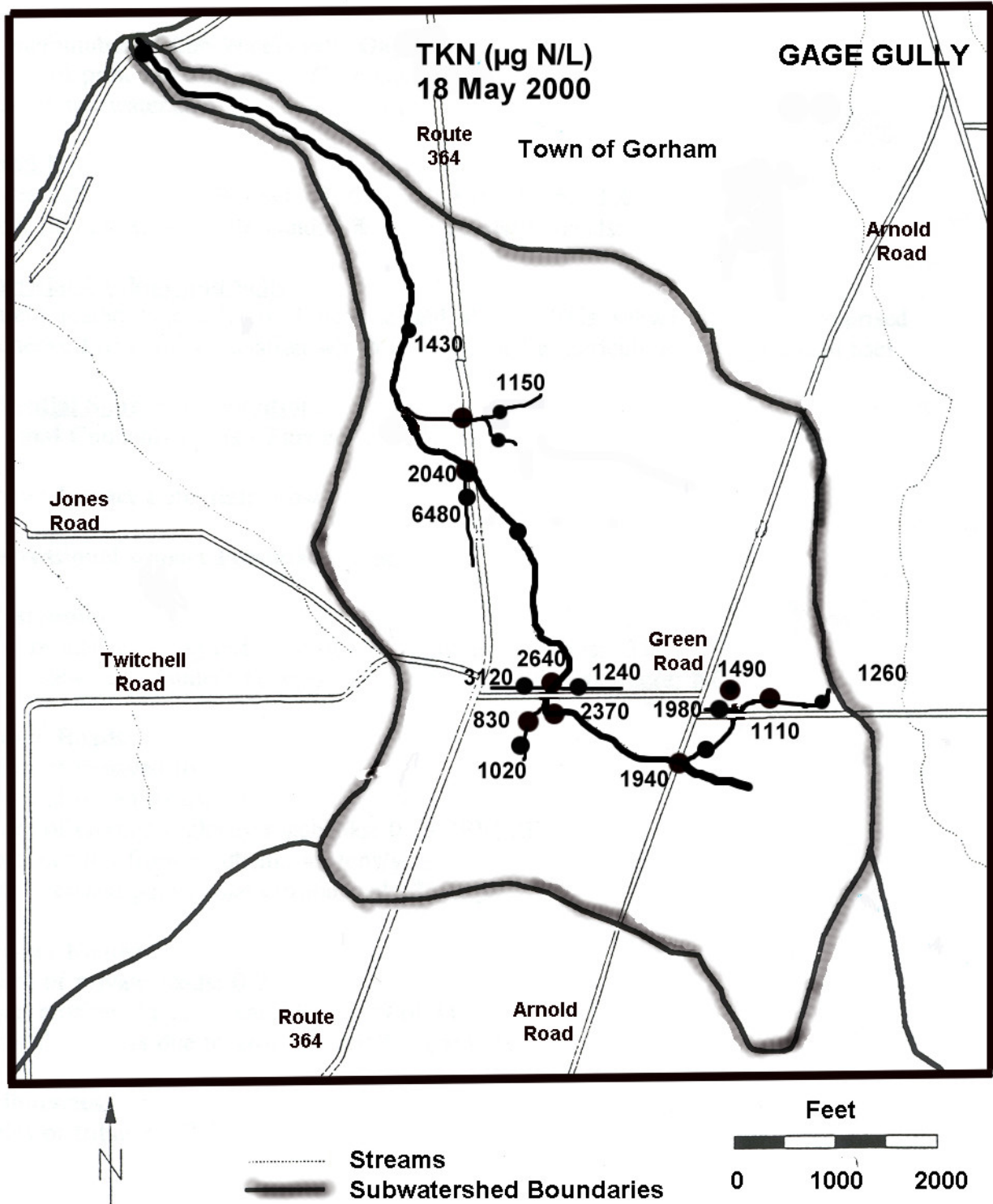


Figure 49. Total Kjeldahl nitrogen (TKN) concentrations from Gage Gully Stressed Stream Analysis on 18 May 2000.

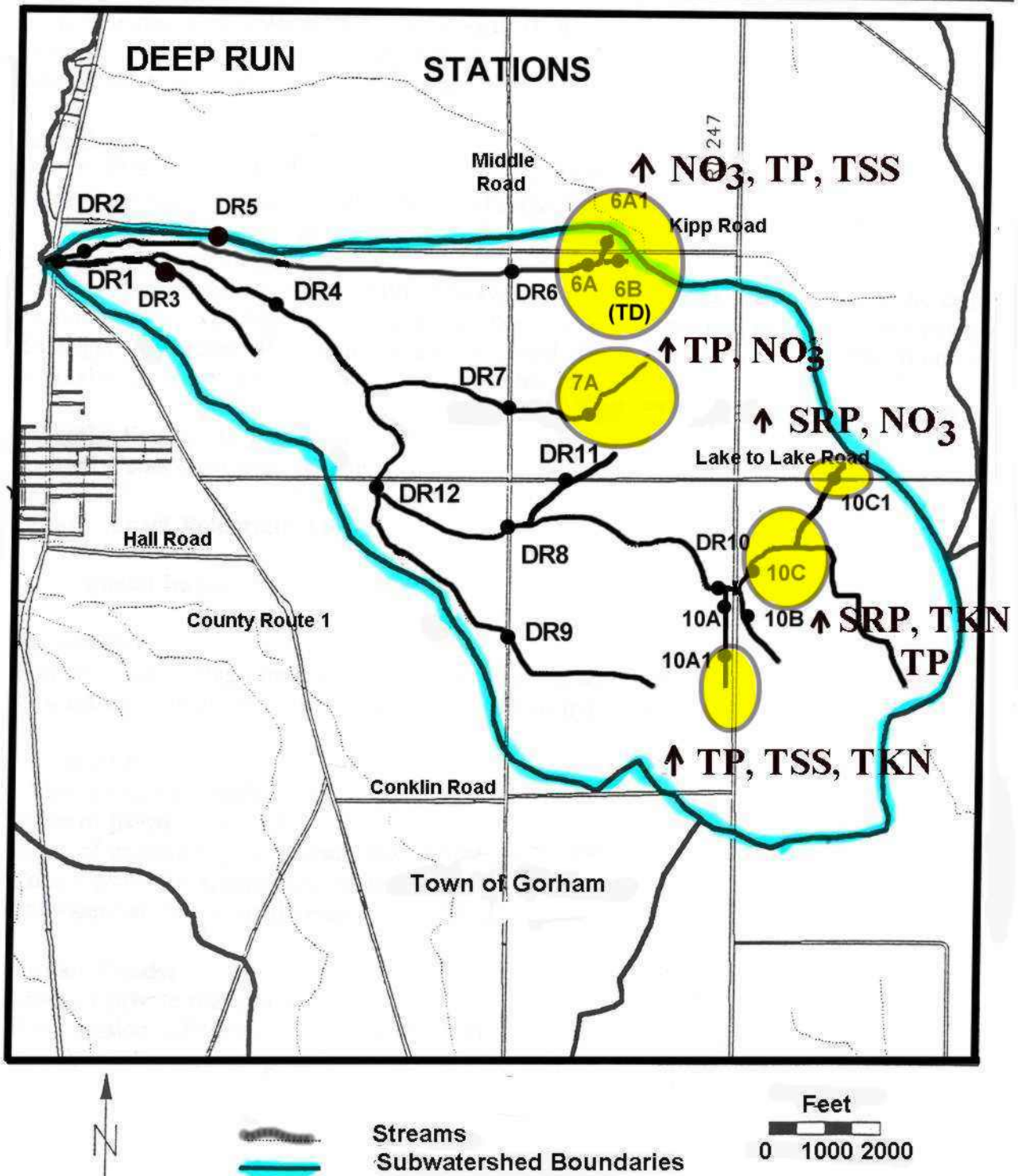


Figure 50. Summary of nutrient and soil sources of pollution in the Deep Run watershed identified using Stressed Stream Analysis, January to May 2000. (TD) = Location of Tile Drain. Circled areas (yellow) represent approximate sources of pollution.

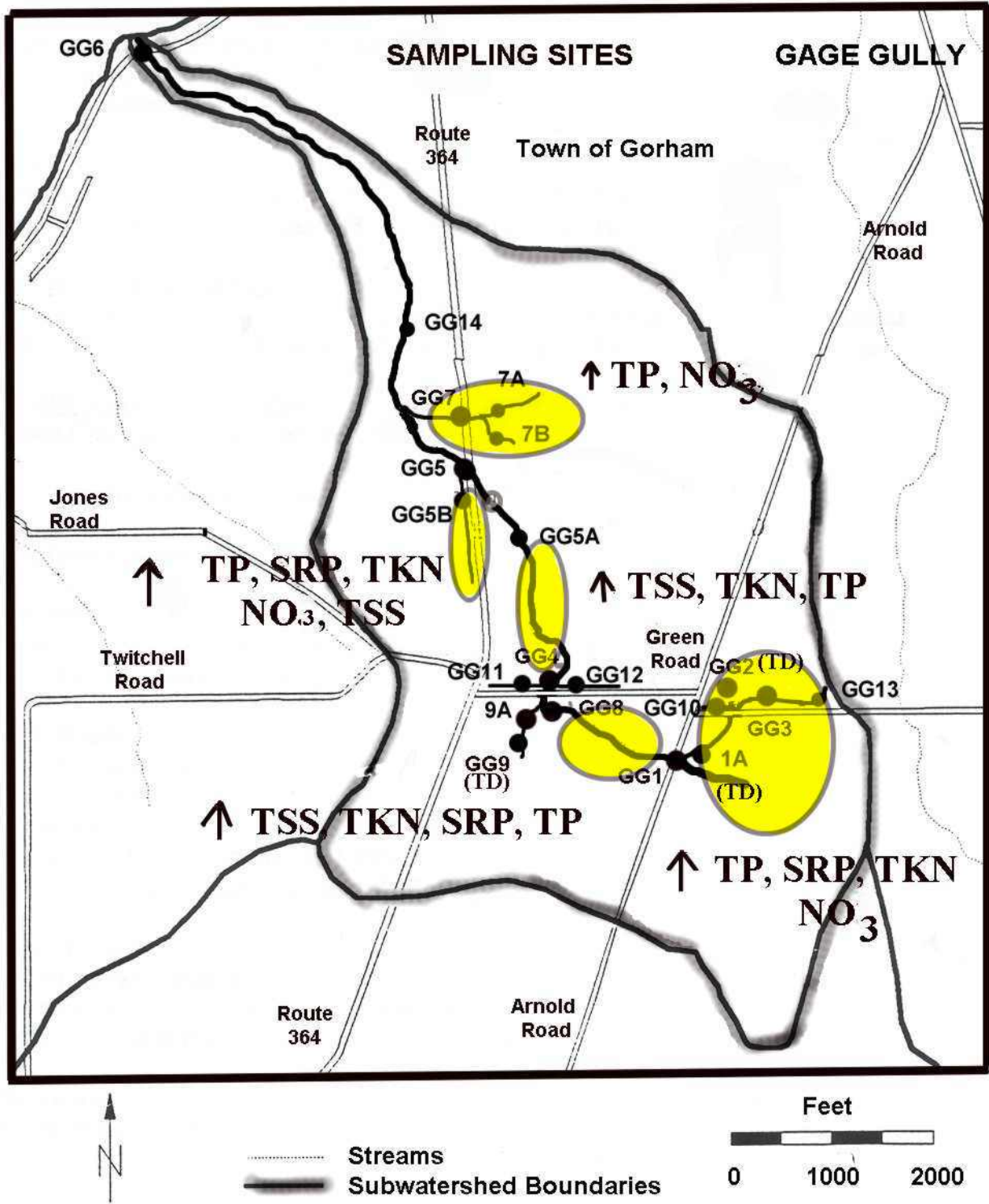


Figure 51. Summary of nutrient and soil sources of pollution in the Gage Gully watershed identified using Stressed Stream Analysis, January to May 2000. TD=Location of a Tile Drain. Circled areas (yellow) approximate source areas of various pollutants.