WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Instream Flow Report for Streams Affected by the City of Cheyenne's Stage II Water Development Project

PROJECT: IF-5090-07-9001

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INTRODUCTION

In 1964, construction was completed on Stage I of the City of Cheyenne's Water Development Project. This project involves the diversion of water from two major drainages in south-central and southeastern Wyoming: the North Fork of the Little Snake River drainage and the Douglas Creek drainage, respectively. Water from the North Fork of the Little Snake River drainage is diverted to a tunnel which passes through the Continental Divide. This water enters Hog Park Creek above Hog Park Reservoir, is stored in the reservoir, and is subsequently released into the North Platte River via Hog Park Creek and the Encampment River. Water entering the North Platte River by this system replaces water diverted to Cheyenne's water supply from the Douglas Creek drainage. Water from Douglas Creek and several of its tributaries is diverted to Lake Owen and then to Middle Crow Creek via a series of pipelines; from Middle Crow Creek, the water enters Granite and Crystal Reservoirs for controlled releases to the City of Cheyenne.

Stage II of the City of Cheyenne's Water Development Project is an expansion of the collection systems in both the North Fork of the Little Snake and the Douglas Creek drainages. Water for Stage II is diverted from a total of 16 streams which support trout fisheries (Figures 1 through 16). All of the streams in the North Fork Little Snake River drainage (Table 1) contain Colorado River cutthroat trout, a species whose status is listed as sensitive in Wyoming. Protection, maintenance and improvement of Colorado River cutthroat trout populations and their habitat is a high management priority of both the Wyoming Game and Fish Department (WGFD) and the U.S. Forest Service, as indicated by the signing of a Memorandum of Understanding (signed February 9, 1977) by the two agencies.

Table 1. Instream flow segments for streams in the North Fork Little Snake River drainage from which water is diverted under Stage II of the City of Cheyenne's Water Development Project.

Stream	Class	Upstream Boundary	Downstream Boundary	Approx. Reach Length (miles)
N. Fk. Little Snake R.[1]	3	NW 1/4 S26 T13N, R85W	NW 1/4 S14 T12N, R86W	9.1
Green Timber Creek[1]	4	NE 1/4 S34 T13N, R85W	NE 1/4 S4 T12N, R85W	1.7
Rose Creek[2]	4	NE 1/4 S16 T12N, R85W	NE 1/4 S18 T12N, R85W	2.2
Ted Creek[1]	4	NE 1/4 S27 T13N, R85W	NE 1/4 S27 T13N, R85W	0.3
Third Creek[1]	4	SE 1/4 S21 T13N, R85W	NW 1/4 S27 T13N, R85W	0.7
Deadman Creek[3]	4	NE 1/4 S29 T13N, R85W	NE 1/4 S33 T13N, R85W	1.3
Harrison Creek[3]	4	SE 1/4 S29 T13N, R85W	NW 1/4 S4 T12N, R85W	1.8
Solomon Creek[3]	4	NE 1/4 S31 T13N, R85W	SW 1/4 S7 T12N, R85W	3.4
Rabbit Creek[2]	4	SE 1/4 S24 T13N, R86W	NE 1/4 S26 T13N, R86W	1.2
West Branch, N. Fk. Little Snake R.[3]	3	SE 1/4 S18 T13N, R85W	NW 1/4 S14 T12N, R86W	7.4

1 - Data collected by Jesperson (1980)
2 - Data collected by Jesperson (1979)
3 - Data collected by Wesche (1977)

Streams in the Douglas Creek drainage (Table 2) are all managed as wild trout fisheries. Maintenance of wild trout fisheries is a high priority of the WGFD because they cost less to manage and wild trout are generally preferred over hatchery trout by most anglers. These streams are primarily managed for brook trout only or brook and brown trout.

Table 2. Instream flow segments for streams in the Douglas Creek drainage from which water is diverted under Stage II of the City of Cheyenne's Water Development Project.

Stream	Class	Upstream Boundary	Downstream Boundary	Approx. Reach Length (miles)
Douglas Creek[1]	3	NE 1/4 S9, T14N, R79W	NW 1/4 S6, T13N, R80W	22.3
Nugget Gulch[1]	4	SE 1/4 S14 T14N, R79W	SE 1/4 S14 T14N, R79W	0.1
Little Beaver Creek[1]	4	SE 1/4 S14 T14N, R79W	SW 1/4 S22 T14N, R79W	1.9
Camp Creek[1]	4	SE 1/4 S13 T14N, R79W	NE 1/4 S19 T14N, R78W	1.2
Lake Creek[1]	3	NW 1/4 S33 T14N, R78W	NW 1/4 S11 T13N, R79W	5.8
Horse Creek[1]	4	SW 1/4 S16 T14N, R79W	SE 1/4 S16 T14N, R79W	0.1

1 - Data collected by Jesperson (1980)

Data were collected during 1976, 1978, and 1979 to conduct instream flow analyses for each of the streams listed in Tables 1 and 2. This report summarizes those studies and was prepared in compliance with instream flow legislation to support a Wyoming Water Development Commission application for an instream flow water right. The specific objective of these studies was to determine year-round instream flows necessary to maintain habitat for trout spawning, cover and aquatic insect production. The maintenance flow recommendations resulting from these studies were incorporated as conditions of the City of Cheyenne's easement on the Medicine Bow National Forest in 1982.

METHODS

Study Sites

The field data used in this study were collected from study sites located at or just downstream from Stage II diversion sites. Legal descriptions for each study site as well as additional instream flow study details are provided in Wesche (1977) and Jesperson (1979, 1980). Each study site contained trout habitat that was representative of habitat features found throughout the instream flow segment of each stream.

For each of the streams listed in Tables 1 and 2, the Stage II diversion structures and the mouth of the stream were identified as the upstream and downstream boundaries of the instream flow segments, respectively. Each of these instream flow segments are contained within the Medicine Bow National Forest and are accessible to

the public. Because they also support important trout fisheries, these stream segments were identified as critical stream reaches.

Models

Two techniques were used to determine instream flow recommendations for the streams listed in Tables 1 and 2. The technique described by Wesche (1977) was used on four of the streams (Table 1) to quantify the available habitat for spawning, cover and food production at a range of simulated flows. Water depth, velocity, top width, wetted perimeter, hydraulic radius, cross-sectional area, and substrate were measured for a single discharge along transects established at each site. Transects were located at 25 foot intervals along the stream bank. Velocity and depth were measured at sufficient intervals along each transect to depict changes in stream bottom morphology.

Available habitat was defined as the area of the stream which met defined hydraulic criteria for depth, velocity and substrate (Table 3). These criteria were compared to the hydraulic data for each habitat, and the width of each transect which met all three of the criteria for a given habitat type was determined. The "habitat" widths for all transects at a site were summed and then divided by the sum of all wetted transect widths for the site. This yielded an estimate of the percentage of the site which met the criteria for a given habitat type. Multiplying this percentage by the total area of the study site produced an estimate of the available habitat.

Manning's equation was used to calculate discharges at various water stages. For each of these discharges, the amount of available habitat was determined. A plot of available habitat versus discharge for several "key" cross-sections (cross-sections which provided the majority of the given habitat type) was then generated. The flow recommendation was identified as the flow below which decreases in discharge resulted in the greatest reductions in available habitat (the inflection point of the curve). Since trout spawning habitat and/or cover were determined to be the habitat types most limiting to trout populations in these streams, recommendations for these streams were based on available habitat for these two habitat types.

Table 3. Criteria used to define habitat for trout spawning, cover and food production areas (from Jesperson 1980).

Habitat Type	Depth (feet)	Velocity (feet/second)	Substrate
Spawning			
Brown trout	$\geq$ 0.3	0.45-1.50	fine to coarse gravel
Brook trout	$\geq$ 0.2	0.12-1.11	fine to coarse gravel
Cutthroat trout	0.2-0.9	0.35-1.25	fine to coarse gravel
Cover (resting)	$\geq$ 0.5	< 0.5	cobble or boulder
Food production	< 1.0	> 0.5	cobble

The technique described by Jesperson (1979, 1980) was used for the remaining 12 streams (Tables 1 and 2). Data from single transects placed across each type of fish habitat within a study area were analyzed with the R-2 Cross computer program (Silvey 1976). The R-2 Cross program was used to simulate depths and velocities over a range of discharges. Flows which provided the hydraulic parameters at a level satisfying species-habitat criteria (Table 3) were identified for each cross-section in a study site. The final flow recommendation resulted from the average of the flows from all transects in a study site.

Rose Creek presented special problems, since the stream was divided into three channels at the diversion site. This prevented the application of the habitat measurement techniques used on other streams. Since flow data could not be collected in Rose Creek at the diversion site, the recommendation for Rose Creek was based on a comparative analysis of streams with similar trout habitat. For each of those other streams, the recommended instream flow was divided by the average daily flow (ADF) and expressed as a percentage of ADF. The percentages of ADF for each of these streams were then averaged and multiplied by the average daily flow of Rose Creek to determine the flow recommendation for Rose Creek.

RESULTS

Flow recommendations derived from the methods described by Wesche (1977) and Jesperson (1979, 1980) are summarized for each stream (Table 4). These recommendations apply to each stream segment defined by the location of the Stage II diversion downstream to the mouth of the stream (Table 2). Each instream flow recommendation applies to the entire year.

Table 4. Summary of year-round instream flow recommendations to maintain existing trout fisheries in streams affected by Stage II of the City of Cheyenne's water project.

Stream	Year-Round Instream Flow Recommendation[1] (cfs)
Douglas Creek	5.5
Rose Creek	0.75
Green Timber Creek	1.0
North Fork Little Snake River	2.0
Ted Creek	1.0
Third Creek	1.0
Deadman Creek	2.0
Harrison Creek	1.0
Solomon Creek	1.0
Rabbit Creek	1.5
West Branch, North Fork Little Snake R.	3.5
Nugget Gulch Creek	0.2
Little Beaver Creek	0.35
Camp Creek	0.2
Lake Creek	0.5
Horse Creek	0.2

1 - Or the natural flow, whichever is less

REFERENCES

Jesperson, D.M. 1980. Instream flow determination for stream affected by Stage I and Stage II of the city of Cheyenne water development project in the Douglas Creek drainage and supplemental flow recommendations in the North Fork of the Little Snake River drainage. U.S. Forest Service Report, Medicine Bow National Forest, Laramie, WY. 129 pp.

_____. 1979. Instream flow determination and impact evaluation of water diversion on the Colorado River cutthroat trout and brook trout in the North Fork and Roaring Fork of the Little Snake River drainage. U.S. Forest Service Report, Medicine Bow National Forest, Laramie, WY. 109 pp.

Silvey, L. 1976. R-2 Cross Program, a sag-tape method of channel cross section measurement for use with instream flow determinations. A U.S.F.S. publication, Region 2.

Wesche, T.A. 1977. Fishery resources and instream flow recommendations for streams to be impacted by Cheyenne's proposed Phase II development. Report submitted to

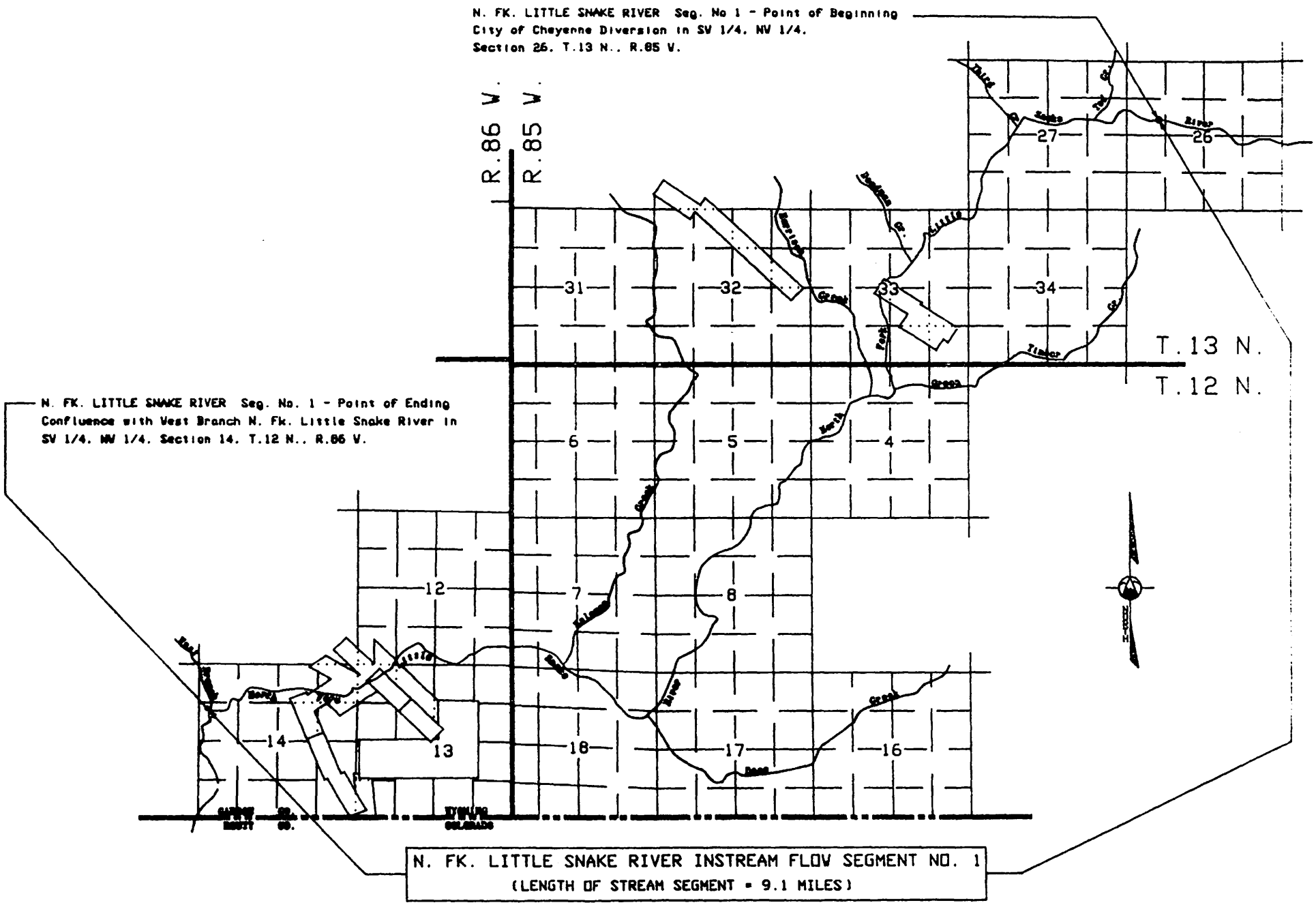

Figure 1. Location of the instream flow reach on North Fork of the Little Snake River.

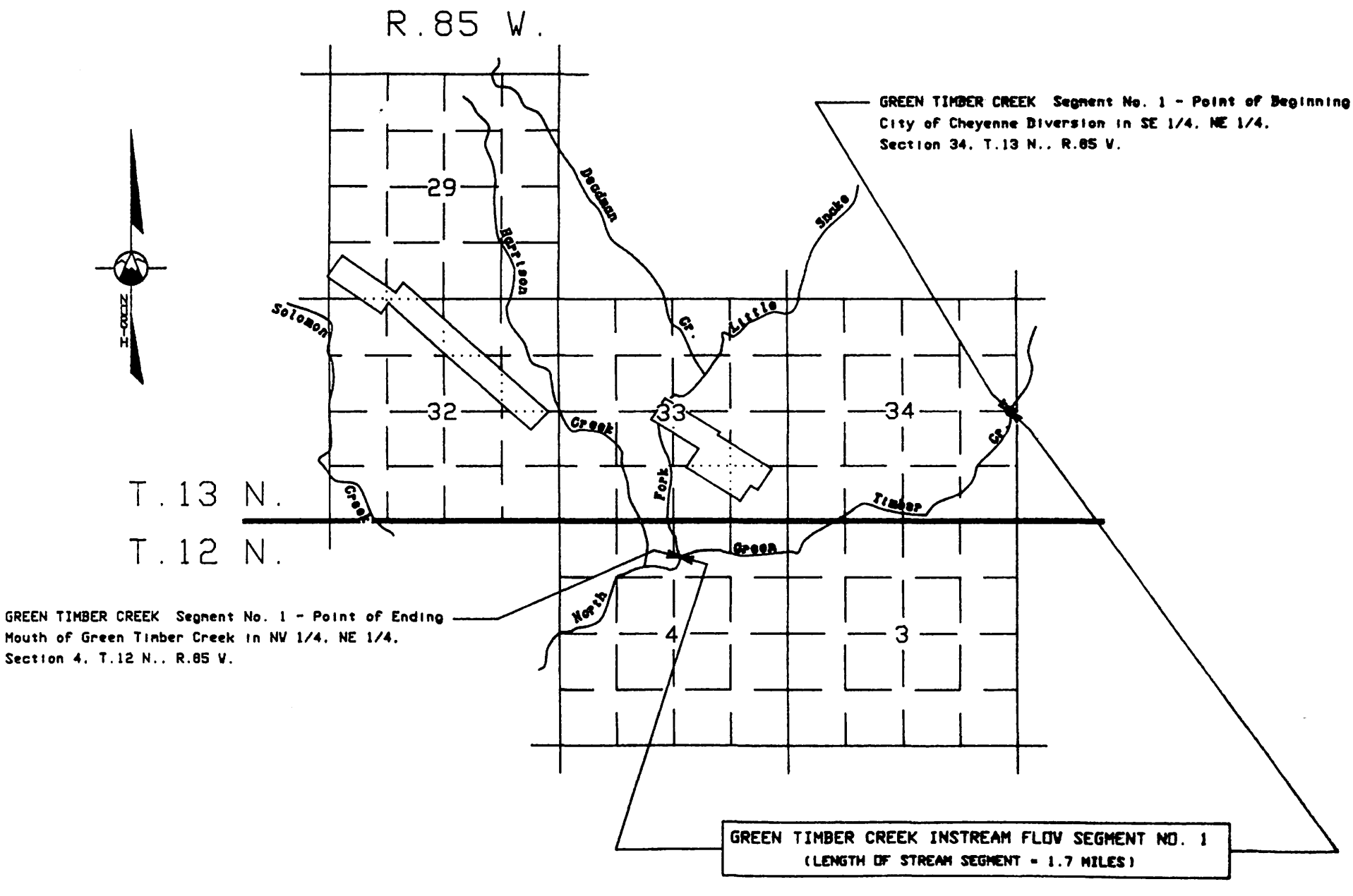

Figure 2. Location of the instream flow reach on Green Timber Creek.

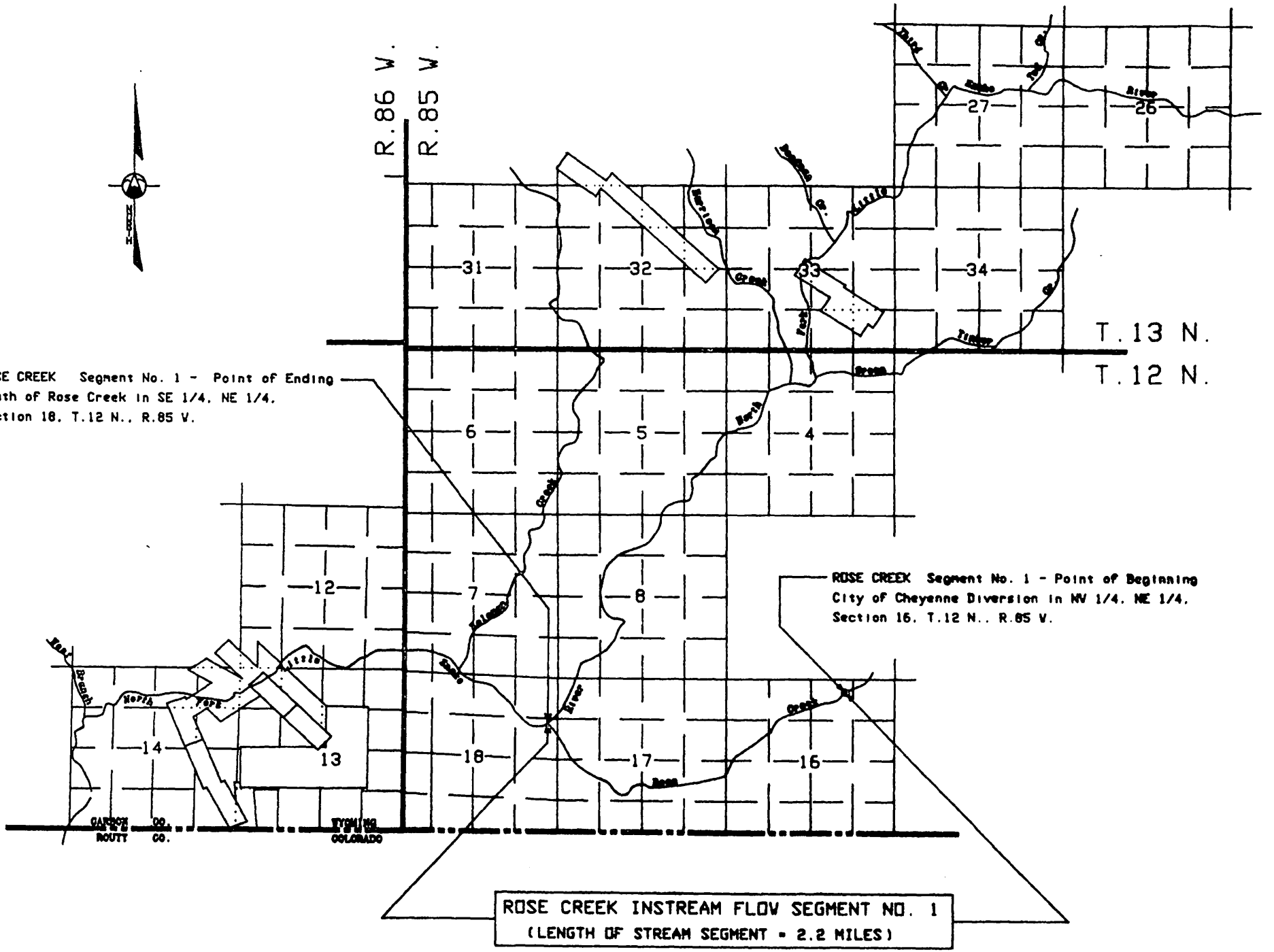

Figure 3. Location of the instream flow reach on Rose Creek.

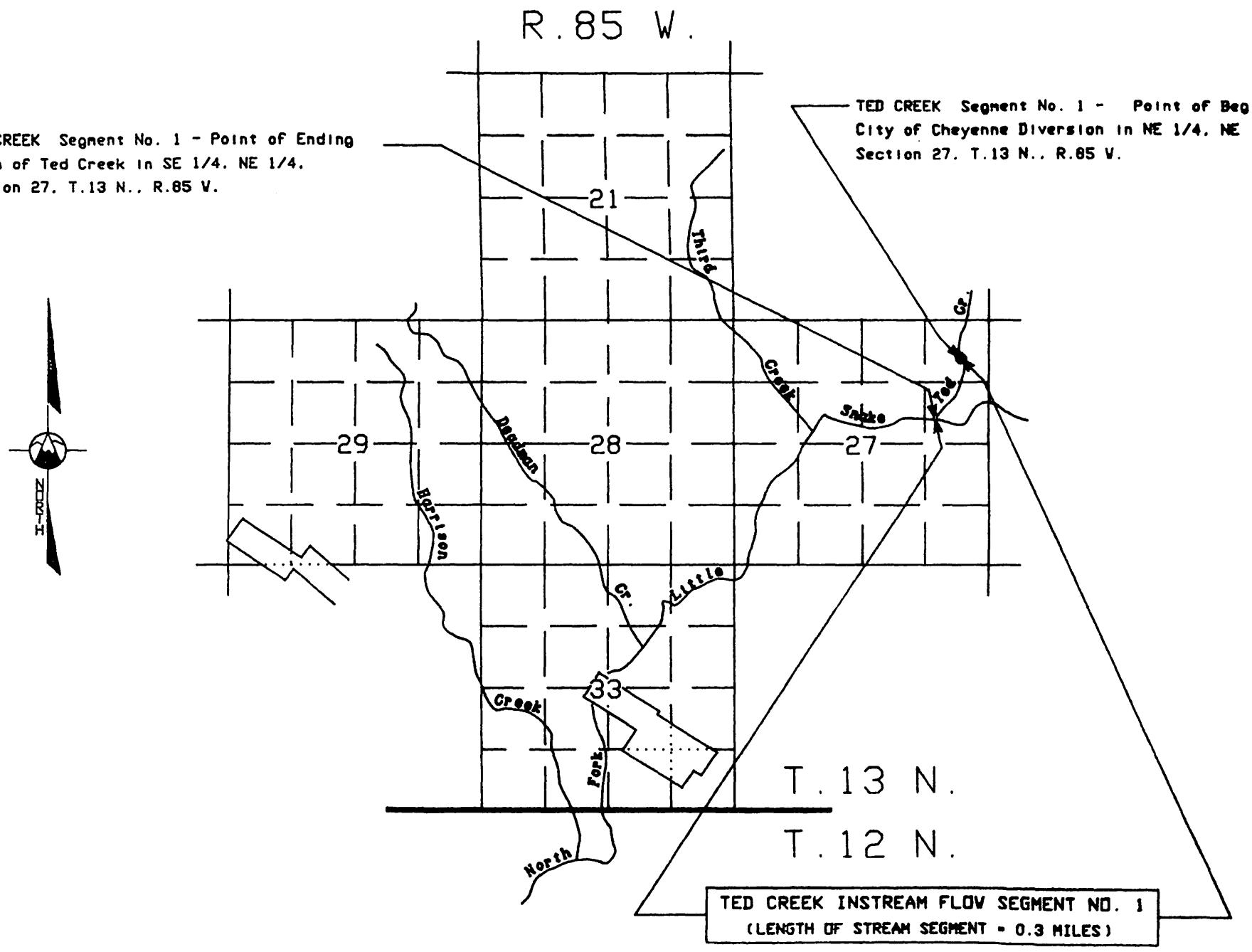

Figure 4. Location of the instream flow reach on Ted Creek.

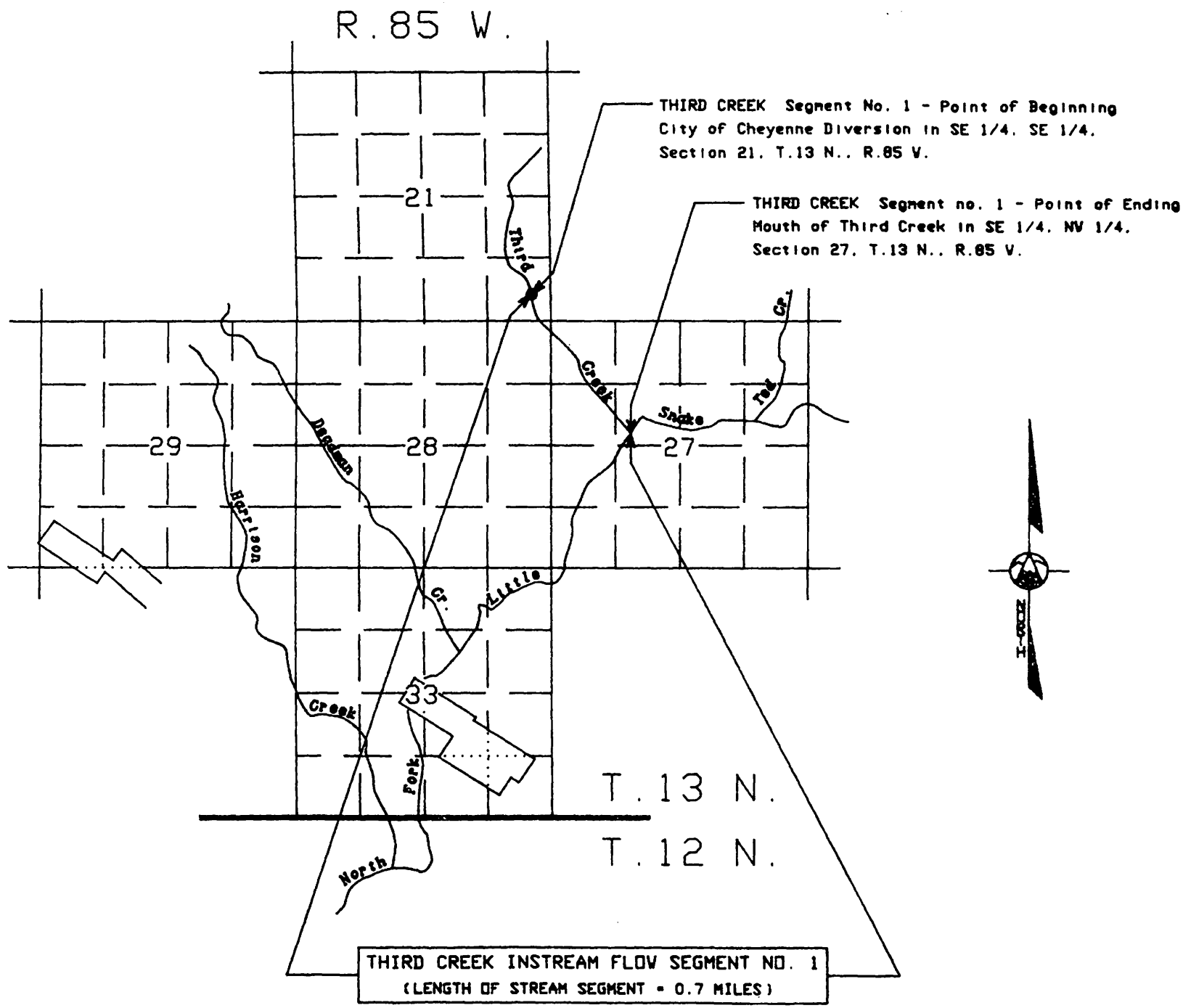

Figure 5. Location of the instream flow reach on Third Creek.

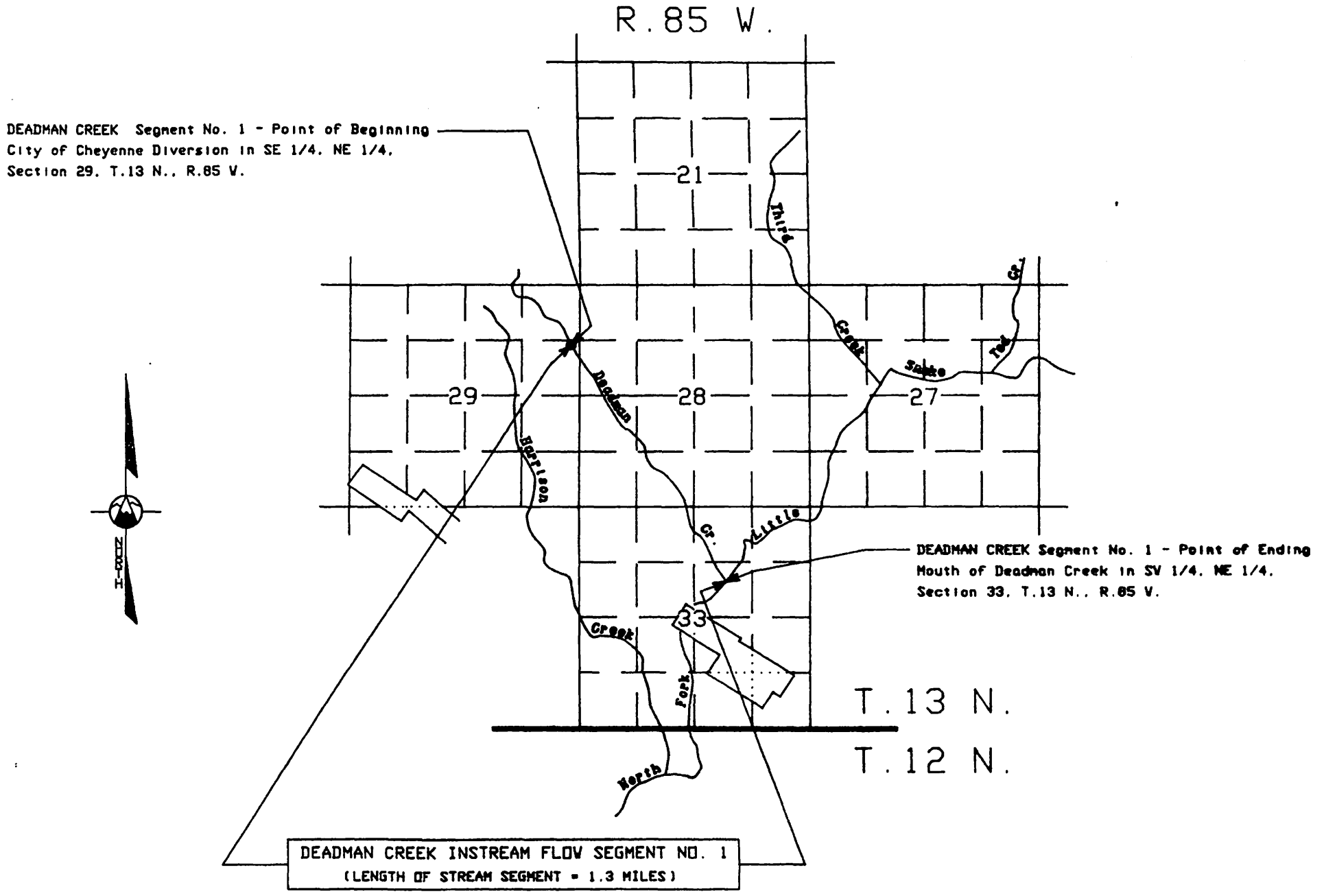

Figure 6. Location of the instream flow reach on Deadman Creek.

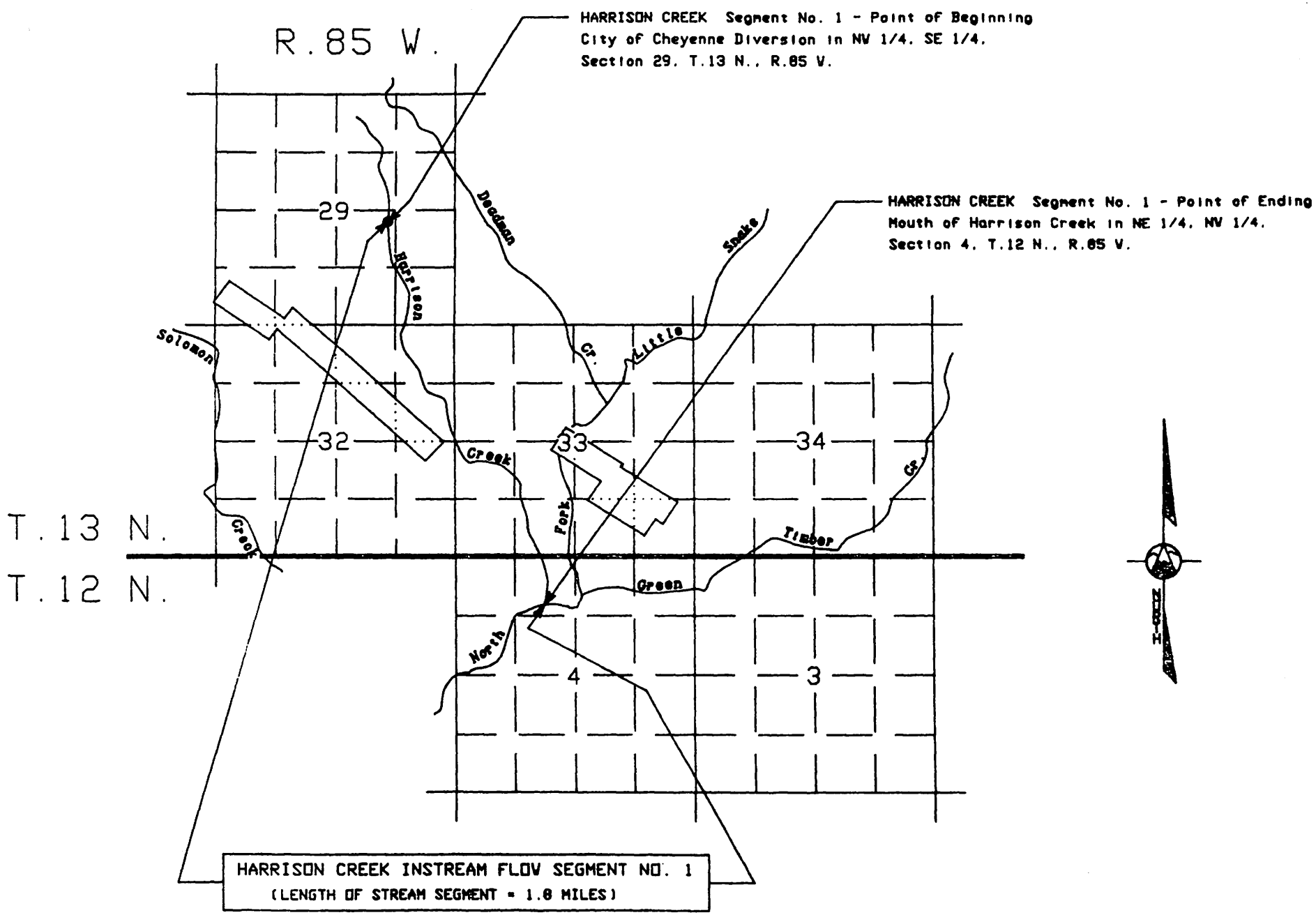

Figure 7. Location of the instream flow reach on Harrison Creek.

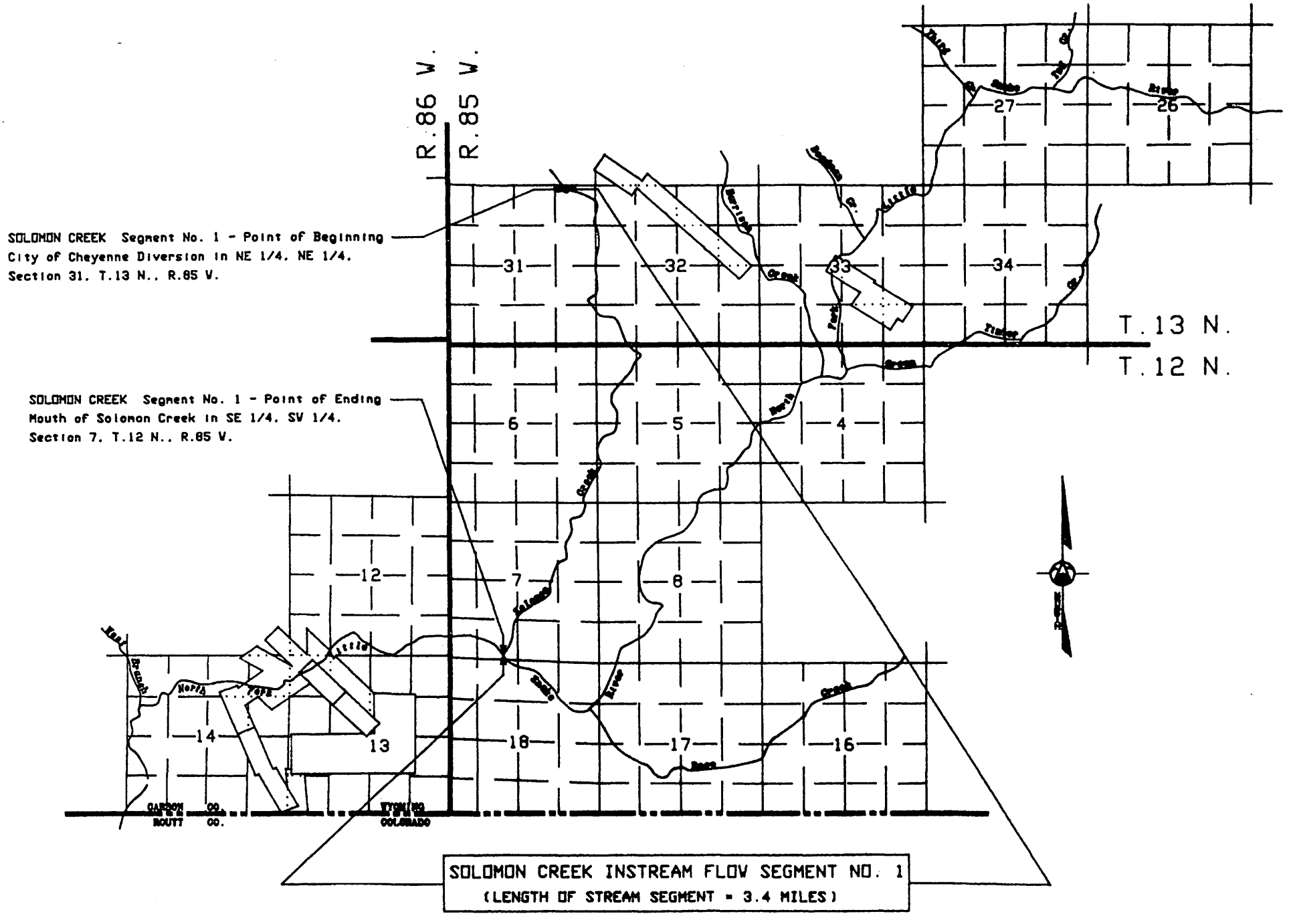

Figure 8. Location of the instream flow reach Soloman Creek.

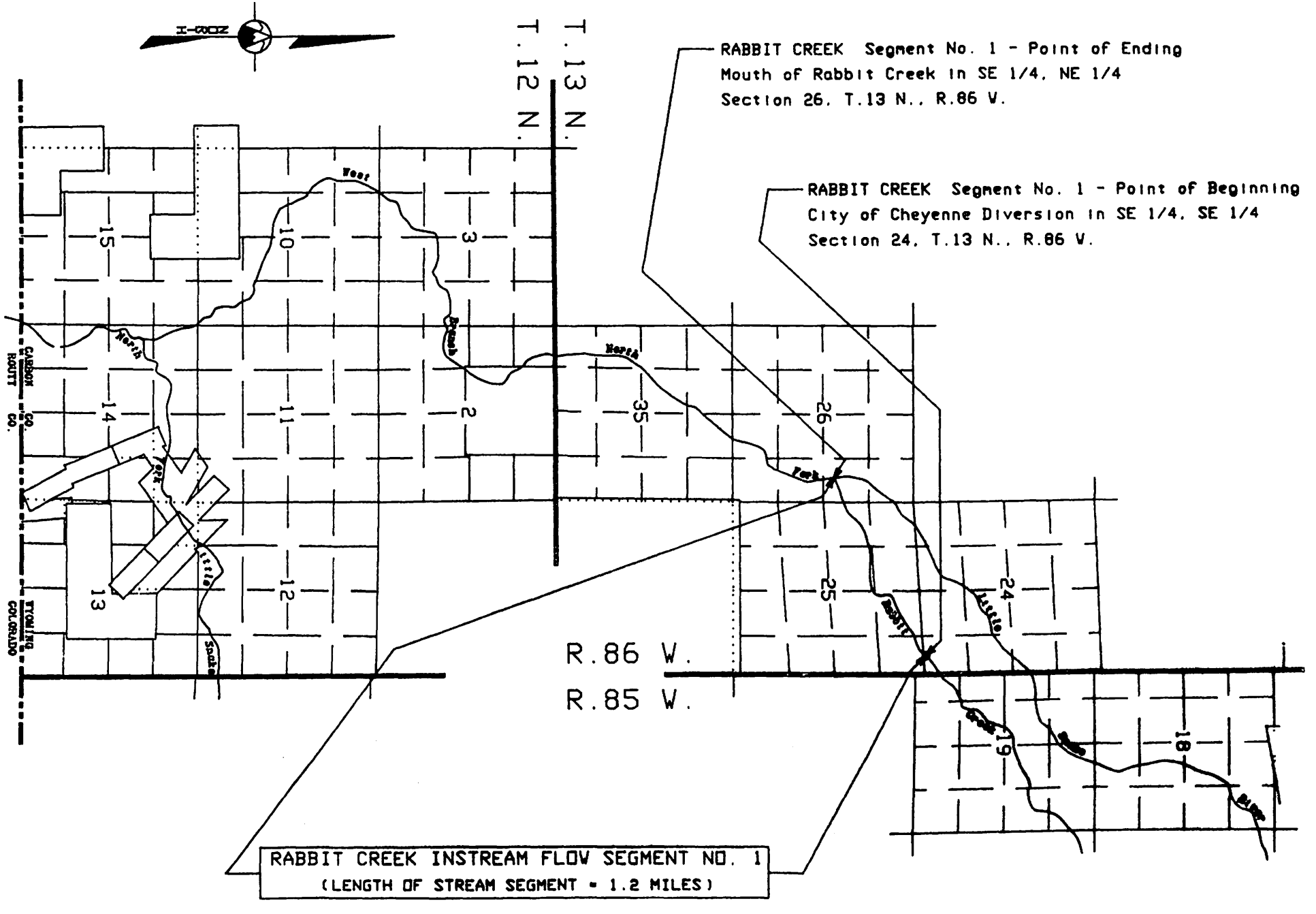

Figure 9. Location of the instream flow reach on Rabbit Creek.

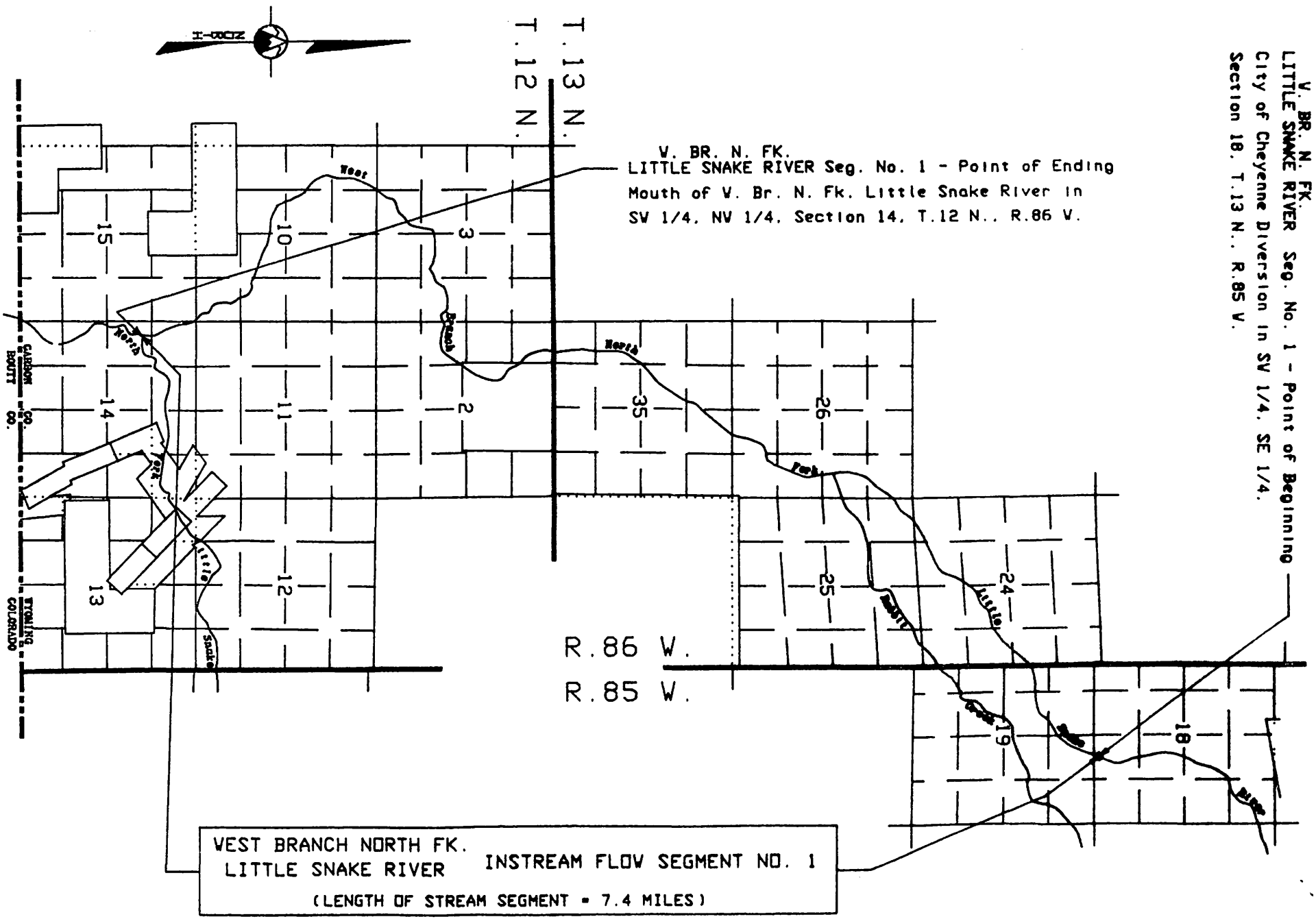

Figure 10. Location of the instream flow reach on West Branch of the North Fork of the Little Snake River.

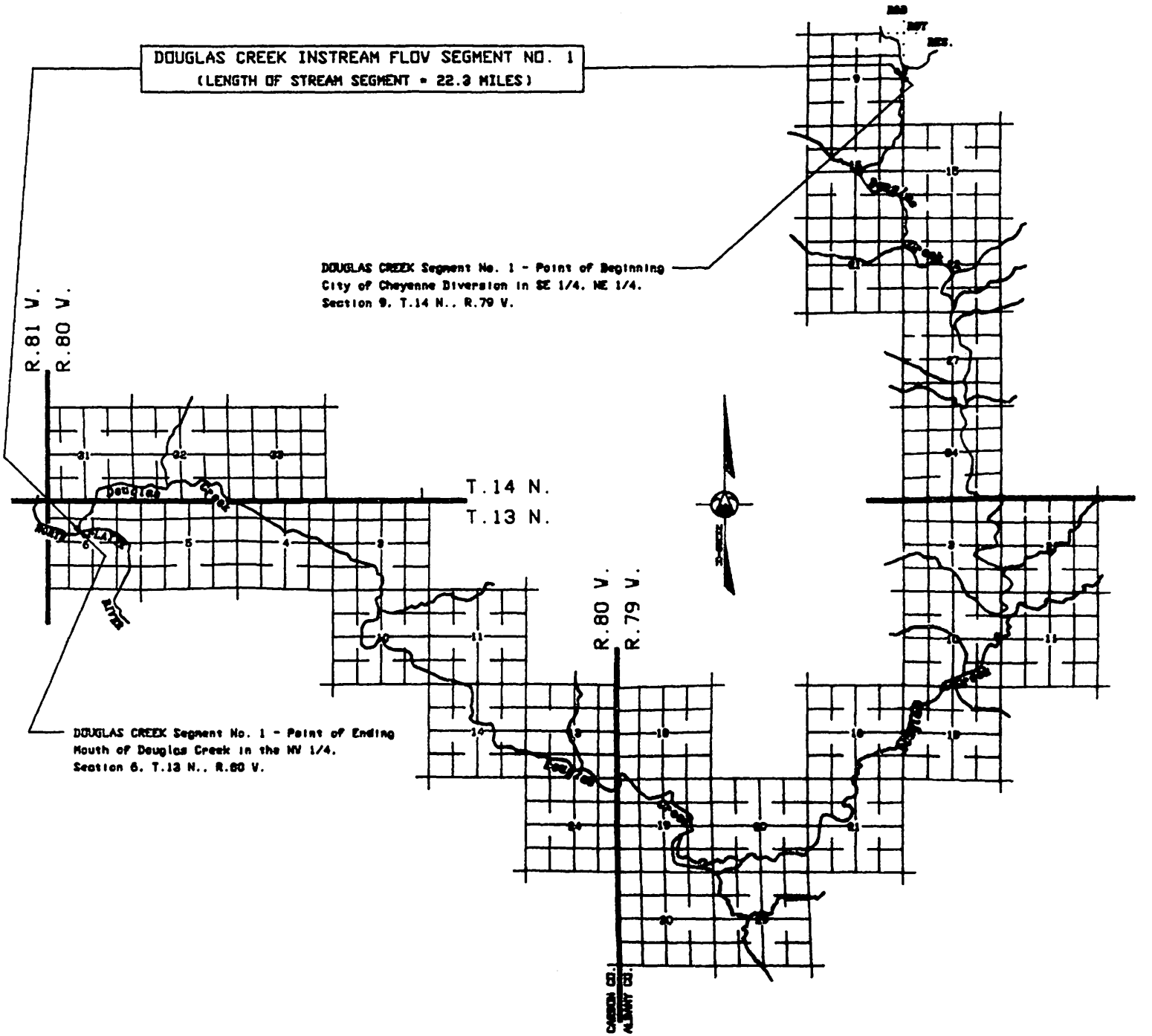

Figure 11. Location of the instream flow reach on Douglas Creek.

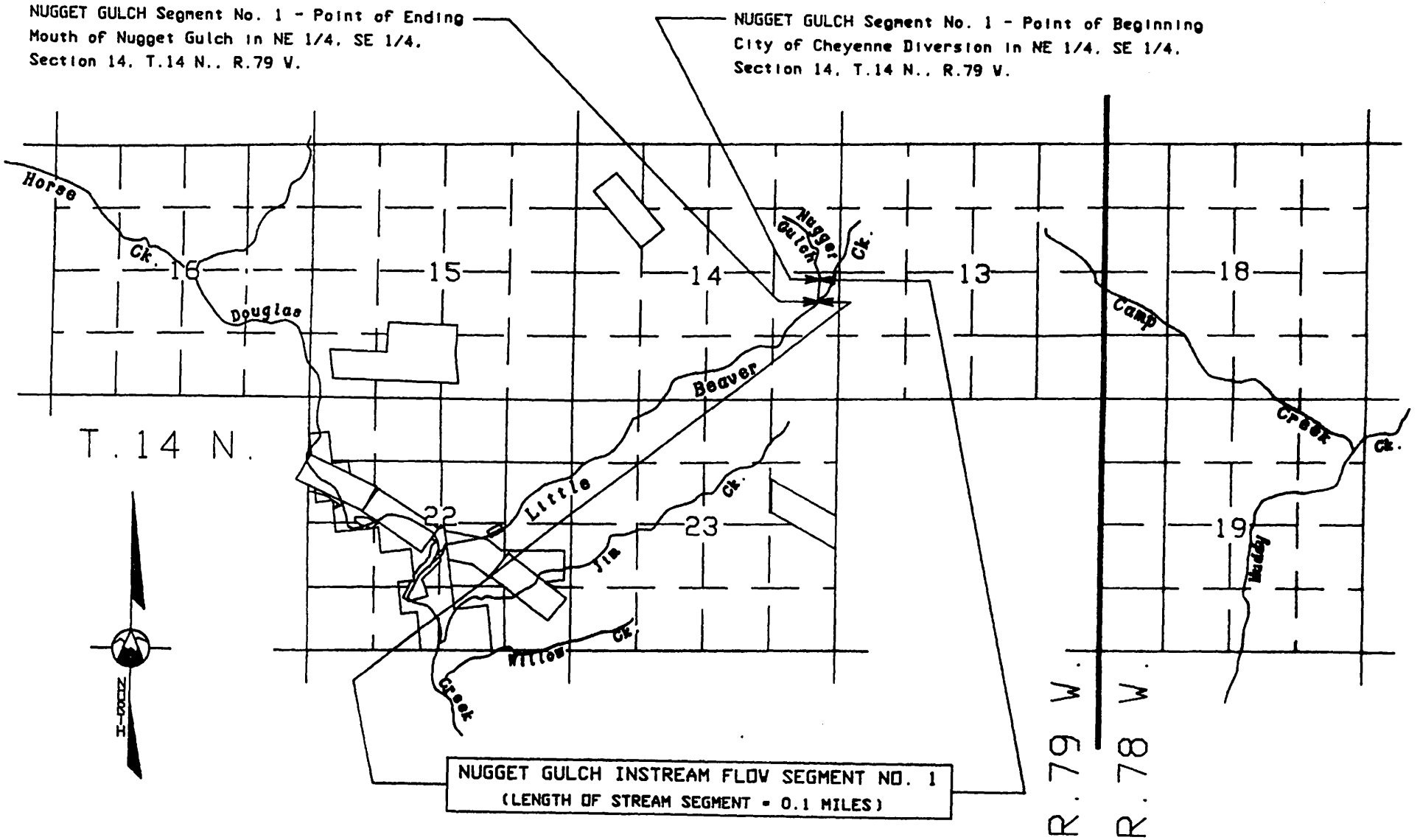

Figure 12. Location of the instream flow reach on Nugget Gulch.

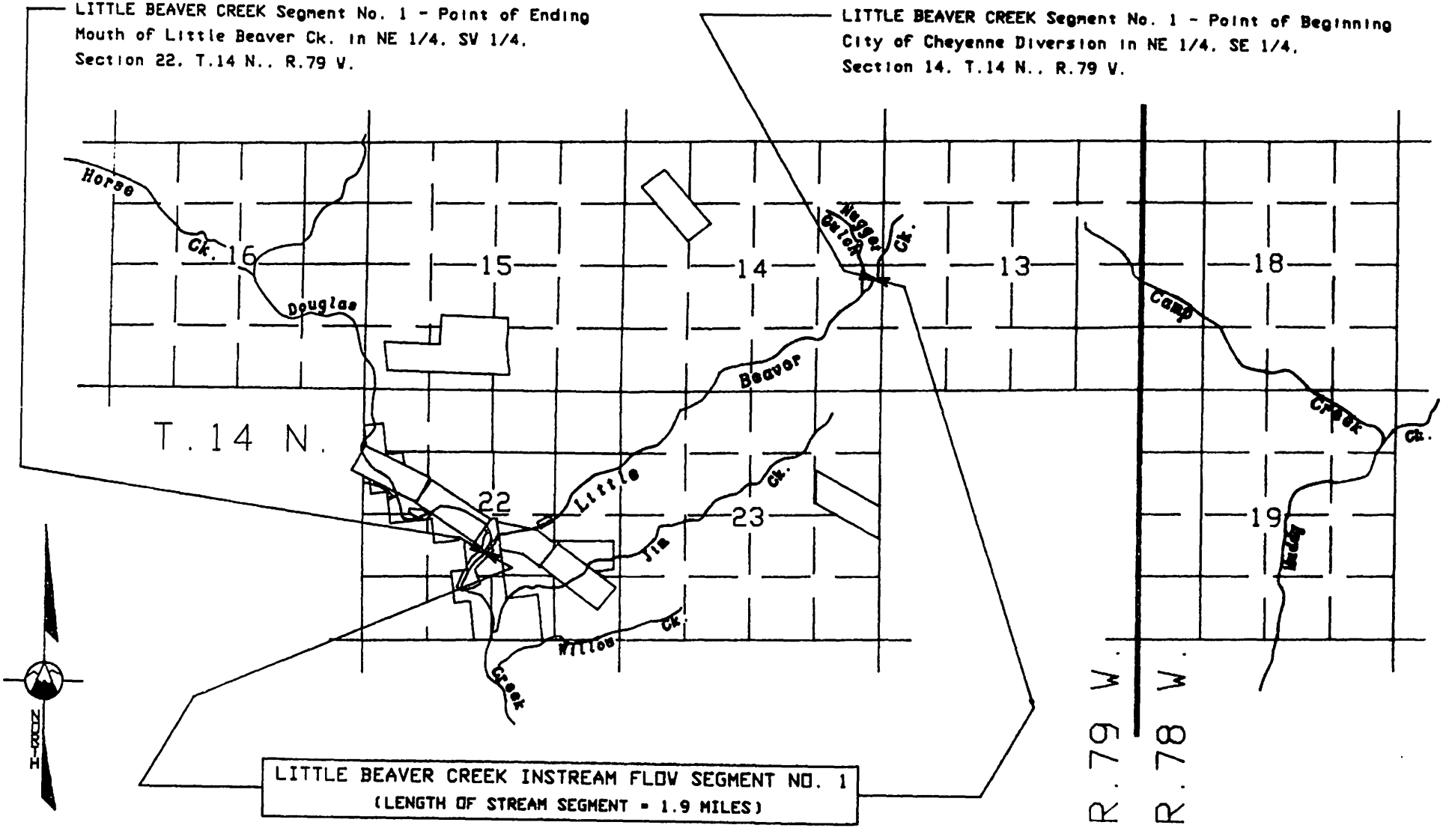

Figure 13. Location of the instream flow reach on Little Beaver Creek.

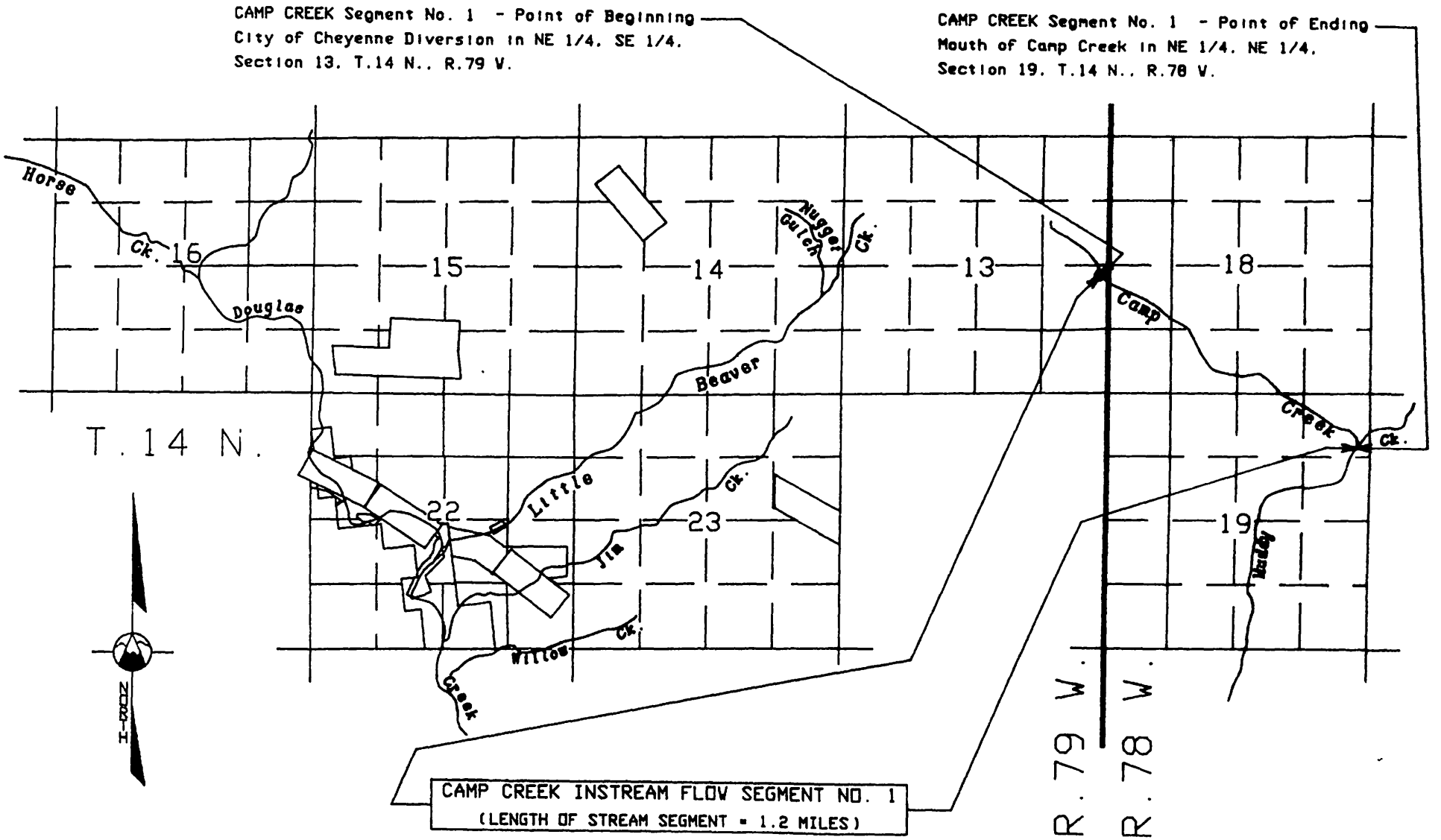

Figure 14. Location of the instream flow reach on Camp Creek.

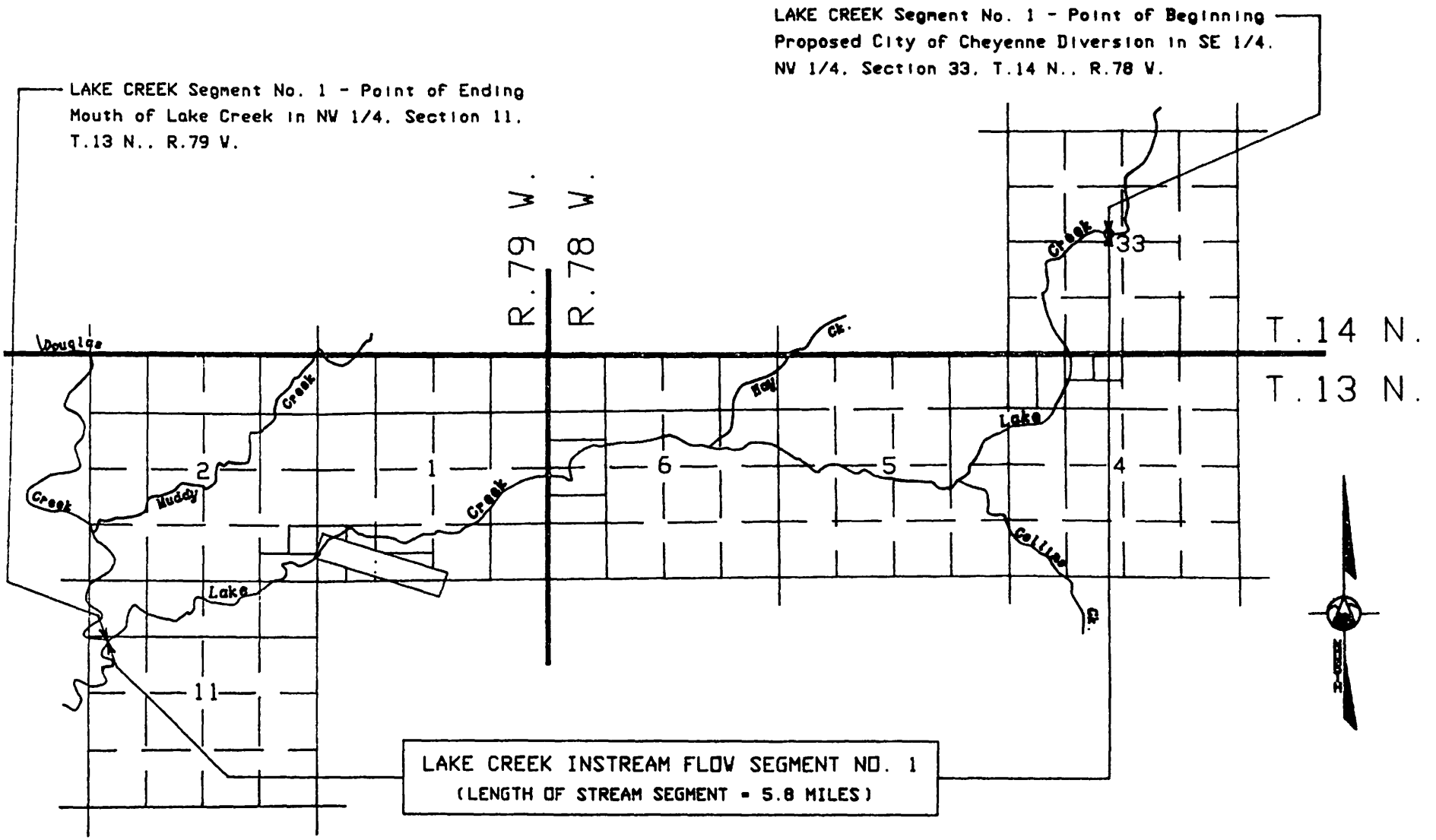

Figure 15. Location of the instream flow reach on Lake Creek.

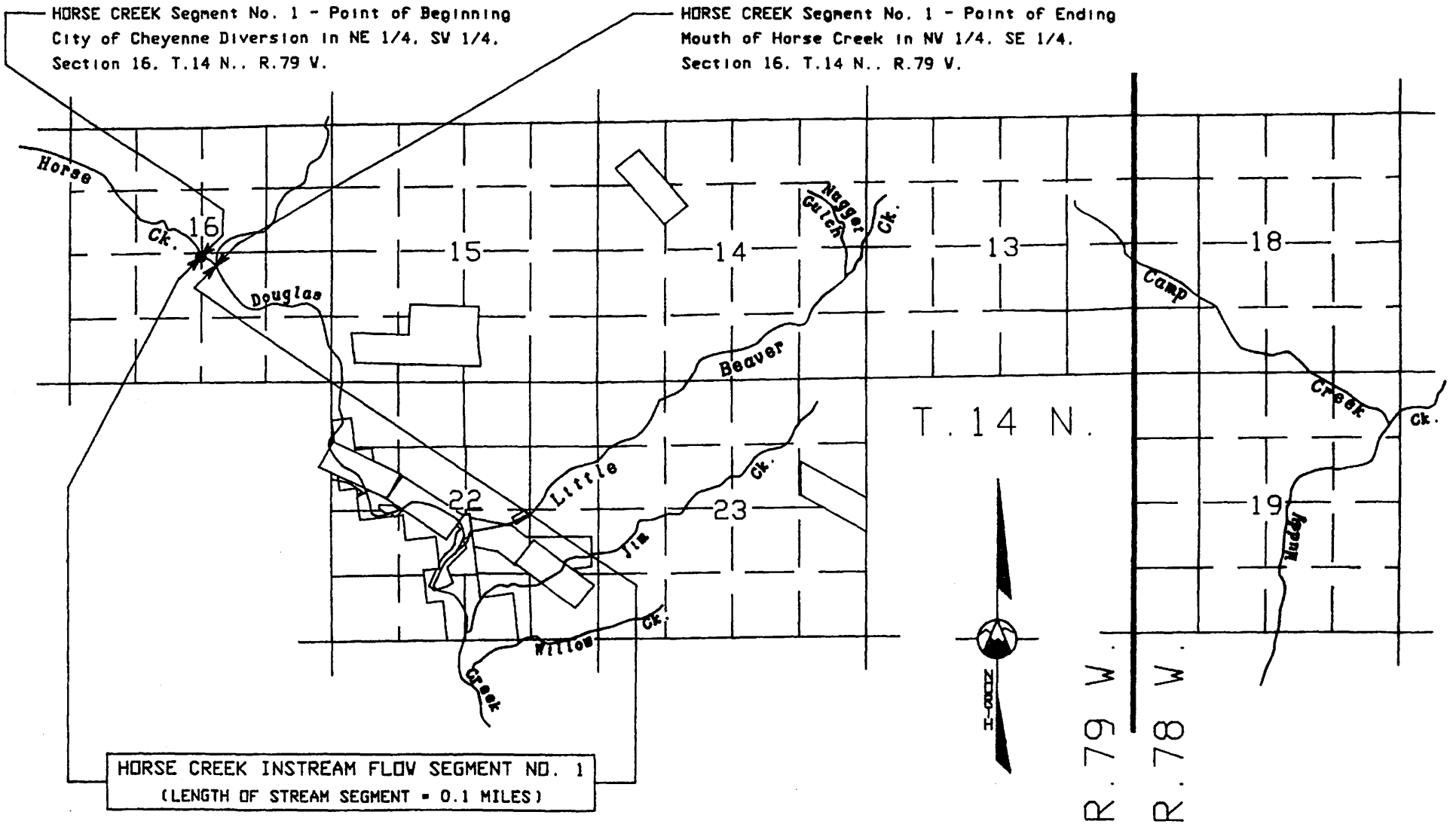

Figure 16. Location of the instream flow reach on Horse Creek.