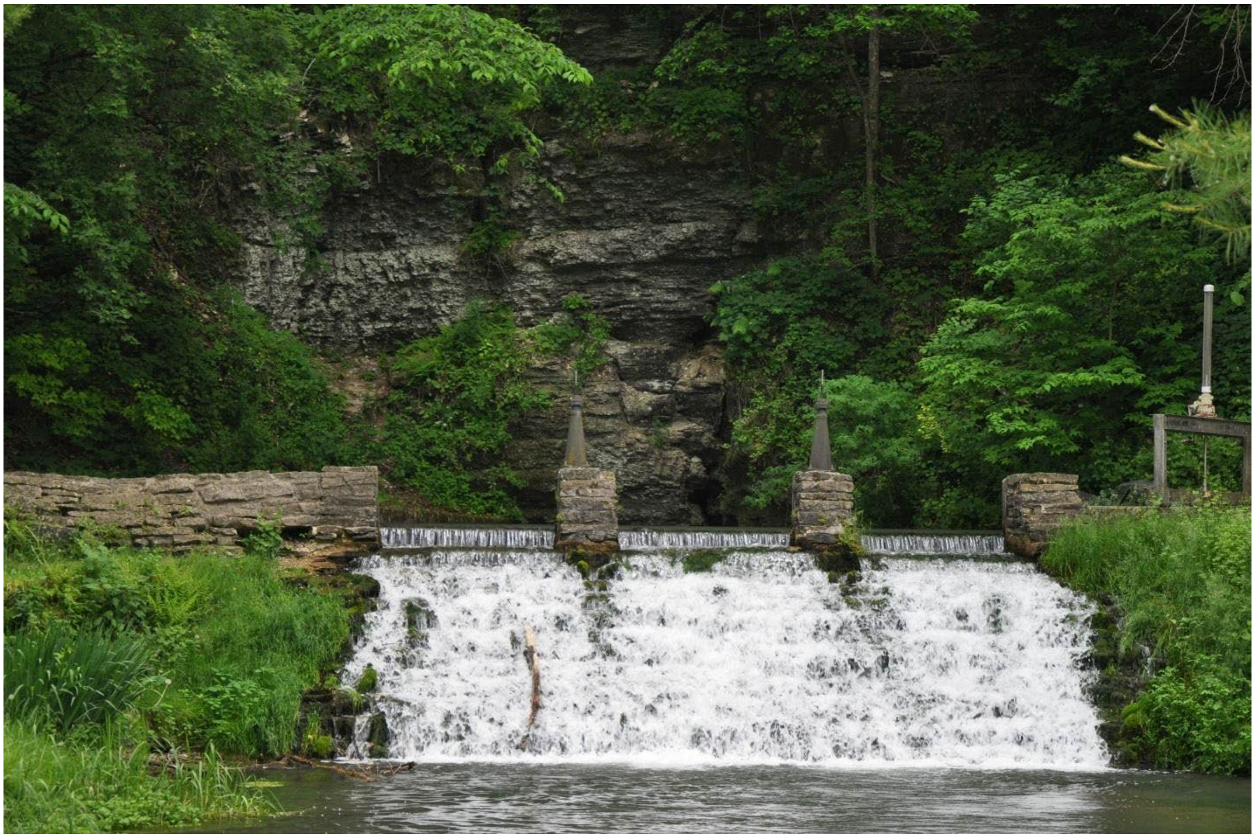
Trout Run and Siewers Spring Watershed Protection Plan



Objective statement: A protection plan for Siewers Spring and the Trout Run watershed to promote cleaner, clearer water by gathering the watershed community and fostering connection between people, life within the soil, and water.

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Prepared by: Megan Giorgenti, Iowa Department of Natural Resources
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Acknowledgements

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- Trout Run Landowners - 70+
- Trout Run Watershed Advisory Team
- Iowa Department of Natural Resources (DNR; Water Quality Improvement, Fisheries, Wildlife, Forestry, Land Quality/GIS, Solid Waste and Contaminated Sites)
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- Decorah Chamber of Commerce
- Northeast Iowa Resource Conservation and Development (NEIA RC&D)
- Iowa Department of Agriculture and Land Stewardship (IDALS) – Division of Soil Conservation and Water Quality
- United States Environmental Protection Agency (EPA)
- Iowa Grotto Association

A tribute to the Trout Run watershed community:

To all Trout Run farmers and landowners: It has been a pleasure working with you. Thank you for your time and for sharing with me your knowledge of the watershed and experience living and farming in this beautiful landscape. So many of you have opened your door (both home and barn) to help me learn. Thank you for graciously allowing me to survey stream banks, sinkholes, cover crops and CRP with a special thanks to those who literally trudged up and down the slopes with me. Thank you for engaging in conversations about water quality, soil health, erosion and farming in Trout Run. You have given me so much of your time so that I may have a better understanding. You have patiently answered my questions and waited patiently while I tried to answer yours. In between your typical day of phone calls, farm decisions, planting, feeding livestock, managing, harvesting, fixing, troubleshooting, and "putting out fires", you have taken time to answer my phone calls, read mailings, attend events, and warmly welcome any site visit that would help further the understanding of this project. I admire the work you do.

To members of the Watershed Community in Decorah: Thank you for welcoming me into the community. I appreciate your support and encouragement to engage in this important work and your honesty about the challenges of working to restore and strengthen community, something

that happens, overtime. Thank you for all the mentorship and leadership, you have shown me. I admire the work you do.

To the Trout Run Advisory Team: Thank you for your time and interest in this project. I appreciate your knowledge and guidance in gathering watershed data and completing watershed assessments, for your help with data interpretation and everything else that encompasses writing a watershed plan. The hours of head scratching and discussions that came to be while fitting together pieces of the Trout Run puzzle have been a challenging yet fulfilling part of this work. Thank you for your patience while working with me as someone who quite literally came from wading interior river streams to coordinating a watershed project in a challenging landscape. I admire the work you do.

Introduction

Trout Run and Siewers Spring (pronounced “see-vers”) are two interconnected waterbodies of significant importance to people and wildlife. Trout Run is one of Iowa’s most popular coldwater trout streams and it flows into the Upper Iowa River, one of Iowa’s rivers nominated as wild and scenic. Siewers Spring, Iowa’s second largest natural spring, is an iconic feature and a major contributor to the Trout Run coldwater fishery. Siewers Spring is the water source of the Chuck Gipp Decorah Fish Hatchery, which raises 150,000 trout each year for stocking into trout streams and community fisheries throughout the state. Both water bodies are located near the town of Decorah, a major urban destination known for trout fishing, water trails, creativity, and captivating karst features like springs, caves, sinkholes and bedrock outcroppings.

Both Trout Run and Siewers Spring have had water quality issues dating back decades. Most notable is the turbid, sediment laden waters that can be observed at Siewers Spring after rainfall events in the Trout Run watershed. An Iowa Department of Agriculture and Iowa DNR 319 project was established for Trout Run in 1991-1997, with efforts focused on reducing sediment, nutrients, pesticides, and animal waste entering Trout Run and Siewers Spring. This project noted a significant source of pollution was attributed to unfiltered surface water runoff entering losing stream segments and sinkholes which resurface at Siewers Spring. Goals of the former watershed project included reducing livestock manure and sediment delivery to Trout Run. Despite past management efforts to reduce sediment and nutrient pollution in the Trout Run Watershed, these issues still largely exist today.

More recent water quality monitoring in Trout Run and Siewers Spring still indicate high amounts of sediment and nutrients present, especially during moderate to heavy rain events in the watershed. Land use within the watershed has changed as more agricultural acres have been converted to row crop production, leaving fewer acres with pasture or hay grown for livestock. Conventional farming practices like tillage, reduced crop diversity and crop rotation, and increased chemical application have depleted soil health, leading to increased erosion and reduced potential of the soil to infiltrate water. In 2016, a rain event within the Trout Run

Watershed received attention from local communities when a downstream town flooded. This flooding event prompted the community to find ways to improve water storage and mitigate flooding in the Trout Run watershed. Since then, the Upper Iowa River watershed project has successfully implemented structural practices to increase water storage capacity in the Trout Run watershed. Structural practices increase water storage capacity however they don't always address poor water infiltration in the surrounding soils. Typically, structural practices are more costly, require more time, and location requirements do not reach every farm and farmer.

In the Trout Run Watershed, there is a need for in-field management practices that keep soil in place and reach every farm and farmer. Because of the watershed's shallow soil depth, there is very little material over the bedrock to filter any pollutants. Soil conservation practices are essential for building soil structure and reducing erosion. For example, implementing soil health practices will help build organic matter and promote a soil food web that allows for increased nutrient cycling and water storage capacity after rain events. Due to the steep slopes and complex geology of the area, additional edge-of-field practices may be needed to reduce sediment delivery to Trout Run.

This watershed project was developed to engage members of the Trout Run watershed community to reduce erosion and protect water quality of Trout Run and Siewers Spring. In order to do this, watershed assessments were needed to better define the sources of sediment and to describe the complex nature of the Trout Run Watershed. Project partners worked together to propose goals and best management practices to address each source of sediment which will improve water quality of these valuable, iconic resources for the enjoyment of years to come.

Background

Project area summary

The Trout Run watershed is a sub-watershed of the Upper Iowa River. It is located in Iowa's karst region, a landscape where dissolution of the underlying bedrock has formed losing streams (i.e., loses water underground as it flows downstream), sinkholes, caves, and springs. Surface waters in the Trout Run watershed connect rapidly to underground aquifers and then surface at Siewers Spring.

The Trout Run Watershed project area consists of two HUC 12 watersheds, Trout Creek and Community of Nordness (Figure 1). Surface waters in these two watersheds have known connections to Siewers Spring. Therefore, improving these surface waters will help improve water quality in Siewers Spring. The defined project area for this protection plan includes both the surface watershed of Trout Creek and Community of Nordness and will be referred to as Trout Run for the remainder of this watershed plan.

Due to the regions dissolvable bedrock and highly connected surface and groundwater dynamics, there is potential for the Trout Run project area to change and likely expand as more information is learned about the hydrogeology and connectivity of surface water in the surrounding watersheds to Siewers Spring. Geographic information about the Trout Run project area is summarized in Table 1.

The populated areas of the watershed include the Northern portion of the City of Calmar (population 1,000), the town of Nordness, and the outskirts of the cities of Decorah (population 7,615), and Ossian (population 800). There are 729 distinct properties within the Trout Run watershed. The majority (337) are zoned as agricultural, 321 are residential (urban and rural), 67 are commercial and 4 are classified as industrial.

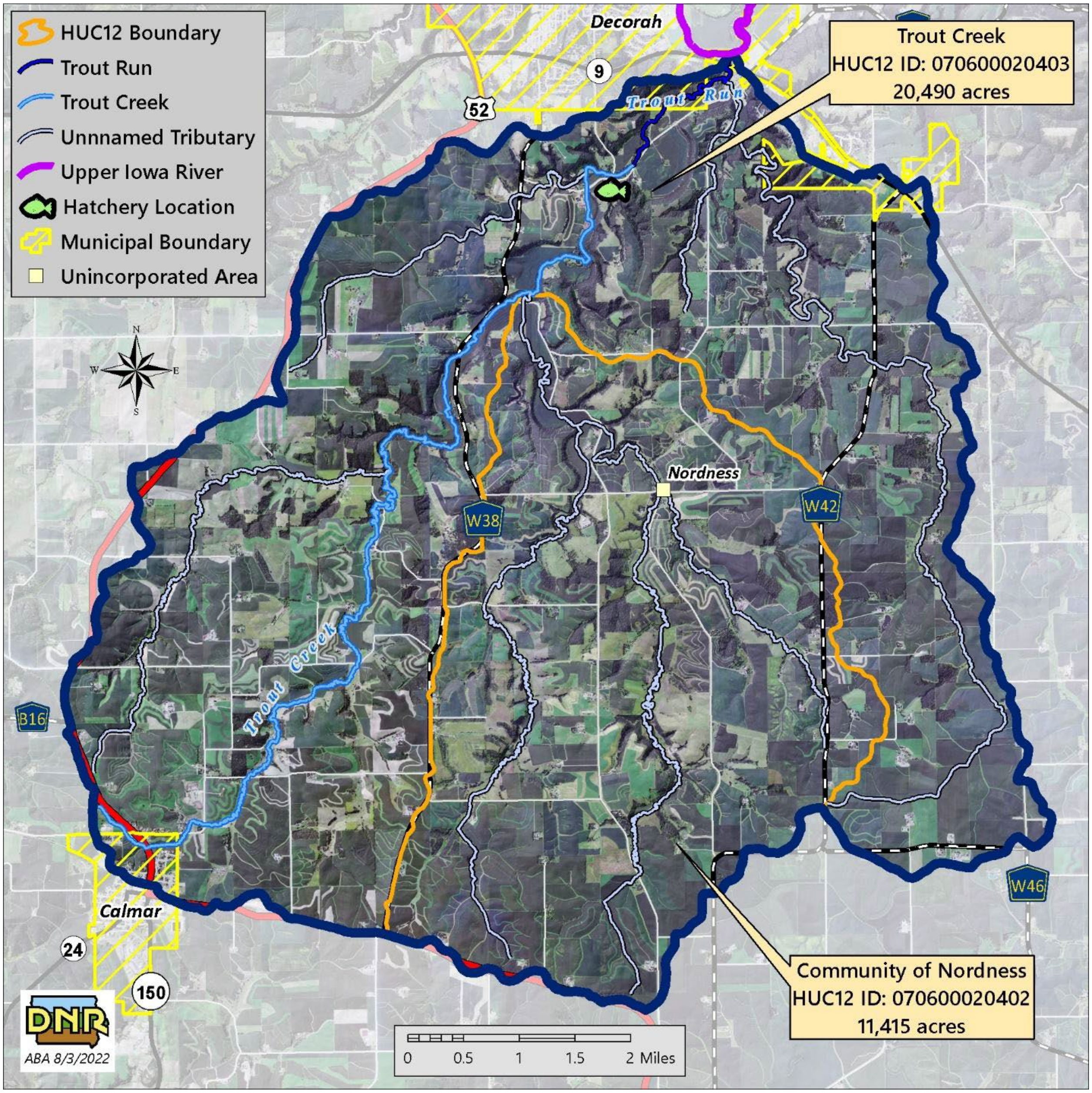


Figure 1. The Trout Run Project Area is composed of two HUC 12 watersheds, Trout Creek and Community of Nordness. The green fish denotes the location of Siewers Spring at the Chuck Gipp Decorah Fish Hatchery.

Table 1. Geographic information of the Trout Run Watershed Project Area. The "Community of Nordness" is the defined name of the HUC 12 watershed and also the name of a community within the project area.

Hydrologic Unit Code Name	12 Digit Hydrologic Unit Code	Total Drainage Area	Stream Length
Trout Creek	070600020403	20,501 acres	39.8 miles

Community of Nordness	070600020402	11,421 acres	22.3 miles
Total		31,922 acres	62.1 miles

Land Use

Based on 2018 USDA Cropland data, agriculture (row crop) is the predominant land cover in the Trout Run Watershed. Nearly 45% of the land area is classified as row crop acres growing primarily corn and soybeans. Less than 3% of the row crop acres also grow cover crops. Other land use types in the Trout Run Watershed include grassland, alfalfa/hay, woodland, pasture, and urban areas (Figure 2). A complete list of land cover type and composition in the Trout Run Watershed can be found in Table 2.

Livestock

Trout Run farmers have a total of 4,800 head of livestock composed of swine, dairy and beef cattle. There are 3,100 swine (1,240 animal units) 1,630 dairy cattle (2,046 animal units), and 70 beef cattle (70 animal units). Livestock facilities range in size from 70 to over 1,000 animals. Trout Run farmers and community members have noted reduced livestock and fewer acres of pasture and hay compared to previous years.

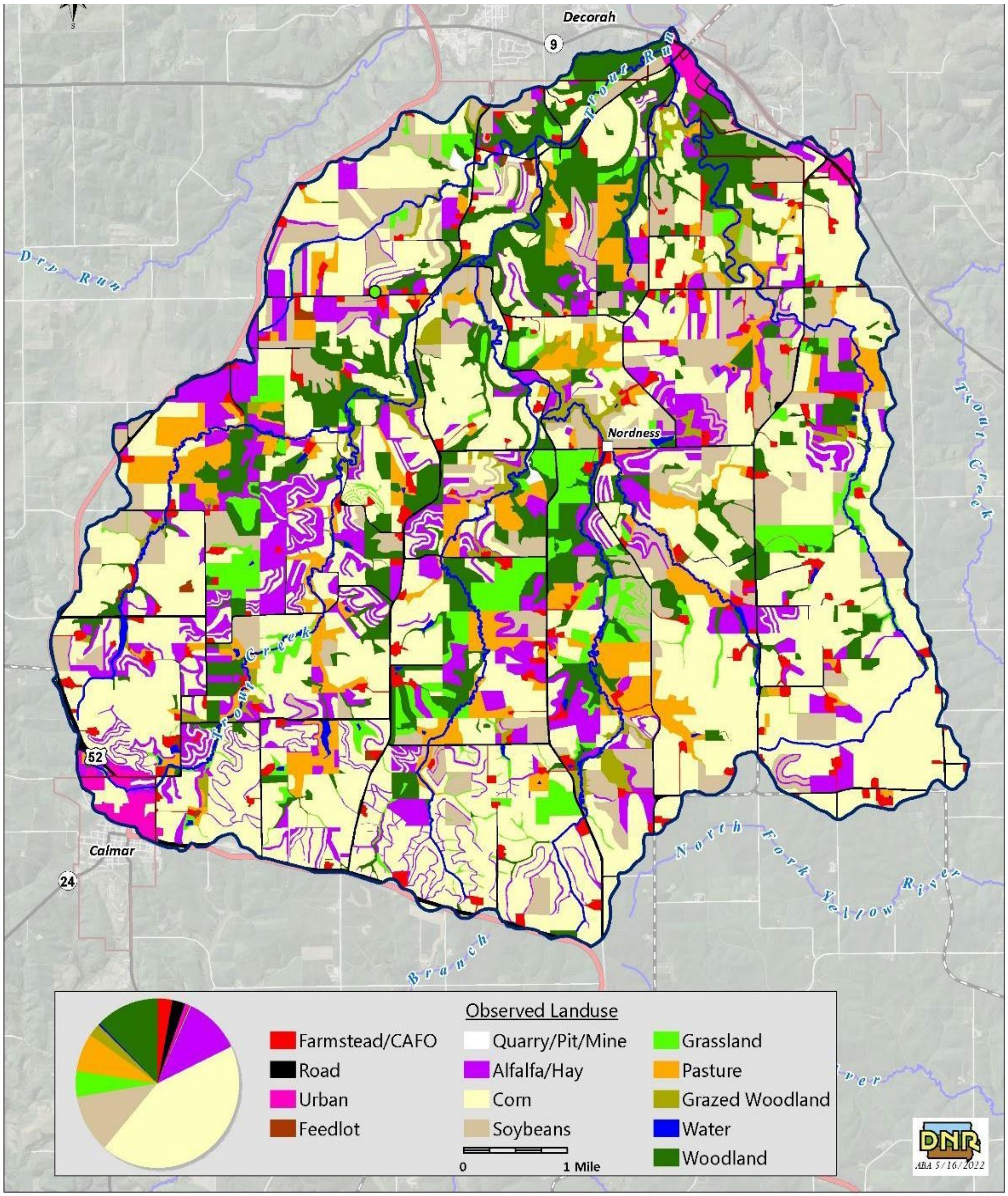


Figure 2. Land cover types in the Trout Run Watershed. Information based on 2018 USDA cropland data.

Table 2. Land Cover type and composition in the Trout Run Watershed Project Area (2018 USDA cropland data).

Land Cover Type	Acres	Percent
Corn	13,908.20	43.60%
Woodland	4,007.80	12.60%
Alfalfa/Hay	3,573.60	11.20%
Soybeans	3,556.10	11.10%
Pasture	2,327.00	7.30%
Grassland	1,545.60	4.80%
Farmstead/AFO	910.2	2.90%
Road	833.7	2.60%
Grazed Woodland	792.9	2.50%
Urban	275.4	0.90%
Water	93.6	0.30%
Feedlot	44.9	0.10%
Quarry/Pit/Mine	35.7	0.10%
Total	**31,904.60**	**100.00%**

Soils

The Trout Run Watershed has two primary soil types, Fayette and Downs. These two soil types have loess parent materials and silt loam textures. Fayette soils are considered to be developed under full timber-plant environments. Downs soils are considered to be developed under transitional timber-prairie environments such as oak-savanna type environments (Neill Sass, NRCS, personal communication). Loess soils are considered to be very productive but highly erodible. Below the topsoil layer, Fayette and Downs soil have an accumulation of clays, called a Bt horizon, which is not as productive. When the topsoil has eroded off, the remaining materials present in the subsoils are low in organic matter and often times require increased inputs to produce a crop yield (Neil Sass, NRCS, personal communication). Fayette and Downs soil characterize 67% of the soils in the Trout Run Watershed. Other soil types present include: Dubuque (7%), Lacrescent (4%), Lawson-Ossian (2%), Ion-Eitzen (2%) Otter-Worthen (3%), Ossian (1%) and others (Figure 3).

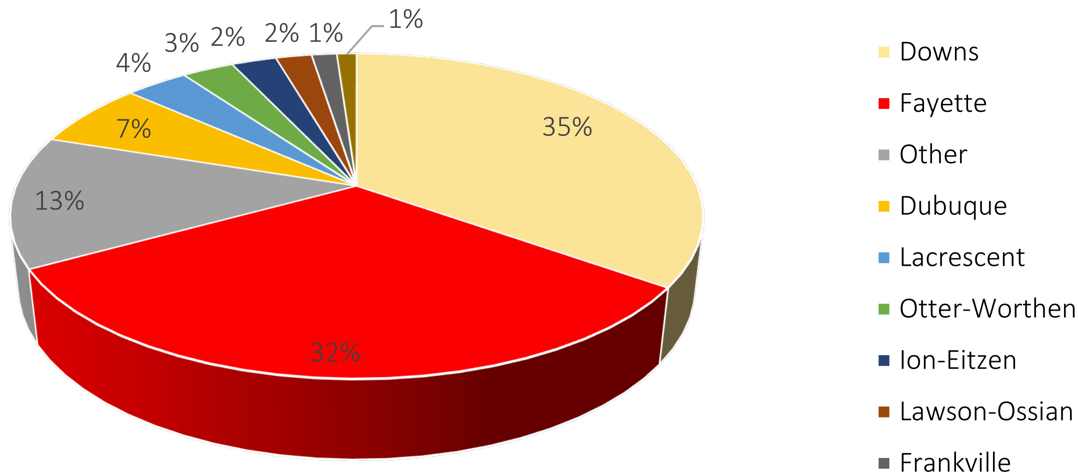


Figure 3. Soil composition in the Trout Run Watershed.

Tillage

Conventional tillage and lack of crop residue left on agricultural fields leads to poor soil structure and contributes to erosion in Trout Run. Tillage breaks apart soil aggregates and disrupts the connectivity of fungi, which form associations with plant roots and help with nutrient uptake for the plants (Stika 2016). Over time, tillage breaks down the soil structure and reduces the soils capacity for storing air and water, which is crucial for the biological and chemical processes that support plant growth. By reducing the level of tillage, especially implementing no-till, soil aggregation will increase and improve water storage capacity (Stika 2016). In Trout Run, less than 15% of the 17,466 corn and soybean acres are no-till acres. The majority (36%) of the row crop acres have conventional tillage or some level of tillage and residue on the landscape (Table 3). A map of observed tillage on agricultural acres in the Trout Run watershed is shown in Figure 4.

Increasing residue and plant cover on the soil surface is another management practice that reduces soil erosion and builds organic matter. Having plant material, both live and dead, provides protection from wind and rain a food source for living organisms in the soil. Converting more row crop acres from conventional tillage to no-till or reduced tillage systems and encouraging farmers to leave residue on the landscape and plant cover crops will help reduce soil loss from Trout Run's row crop acres.

Table 3. Type of tillage systems on Trout Run's row crop acres.

Tillage	Acres	Percent
Conventional Till	6,274.10	35.9 %
Mulch Till	8,657.50	49.6 %
No Till	2,535.00	14.5 %
Total	**17,466.60**	**100 %**

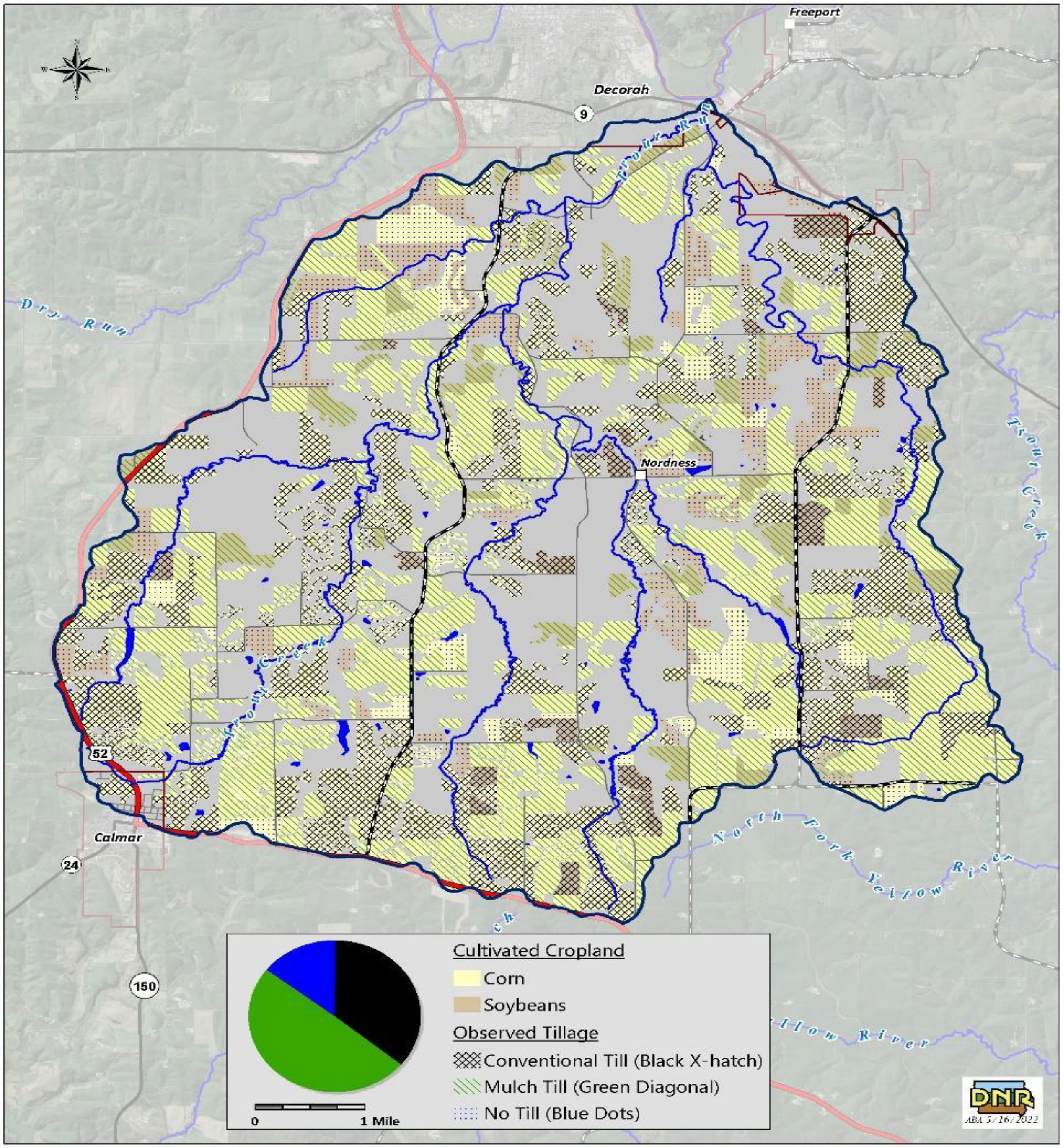


Figure 4. Observed tillage within the Trout Run Watershed. Observations were made using 2018 cropland data and observations during a land use and tillage assessment performed by DNR 319 staff in 2018.

Geologic Summary

In 2011, a geologic summary was completed for the Upper Iowa River Watershed to better understand the hydrology and serve as a guide to future water quality projects in the area. By geologists measuring the top and bottom elevations of bedrock units, researchers created a 3-dimensional map to show the distribution of aquifers (water storage) and aquitards (layer that water doesn't pass through). These data can be used to evaluate the vulnerability of groundwater to nonpoint-source contamination from the land surface and also help understand the contribution of groundwater to surface water contamination (Wolter et al. 2011).

Based on the summary, the Trout Run Watershed has Ordovician age Galena group and Devonian age Cedar-Valley group, which are the most transmissive bedrock units and are prone to the development of karst. Land surface activities in Trout Run can readily result in groundwater contamination of aquifers. The two strata are separated by the Maquoketa formation which acts as an aquitard, limiting the vertical movement of groundwater between the two aquifers. The Maquoketa formation also constrains the horizontal extent of concentrated groundwater flow. Groundwater discharge to the surface in the form of seeps and springs often occurs where the contact between the Cedar Valley and Maquoketa is at the land surface. Karst features such as sinkholes, losing streams, enlarged fractures, and springs may occur in limestones, dolomites or other rocks throughout the watershed. When well developed, these formations may form subsurface drainage systems that can cross watershed boundaries (Wolter et al. 2011) and is thought to be a characteristic of the Trout Run and other neighboring watersheds.

Bedrock Units

The Trout Run Watershed has four major bedrock units closest to the land surface: Wapsipinicon, Maquoketa, Wise Lake/Dubuque and Dunleith formations (Figure 5). The Wapsipinicon formation is located closest to the surface in the southwestern portion of Trout Run near the City of Calmar. This Devonian age bedrock unit is known to be susceptible to karst formation and has been observed to have a rapid rainfall infiltration rate. This 90-100 ft thick bedrock unit forms the lower part of the Devonian aquifer and consists of two formations, the Spillville Formation (60-75' thick) and Pinicon Ridge Formation (15-20' thick; Figure 6). The Spillville Formation contains medium to thick porous and fractured dolomite which results in springs and seeps occurring at the top and bottom of this unit. The overlying Pinicon ridge unit consists of shale, dolomite, and brecciated limestone. Where shale is present in this layer, it may act as a thin and relatively imperfect aquitard.

The Maquoketa Formation is the bedrock unit closest to the surface in the southern and central areas of the Trout Run Watershed. This formation consists of up to 190 ft of limestone and dolomite with shale interbeds. This bedrock formation forms an imperfect aquitard between the underlying Galena aquifer and the overlying Devonian Aquifer. Sinkholes and karst may form in the lower parts of the Maquoketa Formation (Figure 5).

The Wise Lake, Dubuque, and Dunleith formations are part of the Ordovician-age Galena group and are considered the most transmissive bedrock units throughout the watershed. These units are highly karst-susceptible and have an abundance of karst features like sinkholes and caves. These layers are found closest to the surface in the northern portion of the Trout Run Watershed (Figures 5, 6). The Wise Lake and Dubuque formations are the upper division of the Galena Aquifer, composed of 100-105 ft of limestone and some shale. The Wise Lake is distinct from other layers in that it is heavily bioturbated, or influenced by the activities by animals and plants. The Dunleith portion is the lower division of the Galena Aquifer and is composed of 135 feet of fractured limestone. Siewers Spring issues from this unit as well as many domestic wells in the area (Wolter et al. 2011).

The Decorah, Platteville, Glenwood Formation are thin layers but together act as an 80-90-foot-thick aquitard between the overlying Galena Aquifer and the underlying Cambrian-Ordovician Aquifer. This layer is composed of shale, siltstone, quartz and fossiliferous limestone. The presence of the Decorah layer restricts downward vertical migration of water from the overlying Galena Aquifer and forces this groundwater to discharge laterally at seeps and major springs in the Upper Iowa River Watershed including Siewers Spring. This layer is not karst susceptible.

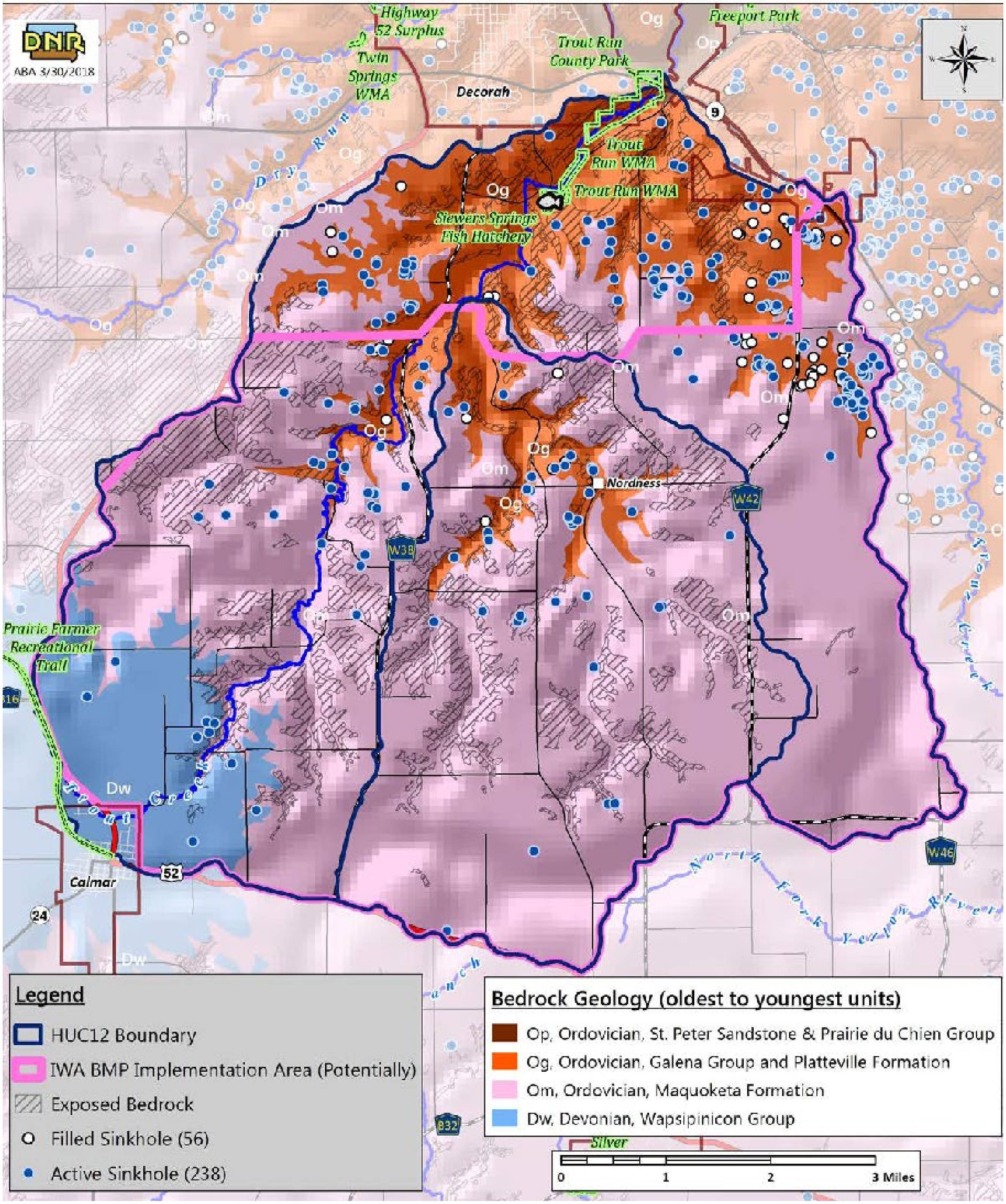
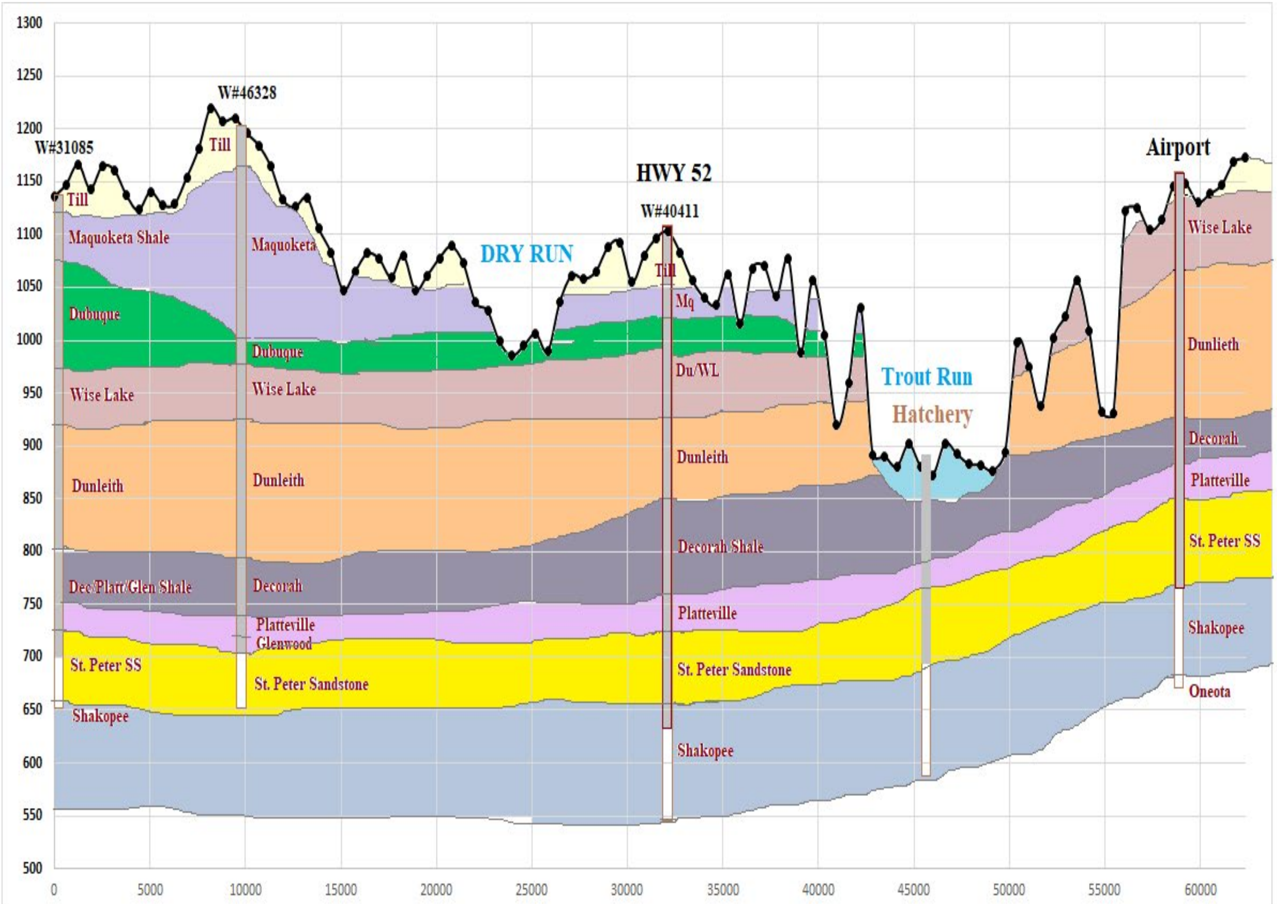


Figure 5. Bedrock units closest to the surface in the Trout Run Watershed and corresponding sinkholes present mainly where the Galena Group is at the surface.



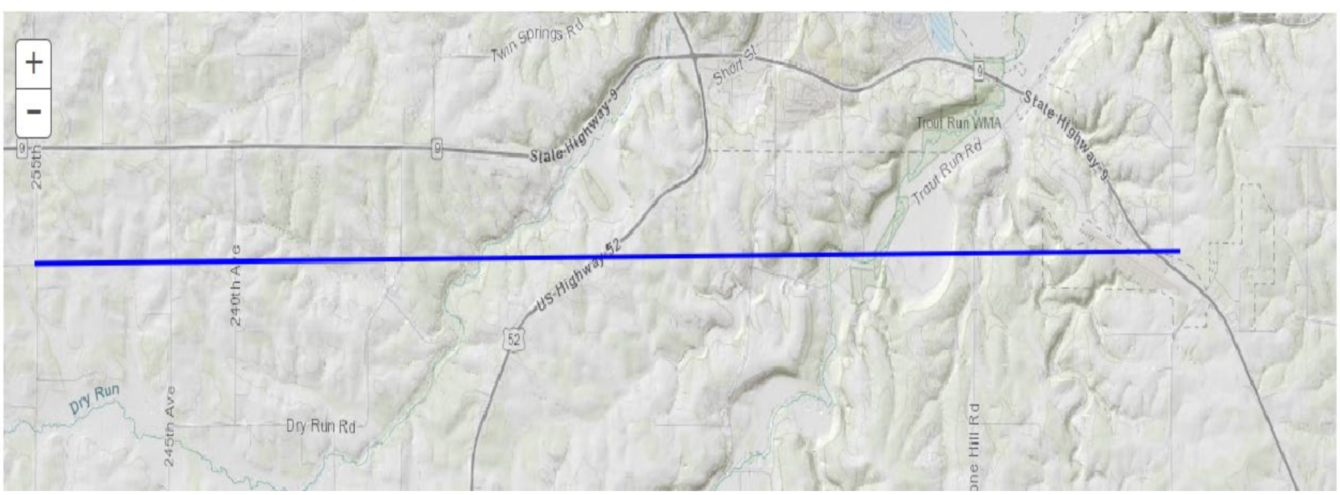


Figure 6. West to East cross section of the Trout Run Watershed. Siewers Spring is on top of the Decorah Shale.

Designated Use, Classifications, and Impairments

According to the Iowa Department of Natural Resources, a 1.94 mile segment of Trout Run has been listed on Iowa DNR's impaired waters list since 1996 for biological impairments (low benthic macroinvertebrate IBI) and *E.coli* resulting from stream bank erosion, stream channel sedimentation, and potential enrichment of organic matter due to nutrient contributions from livestock and other non-point sources. This segment is designated as coldwater aquatic life use (now termed Class B(CW1) uses) and for fish consumption uses (now termed Class HH (human health/fish consumption uses)). Due to changes in Iowa's surface water classification that were approved by U.S. EPA in February 2008, and due to the completion of a Use Attainability Analysis, this segment is also now designated for Class A3 (children's contact recreation) and for Class A2 (secondary contact recreation) uses. Prior to the 2008 Section 305(b) cycle, this stream segment was designated only for Class B(CW) aquatic life uses.

Point Source Pollutants

The only listed point source in the Trout Run Watershed is the Chuck Gipp Decorah Fish Hatchery. The hatchery is defined as a concentrated aquatic animal production facility which produces more than 20,000 pounds of cold water aquatic animals and feeds over 5,000 pounds of food in one year. Water discharged from the hatchery is subject to a National Pollutant Discharge Elimination System (NPDES) permit (# 9600901). Water discharge from the hatchery occurs at two locations, prior to entering Trout Run. At the first location, water from Siewers Spring enters a hatchery clarifier prior to discharging into Trout Run during overflow. At the second location, water leaving the hatchery race ways enters a settling pond, allowing solids to settle out of the water, prior to discharging into Trout Run. In the permit rationale, it was determined water monitoring for BOD5, total suspended solids, ammonia and pH were found to be well below in-stream water quality standards and below levels considered to need treatment. No reasonable potential for the facility to cause or contribute to water quality violations of the receiving stream was found, so no water quality based limits are included. All pollutants in the discharge are below treatable levels and therefore no technology based limits are required.

Water Quality

Watershed partners of the Upper Iowa River Watershed project collected water quality data from 30 sites, spanning 23 sub-watersheds within the Upper Iowa River. Trout Run and Siewers Spring were part of this effort. Ten different water quality parameters were sampled at each site from April-October 2010-2021. Average annual water quality for Trout Run and Siewers Spring and how these data compared to 30 other sites sampled within the Upper Iowa River is summarized in Appendices A and B. In general, Siewers Spring has poorer water clarity (measured as transparency) than other sites and higher levels of nitrogen, chloride, and sulfate. Siewers Spring has a lower pH and colder temperature than other sites. Total phosphorus and total suspended solids are higher than other sites for the majority of sampling years. *E. coli* levels, which is an indicator of the presence of human (i.e. septic systems) and animal waste (i.e., livestock runoff), are higher than other sites for the majority of the sampling years. Ammonia levels are lower or similar to other sites within the Upper Iowa River.

For Trout Run, water samples were collected above the confluence with the Upper Iowa River. In Trout Run, water clarity is variable across years but similar to other sites within the Upper Iowa River. Chloride and sulfite is higher than other sites. Total nitrogen, total phosphorus, total suspended solids and *E.coli* were measured to be higher for the majority of years sampled. Trout Run has a lower temperature and pH than other sites. Ammonia levels in Trout Run were lower or similar to the average of other sites for the majority of sampling years. Atrazine was detected in Trout Run during two years but measured at lower levels compared to other sampling sites in the Upper Iowa River Watershed.

Water quality was also collected after rain events in Trout Run and typically observed to be poorer following rain events. For example, during rain event collections, transparency was measured to be as low as 6 cm and nitrate as high as 11 mg/L, which is above the drinking water Maximum Contaminant Level (MCL) of 10 mg/L (appendix C). *E.coli* was sampled as high as 400,000 CFU's, which is considered to be very high and nearly half of the highest level sampled in nearby streams (Jen Kurth, personal communication). Atrazine was measured to be less than .40 ppb however during one rain event it was as high as 22.0 ppb. Ammonia levels during rain events can be as high as 0.77 mg/L and total phosphorus as high as 1.9 mg/L.

Similar results were shown for Siewers Spring in which nitrate (measured as nitrogen) exceeded the drinking water MCL and in 66.7% of the data records, *E. coli* bacteria exceeded 235 CFUs, Iowa's single sample maximum water quality standard for primary contact recreational use (Class A1) and children's recreational use (A3).

More recent water quality data measured in Trout Run and Siewers Spring indicate the majority of suspended solids in the water comes from inorganic sources like sediment as opposed to organic plant/algal material. *E.coli* levels in Trout Run range from 31- >24,000 CFU's. Nitrate ranges from 3.5-32 mg/L. A complete summary of Trout Run water quality sampled biweekly from July-November 2022 can be found in appendix D.

Siewers Spring and one segment of Trout Run are both listed as "Not Supporting" several of their designated uses due to bacterial *(E. coli)* impairments. In Siewers Spring, Class A1 designated use is not supported (https://programs.iowadnr.gov/adbnet/Segments/6596/Assessment/2022) and in Trout Run segment 269, Class A2 and A3 designated use is not supported (https://programs.iowadnr.gov/adbnet/Segments/269/Assessment/2022).

Based on public health records, Winneshiek County has a higher number of reported cases of Campylobacter, Cryptosporidium, and Hemorrhagic *E.coli* than the State of Iowa average. In order to help quantify bacteria present in public recreational waters and determine the source of the bacteria, Luther College staff and partners conducted water testing on local springs and contributing surface waters in summer 2018. From these observations, the following bacteria were detected in Siewers Spring and Trout Run: *Escherichia coli*, *Cryptosporidium* spp., and *Campylobacter jejeuinii*. *Cryptosporidium* spp. was detected in 50% of the samples and *Campylobacter jejeuinii* was detected in 17% of samples collected at Siewers Spring. In Trout Run, hemorrhagic *E.coli* was found in 33% of the samples. Both bovine (cow) and human sources of fecal contamination were present in Siewers Spring and Trout Run. Source markers linked to cows (Bacteroides-cow M3) were detected in Siewers Spring in 100% of the samples and the human linked source marker (Human Bacteroides) was detected in 17% of the samples collected at Siewers Spring. In Trout Run, both cow and human specific markers were detected in 100% of the samples collected. The presence of human specific markers sampled in Trout Run and Siewers Spring, indicates aging septic systems are contributing bacteria to these public recreational waters (Eric Baack, personal communication). The presence of bovine source markers can be related to poor manure storage from feedlots, over application of manure, and unrestricted cattle access to Trout Run.

Continuous Monitoring of Siewers Spring Water Quality

A water quality sensor was installed at Siewers Spring pool to monitor turbidity, nitrate, dissolved oxygen, pH, temperature, and conductivity (Figure 7). Readings are taken every 5 minutes and stored on a public website: https://iwqis.iowawis.org/app/. This data, combined with a flow curve established from measuring Siewers Spring flow at different water levels,was used to determine sediment and nitrate loads. Total monthly sediment loads in Siewers Spring ranged from 13.89-7,554.78 tons with the daily average ranging from 0.43 tons - 243.70 tons (Table 4). Total monthly nitrate load ranged from 5.30 tons – 36.82 tons. Average daily nitrate load ranged from 0.19 tons – 1.19 tons.

Table 4. Summary of sediment and nitrate loads using continuous water quality monitoring data from Siewers Spring.

Year	Month	Total Monthly Sediment Load (tons)	Avg Daily Sediment Load (tons)	Total Monthly Nitrate Load (tons)	Avg Daily Nitrate Load (tons)
2021	November	35.87	1.20	12.84	0.43
	December	31.89	1.03	13.86	0.45
2022	January	13.44	0.43	7.45	0.24
	February	38.24	1.37	5.30	0.19

March	7,554.78	243.70	18.96	0.61
April	47.44	1.58	17.63	0.59
May	93.99	3.03	23.99	0.77
June	107.53	3.58	26.56	0.89
July	778.17	25.10	36.82	1.19
August	275.49	8.89	27.07	0.87
September	60.70	2.02	17.07	0.57
October	33.67	1.09	11.18	0.36
November	43.70	1.46	13.79	0.46

Figure 7. Water quality sensor installed at Siewers Spring to monitor water quality every 5 minutes. Data recorded from this sensor is available on the following website: https://iwqis.iowawis.org/app/.

Habitats and Species of Concern

Based on Iowa DNR Fisheries stream surveys conducted in 2005-2014, Trout Run has five fish species present that are listed as a species of greatest conservation need in the Iowa Department of Natural Resources' Wildlife Action Plan (IA DNR Wildlife Action Plan 2015). These species represent different trophic guilds and include Banded Darter (*Etheostoma zonale*), Blackside Darter (*Percina maculata*), Brook Trout (*Salvelinus fontinalis*), Longnose Dace (*Rhinichthys cataractae*), and Slimy Sculpin (*Cottus cognatus*). The preferred habitats for these species are clear, flowing streams with rock substrate.

The Rusty Patch Bumblebee (*Bombus affinis*) is listed as a federally endangered species and has been observed at multiple prairies within the City of Decorah. Portions of the Trout Run Watershed are located within the estimated 1-5 mile home range used by Rusty Patch Bumblebees. The Rusty Patch Bumblebee requires sufficient nectar and pollen sources from diverse and abundant flowers, as well as undisturbed nesting sites in upland grasslands and shrublands. Insecticides can be lethal to bees, so limiting use of pesticides in Trout Run and surrounding areas can be helpful to the recovery of this species. Also ensuring there is adequate, diverse nectar sources for forage and timbered areas for overwintering will also help the recovery of this valuable species as well as other pollinators with similar life history needs.

Economic and Cultural Importance of Siewers Spring and Trout Run to the Local Community

Siewers Spring and Trout Run are important local community resources. Siewers Spring, Iowa's second largest spring, is a popular tourist attraction that draws thousands of visitors each year. It is the only source of water for the Chuck Gipp Decorah Fish Hatchery and contributes substantial flow to one of Iowa's most popular Trout Fisheries, Trout Run.

The Chuck Gipp Decorah Fish Hatchery utilizes water from Siewers Spring to raise over 150,000 trout on an annual basis. Trout are kept at the hatchery until reaching a larger size (10-12 inches) and then stocked weekly into 17 cold water streams in northeast Iowa and 17 urban community fisheries across the state. These trout fisheries provide diverse fishing experiences for Iowa's Trout anglers and provide a unique opportunity for anglers who live outside of the driftless area to catch trout. In 2016, trout anglers made 720,611 trips to fish in Iowa's coldwater trout streams (Steuck and Kopaska 2018). One of the most popular trout fishing destinations is Trout Run, which has been ranked by Iowa trout anglers as the 3rd (2016) and 4th (2020) most fished trout stream in Northeast Iowa. In a 2016 survey of Iowa trout anglers, 25,740 angler trips were made to Trout Run on an annual basis (Table 5; Steuck and Kopaska 2018). Trout fishing is important for local economies like Decorah because often times anglers spend their dollars locally while on a fishing trip. In 2016, Trout Run anglers generated nearly $1.2 million dollars to the local economy (Table 5).

Table 5. Economic impact of anglers fishing Trout Run and other trout streams in Winneshiek County, IA in 2016.

2016 Rank	Winneshiek Co. Stream	# Angler Trips	Dollars spent by anglers
1	North Bear Creek	35,286	$1,640,799
2	South Bear Creek	26,510	$1,232,715
3	**Trout Run**	**25,740**	**$1,196,910**
5	Coldwater Creek	22,720	$1,056,480
19	Trout River	13,156	$611,754
20	Twin Springs Creek	13,048	$606,732
33	Bohemian Creek	7,849	$364,979
46	West Canoe Creek	3,729	$173,399
49	Coon Creek	3,401	$158,147
66	South Pine Creek	1,328	$61,752
Total		152,767	$7,103,667

Situated between limestone bluffs and adjacent to Siewers Spring, The Chuck Gipp Decorah Fish Hatchery is an important local community resource and a very popular tourist destination. It is estimated every year the hatchery receives over 100,000 visitors who come to experience the beauty of Siewers Spring, feed trout in the hatchery raceways, go fishing in Trout Run, view and photograph the "Decorah Eagles", and gather with family and friends. Many community members enjoy reading at one of the many benches or rest and relax in the green spaces near Siewers spring. Artists come to create inspiring artwork and families or classmates stop to take pictures with Siewers Spring in the background. Siewers Spring and the Chuck Gipp Decorah Fish Hatchery are popular destinations for hosting family events and gatherings such as weddings, graduation parties, and church socials (Figure 8). Since 2006, nearly 700 tours have been given at the Chuck Gipp Decorah Fish Hatchery and an estimated 17,000 students reached with education about water quality, coldwater fish and aquatic ecosystems in Northeast Iowa (Table 6).


Figure 8. Left: Community members gather together near Siewers Spring during a social for the Midwest Environmental and Education Conference held in Decorah. Right: A wedding celebration is set up to take place at the Chuck Gipp Decorah Fish Hatchery with Siewers Spring as the backdrop.

Table 6. Number of events held and people reached at the Chuck Gipp Decorah Fish Hatchery.

Year	Hatchery Tours	People Reached	Job Shadows	Weddings	Graduation Parties	Church Events	Fun Runs	Other
2006	46	1042	4	4	0	0	0	1
2007	29	687	4	2	1	0	0	3
2008	44	1089	10	4	1	1	2	3
2009	29	766	6	5	0	0	1	5
2010	44	1272	5	9	1	0	1	9
2011	56	1697	5	8	0	0	2	7
2012	64	1682	6	8	2	2	3	6
2013	58	1681	6	8	2	3	4	4
2014	76	2380	5	14	1	4	4	4
2015	44	1062	4	12	2	1	0	12
2016	37	685	5	9	0	3	3	8
2017	53	870	8	12	0	3	3	13
2018	54	941	3	5	0	2	2	3
2019	48	817	5	11	1	2	2	3
2021	15	273	0	7	1	3	2	12
Total	**697**	**16, 944**	**76**	**118**	**12**	**24**	**29**	**93**

Another feature of local importance is the Trout Run Trail. The Trout Run trail is a multi-use trail that begins at the Chuck Gipp Decorah fish hatchery, runs alongside Trout Run to the Upper Iowa River, and passes through portions of the Trout Run Watershed. The trail is very popular, used by members of the local community and maintained year-round for walking, biking, and cross country skiing.

Watershed Planning Process

Several partners, listed below, were involved in the formation of this watershed protection plan. Partners provided support, technical assistance, help with data collection and interpretation, and shared their knowledge and perspectives either as a conservation professional working in a karst landscape or as a landowner, living and farming in the Trout Run watershed.

- Trout Run Farmers and Landowners
- Iowa Department of Natural Resources
  - Fisheries
  - Water Quality Improvement Section
  - Land Quality/GIS
  - Solid Waste and Contaminated Sites
- Winneshiek County NRCS
- Winneshiek County SWCD Commissioners
- Iowa Flood Center
- Iowa Geological Survey
- Luther College professors and staff
- Upper Iowa River Watershed Management Authority
- Winneshiek County and Northeast Iowa area Project Coordinators
- Northeast Iowa RC&D
- Winneshiek County Conservation
- Iowa State University Extension

Partners met throughout the watershed planning process during team meetings and small, in-person meetings to gather input and share knowledge about the Trout Run watershed. Topics discussed among project partners included: identifying areas in the watershed that likely contribute sediment, defining watershed assessments to help quantify sediment delivery, practices for reducing erosion in the Trout Run Watershed, establishing watershed goals, identifying barriers to implementing conservation practices, water quality monitoring and outreach.

From these conversations, a plan was developed to conduct watershed assessments, identify areas contributing sediment, define priority areas and project goals, propose best management practices and develop an outreach and education plan to engage the watershed community.

Trout Run and Siewers Spring Watershed Project Goals

The overall goal of the project is to reduce sediment delivery to Trout Run surface waters and groundwater contributing to Siewers Spring. Sources of sediment delivery include sheet and rill erosion, sinkhole catchments, sediment from exposed stream banks and within the streambed of Trout Creek and its tributaries. The following goals are proposed to reduce sediment delivery and improve water quality of Trout Run and Siewers Spring:

Goal 1: Reduce daily turbidity measured at Siewers Spring to < 27 NTU, requiring an annual sediment load reduction of 6,053 tons/year.

Continuous monitoring of turbidity at Siewers Spring indicates average monthly turbidity levels are variable and range from 3.25 - 77.6 NTU (Nephelometric Turbidity Units). These turbidity levels correspond with a total monthly sediment load of 13.44 – 7,554.78 tons and an annual sediment load of 8,418.98 tons. High turbidity at Siewers Spring and associated sediment loading in Trout Run can be problematic for fish and other aquatic organisms. During rain events, as turbidity levels rise to >27 NTU, water clarity is reduced at Siewers Spring (Figure 10) and begins to cause stress for Trout. A relatively high amount of sediment can be deposited during these rain events which contributes to decreased stream habitat availability for Trout and benthic macroinvertebrates (i.e. aquatic insects that break down organic materials and cycle nutrients through aquatic food webs, also a food source for Trout) in Trout Run. When Siewers Spring turbidity levels are sustained at <27 NTU, Siewers Spring water is visibly clear, less sediment is transported (0.003 - 0.019 tons) into Trout Run, and Trout at the Decorah Fish Hatchery are able to be fed consecutively throughout the growing season. In order to maintain Siewers Spring turbidity levels <27 NTU, an annual sediment load reduction of 6,053 tons of sediment/year is needed, which is a 72% reduction. This goal will be refined over time as additional water quality data is collected at Siewers Spring.

Figure 10. Differences in Siewers Spring water clarity (i.e. turbidity). Left: Siewers Spring turbidity is 6.9 NTU and increases to 45.9 NTU (right) after a rain event in the Trout Run Watershed.

Goal 2: Decrease sheet and rill erosion in Trout Run by implementing 50% of the watershed's agricultural acres into no-till and cover crops.

The Trout Run Watershed has 17,462 agricultural acres of which only 253 acres (1.4%) grow cover crops and 2,535 acres are no-till (14.5 %). A goal to increase the number of no-till and cover crop adoption on 50% of Trout Run's agricultural acres (8,732 acres) is proposed to reduce sediment delivery by 7,595 tons/year. Achieving this goal would require cover crops to be planted on 8,478 acres and 6,196 acres to reduce tillage.

Goal 3: Reduce sediment delivery from sinkholes by adding a native, perennial buffer around 100% of the sinkholes in the Trout Run watershed.

Sinkholes in the Trout Run watershed provide a direct connection to ground water aquifers that ultimately resurface at Siewers Spring. Sediment, nutrients, bacteria, and chemicals from the landscape are all pollutants that can enter the ground water via sinkholes. Placing a native, perennial buffer around sinkholes can trap sediment, nutrients, bacteria, and chemicals before entering the sinkhole. Neighboring watersheds in karst landscapes use a minimum 120’ vegetative buffer around sinkholes to protect groundwater resources. Native, perennial cover can include, tree plantings, native grasses, rotationally grazed pastures, and hay.

Goal 4: Decrease sediment delivery to Trout Creek by placing a riparian buffer along the entire stream corridor of the Trout Run Watershed.

In the Trout Run watershed, about 518 acres of the riparian corridor is row crop and is estimated to contribute 1,410 tons of sediment/year to Trout Creek. The Iowa Nutrient Reduction Strategy (https://www.nutrientstrategy.iastate.edu/) suggests a minimum 35’ riparian buffer to reduce sediment, nutrients, pesticides and to provide stream bank stabilization for Iowa’s streams. In Trout Run, these acres could be converted to native, perennial vegetation which would help reduce sediment delivery to Trout Creek by 1,112 tons/year.

Goal 5: Decrease sediment delivery from Trout Creek by stabilizing stream sections which contribute large pollutant loads to Trout Creek and Siewers Spring.

Stream bank erosion in the Trout Run watershed is estimated to contribute 4,787 tons/year of sediment to Trout Run and Siewers Spring. Stream bank erosion can be caused by frequent use of the stream bank from livestock and heavy machinery or erosion can be caused by stream power and hydraulic action. An estimated 43,126 ft of stream bank has been identified as needing protection. The estimated load reduction for stabilizing the stream bank in these areas will reduce sediment delivery to Trout Creek by 4,727 tons/year.

Expected Benefits to Chuck Gipp Decorah Fish Hatchery and State of Iowa Trout Fisheries

1) **An increase in the number of days Trout are able to be fed at the Decorah Fish Hatchery, resulting in improved fish health.**

   At the Decorah Fish Hatchery, trout are fed two times every day to maintain optimum health and growth for stocking into public waters. Trout are “sight-feeders” and rely primarily on clear water from Siewers Spring to be able to locate their food. When Siewers Spring water becomes too turbid (i.e. cloudy appearance, >27 NTU) from sediment, trout are not able to locate and consume their food, which reduces their overall health and growth. This is especially concerning when trout are not able to be fed on consecutive days. Based on data collected during the last sixteen years, on average, there are 42 days out of the year when hatchery personnel cannot feed the trout due to poor water conditions (Table 7). The majority of missed feedings happen in March-September.

Table 7. Total number of days trout are not fed at the Chuck Gipp Decorah Fish Hatchery due to increased turbidity of Siewers Spring water.

Year	**Days Trout are not fed**
2007	48
2008	52
2009	36
2010	41
2011	46
2012	28
2013	58
2014	47
2015	31
2016	33
2017	32
2018	74
2019	59
2020	42
2021	16
2022	35
Average	**42**

Sediment in the water also stresses the trout which causes them to get sick with secondary infections. Depending upon the severity of the infection and how widespread within the hatchery, many fish can die. High mortality of hatchery fish can be devastating to local and statewide fisheries that rely on stocked fish from the Chuck Gipp Decorah Fish Hatchery. Reducing the number of days when trout are not fed as a result of poor water clarity of Siewers Spring will help produce healthier trout for stocking into public fisheries across Iowa.

2) A reduction in the amount of sediment accumulated in the Decorah Fish Hatchery clarifiers each year.

Following precipitation events (i.e., rainfall, snow melt) in the Trout Run project area, Siewers spring water is diverted through two cement clarifier ponds prior to entering the fish hatchery raceways. The clarifiers are designed to slow water flow and settle some of the sediment out of the water before entering the raceways where Trout are located. Depending on the severity and frequency of rain events, sediment in the clarifier is cleaned out on a monthly or annual basis. In 2016, a memorable flooding year for Trout Run, over 414 tons of sediment was removed from the hatchery clarifier (Table 8, Figure 9). Dry years such as 2021 result in less sediment accumulation (65 tons) and correspond with fewer missed feedings (16 days) for trout (Tables 7,8). By reducing sediment delivery to Trout Run, the amount of sediment accumulated into the fish hatchery clarifier should decrease each year.

Table 8. Total sediment (yd^3 and tons) accumulated in the Chuck Gipp Decorah Hatchery clarifiers.

Year	Total Sediment (yd^3)	Total Sediment (tons)
2016	282.96	424.44
2018	207.96	311.94
2019	237.41	356.11
2021	43.06	64.58
2022	178.31	303.13
Total	**949.7**	**1460.2**

Figure 9. 303.13 tons of sediment accumulated in the Chuck Gipp Decorah Fish Hatchery clarifiers from five rainfall events in July and August 2022.

Watershed Assessments

Watershed assessments were performed to determine the source and quantity of sediment being delivered to Trout Creek and Siewers Spring. In the Trout Run project area, sediment is delivered to Trout Creek surface waters and Siewers Spring in the following ways:

1) Sheet, rill and gully erosion on the landscape
2) Sinkholes
3) Losing stream reaches present in Trout Creek and tributaries of Trout Creek
4) Exposed and eroding stream banks
5) Sediment present and embedded within the stream bed or within underground caverns
6) Other unknown potential sources (i.e. surface waters of surrounding watersheds that may connect via underlying bedrock layers).

Sheet and Rill Erosion

Sheet and rill erosion is the physical removal of soil from the land surface by the action of rainfall, melting snow, irrigation, and runoff. In some situations, sheet and rill erosion may not be readily visible, even when soil is eroding at unsustainable levels. For example, soil loss of 1/32" can represent soil loss of more than 5 tons/acre. Typically, sheet and rill erosion can be observed across the landscape and is identified by small rills or channels on the soil surface, soil deposited at the base of slopes, and sediment deposited in streams.

Trout Run has the highest estimated sheet and rill erosion of any sub-watershed of the Upper Iowa River (Figure 11). Total sheet and rill erosion in the Trout Run Watershed is estimated to be 81,682 tons of sediment/year (Figure 12). About 80% of the sheet and rill erosion comes from 11,818 acres (Table 9). These acres have an estimated soil loss of ≥ 2.0 tons/acre/year. Although it is important for all areas to implement soil health practices, the acres with high amounts of sheet and rill erosion are a priority to address with management practices in the Trout Run Watershed.

Sheet and rill erosion is detrimental to soil health because it disturbs and removes the topsoil layer which has the highest amount of biological activity and soil organic matter. Sheet and rill erosion can be reduced by maintaining a protective cover on the soil and growing diverse crops year-round that feed soil biology. Overtime, the increase biological activity will build soil structure to increase infiltration and water storage capacity and improve nutrient cycling. Practices like reduced tillage, leaving residue on the soil, growing cover crops, increasing plan diversity and incorporating perennial plants, can reduce sheet and rill erosion in Trout Run.

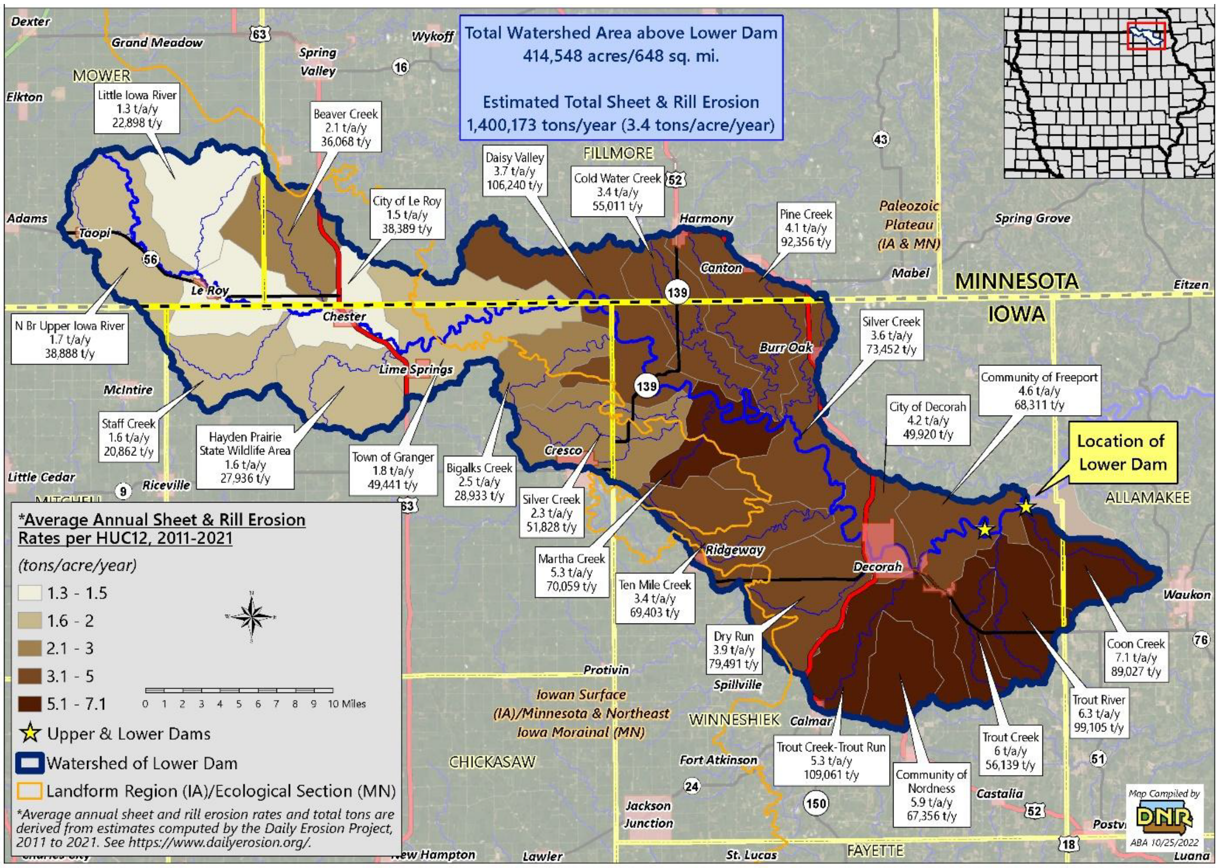


Figure 11. Estimated annual sheet and rill erosion for the Trout Run Watershed project area and other sub-watersheds of the Upper Iowa River.

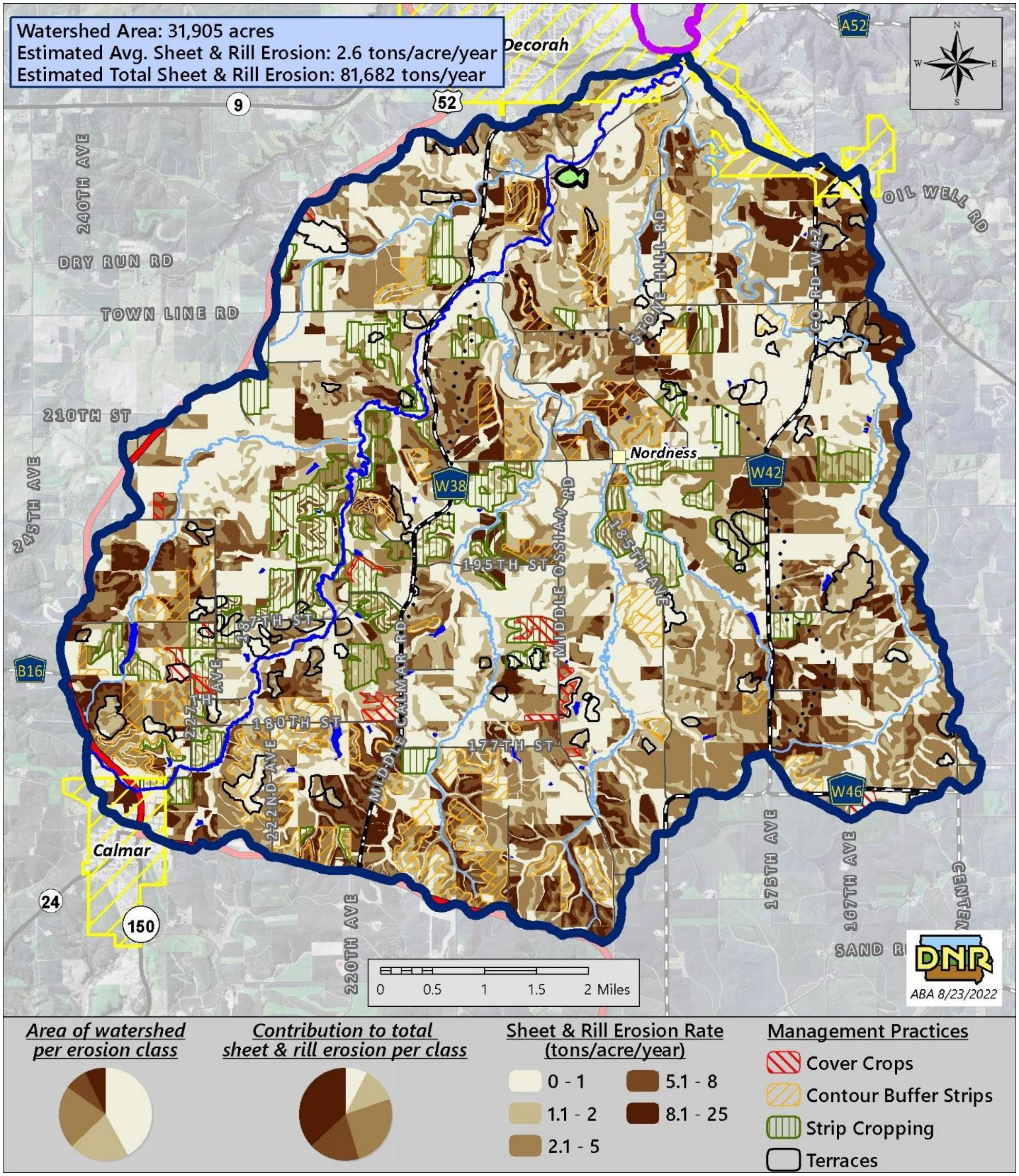


Figure 12. Estimated sheet and rill erosion in the Trout Run watershed.

Table 9. Sheet and rill erosion summary for the Trout Run watershed project area. Highlighted portion shows 37% of the project area accounts for 80% of the total sheet and rill erosion.

Sheet & Rill Class (t/a/y)	Acres	% of Project Area	Total Sheet & Rill Erosion (t/y)	% of Total Sheet & Rill Erosion
≥ 8.0	2,314	7.3%	30,056	36.8%
5.0 to 8.0	2,492	7.8%	14,507	17.8%
2.0 to 5.0	7,012	22.0%	21,056	25.8%
1.0 to 2.0	6,660	20.9%	10,022	12.3%
0.0 to 1.0	13,426	42.1%	6,040	7.4%
Total	**31,905**		**81,682**	

Sediment Delivery

Total estimated sediment delivery for Trout Run is the highest of any sub-watershed in the Upper Iowa River (Figure 13). The estimated sediment delivery for Trout Run is 15,512 tons/year (Figure 14). About 4,453 acres or 14% of the project area have a total sediment delivery of ≥ 1 ton/acre/year (Table 10). These acres deliver about 8,768 tons/year of sediment to Trout Creek, which is 57% of the total sediment delivery. In-field management practices can be utilized to reduce sheet and rill erosion. Edge of field practices like field borders, buffer strips, and perennial plantings in the riparian corridor can help reduce sediment delivery to Trout Creek. Also structural practices like ponds, WASCOBS, and grade stabilization structures can be placed in Trout Run to reduce sediment delivery to Trout Creek. Figure 15 shows areas in Trout Run where structural practices have reduced sediment delivery and where additional practices are propsed to reduce sediment delivery.

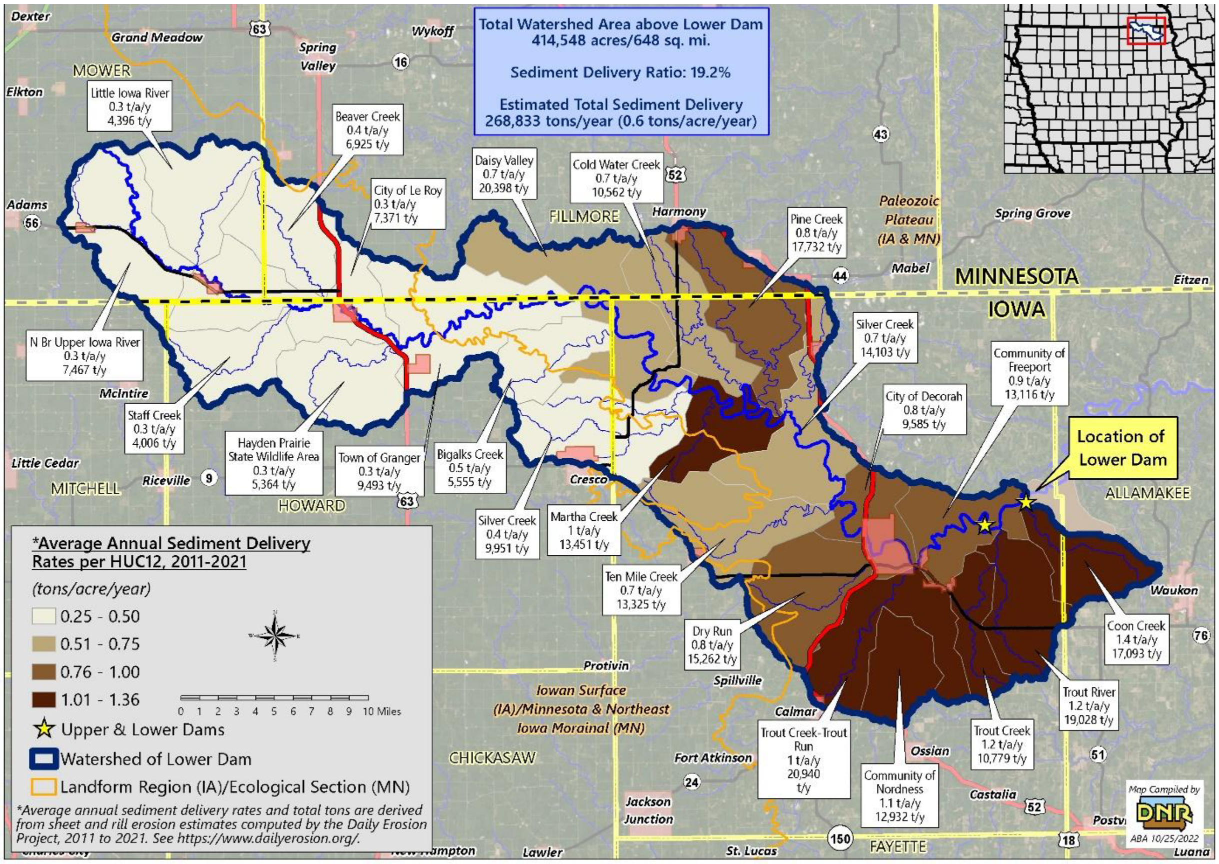


Figure 13. Estimated sediment delivery for the Trout Run project area and all other sub-watersheds in the Upper Iowa River.

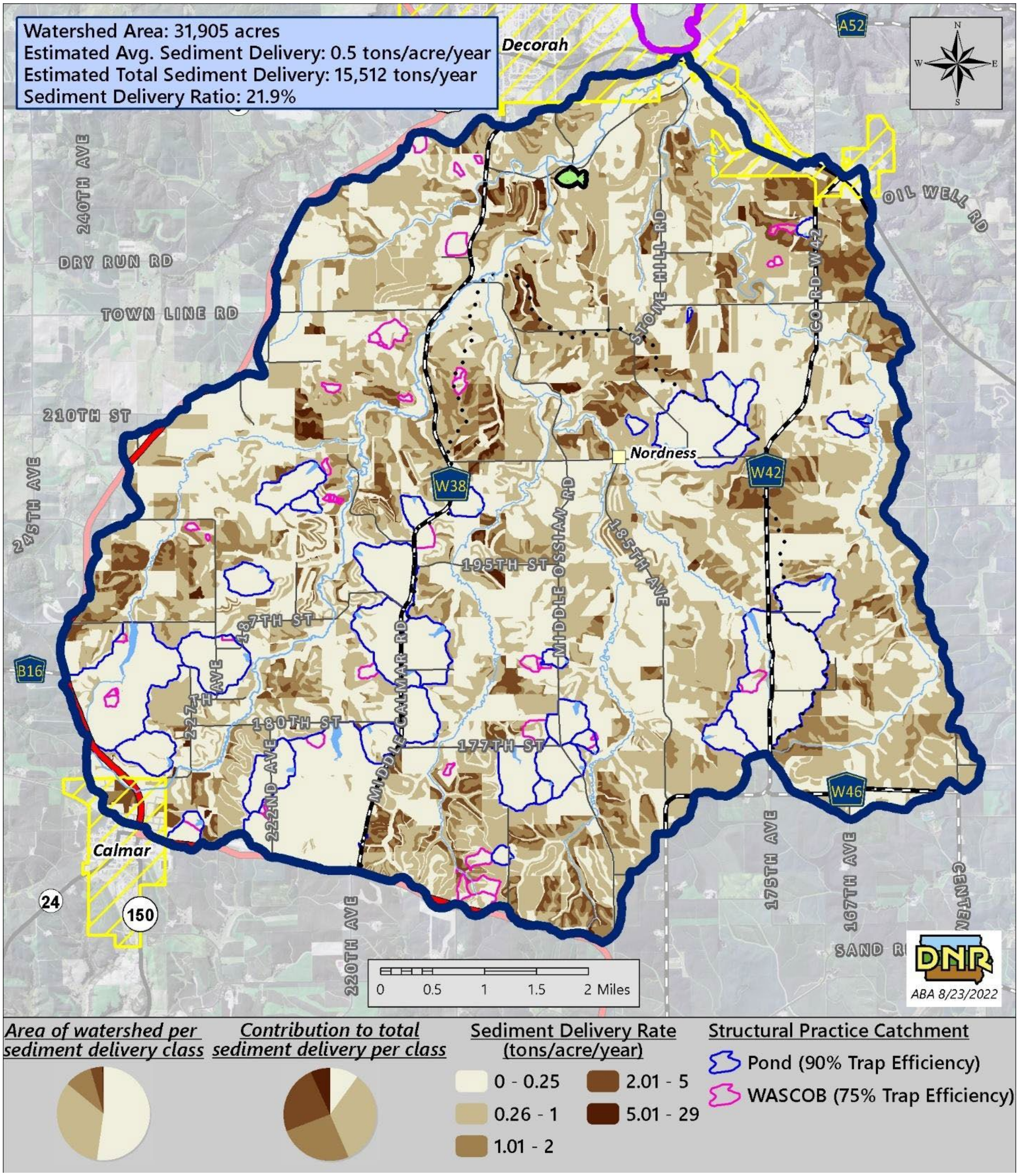


Figure 14. Estimated sediment delivery for the Trout Run Watershed.

Table 10. Summary of sediment delivery summary for the Trout Run project area. The highlighted portion shows 14% of the project area contributes 57% of the total sediment delivery.

Sediment Delivery Class (t/a/y)	Acres	% of Project Area	Total Sediment Delivery (t/y)	% of Total Sediment Delivery
≥ 5.0	168	0.5%	1,062	6.8%
2.0 to 5.0	1,294	4.1%	3,698	23.8%
1.0 to 2.0	2,991	9.4%	4,008	25.8%
0.25 to 1.0	10,777	33.8%	5,222	33.7%
0.0 to 0.25	16,675	52.3%	1,522	9.8%
	31,905		**15,512**	

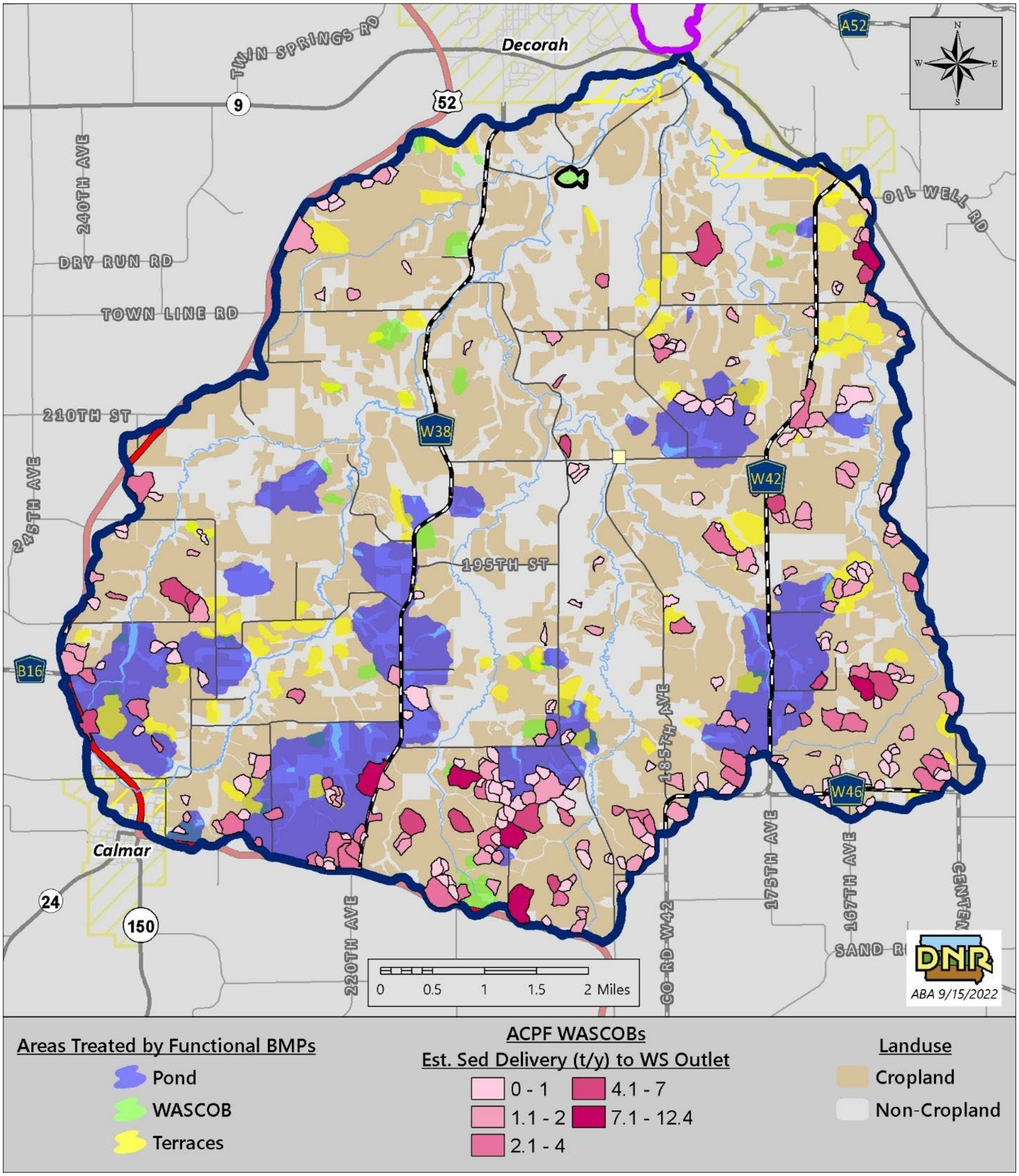


Figure 15. Areas treated by structural practices and potential locations proposed for additional practices which reduce sediment delivery in the Trout Run Watershed.

Existing Best Management Practices

Data collected from Iowa State University's Best Management Practice Mapping Project and a land use and tillage assessment conducted in Trout Run (DNR 319 section in 2018), indicate the Trout Run watershed has 31% of the watershed acres treated by a conservation best management practice. These conservation practices include both in-field management and structural practices or a combination (Table 11). In-field best management practices including cover crops, strip cropping and contour buffer strips treat 5,569 acres or 26.5% of the total cropland acres in Trout Run (Table 12). Only 253 acres (1.2%) are managed with a cover crop. Structural practices like terraces, ponds, and WASCOB's treat 5,685 acres or 17.8% of the total watershed acres (Table 13). Both in-field management and edge-of-field practices are needed to decrease sediment delivery in the Trout Run Watershed.

Table 11. Best management practices (BMP) implemented in the Trout Run watershed

BMP Combos	Acres	% of Treated Acres	% of Watershed Acres
Management Only	4,236	42.7%	13.3%
Structural Only	4,346	43.8%	13.6%
Both Management & Structural	1,333	13.4%	4.2%
	9,915	**100.0%**	**31.1%**

Table 12. In-field best management practices (BMP) implemented in the Trout Run watershed

Management Practice (BMP)	# of BMPs Utilized	Acres	% of Cropland Acres
Strip Cropping	1	2,670	12.7%
Contour Filter Strips	1	2,645	12.6%
Cover Crops	1	131	0.6%
Cover Crops & Strip Cropping	2	84	0.4%
Cover Crops & Contour Filter Strips	2	38	0.2%
***Total cropland acres treated**		**5,569**	**26.5%**
*Total Cropland Acres (corn, soybean, hay)		21,038	

Table 13. Structural best management practices (BMP) implemented in the Trout Run watershed

Structural Practices	BMPs Utilized	Acres Treated	% of Watershed Acres
Pond	1	4,050	12.7%
Terraces	1	1,029	3.2%
WASCOB	1	291	0.9%
Pond, Terraces	2	173	0.5%
Pond, WASCOB	2	78	0.2%
WASCOB, Terraces	2	28	0.1%
Pond, WASCOB, Terraces	3	36	0.1%
Total Cumulative Acres Treated		**5,685**	**17.8%**
Total Watershed Acres		31,905	

A map of all existing BMPs in the Trout Run watershed is shown in figure 16. In order to reduce soil erosion and sediment delivery in Trout Run, additional BMPs are needed. In-field soil health practices are encouraged on all acres. Acres treated with only structural practices could be encouraged to adopt in-field management practices that will reduce soil erosion and increase the longevity of any structural practice.

For a variety of reasons, many of the structural practices in Trout Run are no longer reducing sediment delivery to Trout Creek as originally designed or intended (Figure 16). In these cases, structural practices may need to be repaired or replaced. For example, grade stabilization structures, ponds and WASCOBs have filled with sediment over time, dykes have been breached or have failed due to cattle access or vegetation growth. Some structures have been removed entirely and others were not originally designed to meet NRCS specs and may be undersized with an insufficient storage capacity. For any acres in Trout Run, in-field management practices can help reduce erosion and increase the longevity of practices.

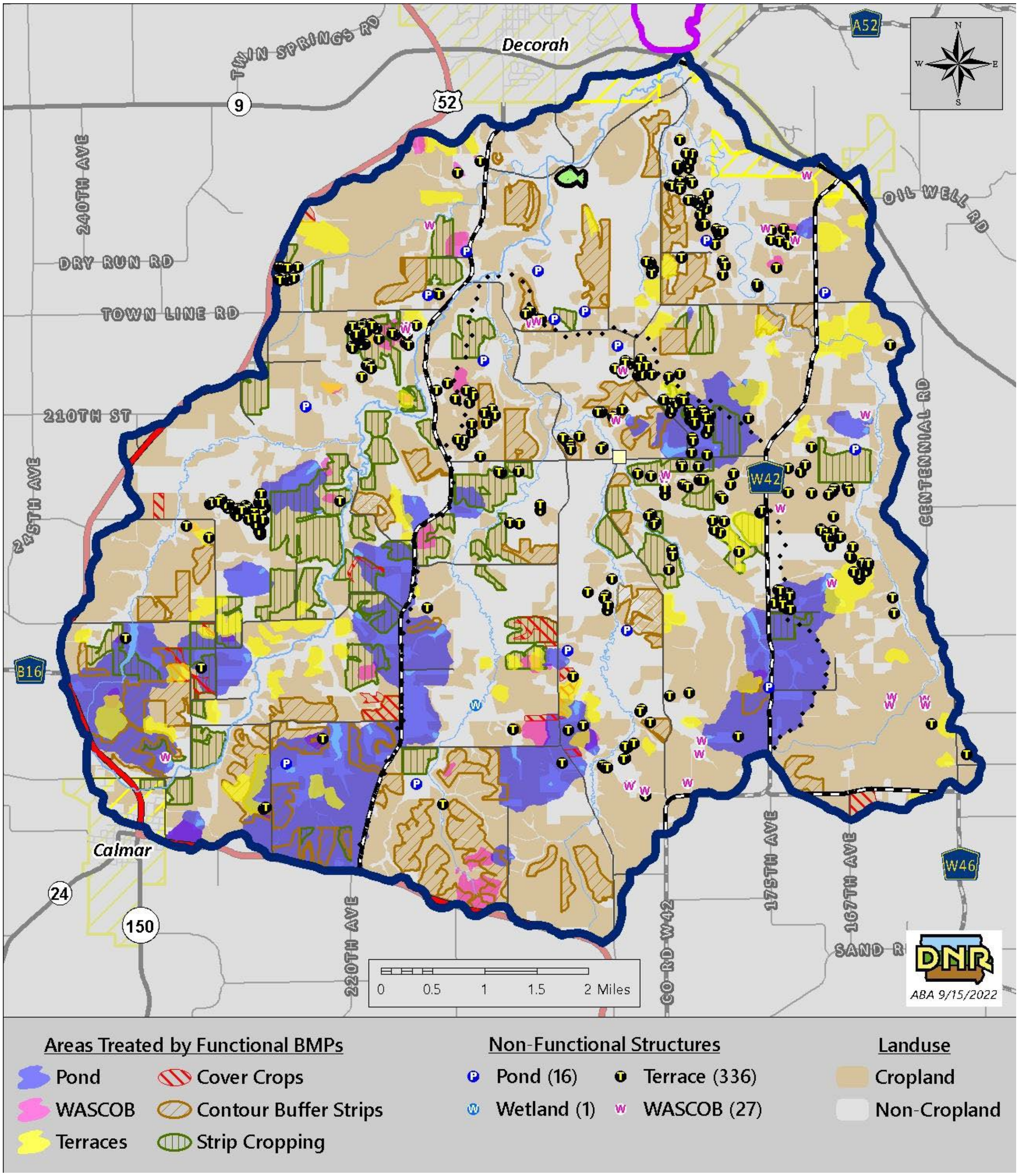


Figure 16. Current best management practices in the Trout Run Watershed.

Sinkholes

Sinkholes are features that occur naturally in areas with fractured bedrock, subsurface drainage and shallow soils like Trout Run. Sinkholes can be seen as a direct conduit of surface water to ground water, with little material to filter any pollutants. On one hand, this connection is a relatively quick way to recharge ground water (Libra 2005) and sustain coldwater ecosystems. However, when surface water is contaminated, sinkholes allow contaminated surface runoff to directly enter groundwater aquifers, which can be detrimental to coldwater ecosystems and shallow wells. Sinkholes can be a significant contributor of sediment and other pollutants to a ground water source like Siewers Spring.

In the Trout Run Watershed, 235 features have been identified as sinkholes (Figure 17) using LiDAR and observations from a field survey conducted by Luther College students in 2007. From these surveys, it was unknown how much sediment is delivered to Trout Creek and Siewers Spring from sinkholes. Also, general information about sinkhole characteristics is lacking such as average size, soil depth to bedrock, change in size and activity, surrounding land use, and acceptable options for treatment. Many farmers within Trout Run and surrounding karst watersheds typically fill sinkholes with sediment or a mixture of materials (rock, clay, concrete, plastic liner), only to have the same spot open again within one year or a new sinkhole open nearby (Figure 18). Thus, it is not recommended sinkholes in Trout Run be filled in, rather buffered so groundwater resources are protected. This also saves the landowner expenses associated with sinkhole filling.

To learn more about sinkholes field assessments were conducted in the Trout Run watershed to better inform this watershed plan about sediment delivery and general characteristics of sinkholes in the Trout Run Watershed.

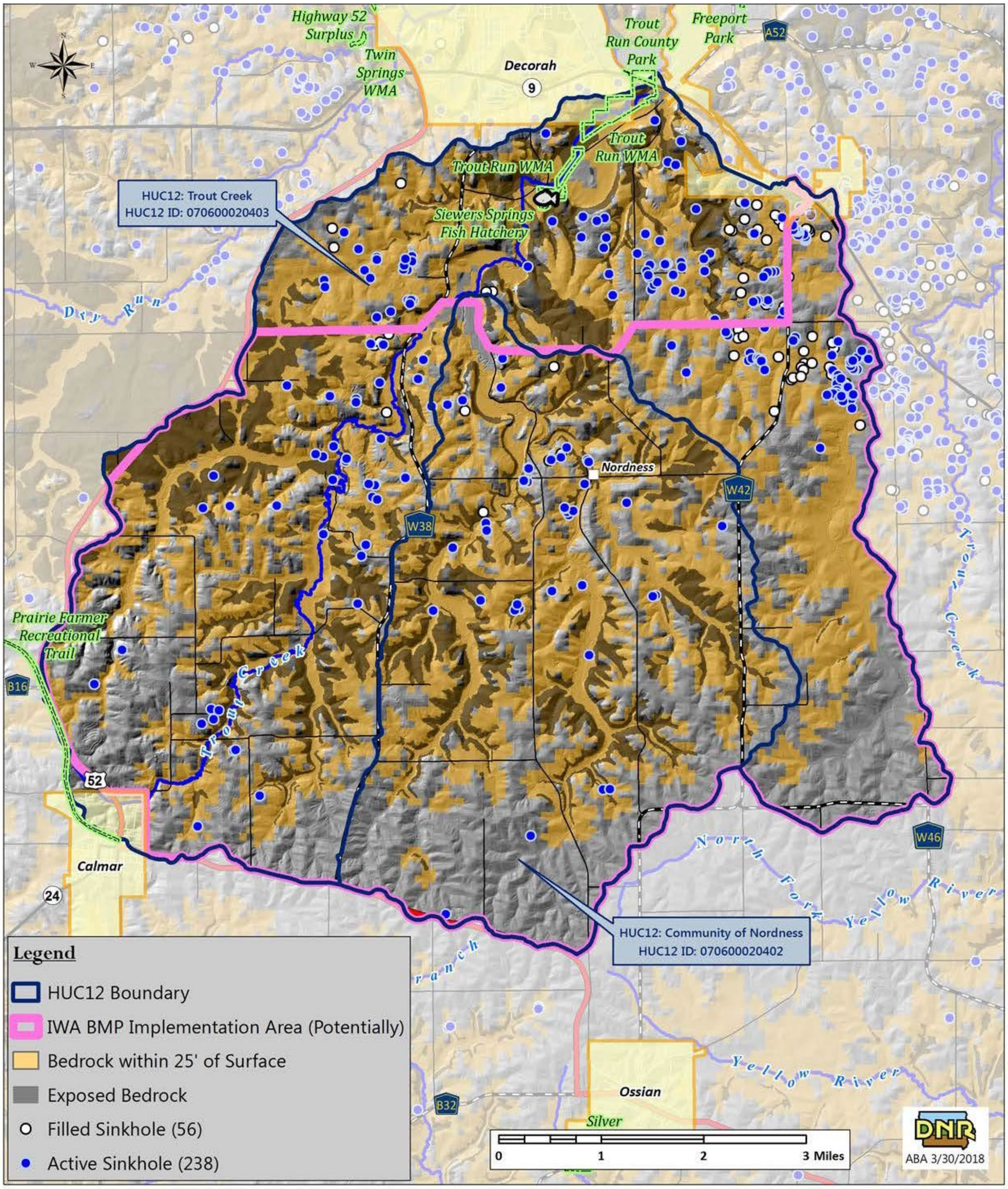


Figure 17. Sinkholes and areas of shallow depth to bedrock in the Trout Run Watershed.

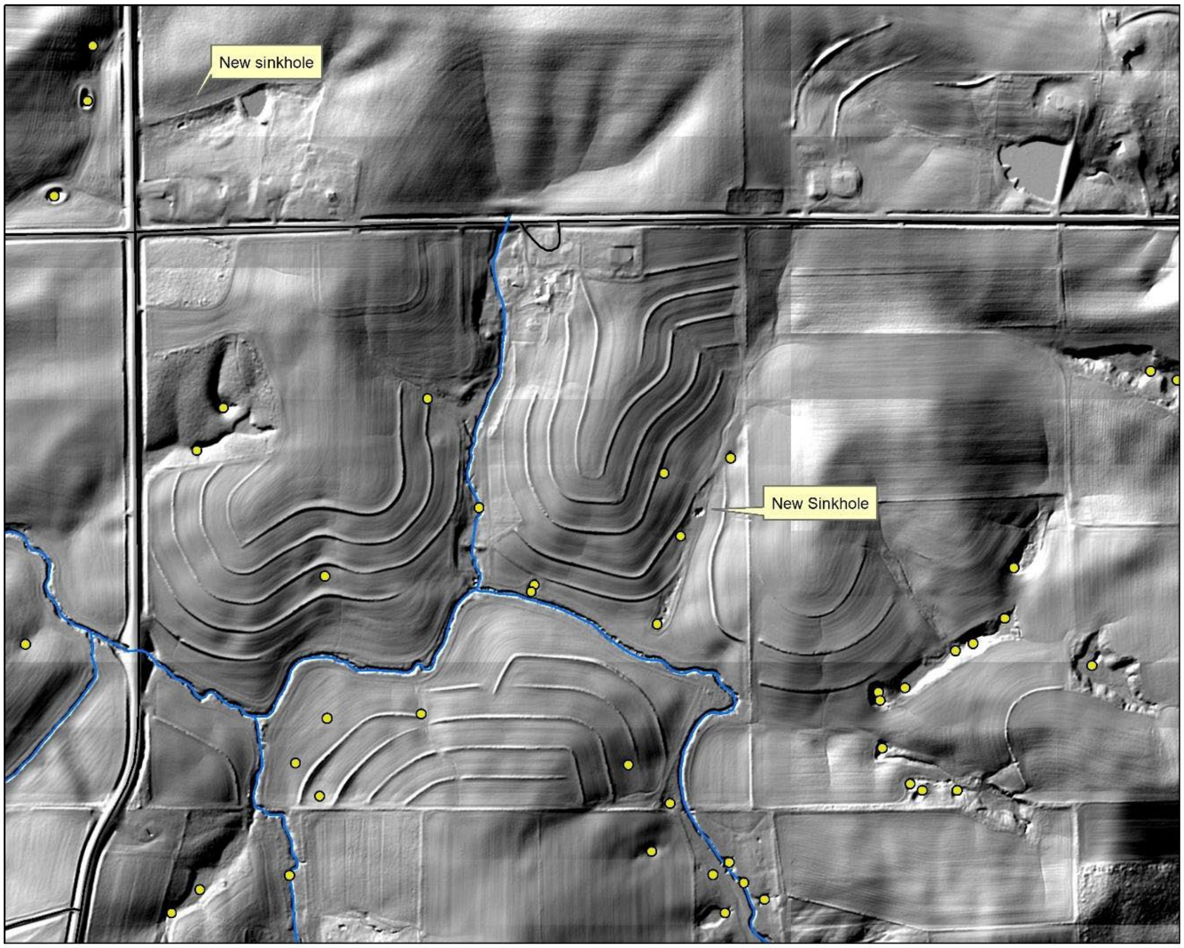


Figure 18. Example of two sinkholes which recently opened in the Trout Run watershed.

To determine the amount of sediment contributed by Trout Run sinkholes, a catchment area was defined for each individual sinkhole or “sinkhole complex”, a term used when multiple sinkholes exist in close proximity to one another. Land use within each catchment was determined from GIS layers and a sediment delivery ratio applied to calculate potential sediment delivery (tons/year). The sediment delivery ratio included catchment size and estimated sheet and rill erosion. Using these methods, total sediment delivered by Trout Run sinkholes is estimated to be 3,313 tons/year. Summary statistics for Trout Run sinkhole catchments can be found in Table 14. A complete list of sinkhole catchment summary statistics can be found in Appendix E.

Table 14. Summary statistics for sinkhole catchments in the Trout Run Watershed.

Sinkhole Catchment Parameter	Average (range)
Catchment Size (acres)	8.34 (< 0.5 - 102.5)
Sediment Delivery (t/y)	18.3 (0 - 213.5)
Grassland (%)	37 (0 - 100)
Cropland (%)	36 (0 - 100)
Forested (%)	23 (0 - 100)
Artificial (%)	3 (0 - 49)

Sinkhole catchments in Trout Run range from 0.5 – 102. 5 acres with an average catchment area of 8.34 acres. Land use within sinkhole catchments is primarily grass, crops, and forest (Table 14). Sediment delivery ranges from 0-213.5 t/y (Figure 19). Typically sinkhole catchments with a low sediment delivery value (< 0.5 t/y), have a small catchment size (average = 0.36 acres) and generally have a larger percentage of the catchment area covered in grasses or forest. (Table 15).

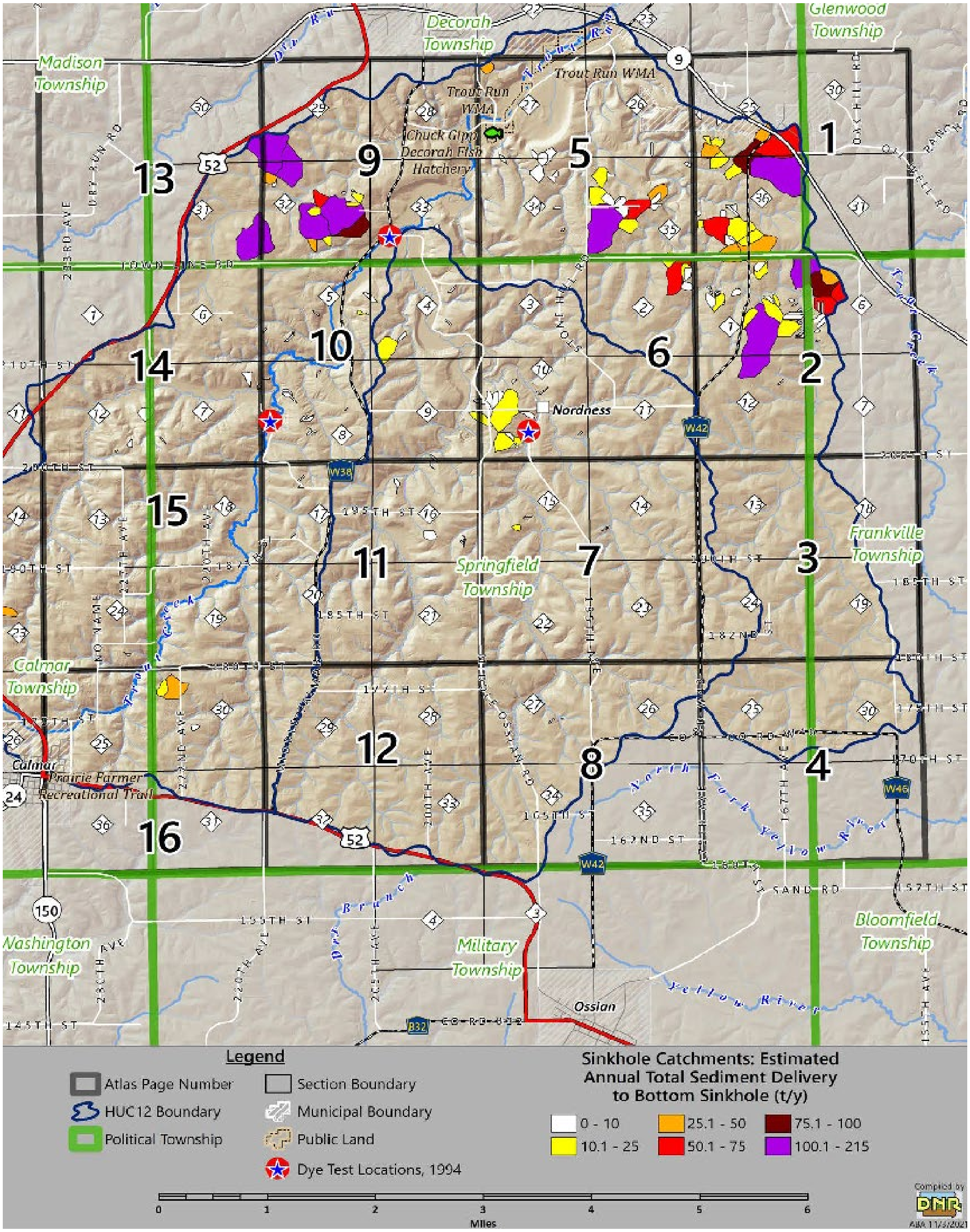


Figure 19. Estimated total sediment delivery (tons/year) for sinkhole catchments in the Trout Run Watershed.

Table 15. Summary statistics for sinkhole catchments in the Trout Run Watershed.

Sinkhole Catchments with Sediment Delivery < 0.5 t/y	Average
Catchment Size	0.36 acres
Grassland	53%
Forested	41%
Cropland	5%
Artificial	2%

Forty-seven sinkhole surveys were conducted in the Trout Run Watershed. On average, Trout Run sinkholes are 48 ft long (range 3-141’), 30 ft wide (range 9-87 ft), and 16 ft deep (range 3-39 ft; Figure 20). Thirty-four percent of the sinkholes surveyed had a visible opening at the bottom and trash was present in 55% of the sinkholes surveyed. Nearly all (85%) sinkholes received some to all of the overland flow from the surrounding landscape, indicating buffers could be implemented. Soil depth within a sinkhole was variable with 70% containing a soil depth >10’ and 30% with a soil depth of less than 10ft. More than half (59%) of the sinkholes surveyed were considered to be a medium-high concern based on surrounding land management practices and presence of a visible opening to bedrock. All sinkholes surveyed were considered to be treatable with a perennial buffer and soil health practices in the catchment area.

Strategies to reduce sediment delivery from sinkholes include addressing sheet and rill erosion within each sinkhole catchment and adding a protective vegetative buffer around each sinkhole. Sheet and rill erosion can be addressed by implementing soil health practices like no-till and cover crops on cropland acres. Implementing continuous conservation cover in areas prone to sinkhole formation and managed rotational grazing systems for sinkholes within pastures. Sinkholes in areas with existing perennial cover (trees, grassland, pasture) can be improved through timber stand improvements, increased seeding and plant diversity. Neighboring watershed projects in karst landscapes have worked with landowners to implement a 120’ native perennial buffer around sinkholes to reduce sediment and pollutant delivery to groundwater sources (Neil Schaefer, personal communication; Eric Palas, personal communication).

Figure 20. Example sinkholes found in the Trout Run Watershed. Top left: Newly formed sinkhole in Trout Run. Top right: Sinkhole receiving tile discharge and overland flow from cropland. Middle left: sinkhole in

a pasture with grazing cattle. Middle right: large sinkhole with a berm and grass buffer strip. Bottom left: Example of sinkhole with direct opening to underlying bedrock. Bottom right: Smaller sinkhole with grass buffer, adjacent to row crop field.

Stream Bank Erosion

Sediment erosion from stream banks within the Trout Run Watershed was quantified by comparing LiDAR elevation data from the 2007 and 2020 time frame (Figure 21). During this time period stream bank elevation changes occurred as some sections eroded and others had sediment deposition. Net erosion was calculated as total erosion – total deposition within the stream channel and was determined to be 39,876 m^3 (or 59,848 tons) over the 12.5-year time span. These changes in stream bank elevation is shown as a net erosion (negative value) or deposition (positive value) for each stream segment in the Trout Run Watershed (Figure 22). On an annual basis, the rate of sediment erosion from Trout Run stream banks is 4,787 tons/year (or 0.245 m^3/m). Based on LiDAR elevation, the highest amount of sediment erosion comes from the Washington Prairie Branch section in the Eastern portion of the watershed (net erosion = 54,463 m^3; rate = 1.5 m^3/m) as well as third and fourth order sections located (net erosion = 26,577 m^3; rate = 0.606 m^3/m) toward the Northern portion of the Trout Run Watershed (Table 16). Trout Run 1st and 2nd order stream sections in the uplands or Southern portion of the watershed have the highest deposition rate (net deposition = 52,021 m^3; rate = 0.452 m^3/m; Figure 22). Other pollutants contributed to Trout Creek through stream bank erosion is estimated to be 9,574 tons/year of Nitrogen and 6,223 tons/year of Phosphorus.

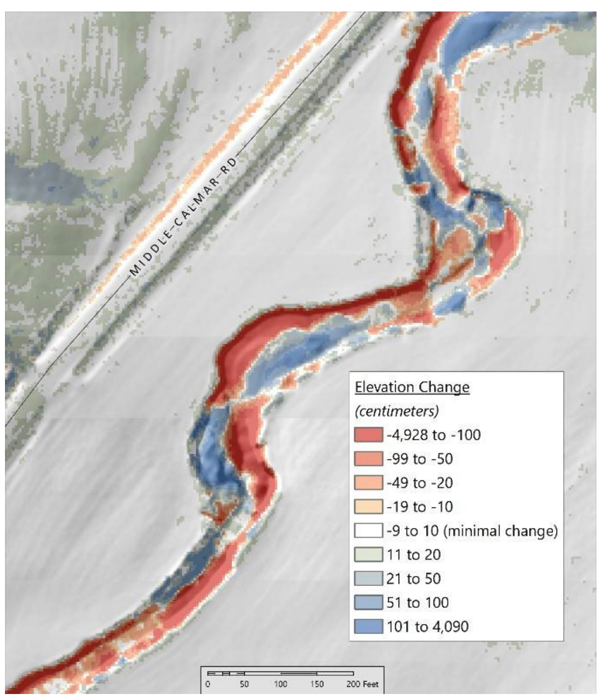


Figure 21. Example segment of Trout Creek showing change in stream bank elevation by comparing 2007 and 2020 LiDAR surveys.

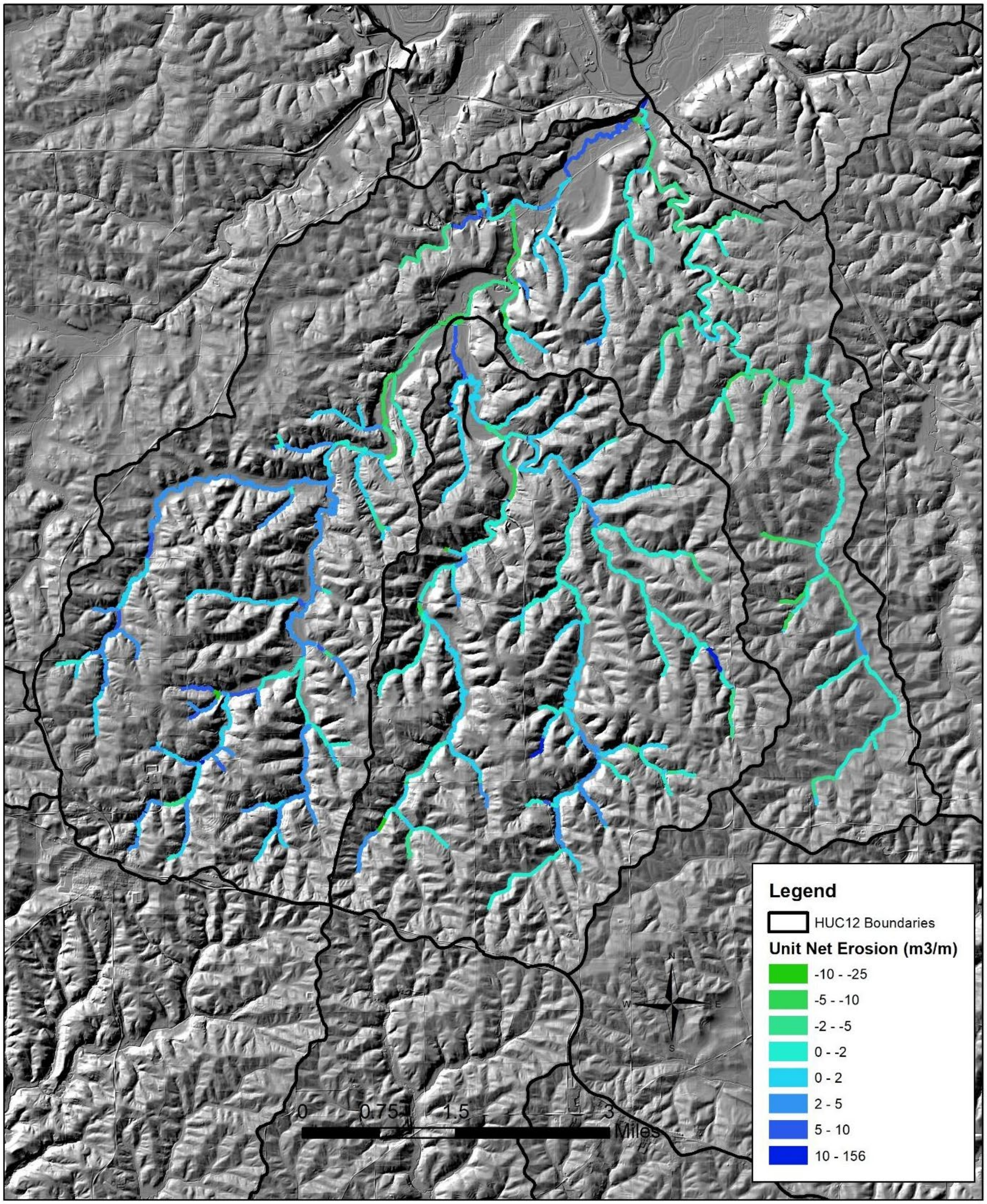


Figure 22. Trout Creek net bank erosion per stream length using 2007 and 2020 LiDAR elevation. Negative values (green) is net erosion and positive values (blue) is net deposition.

Table 16. Summary of net sediment erosion (-) and deposition (+) for Trout Creek stream banks.

Stream Section	Erosion (m^3)	Deposition (m^3)	Net Erosion (m^3)	Length (m)	Unit Net Erosion (m^3/m)
All streams in watershed	-491,810	531,686	39,876	162,908	0.245
1st and 2nd order sections	-252,431	304,451	52,021	115,157	0.452
3rd and 4th order sections	-239,287	226,957	-12,330	47,715	-0.258
3rd and 4th order sections not including main stem below hatchery	-199,796	173,219	-26,577	43,845	-0.606
Washington Prairie Section	-113,440	58,977	-54,463	36,307	-1.500

Stream bank erosion in the Trout Run Watershed can be addressed with stream bank protection practices such as bank stabilization, maintaining perennial vegetation along the stream bank (i.e. introducing a riparian corridor), and limiting cattle access to stream banks. Cattle access can be limited by offering alternative water systems, exclusion fencing with managed rotational grazing, and heavy use protection areas for small segments along the bank where cattle and equipment cross.

Further, implementing soil health practices in the watershed overtime, will increase the soil's capacity to store water and slow water flow, reducing the stream power that causes bank erosion.

Stream Assessment: Rapid Assessment of Stream Conditions Along Length (RASCAL)

A RASCAL stream assessment was used to identify and characterize areas of stream bank erosion, determine the extent of sediment embedded in the stream, and to describe characteristics of the riparian corridor and adjacent land area along Trout Creek. A RASCAL stream assessment was completed on a 6.2 mile reach in Trout Creek which covered the lower branch of Nordness and a portion of lower Trout Creek and Trout Run (Figure 23). Along this section, twenty-one different stream characteristics were measured at multiple points to evaluate in-stream, stream bank, and riparian characteristics. A complete list of summary statistics generated from the RASCAL assessment can be found in Appendix F.

Data and observations collected from this assessment were used to help determine potential areas in need of stream bank stabilization and other riparian initiatives in the Trout Run Watershed. Based on the survey, the major issues identified were poor bank stability, limited riparian zone width, embeddedness, and livestock access to the stream.

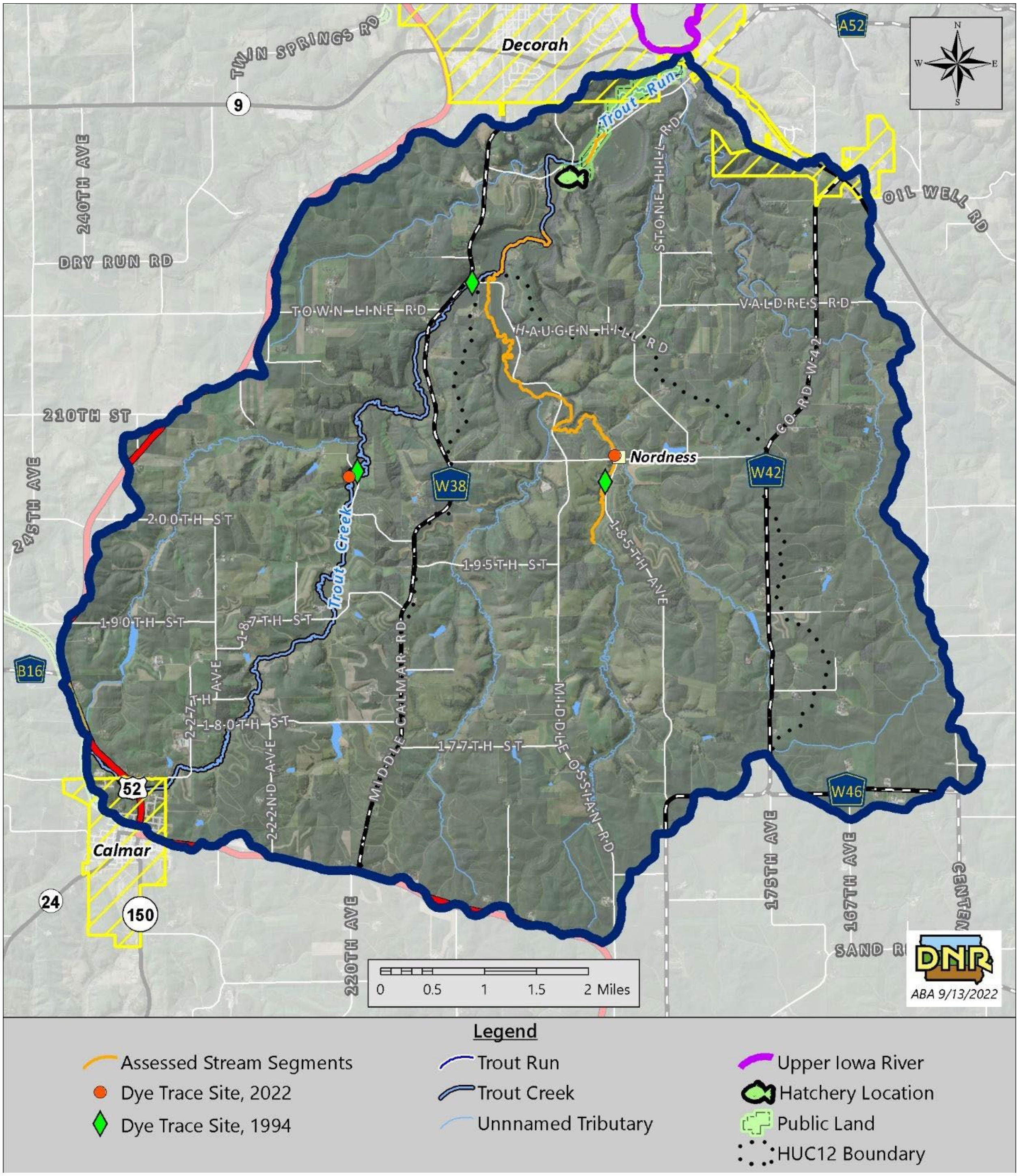


Figure 23. 6.2-mile section of Trout Creek which was evaluated using a RASCAL survey.

The RASCAL survey was conducted in fall and winter when Trout Creek's Stream flow conditions were considered to be normal (86%) or low (3%; Figure 24). However, during this time period, 10% of the section surveyed had visibly reduced flow compared to adjacent upstream sections or were entirely dry due to characteristics of a losing stream reach (i.e. porous and fractured bedrock, visible sinkholes in the stream bed; Figure 25). During the survey, water clarity was mostly clear to somewhat cloudy (Figure 26) although not cloudy enough to inhibit instream observations.

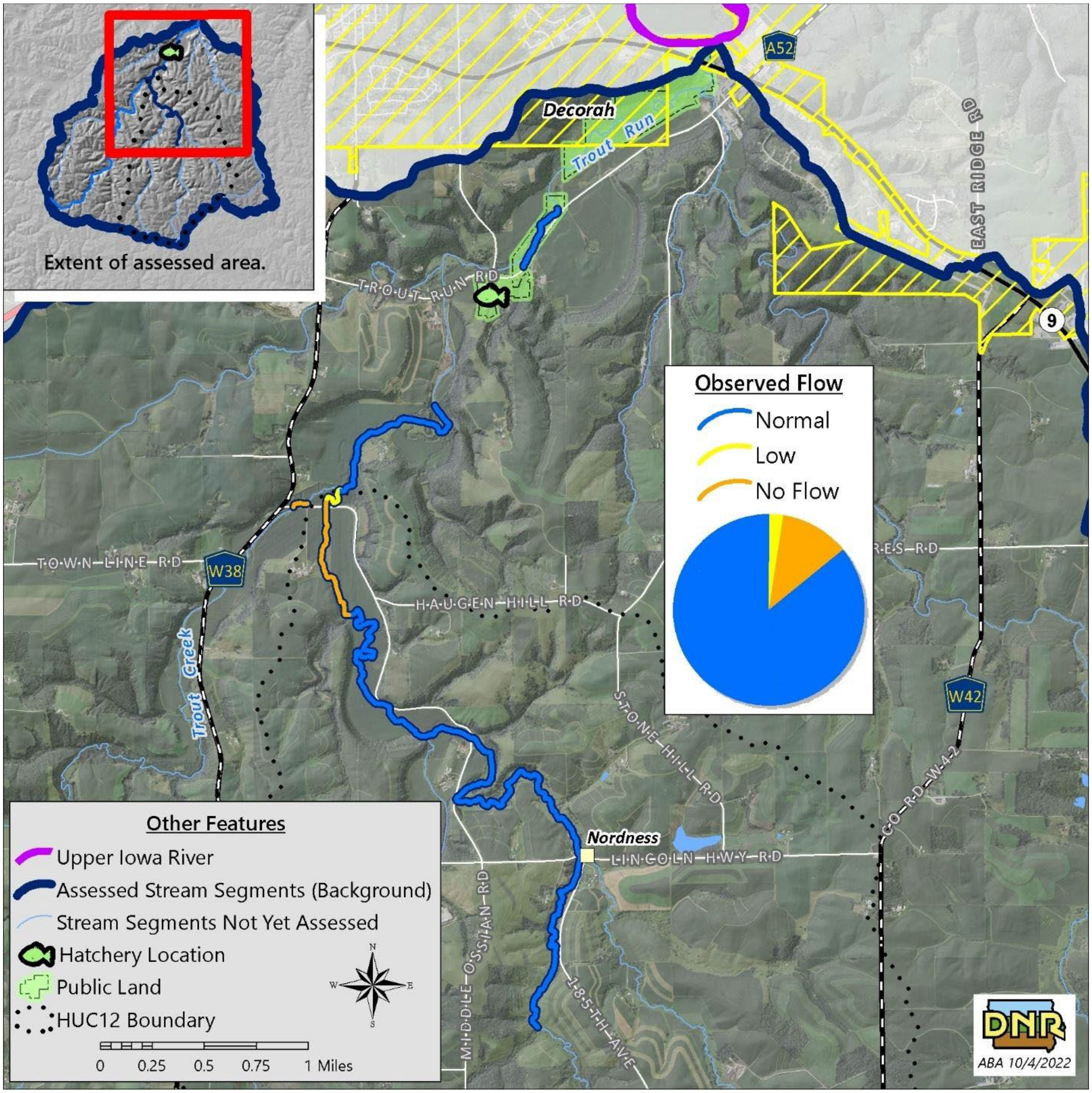


Figure 24. Observed flow in Trout Creek during the RASCAL stream assessment.

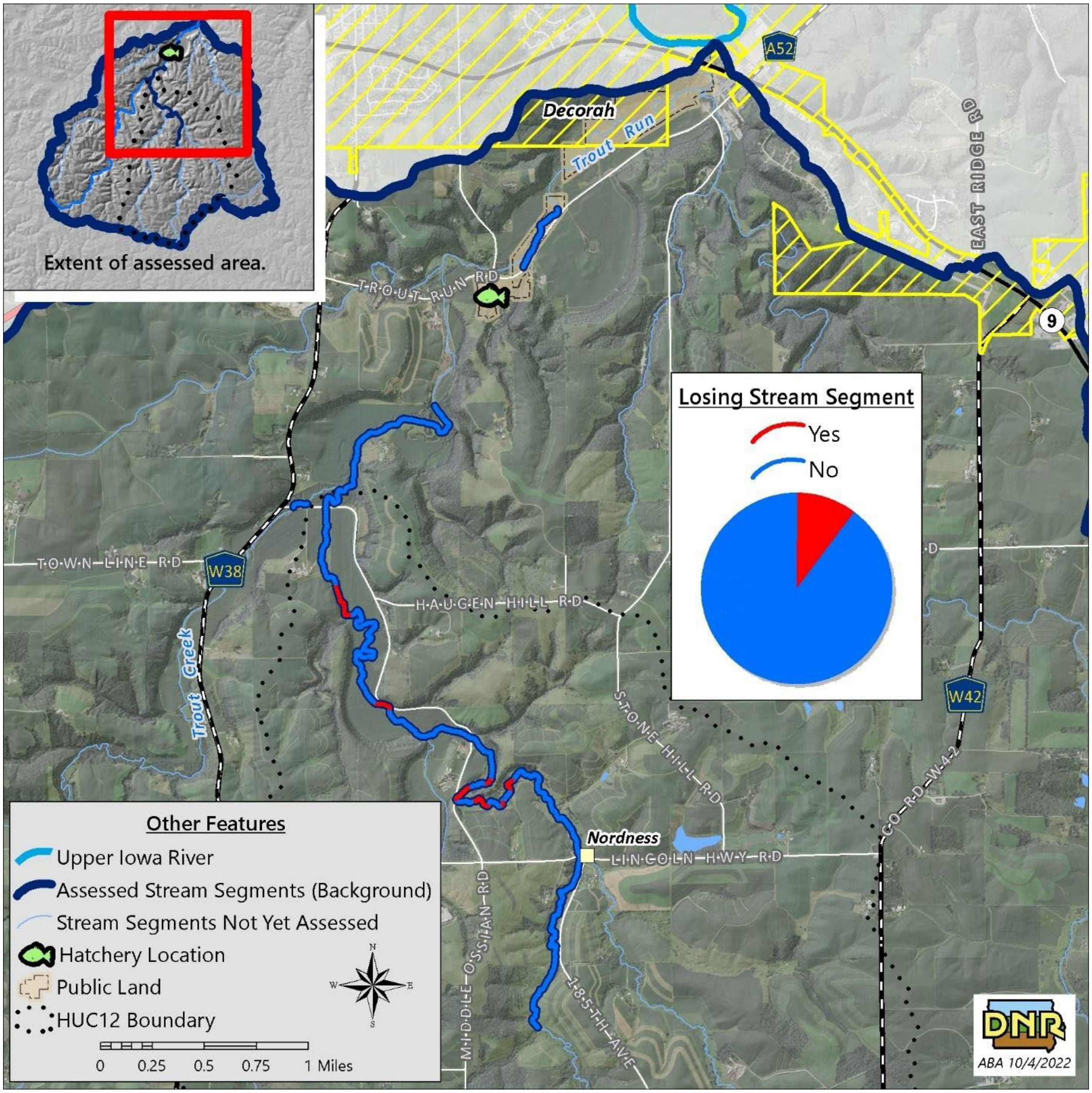


Figure 25. Losing stream reaches identified in Trout Creek during a RASCAL stream assessment.

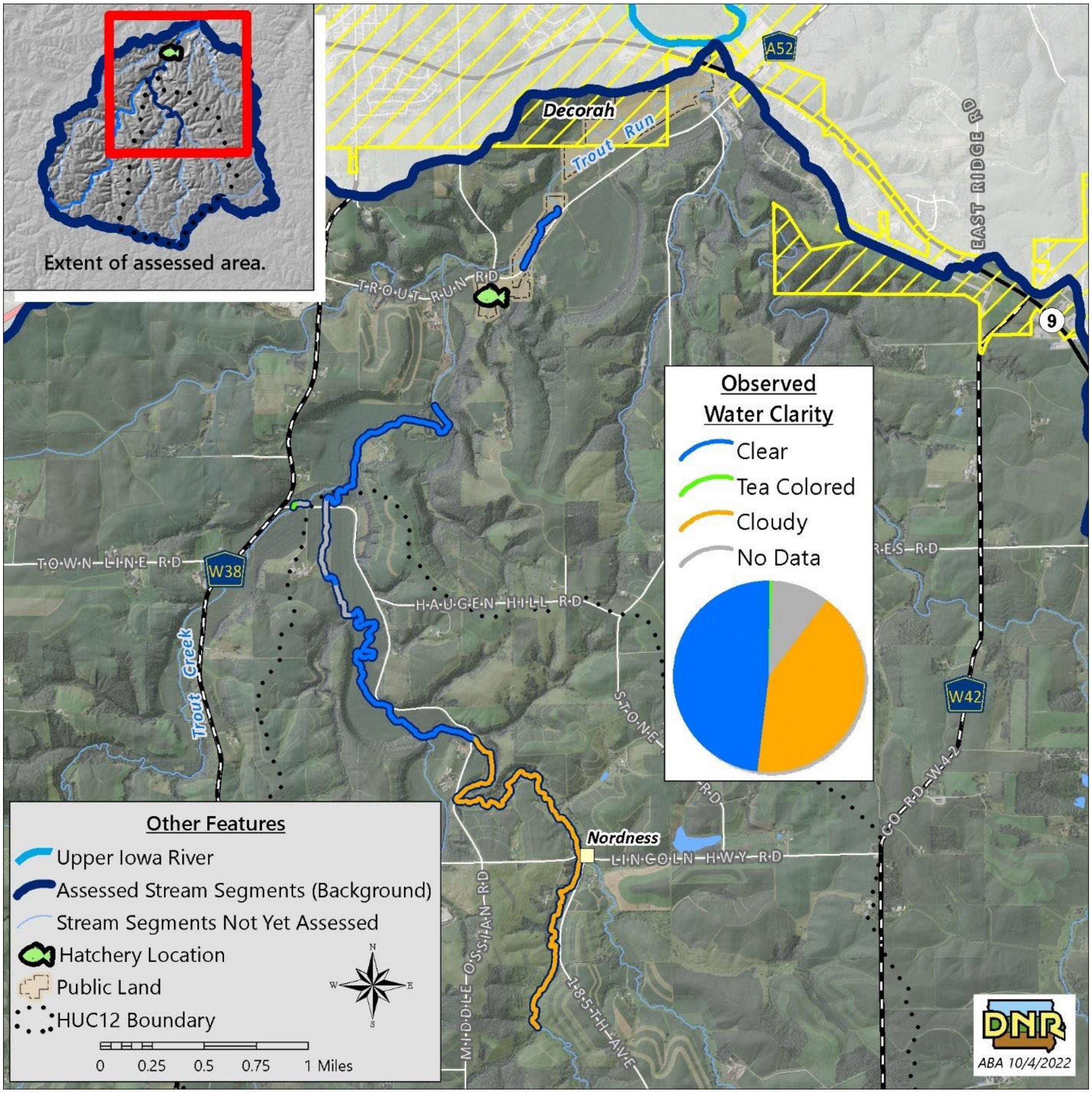


Figure 26. Water clarity in Trout Creek during the RASCAL assessment.

Most of the stream banks surveyed in Trout Run are 6-10’ high with some sections 3-6’ high and 10-15’ high (Figure 27). The majority of the bank material is soil and silt (Figure 28). Over half (55%) of the stream banks surveyed were considered to have moderate or severe erosion. About 39% was observed to have minor erosion and only 6.1% was observed to be stable, with no erosion (Figure 29). Stream bank erosion occurred mostly in an alternate pattern with some erosion occurring on both banks or in a random fashion (Figure 30).

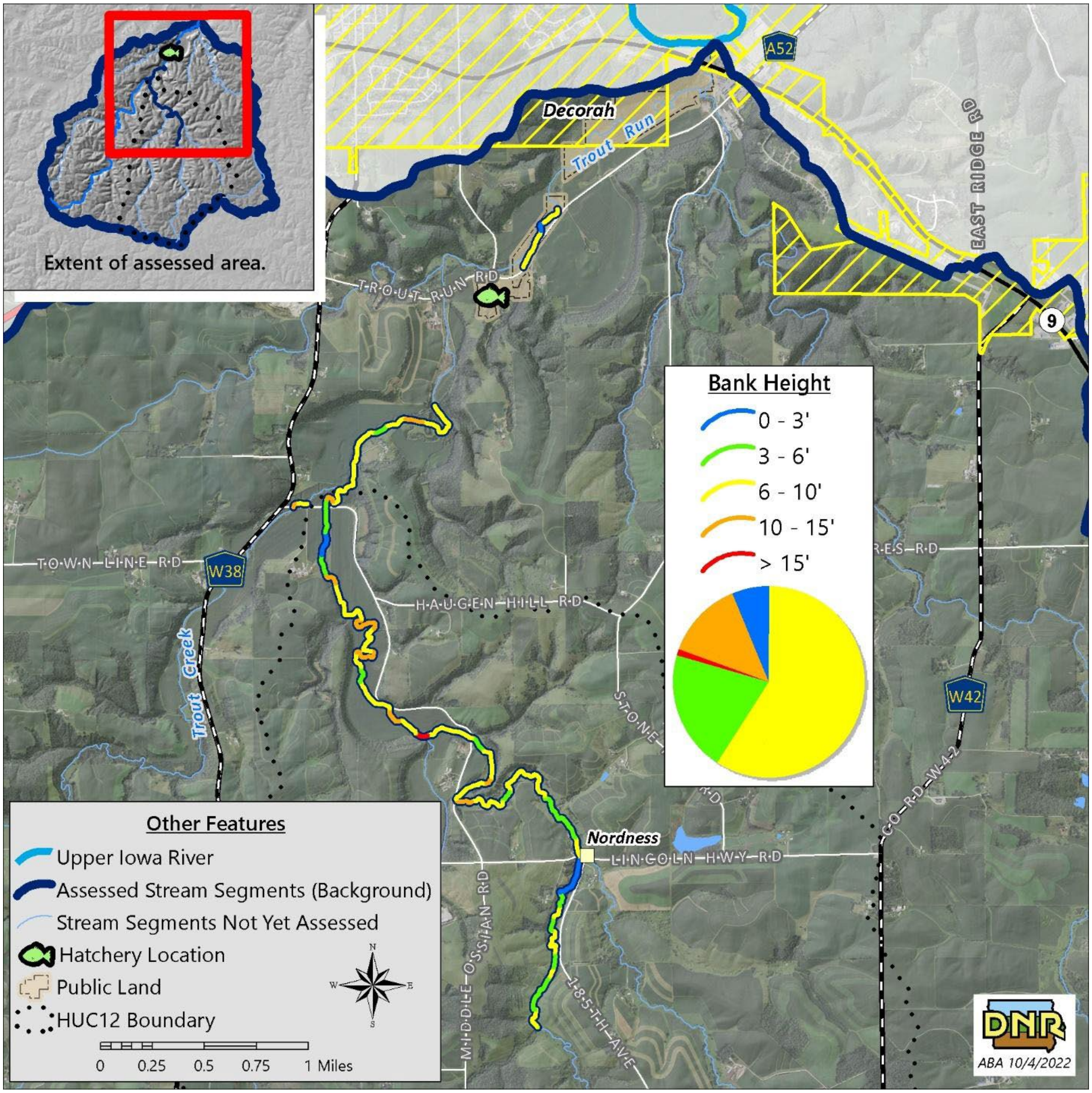


Figure 27. Trout Creek bank height.

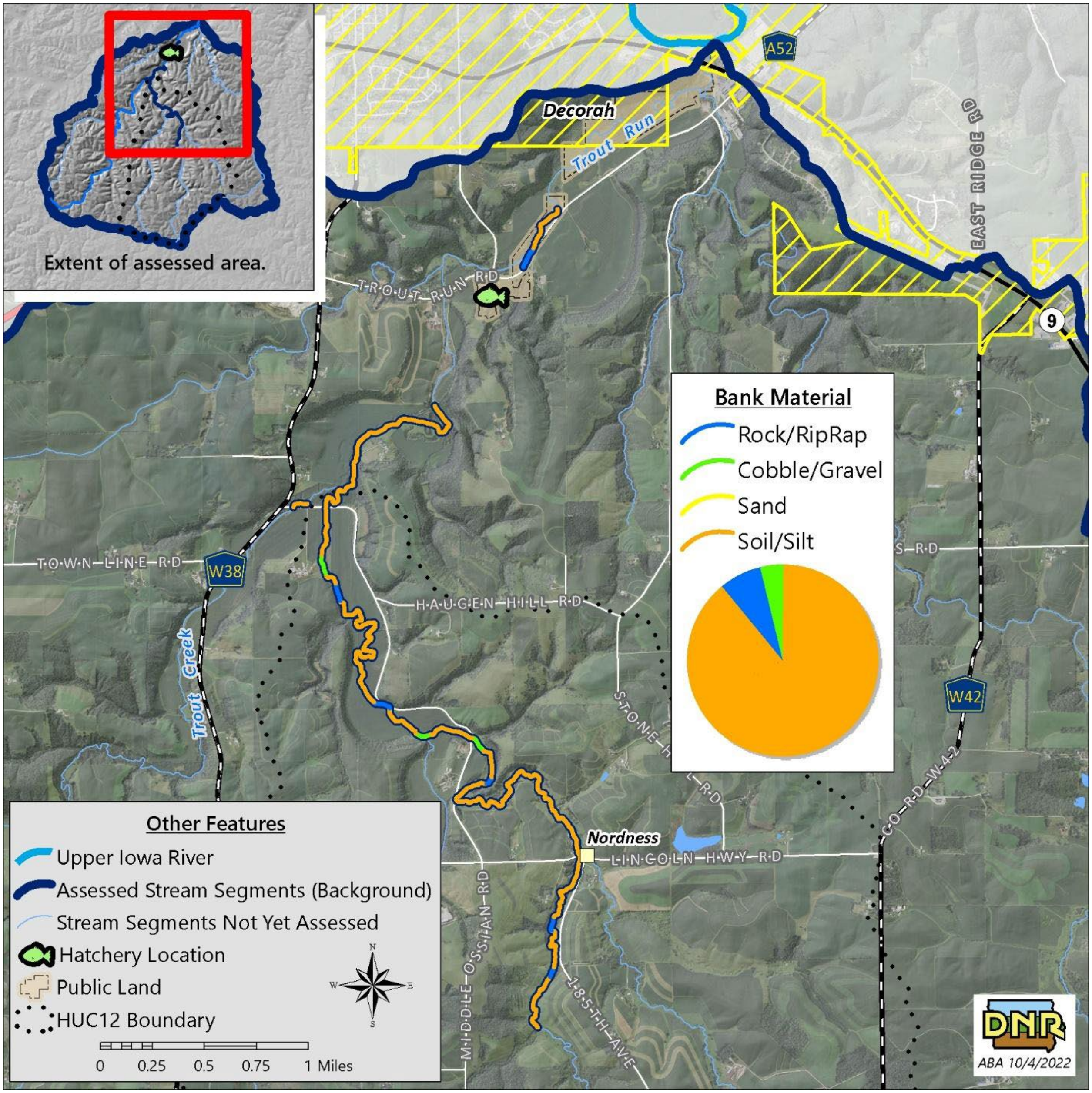


Figure 28. Composition of stream bank material in Trout Creek.

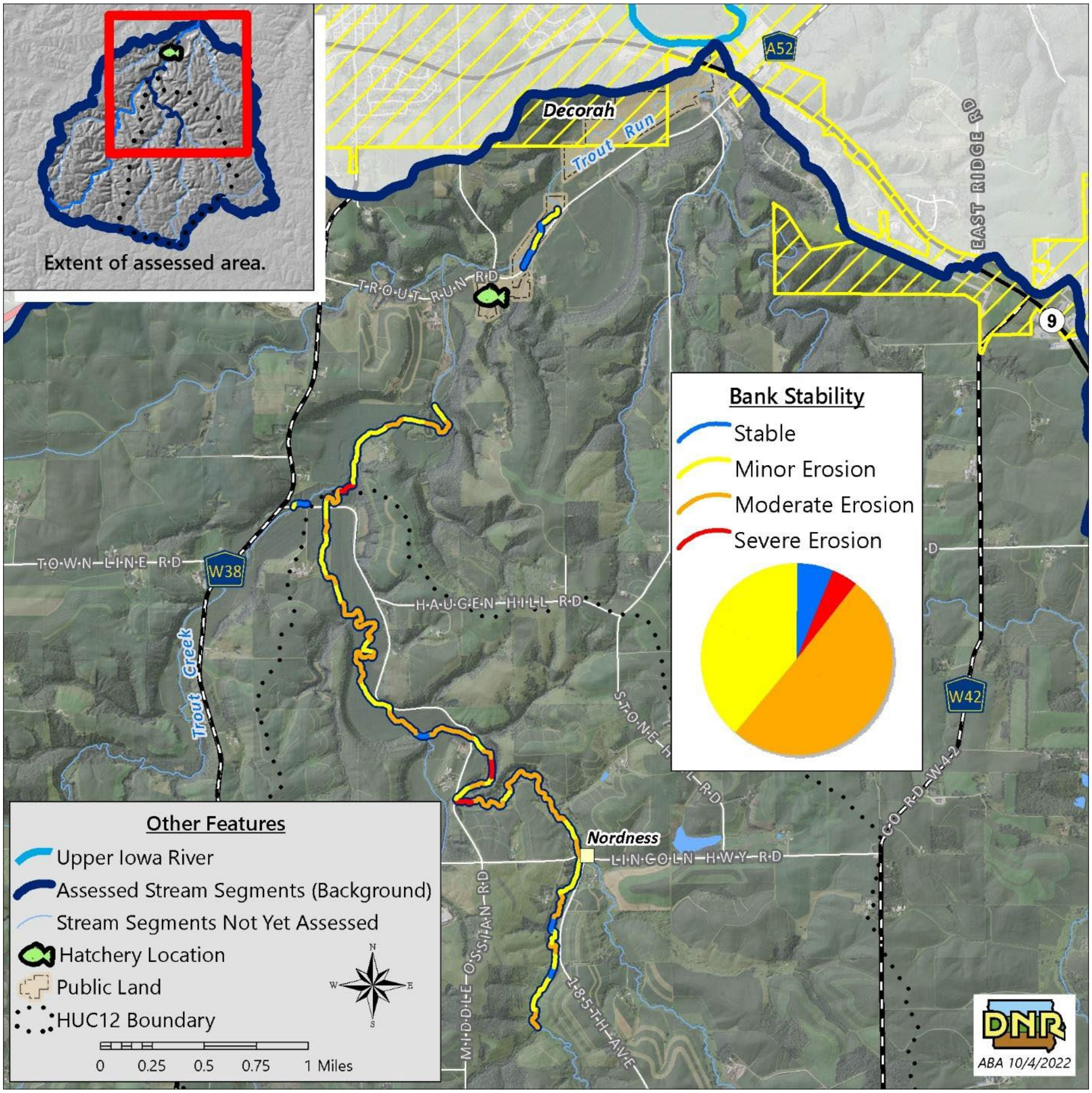


Figure 29. Observed stream bank stability in Trout Creek.

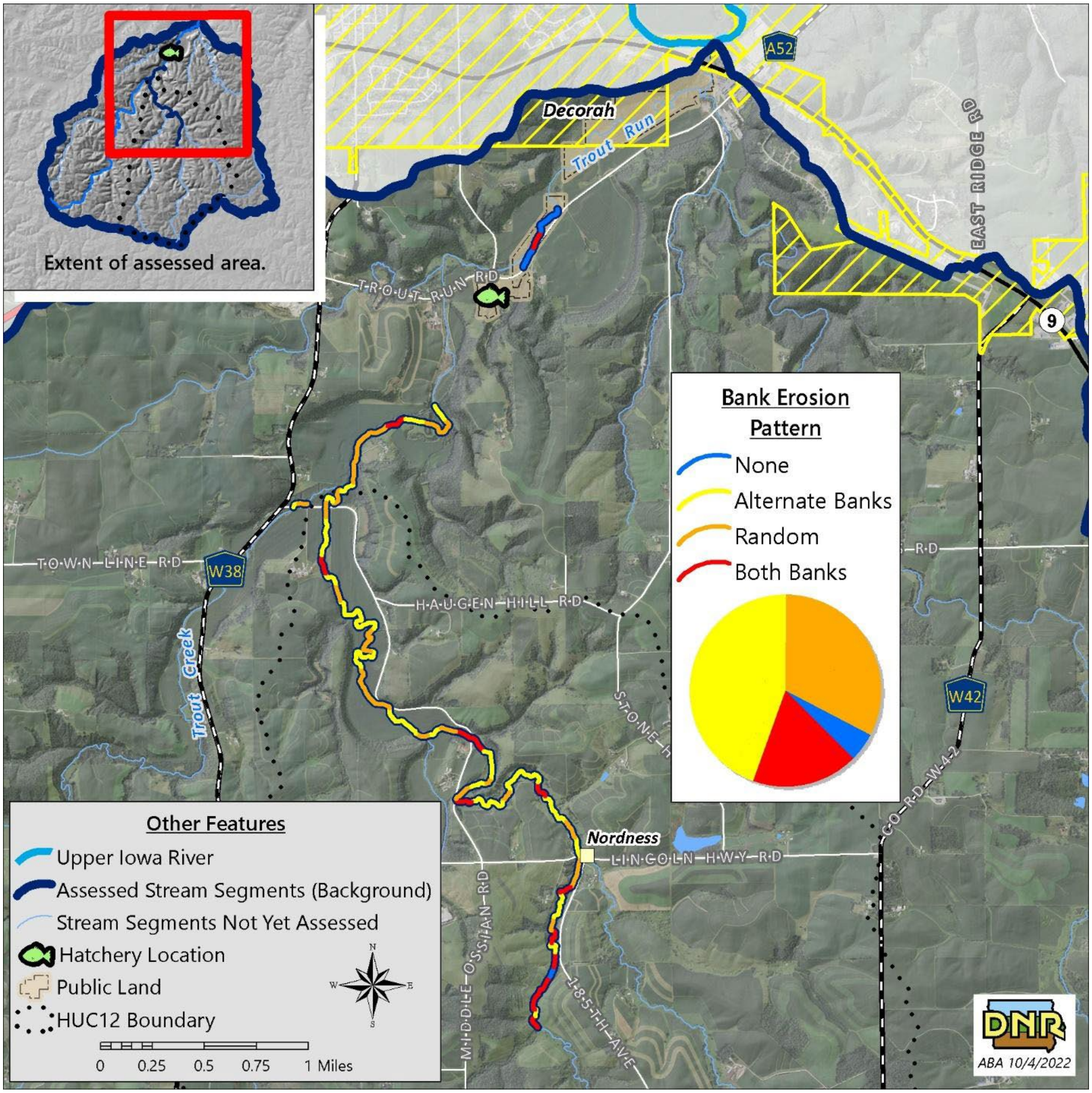


Figure 30. Stream bank erosion in Trout Creek.

When moderate to severe stream bank erosion was observed, additional measurements were taken such as bank height and length to help quantify potential sediment delivery to Trout Creek. Severely eroded stream banks in Trout Creek range in size from 8-13’ high and 10-350’ long. Examples of eroded stream banks are shown in figure 31. Total sediment erosion from severely eroded banks ranges from 7-63 tons/year (Table 17; Figure 32). Continuous livestock access to stream banks can contribute to poor bank stability and increased sediment delivery to Trout Creek, however other hydrologic factors such as water quantity and stream flow also contribute to stream bank erosion in the Trout Run Watershed. For example, three sites with highest stream bank erosion (#9,11,15; Figure 32), do not have livestock access (Table 17). Livestock have access to 20% of the stream reach sites classified as severely eroded in Trout Run. Overall, 125,104 ft (38%) of Trout Creek stream reaches are accessible to livestock and contribute 1,500 tons/year of sediment. Figure 33 shows sections of the Trout Run Watershed where cattle have unrestricted access to the stream.

Figure 31. Moderate to severely eroded stream banks observed and measured during a RASCAL stream survey in the Trout Run Watershed.

Table 17. Summary statistics for moderate to severely eroded stream banks in the Trout Run Watershed.

Site ID	Length (ft)	Height (ft)	Total Erosion (tons/year)	Accessible to Livestock
1	35	13	7	No
3	100	10	14	Yes
4	100	15	24	Yes
5	120	12	9	No
6	70	12	14	No
7	130	10	21	No
8	200	8	26	No
9	240	13	51	No
10	120	12	23	No
11	250	11	45	No
12	150	10	24	Yes
13	120	11	22	No
14	200	11	36	No
15	350	11	63	No
16	120	10	20	No
		Total	400	

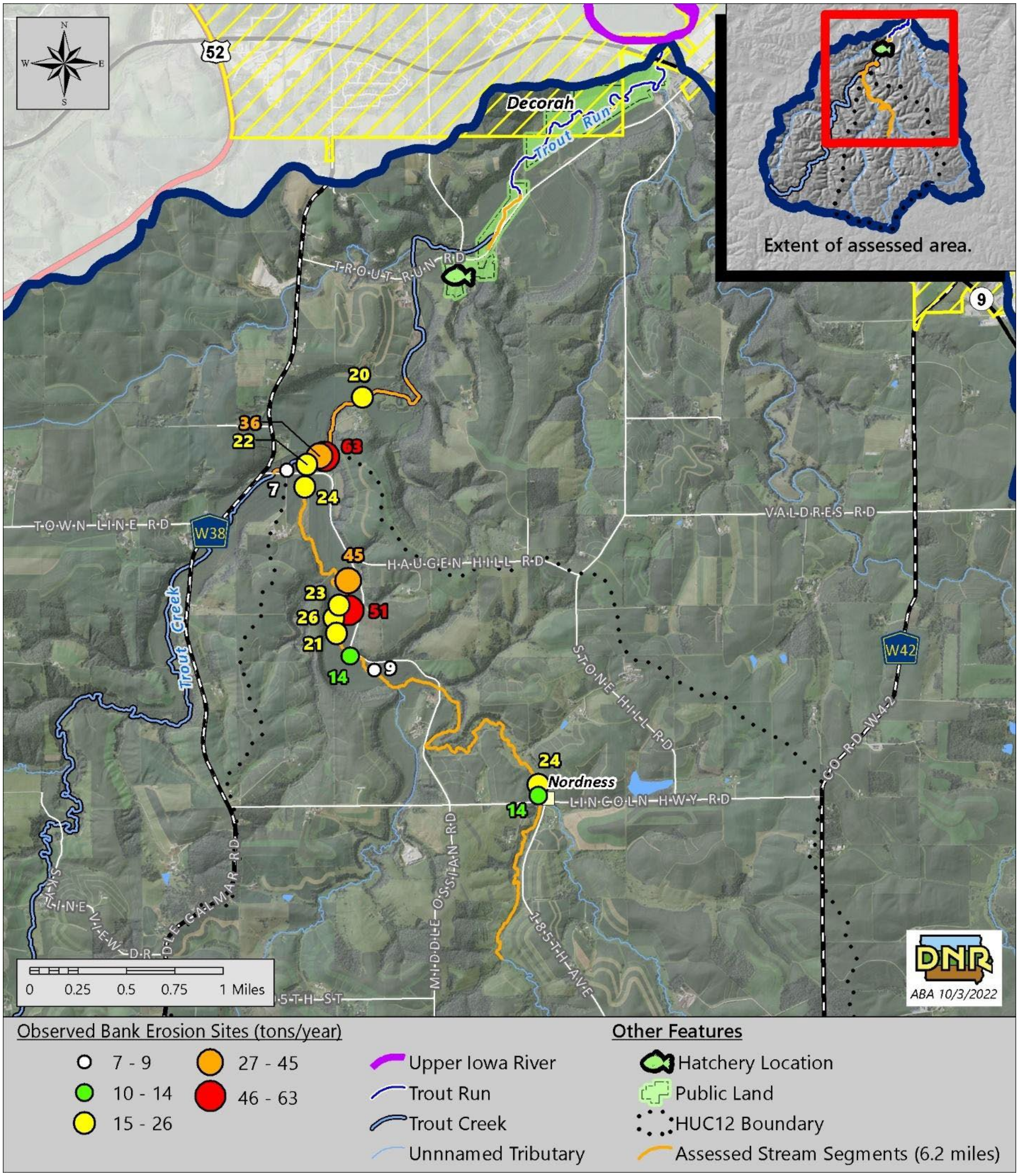


Figure 32. Observed Bank Erosion (tons/year) on lower Trout Creek.

Severe to moderate stream bank erosion was observed on 2,185 ft (6.7%) of the total length of Trout Creek surveyed (32,610 ft) during the RASCAL assessment. Additional measurements (length and height) of these moderate to severely eroded stream banks determined sediment delivery to be 400 tons/year of sediment delivered to Trout Creek (Table 17). Erosion rate determined from the RASCAL segment is 0.012 tons/ft/year (i.e. 400 t/y ÷ 32,610 ft = 0.012 tons/ft/year). Using this ratio applied to the entire length of Trout Creek, the estimated sediment delivery of Trout Creek stream banks is 6,414 tons/year (i.e. total stream length of 534,475 ft. x 0.012 t/ft = 6,414 tons/year).

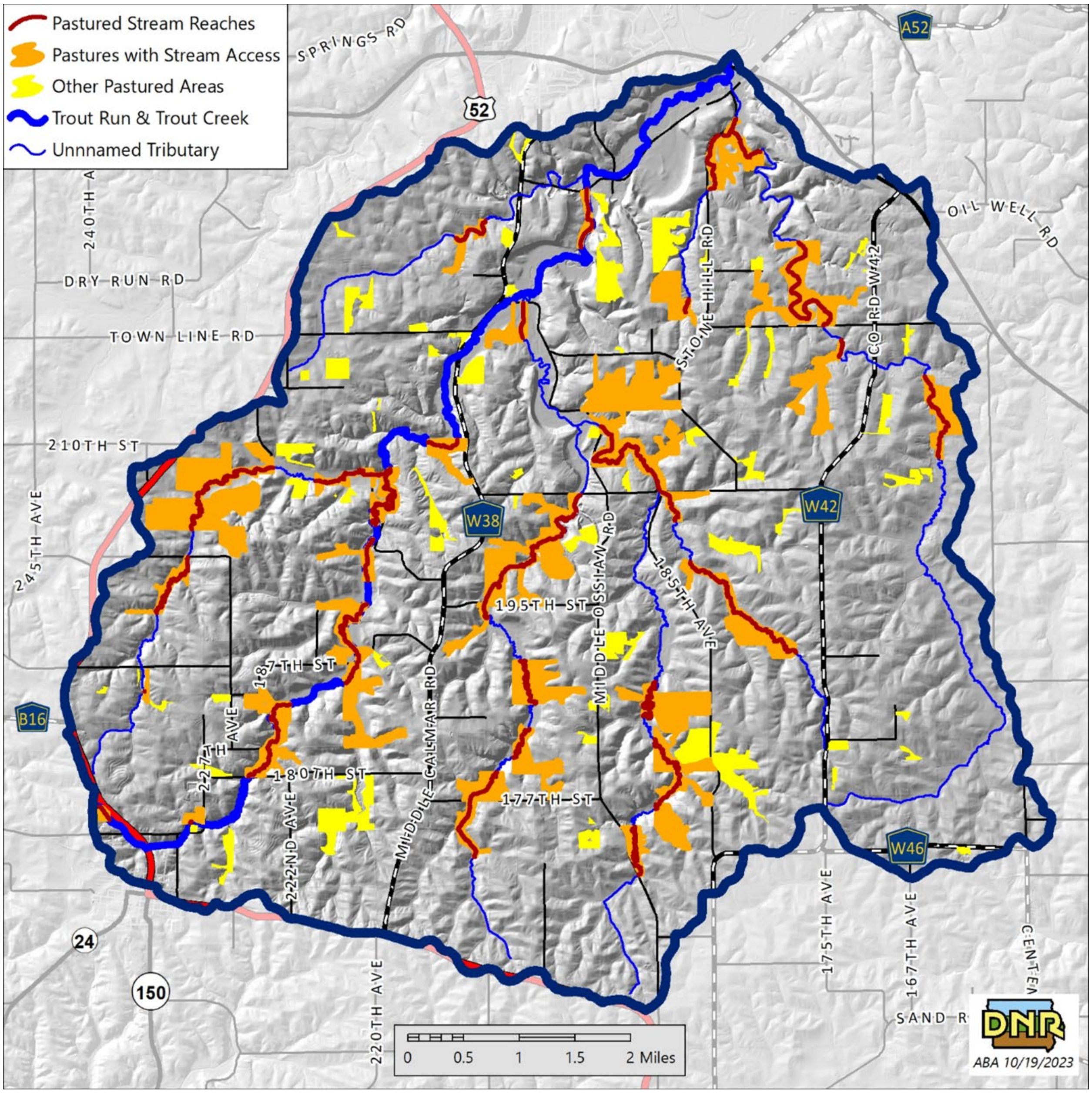


Figure 33. Stream reaches with livestock access in the Trout Run Watershed.

To help quantify sediment embedded within the stream bottom of Trout Creek, visual observations were made along stream reaches to determine the percent length of the stream reach covered with sediment. Nearly 45% of the stream reach surveyed had 50-100% of the stream bed covered in sediment (Figure 34). The majority (47%) of the stream reaches surveyed had 0-50% of the stream bed covered in sediment. Some losing stream reaches were dry and observed to have no sediment covering the stream bed.

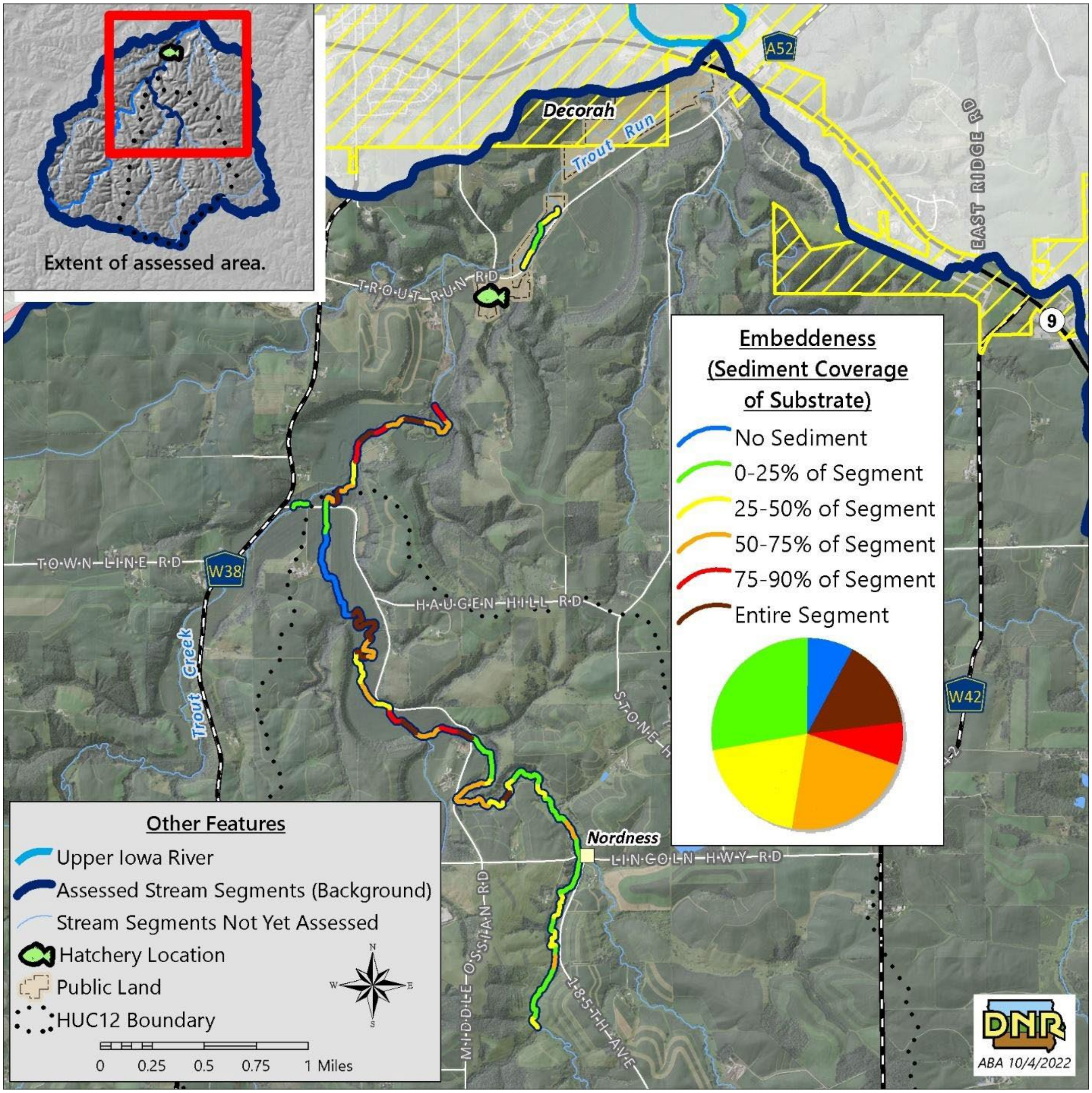


Figure 34. Percent of Trout Creek stream bed covered in sediment (embeddedness).

The primary substrate found in Trout Creek is cobble and other hard materials like bedrock, boulder and gravel (Figure 35). When not embedded with sediment, these hard substrates are important instream habitat for benthic macroinvertebrates and fish.

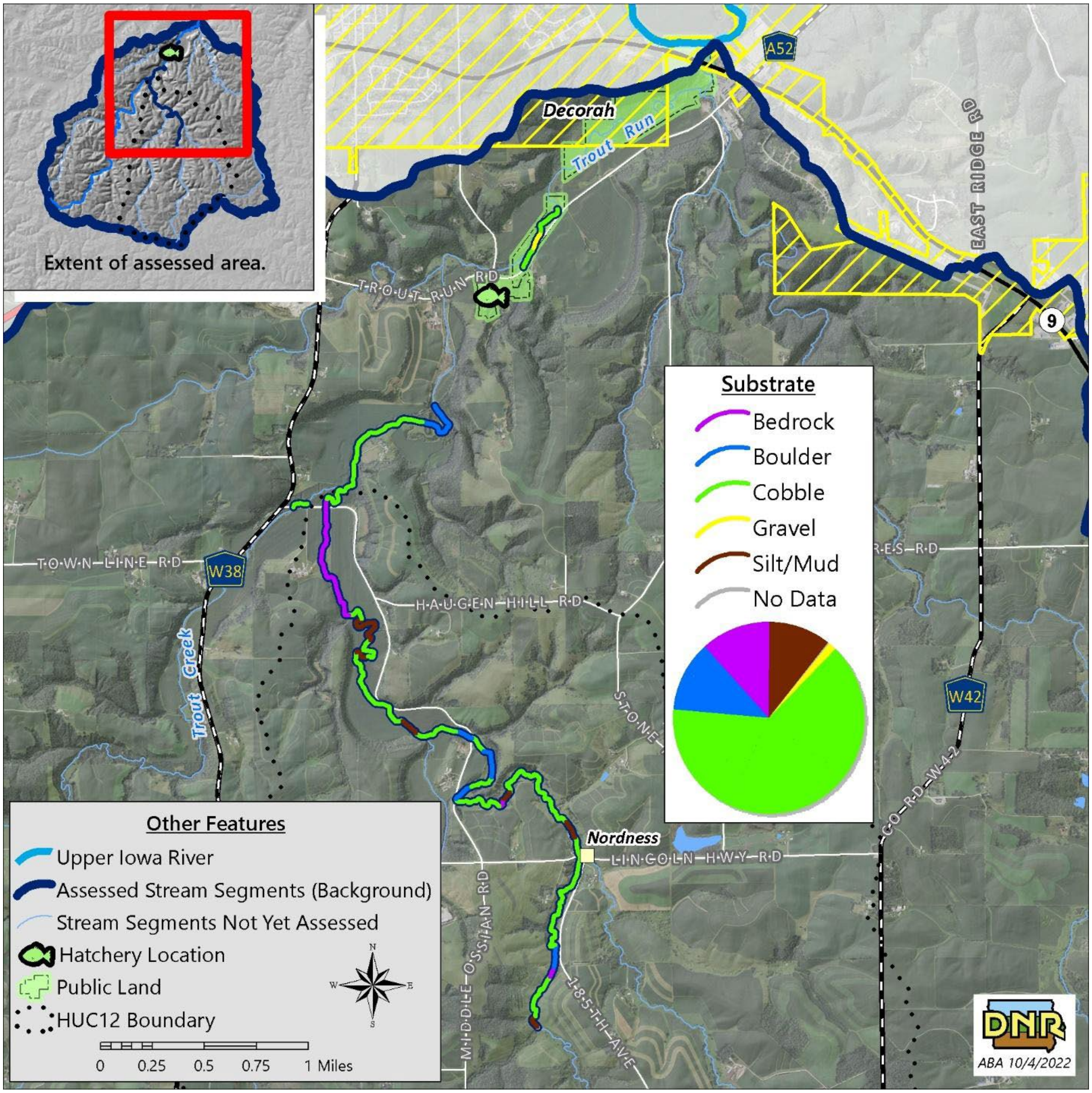


Figure 35. Substrate composition in Trout Creek.

Land use in the riparian corridor and adjacent area was characterized during the RASCAL assessment. On the left bank, 41% of the stream reach surveyed had a riparian corridor of <60'. The main cover type is trees (48%), pasture (28%) and grass (18%; Figure 36). Characteristics of the right bank are similar with 48% of the riparian corridor <60'. The main cover type is trees (54%), pasture (26%) and grass (9%; Figure 37). Beyond the riparian corridor, the primary land use on the left bank is row crop (43%), road (18%), or pasture (13%; Figure 38). On the right bank, nearly 60% of the adjacent land cover is row crop followed by trails (6%) and hay (6%; Figure 39).

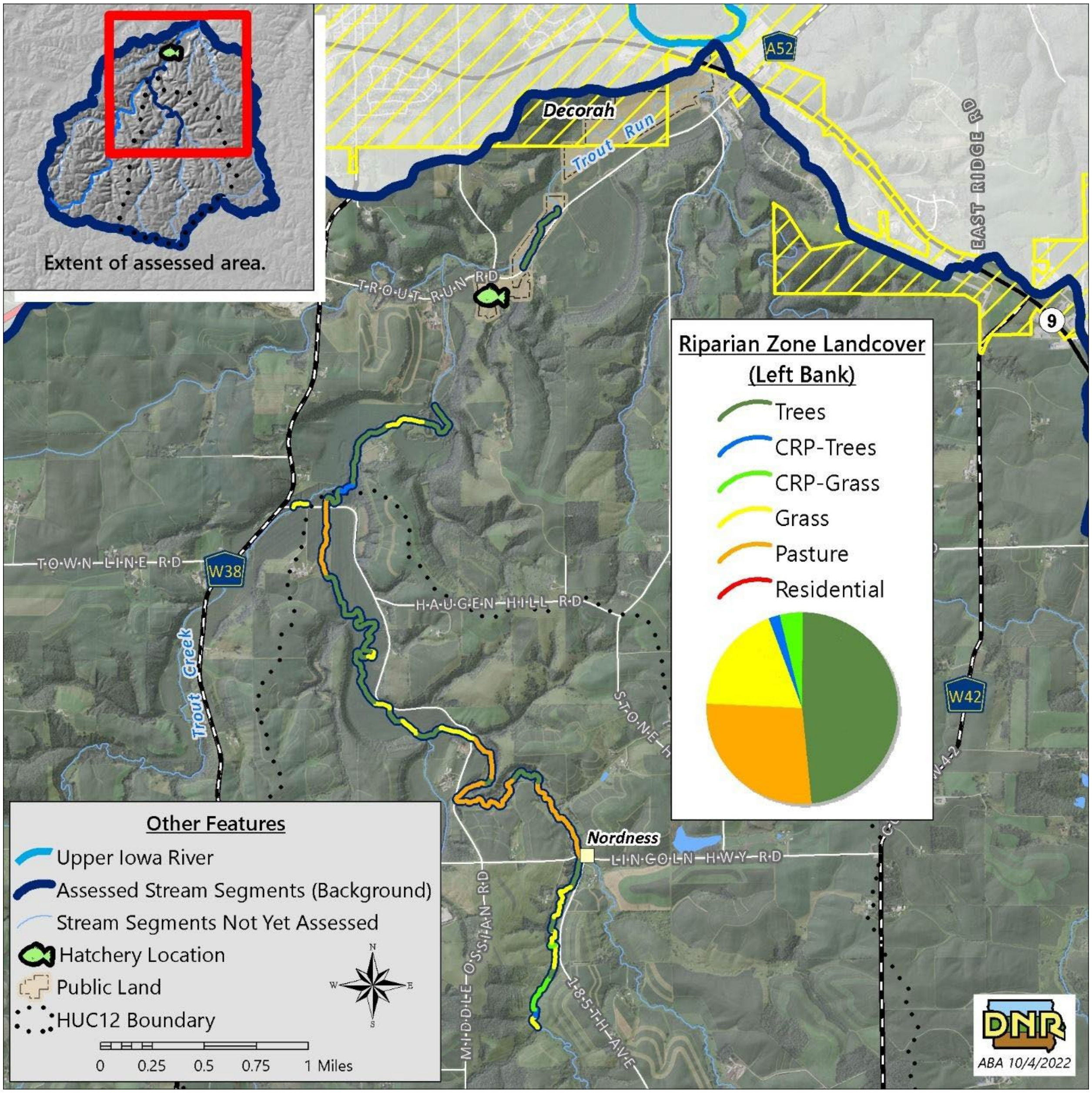


Figure 36. Observed land cover in Trout Creek riparian zone (left bank).

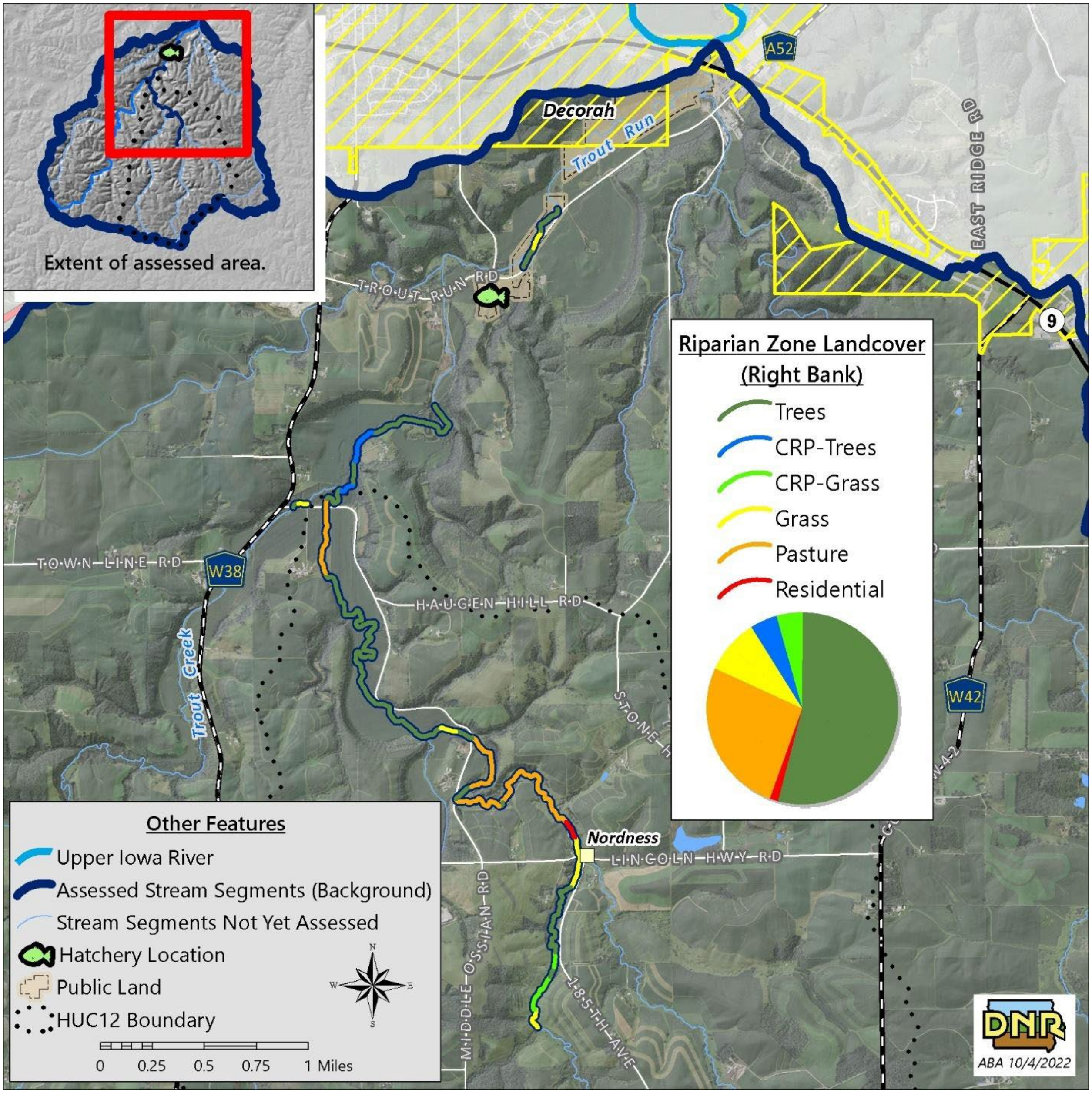


Figure 37. Observed land cover in Trout Creek riparian zone (right bank).

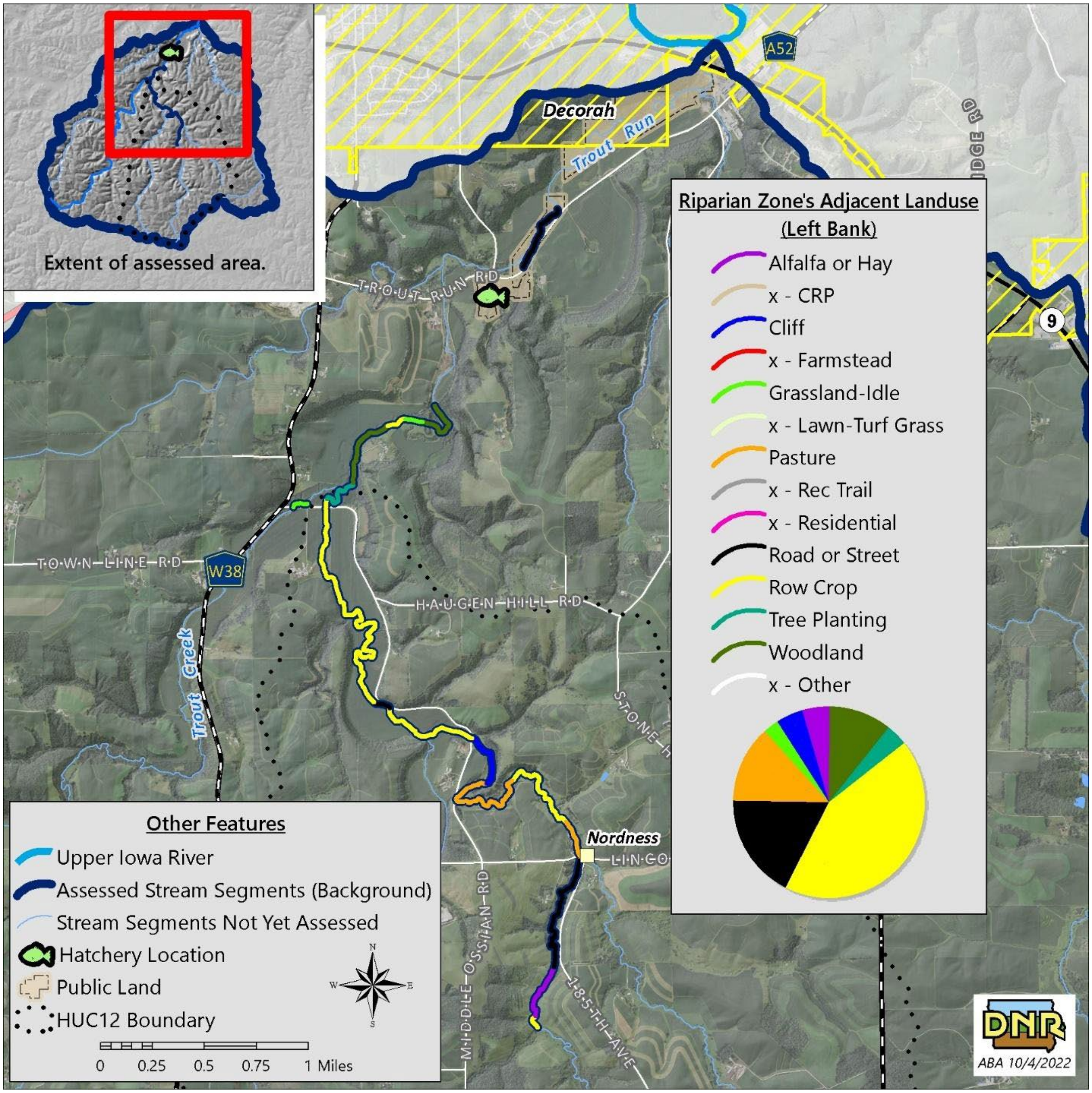


Figure 38. Observed land use adjacent to Trout Creek riparian zone (left bank).

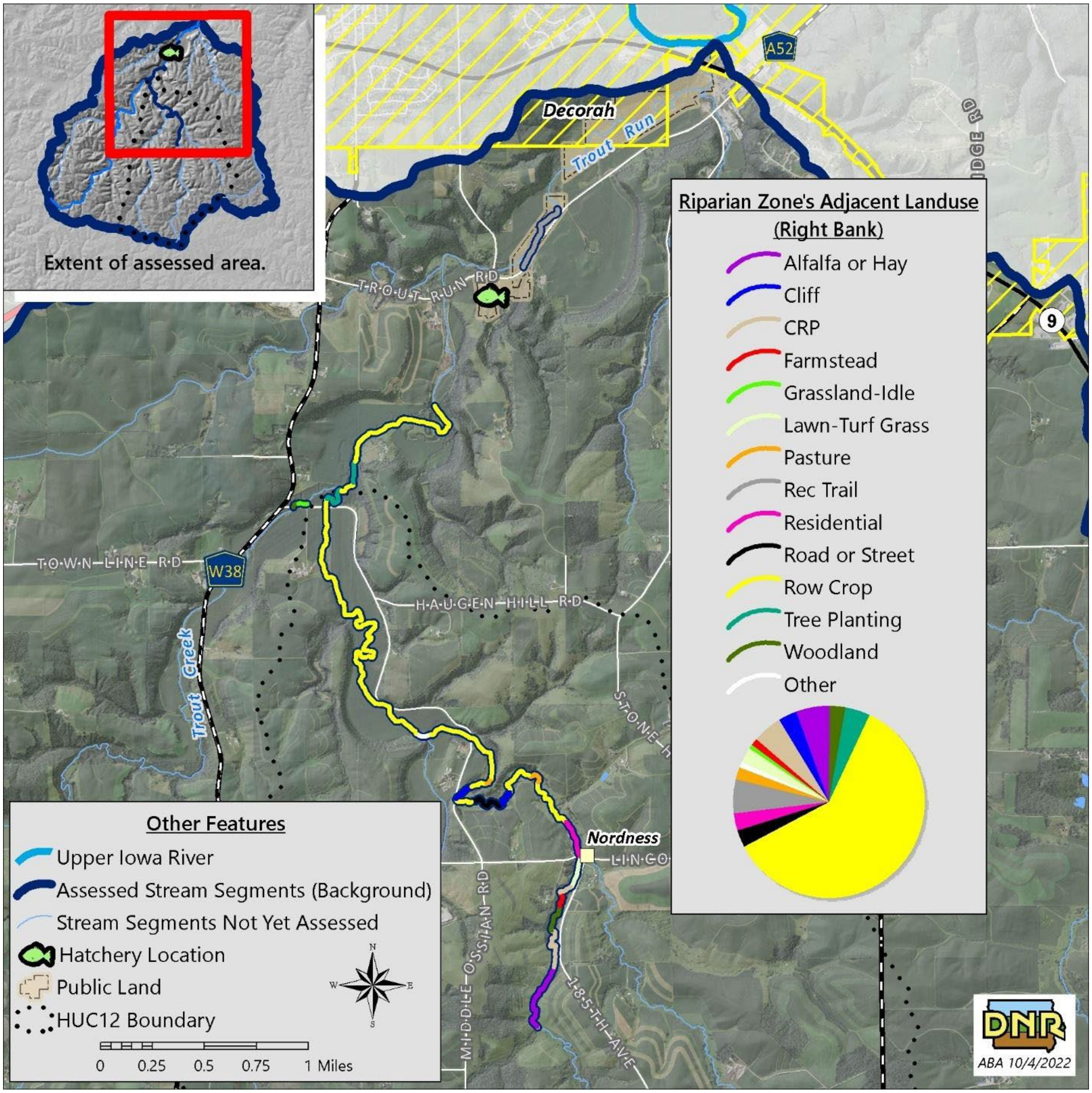


Figure 39. Observed land use adjacent to Trout Creek riparian zone (right bank).

Utilizing data from the 2018 land use assessment, a 35’ buffer extending from each side of Trout Creek is 837 acres and is composed of permanent vegetation (47%), pasture (22%), grazed woodland (13%), row crop (11%), developed/artificial land (5%), and hay (2%). A total of 182,885 ft of riparian corridor could benefit from conversion of row crop to perennial vegetation. Given the majority of these sections along the stream have <2% slope, a second buffer of 200’ beyond the stream bank could be converted to perennial vegetation to reduce sediment delivery from these areas. The estimated pollutant load reduction from a 200’ riparian buffer along row cropped reaches in Trout Run is 1,112 tons/year of sediment, 2,224 tons/year of nitrogen, and

1,446 tons/year of phosphorus. Figure 40 shows areas of the Run Watershed that could be prioritized to implement a riparian buffer along Trout Creek.

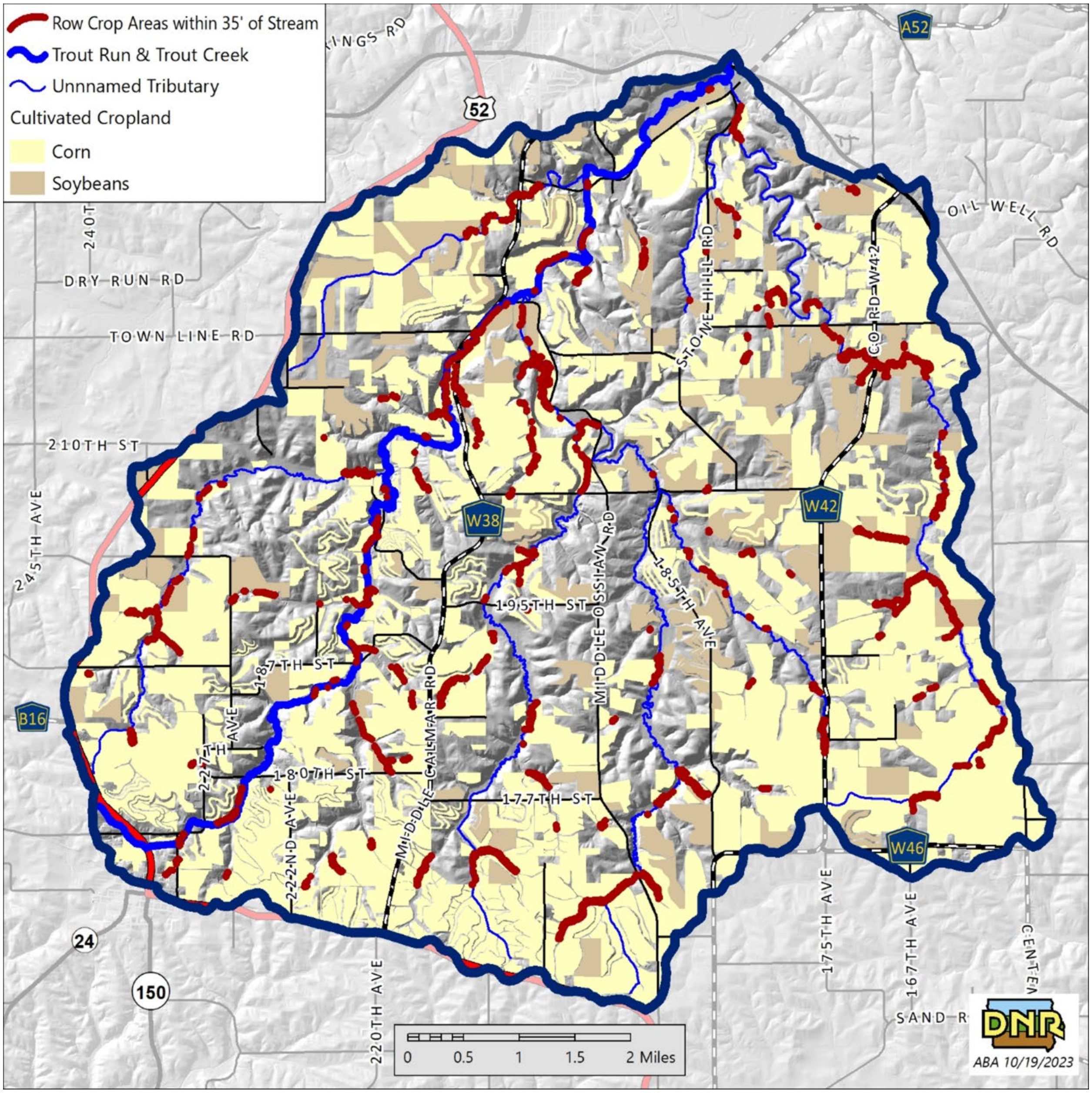


Figure 40. Row Crop areas within 35' of Trout Creek.

Needed Assessments

Urban Assessment

A small component of the Trout Run watershed (275 acres) is urban. Urban areas typically have impervious surfaces and likely contribute to thermal pollution of coldwater resources like Trout Run and Siewers Spring. Urban areas contribute to increased runoff, altered hydrology, and can contribute hydrocarbons and other pollutants into waterways. On average, urban land makes up about 3% of the land use in sinkhole catchments. An urban assessment could be done in Trout Run to determine the extent of pollution from urban areas. From these assessments, priority areas and practices would be developed to slow water flow, reduce runoff and increase infiltration from urban areas in the Trout Run Watershed. For example, in 2018 a bioretention cell was installed at the chuck Gipp Decorah Fish Hatchery to treat water coming off cement parking areas before entering into Trout Run. Urban practices may include pervious pavers, bioretention cells, bioswales, rain gardens, tree planting, and turf management.

Source water protection plan

The Trout Run Watershed contains one public source water supply which is located at the Decorah Fish Hatchery. The source water supply serves a population of 50 including a private residence, office staff with 7-10 employees, and members of the public which can reach up to 100,000 visitors in a year. In 2011, a new was drilled to 300 ft in the Cambrian-Ordovician aquifer. A phase 1 source water plan was recently developed for this public water supply. Future work can include working with the DNR source water section to write a phase 2 source water protection plan which would define a capture zone and identify potential contaminants or risks to the public water supply at the Decorah Fish Hatchery.

Delineating the Siewers Spring Springshed

Dye tracing is a tool commonly used in karst landscapes to determine underground flow pathways. For the Trout Run Watershed Project, dye tracing was used to help better define the Siewers Spring springshed. A springshed is an area of land that contributes groundwater to a spring. Sinkholes and losing stream sections present in Trout Run and surrounding watersheds can transmit surface waters and pollutants to below ground aquifers that resurface at Siewers Spring. Because of the fractured and porous nature of the underlying bedrock in Trout Run and surrounding watersheds, there is potential for underground flow pathways to connect below surface watershed boundaries, which has been documented in other nearby watersheds such as Big Spring (Eric Palas, personal communication).

Two dye traces were previously completed in the Trout Run watershed project area in December of 1994. Results of these traces indicated strong connectivity between surface waters of Trout Creek and Siewers Spring; however, data provided in the reports was more qualitative and anecdotal. Information such as site-specific locations of the dye input points, hydrological conditions at the time of the dye trace, and travel time to Siewers Spring was not available. Further, information regarding which dye trace area connected to Siewers Spring remained unclear in the reports that were available.

Defining the land area that contributes surface and ground water to Siewers Spring is essential for improving water quality (Rebecca Ohrtman, personal communication). With the help of University of Iowa and Iowa DNR staff, three dye traces were completed in the Trout Run project area to better define hydrological pathways and the land area contributing surface and ground water to Siewers Spring.

Trout Run landowners assisted with dye tracing efforts and are generally interested in learning about surface and groundwater connectivity in Trout Run. Trout Run landowners provided information such as known locations of losing stream sections, springs, sinkholes, and any historical observations of these features during rain events and dry periods. This information is summarized in figure 41 and helped determine location of dye traces and placement of instream charcoal packets. Other watershed community partners such as Luther College, Northeast Iowa RC&D, Winneshiek County NRCS, Winneshiek County SWCD and the Winneshiek County Sanitarian were also consulted for dye tracing methods and to advise based on former work done in the project area.

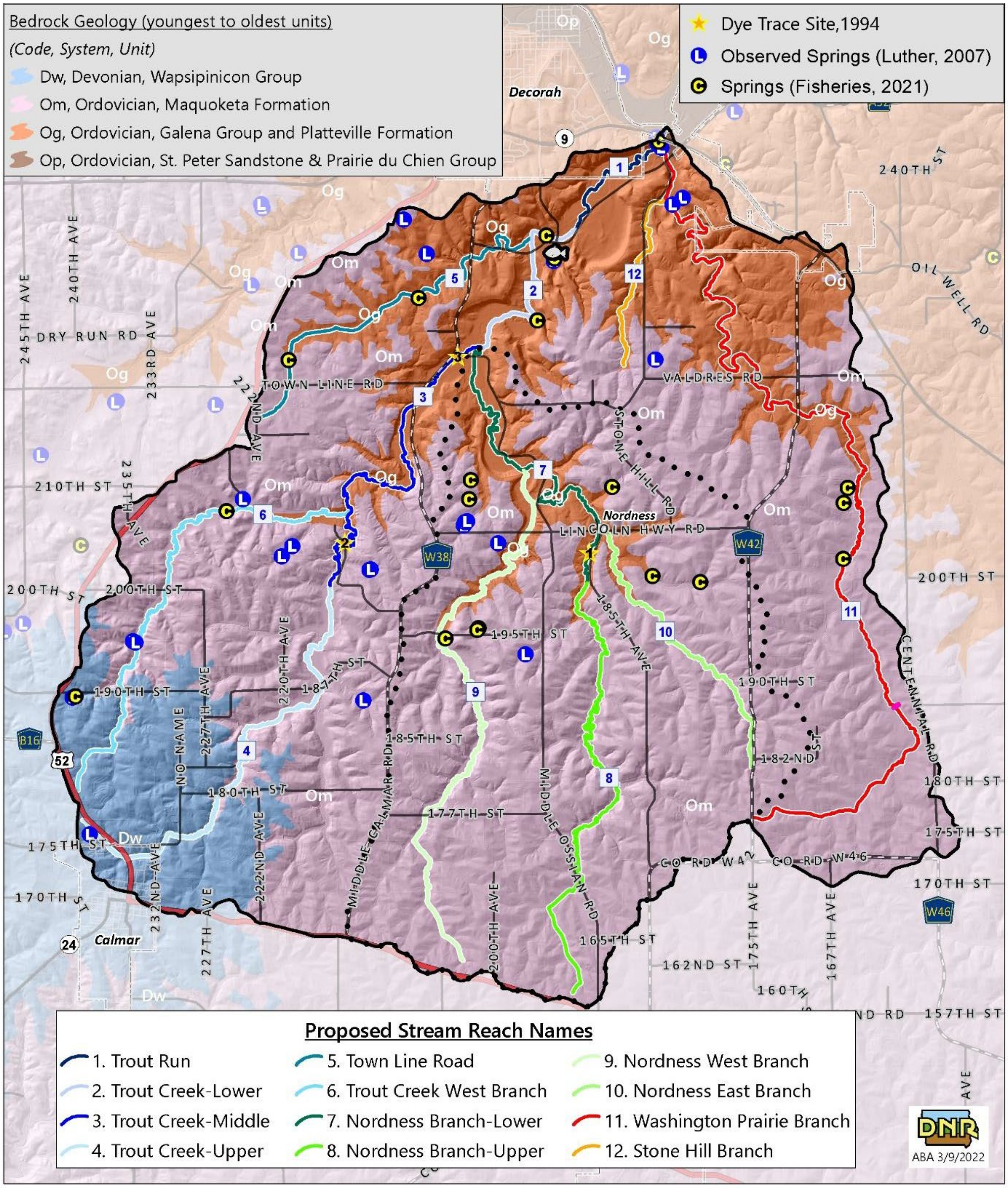


Figure 41. Location of springs and former dye trace sites in the Trout Run Watershed.

In spring-fall 2022, three dye traces were completed in the Trout Run Watershed. Prior to each dye trace, a rhodamine sensor was deployed at Siewers Spring to establish baseline water quality conditions and quantify background fluorescence (Figure 42). With the cooperation of landowners, charcoal packets were placed at surface sites and springs in the Trout Run Watershed to observe presence or absence of dye at those locations (Figure 42). Charcoal packets were also placed in household toilet tanks using a shallow well as a water source within a 5-mile radius of the dye trace location. After each dye trace, charcoal packets were collected, eluted and observed for fluorescence using methods described by Aley 2002.

Prior to each dye trace, water quality data was measured using a YSI EXO2 data sonde at seven different locations within the Trout Run Watershed. At each location, visual observations of water clarity were made, a picture taken, and 6 water quality parameters measured to observe water quality trends on a spatial scale. The parameters measured were temperature (°F), dissolved oxygen (mg/L), specific conductivity (µs/cm), pH, turbidity (NTU), and nitrate (mg/L).

Figure 42. Left: Rhodamine sensor installed at Siewers Spring during Trout Run dye traces. Right: Charcoal packet placed at sites instream and in household toilet tanks during dye trace 1 and 2.

Dye Trace 1

On March 23, 2022 one gallon of Rhodamine WT dye was poured on the surface of Trout Creek in the lower Nordness branch (Figure 43). From this surface location, time of travel to Siewers Spring was observed to be 10 hours and returned to baseline conditions within 28 hours (Figure 44). Water level at Siewers Spring (discharge = 49 ft^3/s) and at the dye trace site (discharge = 37.78 ft^3/s) was high from a recent rainfall event. No losing stream sections were visible in the watershed under these conditions. Due to these higher flows, very little dye (0.008%) was observed at Siewers Spring from the Lower Nordness Branch, indicating under high flow, most of the water in this section remains as surface waters until reaching the Upper Iowa River.

Figure 43. Left: Rhodamine dye poured into Trout Creek above a losing stream segment in Nordness. Right: Trout Creek surface waters one mile below dye input location.

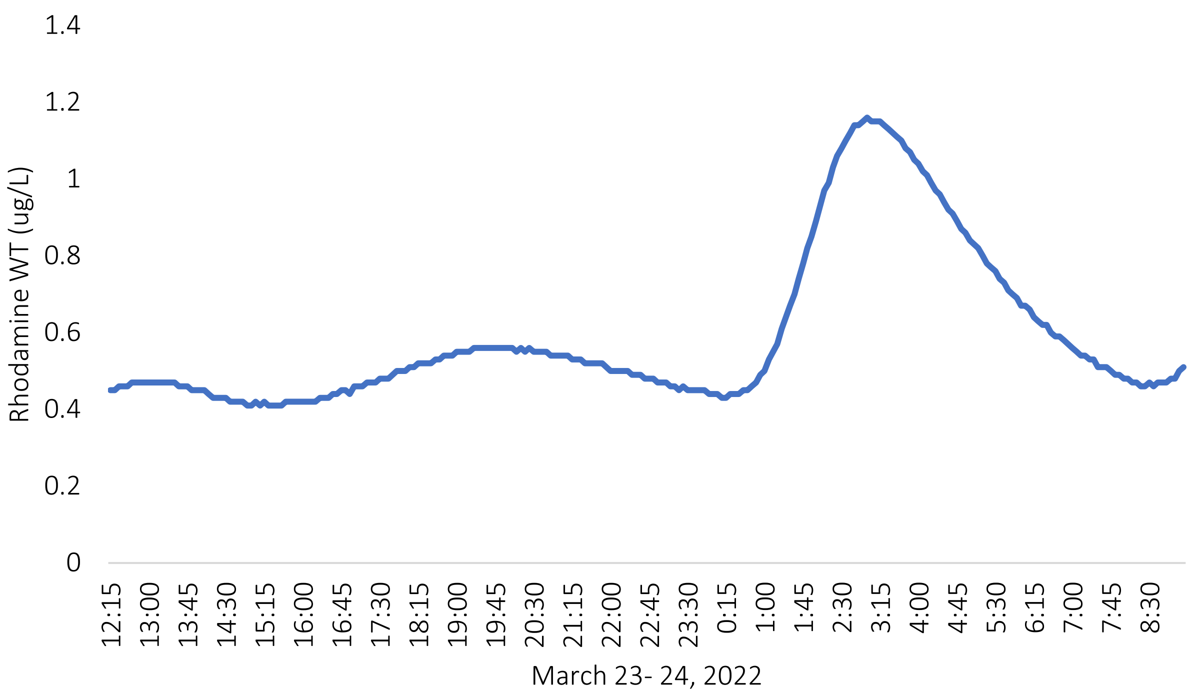


Figure 44. Rhodamine WT concentration monitored at Siewers Spring from March 23-24, 2022.

Water quality was measured on March 22, prior to the dye trace. At Siewers Spring, water was warmer and had lower dissolved oxygen than all other Trout Run surface sites (Appendices G and

H). Conductivity was higher in the upper parts of the watershed (Appendix I). Turbidity was variable across sites, but the highest turbidity was measured on Upper Trout Creek (109.09 NTU) and the lowest (15.79 NTU) on the West branch of the Nordness reach (Appendix K). Nitrate was measured above 4.86 mg/L at all sites with the highest being 32 mg/L on the Nordness West branch (Appendix L). A summary of water quality taken at each site can be found in Appendices G-L.

Dye Trace 2

A second dye trace was conducted on the West branch of Trout Creek on May 24, 2022. One pint of Rhodamine dye was poured upstream of a long fracture in the streambed. This fracture diverted some flow underground (Figure 45). Rhodamine dye was later observed at the hatchery after 23 hours and continued to send pulses of dye through the watershed and to the spring for another 13 days (Figure 46). Water conditions during this trace were lower, with losing stream sections observed in portions of the watershed. Surface flows taken at the dye trace site were 3.86 ft^3/s and 31.33 ft^3/s at Siewers Spring.

Figure 45. Left: a fracture in the stream bed of a losing stream reach in Trout Creek. Right: dye trace #2 along a losing stream reach on the West branch of Trout Creek.

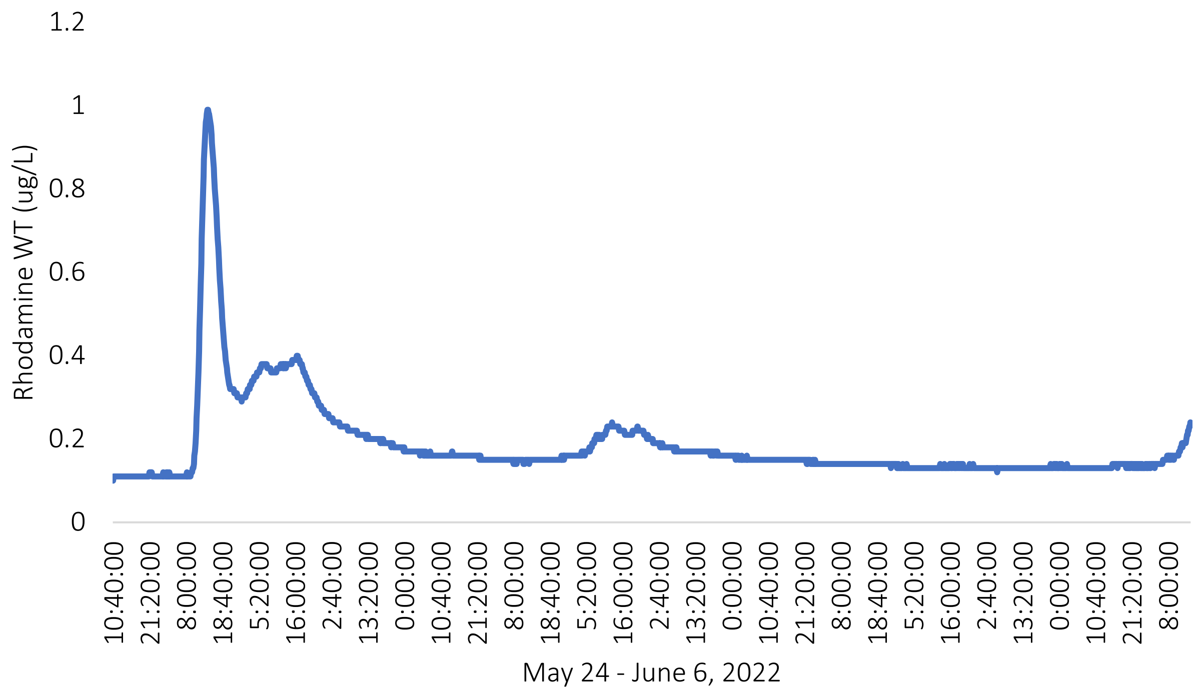


Figure 46. Rhodamine levels monitored at Siewers Spring from May 24 – June 6, 2022

Water quality collected prior to dye trace 2 showed increased water temperature with temperatures on the Nordness branch being much warmer (60F; Appendix M). Dissolved oxygen remained high across the watershed (Appendix N). Conductivity varied but was highest at Upper Trout Creek and the West Branch of Nordness (Appendix O). Turbidity ranged from .91 NTU at Upper Trout Creek to 5.62 NTU on the East Branch of Nordness (Appendix Q). Nitrate was measured above 5.32 mg/L at all sites with the highest at West Branch Nordness (13.4 mg/L; Appendix 0). Appendices M-R show water quality data collected at all sampling sites.

Dye Trace 3

A third dye trace was performed in the Washington Prairie Branch, upstream of a known losing reach. Landowners who own and operate a farm along the losing stream reach reported numerous sinkholes and openings in the stream that lose water below the surface. On November 16th, 2022, one pint of Rhodamine dye was poured 30 ft upstream of a visible losing stream reach (Figure 47). Rhodamine dye was first detected at Siewers Spring 45 hours later, peaked at 50 hours and made its way through the aquifer within 60 hours post dye trace (Figure 48). Stream flow conditions were low (Siewers Spring discharge = 16.41 ft^3/s) with many losing stream sections visible within the project area.

Figure 47. Rhodamine dye flowing into a losing stream reach in the Washington Prairie Branch of the Trout Run watershed. Direction of flow goes from top right to bottom left.

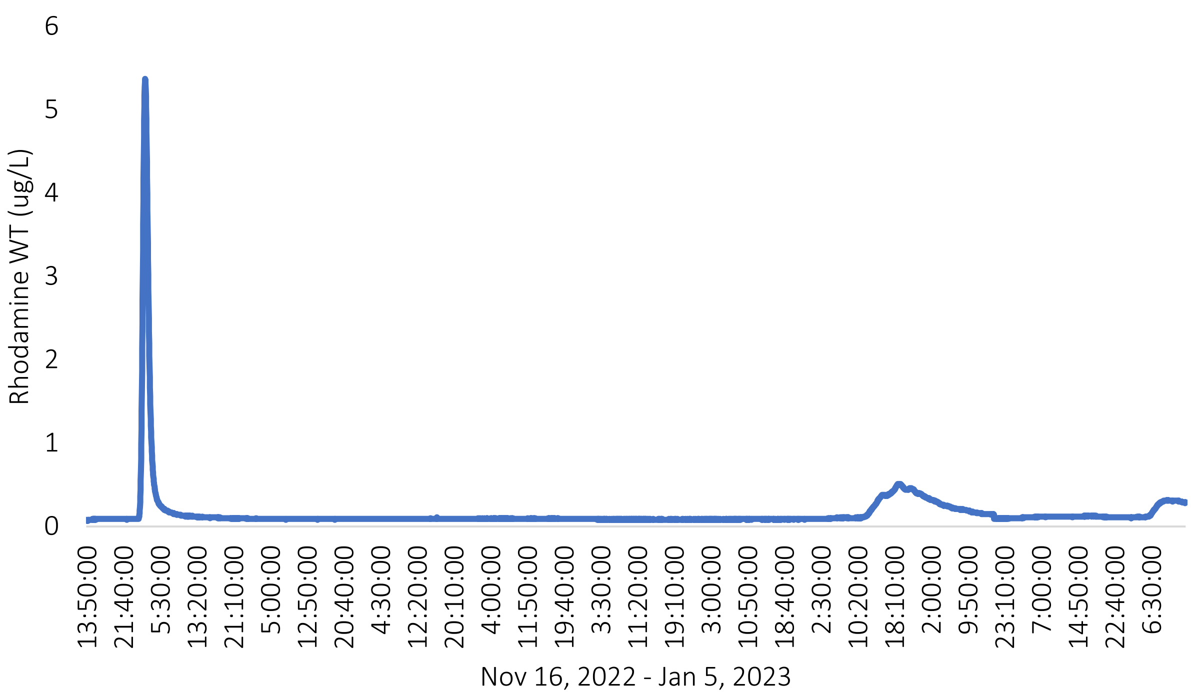


Figure 48. Rhodamine levels monitored at Siewers Spring from November 16,2022 - January 5, 2023

A summary of results from all three dye traces can be found in Table 18. Based on dye tracing results conducted in the Trout Run project area, there is strong connectivity between several locations of Trout Creek surface waters and Siewers Spring. Connections may be weaker during high flows as was observed on the Nordness Branch (dye trace 1) and more persistent during lower flow conditions as seen with the traces done on the Washington Prairie Branch of Trout Creek (dye trace 3). Further, since all three of these stream reaches are losing and have known connections to Siewers Spring, it is pertinent that water flowing into these points is kept as clean as possible by reducing the amount of sheet and rill erosion in the uplands and stabilizing the sediment found along stream banks.

Table 18. Summary of Trout Run dye traces conducted in Spring-fall 2022.

Dye Trace	Date	Distance From Spring (mi)	Elevation Above Spring (ft)	Catchment Area (ac)	Spring Discharge (cfs)	Time to Detect (hr)	Time to Peak (hr)	Peak Dye (ug/L)
1	3/23/2022	2.65	133	6,272	49	10	11.5	1.16
2	5/24/2022	3.52	130	5,077	31.33	23	28	0.99
3	11/16/2022	3	198	3,570	16.41	45	50.5	5.37

Dye traces in Trout Run have helped further define what is likely the southern and western most boundary of the Siewers Spring springshed (Calvin Wolter, personal communication). Dye trace 1 and 2 are located near the contact points of the Galena and Maquoketa bedrock formation. At these contact points, water from the uplands is transported and begins to infiltrate underground at varying rates and locations depending on current streamflow conditions. The highly transmissive Galena Bedrock formation exists to the north and eastern portion of Trout Run into neighboring watersheds as well as the western portion of Trout Run (Figure 49). Plans to conduct future dye traces in these areas will help to further define Siewers Spring springshed (i.e. Northern and Eastern boundary, Table 19) and understand surface intake of stream sections to underground aquifers under different flow conditions.

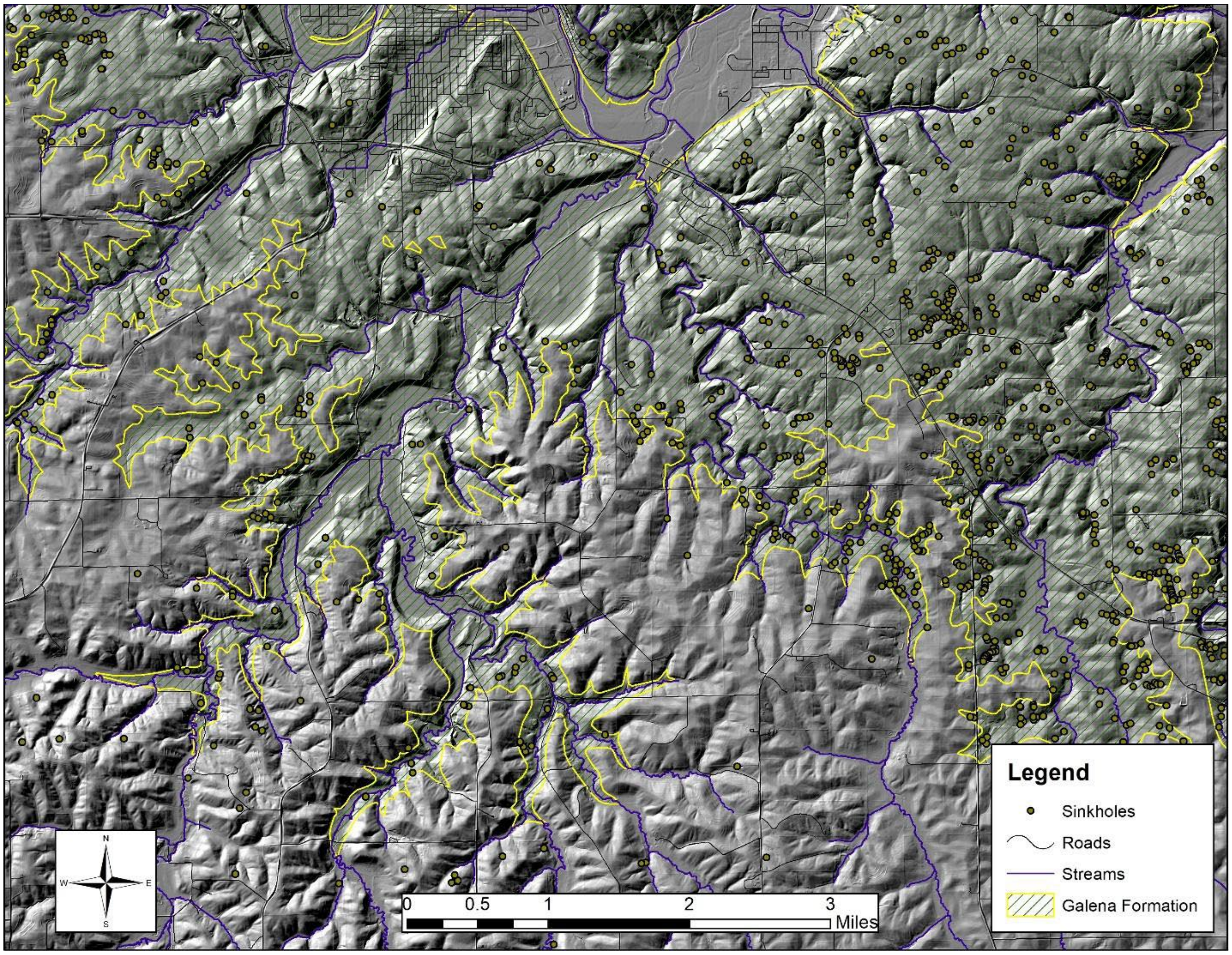


Figure 49. Galena Bedrock formation (hatched area) with corresponding sinkholes in Trout Run and surrounding watersheds. The overlying bedrock formation is the Maquoketa.

Table 19. Proposed future dye trace locations to help further define the Siewers Spring springshed.

Dye Trace Location	Feature	Flow Conditions
NE boundary- Trout River	Sinkhole complex	Low flow
Nordness Branch	Losing stream	Low flow
Eastern boundary	Sinkhole complex	Low flow
Sinkhole near hatchery	Sinkhole	Low flow
NW boundary- Dry Run	Sinkhole	Low flow

Watershed Modeling

To better understand the relationship between groundwater and surface water dynamics in the Trout Run watershed, stream sensors were put in place at Siewers Spring and at three surface location. Each sensor monitors stream stage (height) and can be used to determine a water balance. A water balance measures the amount of precipitation coming into the watershed while monitoring the surface and groundwater leaving the watershed. If the amount of precipitation is equal to the amount of surface flow from the watershed plus discharge from the spring plus evapotranspiration ($P = Qsur + Qgw + ET$), then the watershed area being monitored likely corresponds to the springshed. If the water balance is not equal, then some spring flow is contributed from outside the watershed.

General inferences of the Siewers Spring springshed can also be made by comparing it to Iowa's largest spring, Big Spring. Big Spring has an average discharge of 47 f^3/s and a defined springshed of 64,000 acres. If Trout Run is 32,000 acres, it's expected the average flow from Siewers Spring to be around 23.5 f^3/s. If average spring flow is much greater, then the springshed is likely larger than the Trout Run project area. Average flow from Siewers Spring needs to be determined from several years of monitoring under different flow conditions to accurately make this inference (Calvin Wolter, personal communication).

Rainfall in the Trout Run Watershed can be measured using NEXRAD Radar models. An example of how Siewers Spring responded to runoff from a rainfall event in August 2021 is shown in figure 50 where water temperature, turbidity, and nitrate at Siewers Spring increased after the rainfall occurred.

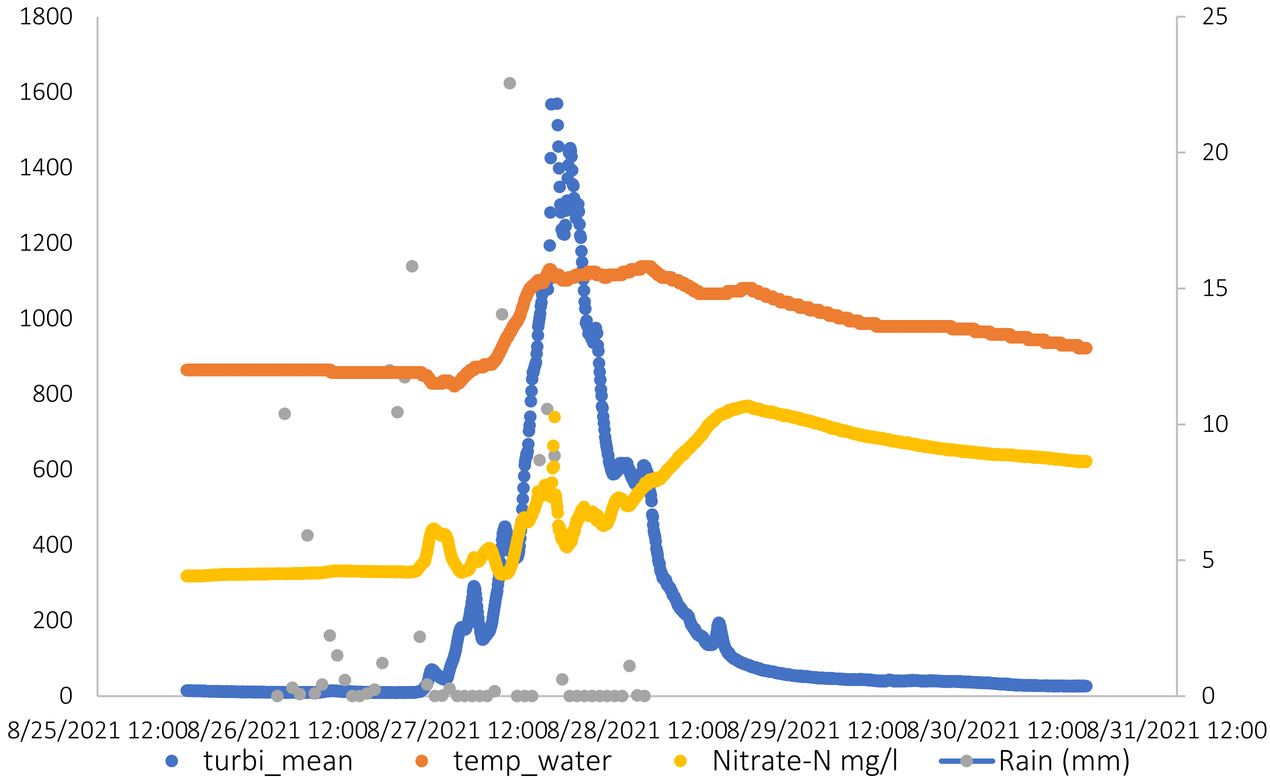


Figure 50. Rainfall model shows water quality at Siewers Spring after an August rain event in the watershed.

Bridge sensors were installed at three surface sites in the Trout Run Watershed and below Siewers Spring (Figure 51). At these locations, water stage (height) is measured every 15 minutes. For each location, a stage discharge relationship was determined by measuring stream discharge at different stations along a transect, under different water levels (stage height; Figure 51). Discharge measured at Siewers Spring ranged from 5.89 f^3/s – 59.07 f^3/s. Stream flow was variable although stage height varied little at each location. One example in June 2023 estimated surface discharge of lower Trout Creek to be 3.89 f^3/s while Siewers Spring discharge was measured at 34.62 f^3/s. During this time, the Washington Prairie branch was dry and the lower Nordness Branch was dry in the section before joining with Trout Creek. There was some flow (3.17 f^3/s) further upstream in the Nordness Branch before going dry, meaning 100% of the surface flow in this section was being directed underground to Siewers Spring. There is also a loss of flow from Trout Creek at Middle Calmar bridge (4.79 f^3/s) to lower Trout Creek (3.89 f^3/s), indicating portions of this section also lose to the underground aquifer. These observations also suggest the Washington Prairie tributary contributes surface water into the groundwater under higher flow conditions, followed by the Nordness Branch, and finally by Trout Run under lower flow conditions. (Calvin Wolter, personal communication).

Figure 51. Upper Left and Right: Stream stage sensor installed below Siewers Spring. Lower Left: Stream sensor installed on bridges in Trout Run. Lower Right: measuring flow of Siewers Spring to establish a stage-discharge relationship.

Based on information learned from dye tracing, stream monitoring, and field observations, all major stream sections (Washington Prairie Branch, Nordness Branch, and Trout Creek) in the Trout Run Watershed project area lose flow underground and contribute surface water to

Siewers Spring. Surface water influence on Siewers Spring depends on how saturated the watershed system is. Typically, in karst watersheds, when the system is full, groundwater will discharge to all streams and springs. When the system is low, streams dry up and the water table drops however still discharging to some bigger springs, such as Siewers Spring (Calvin Wolter, personal communication).

Under low flow conditions in the Trout Run Watershed, the lower branches of losing stream reaches dry up, despite the headwaters still flowing. Trout Run headwaters are fed by groundwater but flow underground to Siewers Spring once they reach a losing stream section. During low flow conditions in the Trout Run Watershed, there is stored groundwater in the Galena aquifer that continues to feed Siewers spring (Calvin Wolter, personal communication).

Under high flow conditions, water coming out of the spring has a large surface component. Generally, flow from the Washington Prairie tributary puts water into the groundwater first, followed by the Nordness Branch, and finally Trout Creek (Calvin Wolter, personal communication).

How full the system is determines where sediment comes from when a runoff event occurs. After a long, dry period, when the system is low, a rainfall event will likely contribute sediment to Siewers Spring from all stream sections. If the system is full when the runoff event occurs, flow from the Washington Prairie section may be the main contributor of sediment to Siewers Spring. Under these conditions, flow from Nordness Branch and Trout Creek likely cannot get into the groundwater and remains mostly on the surface as was seen in Dye trace #2. If the system is somewhere in between, the Washington Prairie section and the Nordness Branch likely contribute sediment (Calvin Wolter, personal communication).

The intensity of the runoff event may determine if the sediment comes from sheet and rill erosion or bank erosion. For a minor runoff event, sheet and rill erosion may be the largest component. For a large runoff event, more bank erosion will be added to the sheet and rill erosion (Calvin Wolter, personal communication).

Load Reductions and Priority Areas for Best Management Practices in Trout Run

Total sediment delivery for the Trout Run Watershed is estimated to be 20,299 tons/year (Table 20). This total amount includes sediment from upland areas, sediment contributed from stream banks and delivered from the stream corridor and sinkholes. With an overall goal to reduce sediment delivery to Trout Run and Siewers Spring, priority areas have been defined to address each source of sediment in the Trout Run Watershed. Priority areas to reduce sheet and rill erosion are shown as the orange and yellow areas in figure 52. These priority areas have an estimated sheet and rill erosion rate > 2 tons/acre/year. Priority areas to reduce sediment delivery from sinkholes in Trout Run are shown as purple hatched areas in Figure 52. A more detailed list of potential sediment delivery for each sinkhole catchment is listed in Appendix E. Priority areas to reduce stream bank erosion and improve stabilization are shown as red and black areas in figure 52. By working with landowners to address sediment erosion in Trout Run priority areas, sediment delivery can be reduced by 15,999 tons/year, which is 79% of the Trout Run watershed's estimated total sediment delivery. Estimated nutrient load reductions include 31,999 lbs./year of nitrogen and 20,800 lbs./year of phosphorus (Table 20).

Current Conditions			Implementation Strategy			Estimated Load Reductions		
Sediment Source	**Estimated Total Sheet & Rill (t/y)**	**Estimated Total Sediment Delivery (t/y)**	**Site Quantity**	**Management Practice**	**Successful Implementation Sediment Delivery (t/y)**	**Estimated LR Sediment (t/y)**	***Estimated LR N (lbs/y)**	****Estimated LR P (lbs/y)**
Upland Areas	74,190	10,789	8,730 acres	No-till, cover crops, filter strips, buffers, structural practices	3,776	7,013	14,026	9,117
Streambank Erosion	-	4,787	43,126 feet	Streambank Stabilization/Cattle Exclusion/Heavy Use Crossings	60	4,727	9,454	6,145
Sinkholes	5,729	3,313	~185 sinkholes	130' Buffer	166	3,147	6,295	4,092
35' area surrounding stream	1,763	1,410	88 acres (430 acres within 200')	Row Crop Conversion to perm veg within Buffer	298	1,112	2,224	1,446
	Totals	**20,299**			**4,401**	**15,999**	**31,999**	**20,800**

Table 20. Estimated current sediment load and corresponding pollutant load reductions after a given BMP is implemented for each source of sediment in the Trout Run Watershed. *Estimate assumes statewide average of 2lbs. of Nitrogen/ton sediment and **Assumes statewide average of 1.3 lbs. of Phosphorus/ton of sediment.

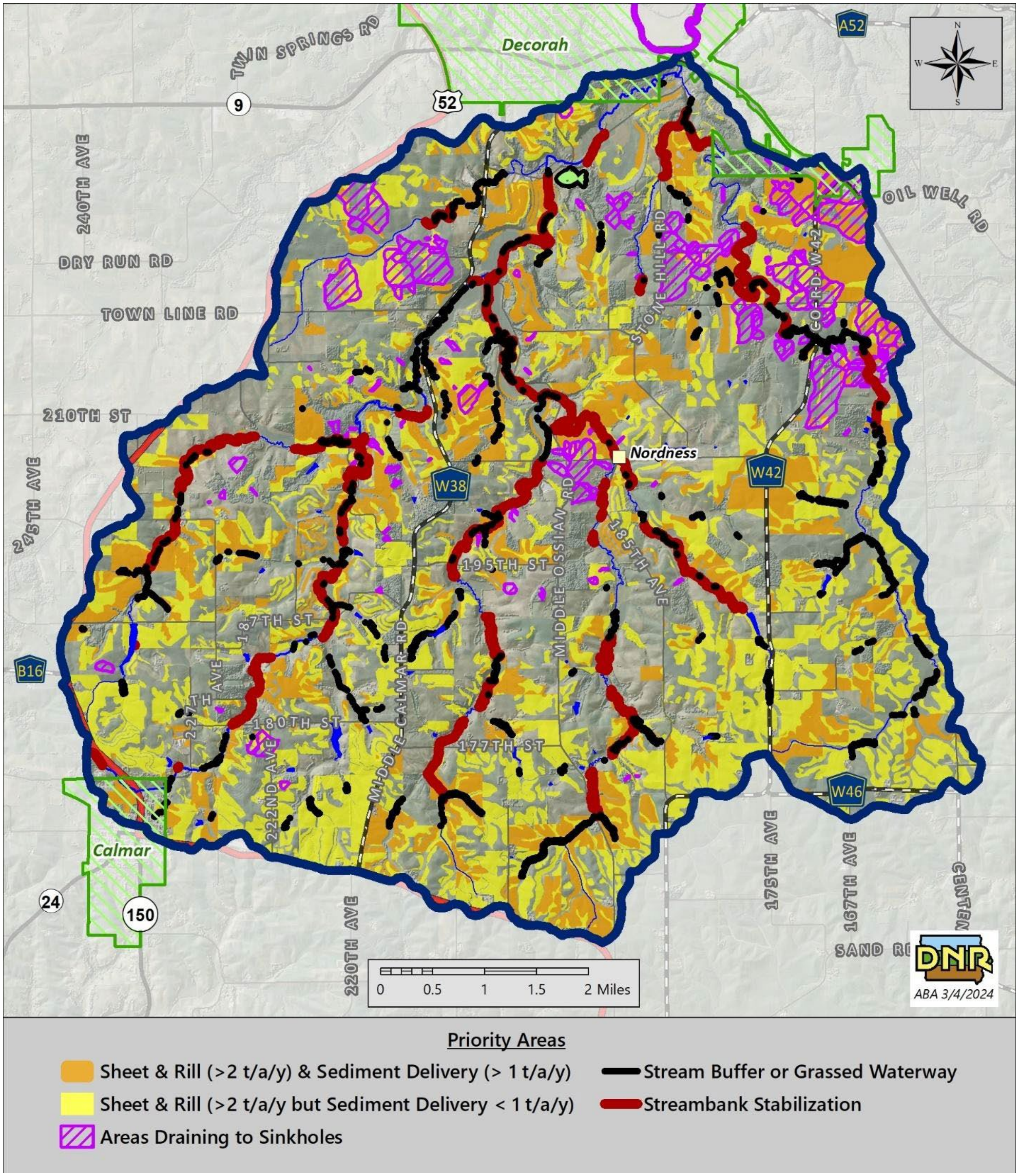


Figure 52. Priority areas to address sheet and rill erosion and sediment delivery in Trout Run.

Best Management Practices for Sediment Reduction

The Trout Run project area has a shallow soil depth to bedrock profile, fractured underlying bedrock, and steep slopes. These factors contribute to the increased susceptibly of soil loss but also convey the importance of adopting practices to keep soil in place and improve soil structure. The management practices promoted in this watershed plan will primarily focus on keeping soil in place on the landscape and improve soil structure and health to allow for increased infiltration and water storage capacity during rain events.

Information for the following practices that reduce soil erosion were taken from the NRCS FOTG guide. All practices implemented as part of the Trout Run Watershed plan will follow NRCS standards, specifications and any maintenance agreement guidelines.

Residue and Tillage Management - No-Till (329)

Limiting soil disturbance to manage the amount, orientation, and distribution of crop and plant residue on the soil surface year around. This practice is used to reduce sheet, rill and wind erosion, reduce sediment in surface waters, reduce tillage-induced particulate emissions, maintain or increase soil health and organic matter content, increase plant-available moisture, reduce energy use, provide food and cover for wildlife.

Residue and Tillage Management- Reduced Till (345)

Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round while limiting soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting. This practice is used to reduce sheet, rill, and wind erosion, excessive sediment in surface waters, reduce tillage-induced particulate emissions, improve soil health and maintain or increase organic matter content, reduce energy use.

Cover Crops (340)

Grasses, legumes, and forbs planted for seasonal vegetative cover to reduce erosion from wind and water, maintain or increase soil health and organic matter content, reduce water quality degradation by utilizing excessive soil nutrients, suppress excessive weed pressures and break pest cycles, improve soil moisture use efficiency, minimize soil compaction.

Cover crops, planted in the fall before or after harvest, have many benefits such as reducing soil erosion, increasing water infiltration, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter and improving overall soil quality. Diverse cover crops are even more beneficial for overall soil health.

Conservation Cover (327)

Establishing and maintaining permanent vegetative cover that will reduce sheet, rill, and wind erosion, reduce ground and surface water quality degradation by nutrients and sediment, reduce emissions of particulate matter (PM), PM precursors, and greenhouse gases.), enhance wildlife, pollinator and beneficial organism habitat, improve soil health.

Conservation Crop Rotation (328)

A planned sequence of crops grown on the same ground over a period of time (i.e. the rotation cycle) that helps to reduce sheet, rill and wind erosion, maintain or increase soil health and organic matter content, reduce water quality degradation due to excess nutrients, improve soil moisture efficiency, reduce plant pest pressures, provide feed and forage for domestic livestock, provide food and habitat for wildlife, including pollinator forage, and nesting.

Grassed Waterways (412)
Wide, shallow, channels of perennial vegetation that are designed to move surface water across farmland without causing soil erosion. Vegetation in the waterway reduces the speed of water, acts as a filter by trapping sediment, and prevents gully formation.

Field borders (386)
A strip of permanent vegetation established at the edge or perimeter of a field to reduce erosion from wind and water, reduce excessive sediment to surface waters, reduce sedimentation offsite and protect water quality and nutrients in surface and ground waters, provide food and cover for wildlife and pollinators or other beneficial organisms, reduce greenhouse gases and increase carbon storage, reduce emissions of particulate matter.

Filter Strips (393)
A strip of perennial vegetation that filters runoff and removes sediment and contaminants before they reach water bodies or water sources. Filter strips are established where environmentally sensitive areas, such as sinkholes and losing stream sections, need to be protected from sediment and other contaminants. Filter strips can reduce suspended solids and associated contaminants in runoff and reduce excessive sediment in surface waters. Note: for sinkhole protection, continuous conservation cover is recommended with a vegetated buffer of at least 120'.

Grazing management along pastured streams (528)
Managing the harvest of vegetation with grazing and/or browsing animals to improve or maintain surface and/or subsurface water quality and quantity, improve or maintain riparian and watershed function, reduce accelerated soil erosion, and maintain or improve soil condition, improve or maintain desired species composition and vigor of plant communities, improve or maintain quantity and quality of forage for grazing and browsing animals' health and productivity, improve or maintain the quantity and quality of food and/or cover available for wildlife, manage fine fuel loads to achieve desired conditions.

Includes managed grazing plans, livestock exclusion from the stream, fencing (382) and alternative watering systems (614). Limiting livestock access to streams where stabilized crossings are present and use of rotational grazing on fields adjacent to streams can decrease sediment loading from stream banks.

Sinkhole Treatment (527)
A treatment of karst or pseudokarst sinkholes or sinkhole areas on agricultural land to improve

groundwater and surface water quality and reduce soil erosion. Sinkhole protection includes a perennial buffer a minimum of 120’ from the center of a sinkhole.

Contour farming (330)

Aligning ridges, furrows, and roughness formed by tillage, planting and other operations to alter velocity and/or direction of water flow to around the hillslope to reduce sheet and rill erosion, reduce transport of sediment, solids and other contaminants attached to them, and increase water infiltration.

Contour farming is generally used on sloping land where tillage, planting, and cultivation are used to grow annual crops. In a properly designed contour farming system the tillage furrows intercept runoff and allow more moisture to infiltrate into the soil. Contour farming is most effective on slopes between 2 and 10 percent. Conservation benefits include: reduced sheet and rill erosion, reduced sediment transport to surface waters, reduce excess nutrients in surface waters, reduce pesticide transport to surface waters, increase water infiltration.

Contour Buffer Strips (332)

Narrow strips of permanent, herbaceous vegetative cover established around the hill slope, and alternated down the slope with wider cropped strips that are farmed on the contour. This practice helps reduce sheet and rill erosion, reduce water quality degradation from the transport of sediment and other water-borne contaminants downslope, improve soil moisture management through increased water infiltration.

Riparian Herbaceous Cover (390)

Grasses, sedges, rushes, ferns, legumes, and forbs tolerant of intermittent flooding or saturated soils, established or managed as the dominant vegetation in the transitional zone between upland and aquatic habitats. This practice may be applied to reduce erosion and improve stability to stream banks and shorelines, dissipate stream energy and trap sediment, enhance stream bank protection as part of stream bank soil bioengineering practices, provide or improve food and cover for fish, wildlife and livestock, improve and maintain water quality, establish and maintain habitat corridors, increase water storage on floodplains, increase net carbon storage in the biomass and soil, enhance pollen, nectar, and nesting habitat for pollinators, restore, improve or maintain the desired plant communities.

Riparian Forest Buffer (391)

An area predominantly covered by trees and/or shrubs located adjacent to and up-gradient from a watercourse or water body. This practice is used to reduce transport of sediment to surface water, and reduce transport of pathogens, chemicals, pesticides, and nutrients to surface and ground water, improve the quantity and quality of terrestrial and aquatic habitat for wildlife, invertebrate species, fish, and other organisms, maintain or increase total carbon stored in soils and/or perennial biomass to reduce atmospheric concentrations of greenhouse gasses, lower elevated stream water temperatures, restore diversity, structure, and composition of riparian plant communities.

Restoration of Rare or Declining Natural Communities (643)

Restoring and managing rare and declining habitats and their associated wildlife species to conserve biodiversity. This practice is applied to restore and manage unique or declining land or aquatic, native habitats, provide habitat for rare and declining species, restore, conserve, and manage native plant communities, increase native plant community diversity. Habitats include: Prairie, Savanna, Fen, Sedge and Wet Meadow, Forest/woodland.

Sediment Basin (350)

A basin constructed with the purpose to capture and detain sediment-laden runoff, or other debris for a sufficient length of time to allow it to settle out in the basin. Sediment basins are constructed with an engineered outlet, formed by constructing an embankment, excavating a dugout, or a combination of both.

Grade Stabilization Structure (410)

A structure used to control the grade in natural or constructed channels. The purpose of the project is to reduce erosion by placing a structure to stabilize the grade or control gully erosion.

Stream Crossing (578)

A stabilized area or structure constructed across a stream to provide controlled access for people, livestock, equipment, or vehicles to Improve water quality by reducing sediment, nutrient, or organic loading to a stream and reduce streambank and streambed erosion.

Stripcropping (585)

Growing planned rotations of erosion-resistant and erosion-susceptible crops or fallow in a systematic arrangement of strips across a field. This practice is used to accomplish one or more of the following purposes: reduce water erosion, reduced wind erosion, reduce the transport of sediment and other water and wind borne contaminants, protect growing crops from damage by wind-borne soil particles.

Tree Establishment (612)

Establishing native woody plants by planting seedlings or cuttings, direct seeding, or through natural regeneration for the following purpose: control erosion, maintain or improve desirable plant diversity, productivity, and health by establishing woody plants, Improve water quality by reducing excess nutrients and other pollutants in runoff and ground water, restore or maintain native plant communities, create or improve habitat for desired wildlife species, beneficial organisms, or pollinator species compatible with ecological characteristics of the site, sequester and store carbon, conserve energy, and provide livestock shelter.

Water and Sediment Control Basin (WASCOB; 638)

A water and sediment control basin is an earth embankment or a combination ridge and channel constructed across the slope of a minor drainageway to reduce gully erosion, trap sediment, and reduce and manage runoff. The basin detains runoff and slowly releases it allowing sediment to settle. WASCOBs generally use an underground outlet to control the release and carry the runoff in a pipe to a receiving stream or ditch. Note: WASCOBs alone may not be sufficient to control sheet and rill erosion on sloping upland areas. In addition, outlets from water and sediment control basins can provide a direct conduit to receiving waters for contaminated runoff from cropland. For these reasons, additional practices may be needed to adequately protect sloping upland areas from erosion and to protect down-slope water quality.

Pasture and Hay Planting (512)

Establishing perennial herbaceous plants that are adapted and compatible species, varieties, or cultivars suitable for pasture or hay production. This practice is used to accomplish one or more of the following purposes: reduce soil erosion, improve soil health, improve water and air quality, improve or maintain livestock nutrition and health, provide or increase forage supply during periods of low forage production.

Streambank and shoreline protection (580)

Used to stabilize and protect stream banks to maintain the flow capacity of streams or channels, reduce the offsite or downstream effects of sediment resulting from bank erosion, prevent the loss of land or damage to land uses or facilities adjacent to the banks of streams. Also used to improve or enhance the stream corridor or shoreline for fish and wildlife habitat, aesthetics, or recreation.

A vegetative, structural or combination treatment of stream banks designed to stabilize the stream bank and reduce erosion. Typically, this consists of grading the stream bank back to a 4:1 slope, armoring the toe of the bank with rock or large woody material, and seeding the bank down with diverse, native, perennial vegetation.

Implementation Schedule

Watershed improvement activities are outlined in the following four implementation phases:

Phase 1: January 1, 2024-December 31, 2028
Phase 2: January 1, 2029-December 31, 2033
Phase 3: January 1, 2034-December 31, 2038
Phase 4: January 1, 2039-December 31, 2043

The list of practices in each implementation phase are proposed because of their effectiveness at reducing sediment delivery to Trout Creek and Siewers Spring, however actual practice adoption will largely depend on landowner interest in the Trout Run project area.

Implementation Phase 1: January 1, 2024 - December 31, 2028

Goal: 50% of upland agricultural acres treated with management and structural practices

Milestone: 12.5% of the cropland acres operate with no-till and grow cover crops

Milestone: Sediment delivery is reduced by 1,753 tons/year; Average spring turbidity is <70 NTU

Practice	Metric	Phase Total	2024	2025	2026	2027	2028
Cover crops	Acres	2,125	425	425	425	425	425
Reduced till-no till	Acres	1,550	310	310	310	310	310
Continuous conservation cover (i.e., field borders, filter strips, buffer strips)	Acres	50	10	10	10	10	10
Pasture improvement	Acres	290	58	58	58	58	58
Grassed waterways	Number	20	4	4	4	4	4
Sediment basins/WASCOBs	Number	10	2	2	2	2	2
Grade stab. structure/Pond	Number	5	1	1	1	1	1

Goal: Reduce sediment delivery from Trout Run sinkholes

Milestone: Sediment delivery from sinkholes is reduced by 786.75 tons/year

Practice	Metric	Phase Total	2024	2025	2026	2027	2028
Sinkhole protection- buffer	Acres	80	16	16	16	16	16

Goal: Reduce sediment delivery from streambanks and surrounding corridor

Milestone: Sediment delivery from stream banks is reduced by 1,181.75 tons/year

Milestone: Sediment delivery from stream corridor is reduced by 278 tons/year

Practice	Metric	Phase Total	2024	2025	2026	2027	2028
Riparian corridor establishment	acres	25	5	5	5	5	5
Stream bank stabilization	Feet	10,780	2156	2156	2156	2156	2156

Objective: Develop material to increase public understanding of water quality and soil health issues and engage with watershed community in ways that will encourage greater involvement and participation in programs.

Milestone: Reach 25% of the landowners in Trout Run using different methods

Task	Metric	Phase Total (2024-2028)
On-farm planning visits	No. conducted	100
Project newsletters and news articles	No. distributed	10
Field days and demonstrations	No. conducted	5
Stakeholder and public meetings	No. conducted	5
Watershed landowner surveys	No. conducted	1

Implementation Phase 2: January 1, 2029 - December 31, 2033

Goal: 50% of upland agricultural acres treated with management and structural practices

Milestone: 25% of the cropland acres operate with no-till and grow cover crops

Milestone: Sediment delivery is reduced by 3,506 tons/year; Average spring turbidity is <60 NTU

Practice	Metric	Phase Total	2029	2030	2031	2032	2033
Cover crops	Acres	2,125	425	425	425	425	425
Reduced till-no till	Acres	1,550	310	310	310	310	310
Continuous conservation cover (i.e., field borders, filter strips, buffer strips)	Acres	50	10	10	10	10	10
Pasture improvement	Acres	290	58	58	58	58	58
Grassed waterways	Number	20	4	4	4	4	4
Sediment basins/WASCOBs	Number	10	2	2	2	2	2
Grade stab. structure/Pond	Number	5	1	1	1	1	1

Goal: Reduce sediment delivery from Trout Run sinkholes

Milestone: Sediment delivery from sinkholes is reduced by 1573.5 tons/year

Practice	Metric	Phase Total	2029	2030	2031	2032	2033
Sinkhole protection- buffer	Acres	80	16	16	16	16	16

Goal: Reduce sediment delivery from streambanks and surrounding corridor

Milestone: Sediment delivery from stream banks is reduced by 2363.5 tons/year

Milestone: Sediment delivery from stream corridor is reduced by 556 tons/year

Practice	Metric	Phase Total	2029	2030	2031	2032	2033
Riparian corridor establishment	acres	25	5	5	5	5	5
Stream bank stabilization	Feet	10,780	2156	2156	2156	2156	2156

Objective: Develop material to increase public understanding of water quality and soil health issues and engage with watershed community in ways that will encourage greater involvement and participation in programs.

Milestone: Reach 50% of the landowners in Trout Run using different methods

Task	Metric	Phase Total (2029-2033)
On-farm planning visits	No. conducted	100
Project newsletters and news articles	No. distributed	10
Field days and demonstrations	No. conducted	5
Stakeholder and public meetings	No. conducted	5
Watershed landowner surveys	No. conducted	1

Implementation Phase 3: January 1, 2034 - December 31, 2038

Goal: 50% of upland agricultural acres treated with management and structural practices

Milestone: 37.5% of the cropland acres operate with no-till and grow cover crops

Milestone: Sediment delivery is reduced by 5,259.75 tons/year; Average spring turbidity is <44 NTU

Practice	Metric	Phase Total	2034	2035	2036	2037	2038
Cover crops	Acres	2,125	425	425	425	425	425
Reduced till-no till	Acres	1,550	310	310	310	310	310
Continuous conservation cover (i.e., field borders, filter strips, buffer strips)	Acres	50	10	10	10	10	10
Pasture improvement	Acres	290	58	58	58	58	58
Grassed waterways	Number	20	4	4	4	4	4
Sediment basins/WASCOBs	Number	10	2	2	2	2	2
Grade stab. structure/Pond	Number	5	1	1	1	1	1

Goal: Reduce sediment delivery from Trout Run sinkholes

Milestone: Sediment delivery from sinkholes is reduced by 2360.25 tons/year

Practice	Metric	Phase Total	2034	2035	2036	2037	2038
Sinkhole protection- buffer	Acres	80	16	16	16	16	16

Goal: Reduce sediment delivery from streambanks and surrounding corridor

Milestone: Sediment delivery from stream banks is reduced by 3,545.25 tons/year

Milestone: Sediment delivery from stream corridor is reduced by 834 tons/year

Practice	Metric	Phase Total	2034	2035	2036	2037	2038
Riparian corridor establishment	acres	25	5	5	5	5	5
Stream bank stabilization	Feet	10,780	2156	2156	2156	2156	2156

Objective: Develop material to increase public understanding of water quality and soil health issues and engage with watershed community in ways that will encourage greater involvement and participation in programs.

Milestone: Reach 75% of the landowners in Trout Run using different methods

Task	Metric	Phase Total (2034-2038)
On-farm planning visits	No. conducted	100
Project newsletters and news articles	No. distributed	10
Field days and demonstrations	No. conducted	5
Stakeholder and public meetings	No. conducted	5
Watershed landowner surveys	No. conducted	1

Implementation Phase 4: January 1, 2039 - December 31, 2043

Goal: 50% of upland agricultural acres treated with management and structural practices

Milestone: 50% of the cropland acres operate with no-till and grow cover crops

Milestone: Sediment delivery is reduced by 7,013 tons/year; Average spring turbidity is <27 NTU

Practice	Metric	Phase Total	2039	2040	2041	2042	2043
Cover crops	Acres	2,125	425	425	425	425	425
Reduced till-no till	Acres	1,550	310	310	310	310	310
Continuous conservation cover (i.e., field borders, filter strips, buffer strips)	Acres	50	10	10	10	10	10
Pasture improvement	Acres	290	58	58	58	58	58
Grassed waterways	Number	20	4	4	4	4	4
Sediment basins/WASCOBs	Number	10	2	2	2	2	2
Grade stab. structure/Pond	Number	5	1	1	1	1	1

Goal: Reduce sediment delivery from Trout Run sinkholes

Milestone: Sediment delivery from sinkholes is reduced by 3,147 tons/year

Practice	Metric	Phase Total	2039	2040	2041	2042	2043
Sinkhole protection- buffer	Acres	80	16	16	16	16	16

Goal: Reduce sediment delivery from streambanks and surrounding corridor

Milestone: Sediment delivery from stream banks is reduced by 4727 tons/year

Milestone: Sediment delivery from stream corridor is reduced by 1,112 tons/year

Practice	Metric	Phase Total	2039	2040	2041	2042	2043
Riparian corridor establishment	acres	25	5	5	5	5	5
Stream bank stabilization	Feet	10,780	2156	2156	2156	2156	2156

Objective: Develop material to increase public understanding of water quality and soil health issues and engage with watershed community in ways that will encourage greater involvement and participation in programs.

Milestone: Reach 100% of the landowners in Trout Run using different methods

Task	Metric	Phase Total (2039-2043)
On-farm planning visits	No. conducted	100
Project newsletters and news articles	No. distributed	10
Field days and demonstrations	No. conducted	5
Stakeholder and public meetings	No. conducted	5
Watershed landowner surveys	No. conducted	1

Resource Needs

A summary of the proposed financial resources needed to reduce erosion and sediment delivery in Trout Run over the course of a 20-year project timeline are included in Table 21. Cost estimates for the proposed conservation practices were determined from an average cost of similar projects completed in Winneshiek County in recent years. For practices that include a landowner cost, the landowner contribution is 25-50% of the total cost, which equals a 50-75% cost-share rate. Other forms of cost-share may come from EQIP, CSP, local hunting and angling groups, DNR 319, private organizations, community groups, and other partners.

Table 21. Estimated financial resource needs for proposed conservation practices in the Trout Run Watershed for a 20-year project timeline.

Practice	Amount Needed	Cost/Unit	Cost Share	Landowner Cost
No Till	6, 198 acres	$25/acre	$ 154,950	$ 154,950
Cover Crops	8,478 acres	$30/acre	$ 254,340	$ 254,340
Continuous CRP	200 acres	$280/acre	$ 56,000	$ -
Pasture Improvement	1,164 acres	$800/acre	$ 698,250	$ 232,800
Grassed Waterways	80	$8,000	$ 480,000	$ 160,000
Water and Sediment Basins	40	$17,500	$ 525,000	$ 175,000
Grade Stabilization structures	20	$112,500	$ 1,687,500	$ 562,500
Sinkhole protection-buffer	322 acres	$500/acre	$ 161,000	$ -
Riparian Corridor Establishment	88 acres	$500/acre	$ 33,000	$ 11,000
Streambank stabilization & heavy use protection	43,126 ft	$50/ft	$ 1,617,225	$ 176,238
Total			$ **5,667,265**	$ **1,726,828**

Water Quality Monitoring Plan

Water quality monitoring, as part of this watershed project, helps determine baseline water quality information that can be used to assess the influence of row crop agriculture, livestock management activities, household septic systems and urban areas on water quality in Trout Run and Siewers Spring. Collected over time, this data will help identify areas in the watershed in need of best management practices, guide future monitoring, and help quantify changes in water quality.

Surface Water Quality Monitoring will include Siewers Spring and the main branches of Trout Creek to assess the influence of land use practices throughout the watershed. Eight monitoring locations have been selected throughout the project area (Figure 53) to assess water quality data on a spatial scale. All sites will be sampled by local project staff and partners biweekly from April-November. In addition, event samples will be collected within 24 hours of a rain event in Trout Run to monitor water quality during high flow events. At each monitoring location, seven parameters will be sampled (Table 22). The parameters chosen will help determine source of sediment (total suspended solids, total dissolved solids), source of nutrients (total phosphorus, orthophosphate, total nitrogen, and Total Kjeldahl Nitrogen), and presence of bacteria (*E.coli*) from livestock or human waste. Water quality monitoring at these surface sites as well as continuous monitoring at Siewers Spring will continue through the duration of the project. In addition to biweekly water sampling in the Trout Run project area, continuous monitoring of Siewers Spring turbidity, nitrate, pH, temperature and dissolved oxygen, will take place every 5 minutes, year round, throughout the duration of this project.

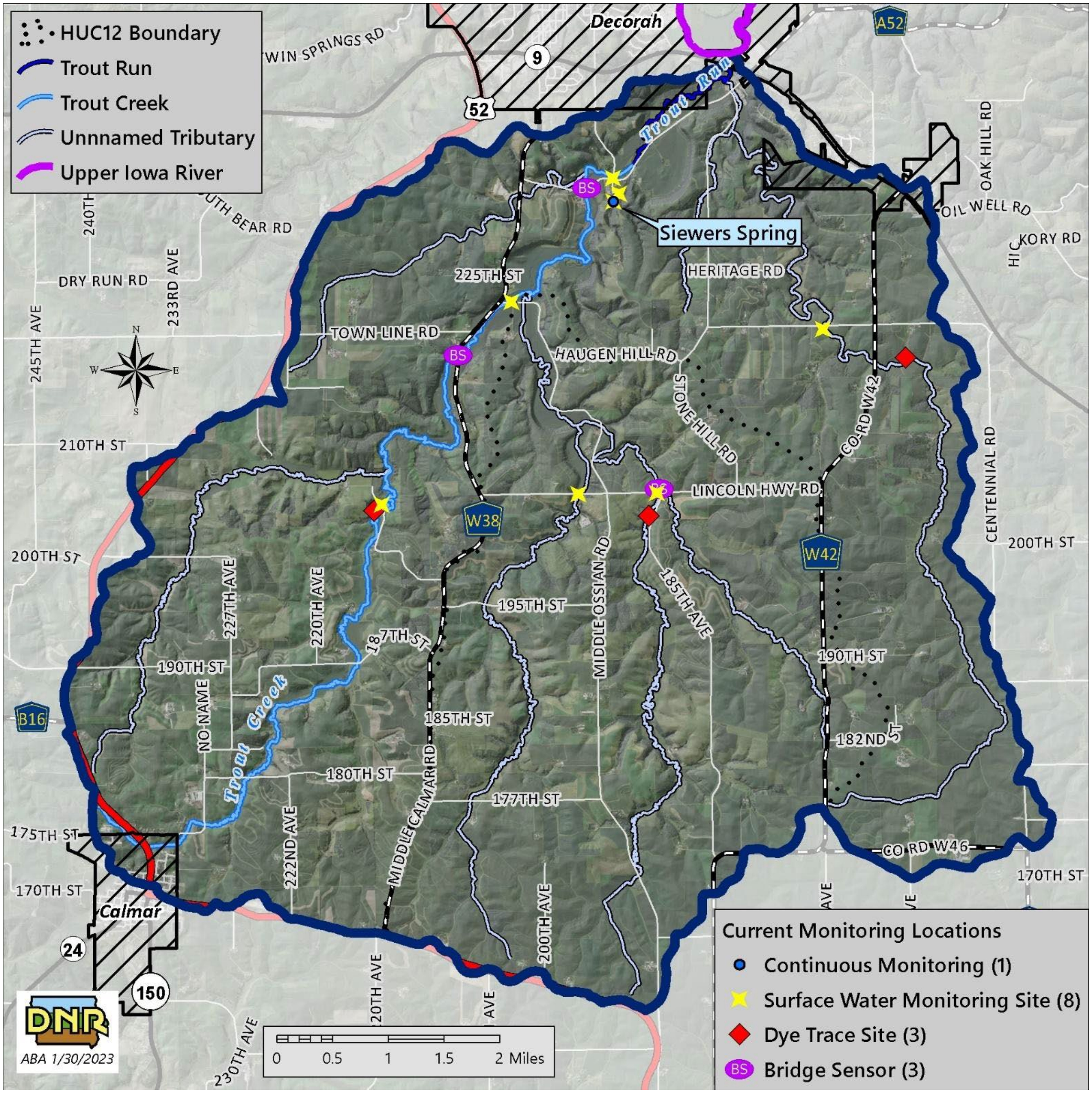


Figure 53. Water monitoring locations for the Trout Run Watershed Project.

Table 22. Trout Run surface water quality monitoring plan.

Frequency	Start/End Dates	Parameters Collected (mg/L except *E.coli*)
Two times a month if consistent flow is present.	March 1- November 30 (Sampling can occur Mon.-Thurs. only)	Total suspended solids Total volatile suspended solids Total phosphorus Orthophosphate Total Kjeldahl nitrogen Nitrate + Nitrite nitrogen *E. coli* (CFU/100mL)
Event Sampling: as soon as possible after a rainfall event larger than 0.35 in. over a 24 hour period, with at least 1 week between event samples.	March 1- November 30 (Sampling can occur Mon.-Thurs. only)	Total suspended solids Total volatile suspended solids Total phosphorus Orthophosphate Total Kjeldahl nitrogen Nitrate + Nitrite nitrogen *E. coli* (CFU/100mL)

Public Outreach and Education Plan

The purpose of a public outreach and education plan is to help inform and implement the goals of the Siewers Spring and Trout Run Watershed Protection Plan. Education and outreach strategies included in this plan have been identified as a way to promote the watershed project, build and strengthen the watershed community, and help guide the project coordinator in engaging stakeholders to implement sediment reduction practices and water quality improvements in the Trout Run Watershed.

Watershed Logo

A watershed identification logo will be created with the help of community partners such as community artists. A watershed logo will serve the purpose of establishing a connection between a watershed project and the community of landowners, supporters, allies and champions. The watershed logo will be used on communication and outreach materials such as newsletters and brochures, promotional items, business cards, letterhead, notecards and signage.

Watershed Signage

Creek and watershed signs will be placed at high visibility areas within the Trout Run Watershed allowing landowners and members of the community to begin to identify the watershed project area. Naming water bodies in a community allows community members to connect to a local stream and people tend to care for something they know about. Figure 54 shows an example creek sign for the Trout Run Watershed Project.

Figure 54. A Trout Run creek sign that increases awareness for the Trout Run Watershed.

Watershed Advisory Committee

A watershed advisory committee can be developed that has representation from landowners, local conservation agency staff, area businesses, and community members. Suggested speakers to attend meetings to share information with the advisory committee are: Trout Unlimited, karst geologists, local professors studying soil, water, and geology, local agency staff, and agronomists, technical staff working on project design and applicant scoring, etc.

Outreach Materials

A watershed newsletter can be developed for watershed residents and community partners. Example content may include results from water quality monitoring and watershed assessments, information about best management practices and cost share incentives, soil health and sediment reduction practices, landowner success stories or testimonies, upcoming watershed events, and other information about the watershed.

Local Newspaper Articles

Success stories can be published in local newspapers such as the Decorah Newspapers and Calmar Courier with the goal of one news article in public papers per year.

Local Events to Promote and Strengthen the Watershed Community

The Winneshiek County Soil and Water Conservation District maintains a booth at the Winneshiek County Fair. The fair booth is visited by farmers and community members to learn about partnerships and programs that can help implement conservation practices. The fair booth is a good place to advertise and gather support for the Trout Run Watershed Project.

Host a landowner appreciation day at the Chuck Gipp Decorah Trout Hatchery which will encourage families within the watershed to visit the hatchery, learn about Trout production and coldwater fisheries that depend on clean clear water from Siewers Spring.

Work with landowners and partnering agencies to host field days in the Trout Run Watershed. Conservation practices highlighted in the watershed plan can be the topic of the field days. Target audience will be landowners in the Trout Run Watershed as well as watershed community and project partners.

Watershed Resident Survey

At the beginning of the plan, landowners were contacted to discuss the Trout Run project. From these discussions several topics were brought forward, which include: There is lack of knowledge about current water quality of Trout Run and how surface and groundwater connects throughout the watershed. More up to date information is needed regarding sinkhole protection and how to farm responsibly in karst landscapes. Education and outreach is needed regarding soil health, available conservation practices, and scoring criteria and eligibility for cost share programs. Based on these conversations with Trout Run landowners, a broader survey could be distributed to all watershed residents to gather additional input from landowners.

Pre and post surveys or questionnaires can be distributed to watershed residents interested in conservation practices to determine things like: information learned, changes in soil erosion and soil health, and satisfaction with a conservation practice. Pre and post surveys can also help address any questions the landowner may have and determine interest in additional practices.

On farm visits

On farm visits with landowners in a more comfortable setting such as their farm is a good way to determine resource concerns and help implement conservation practices.

Develop an educational tool kit

Some discussions indicate landowners are not familiar with the connectivity of Trout Run surface waters to Siewers Spring so more education could be centered around karst geology, surface and ground water connectivity, susceptibility of groundwater to pollutants and contamination, and responsible farming in a karst landscape.

Not all farmers and watershed partners think of soil as a living organism and may not understand the importance of healthy soils for growing crops, improving water quality, farming sustainably and reducing farm inputs. Farmers may not be aware of conservation practices that build soil health while reducing soil erosion or they may not be aware of current conservation programs they may be eligible for. Outreach efforts to increase awareness of soil health building practices and current programs available can be helpful for Trout Run watershed residents. Example information in the toolkit may include: info graphic covering available conservation practices and how they function, soil health information, information on the financial benefits of soil health practices.

Project Evaluation

Load reductions achieved through practice implementation will be calculated and documented to demonstrate project success. Sediment and nutrient reductions will be estimated using the sediment delivery calculator for completed practices.

Water monitoring at Siewers Spring and within the Trout Run project area will continue over the life of the project to help determine changes in water quality. Project activities proposed in this watershed plan are expected to reduce sediment delivery and result in water quality improvements to Trout Run and Siewers Spring.

On an annual basis, project staff will review progress made toward the project goals and milestones identified in the watershed management plan and adjust where necessary. Project success will be measured not only by load reductions and improvements to water quality but by practices installed, acres improved, outreach, and an increase in overall participation in watershed project activities.

Various landowner and watershed resident surveys will be completed throughout the project to help determine changes in attitudes or perceptions, awareness of soil and water conservation practices, and resources needed to implement conservation practices.

Appendices

Appendix A

Year	pH	Fahrenheit (F)	Transparency (cm)	P (mg/L)	N (mg/L)	*E. coli* (MPN/100mL)	Ammonia (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Total Suspended Solids (mg/L)
2010	7.2 *(8.0)*	49.8 *(57.0)*	53 *(60+)*	0.14 *(0.1)*	7.0 *(6.1)*	634 *(436)*	**<0.05** *(<0.05)*	-	-	-
2011	7.9 *(8.4)*	51.7 *(62.5)*	**60+** *(60+)*	0.13 *(0.08)*	7.1 *(5.5)*	624 *(214)*	**<0.05** *(<0.05)*	-	-	-
2012	8.0 *(8.3)*	52.5 *(61.4)*	**60+** *(60+)*	0.12 *(0.09)*	5.2 *(3.7)*	659 *(230)*	**<0.05** *(0.06)*	-	-	-
2013	8.0 *(8.2)*	51.2 *(57.0)*	**50** *(49)*	0.14 *(0.14)*	8.0 *(6.3)*	519 *(437)*	**<0.05** *(0.08)*	-	-	-
2014	7.7 *(8.2)*	52.1 *(57.0)*	35 *(48)*	0.25 *(0.16)*	6.8 *(6.2)*	1156 *(479)*	-	-	-	-
2015	7.7 *(8.4)*	52.9 *(59.1)*	59 *(60+)*	0.13 *(0.09)*	6.9 *(5.8)*	635 *(197)*	-	20.48 *(15.12)*	18.13 *(14.49)*	9 *(5)*
2016	7.6 *(8.2)*	54.0 *(59.2)*	48 *(60+)*	0.15 *(0.12)*	9.5 *(7.3)*	403 *(236)*	-	23.1 *(16.26)*	16.39 *(14.3)*	23 *(14)*
2017	7.6 *(8.1)*	54.1 *(58.4)*	51 *(59)*	0.19 *(0.12)*	7.5 *(5.7)*	686 *(359)*	-	20.77 *(15.39)*	20.09 *(14.51)*	**14** *(15)*
2018	7.8 *(8.2)*	52.7 *(57.4)*	33 *(43)*	**0.23** *(0.26)*	8.3 *(6.1)*	**363** *(391)*	-	18.93 *(14.8)*	15.27 *(13.58)*	**61** *(72)*
2019	7.4 *(7.9)*	52.0 *(57.0)*	49 *(60+)*	0.14 *(0.11)*	6.8 *(5.6)*	**151** *(189)*	-	16.16 *(12.79)*	17.69 *(13.72)*	13 *(10)*
2020	7.6 *(8.1)*	51.5 *(55.5)*	46 *(60+)*	0.11 *(0.06)*	6.5 *(5.2)*	383 *(121)*	-	15.34 *(13.01)*	18.31 *(14.7)*	16 *(10)*
2021	7.8 *(8.1)*	53.7 *(59.8)*	**60+** *(60+)*	0.1 *(0.06)*	5.2 *(4.5)*	435 *(166)*	-	17.13 *(13.83)*	22.44 *(16.38)*	9 *(7)*

Annual average water quality for Siewers Spring from 2010-2021. Samples were collected monthly from April-October. Red values denote worse than average and green values denote better than average water quality compared to other sites (n=30) sampled within the Upper Iowa River Watershed. Gray values denote the overall average calculated from all water quality sampling sites.

Appendix B

Year	Temperature (F)	Transparency (cm)	P (mg/L)	N (mg/L)	*E. coli* (MPN/100mL)	Ammonia (mg/L)	Atrazine (ppb)	Chloride (mg/L)	Sulfate (mg/L)	Total Suspended Solids (mg/L)
2000			0.2 *(0.41)*	5.7 *(4.8)*		0.08 *(0.12)*	0.09 *(0.21)*			
2001			*(0.14)*	*(12.6)*		*(0.1)*	*(0.54)*			
2002			0.11 *(0.21)*	5.1 *(5.9)*		<0.05 *(0.15)*	0.07 *(0.09)*			
2004			0.1 *(0.1)*	6.1 *(5.4)*	157 *(170)*	<0.05 *(0.05)*	*(0.19)*			
2005	56.1 *(61.9)*	60+ *(55)*	0.13 *(0.11)*	4.5 *(5.3)*	221 *(180)*	<0.05 *(0.11)*	*(0.14)*			
2006	54.0 *(61.7)*	60+ *(56)*	0.16 *(0.14)*	6.2 *(5.3)*	991 *(388)*	0.05 *(<0.05)*	*(0.12)*			
2007	57.2 *(59.8)*	41 *(53)*	1.52 *(0.22)*	7.2 *(6.2)*	4026 *(745)*	0.26 *(0.06)*	*(0.11)*			
2008	55.7 *(59.1)*	53 *(58)*	0.16 *(0.12)*	7.2 *(5.7)*	774 *(357)*	0.09 *(0.09)*	*(0.09)*			
2009	50.9 *(56.1)*	60+ *(60+)*	0.11 *(0.08)*	4.8 *(4.3)*	227 *(204)*	<0.05 *(0.05)*				
2010	56.1 *(57.0)*	59 *(60+)*	0.18 *(0.1)*	6.8 *(6.1)*	2183 *(436)*	0.07 *(<0.05)*				
2011	54.7 *(62.5)*	60+ *(60+)*	0.11 *(0.08)*	7.1 *(5.5)*	466 *(214)*	<0.05 *(<0.05)*				
2012	55.0 *(61.4)*	60+ *(60+)*	0.1 *(0.09)*	5.0 *(3.7)*	211 *(230)*	<0.05 *(0.06)*				
2013	53.2 *(57.0)*	49 *(49)*	0.14 *(0.14)*	7.5 *(6.3)*	846 *(437)*	0.07 *(0.08)*				
2014	53.1 *(57.0)*	47 *(48)*	0.2 *(0.16)*	6.8 *(6.2)*	1823 *(479)*					
2015	53.7 *(59.1)*	60+ *(60+)*	0.13 *(0.09)*	6.5 *(5.8)*	825 *(197)*			20.15 *(15.12)*	22.03 *(14.49)*	6 *(5)*
2016	55.5 *(59.2)*	57 *(60+)*	0.17 *(0.12)*	8.2 *(7.3)*	671 *(236)*			30.8 *(16.26)*	17.33 *(14.3)*	29 *(14)*
2017	53.1 *(58.4)*	59 *(59)*	0.2 *(0.12)*	7.5 *(5.7)*	474 *(359)*			23.23 *(15.39)*	20.0 *(14.51)*	13 *(15)*
2018	53.6 *(57.4)*	38 *(43)*	0.32 *(0.26)*	7.8 *(6.1)*	1047 *(391)*			18.44 *(14.8)*	15.51 *(13.58)*	86 *(72)*
2019	53.3 *(57.0)*	51 *(60+)*	0.14 *(0.11)*	7.2 *(5.6)*	274 *(189)*			16.23 *(12.79)*	17.67 *(13.72)*	12 *(10)*
2020	51.7 *(55.5)*	53 *(60+)*	0.11 *(0.06)*	6.6 *(5.2)*	610 *(121)*			16.2 *(13.01)*	18.86 *(14.7)*	13 *(10)*
2021	52.9 *(59.8)*	60+ *(60+)*	0.11 *(0.06)*	5.1 *(4.5)*	467 *(166)*			17.34 *(13.83)*	21.56 *(16.38)*	7 *(7)*

Annual average water quality for Trout Run. Samples were collected monthly from April-October. Red denotes worse than average and green denotes better than average water quality compared to other sampling sites (n=30) within the Upper Iowa River Watershed. Gray denotes the overall average from all water quality sampling sites.

Appendix C

Rain Event Sample Date	Temperature (F)	Transparency (cm)	P (mg/L)	N (mg/L)	*E. coli* MPN/100 (mL)	Ammonia (mg/L)	Atrazine (ppb)	Fecal Coliform (MPN/100mL)
02/24/2000			1.3	3.8		1.0	0.1	5,800
05/18/2000			<0.1	3.7		0.1	0.52	740
07/05/2000			0.2	7.5		<0.1	0.29	1,200
08/17/2000			1.9	3.9		0.2	0.15	400,000*
04/03/2001			0.4	9.6		<0.1	<0.05	130
06/15/2001			0.3	6.5		<0.1	0.4	50,000
06/04/2002			1.8	4.5		0.55	22.0	200,000
07/29/2002			1.9	2.8		0.31	0.36	190,000
05/25/2004			0.4	11.0	13,000	0.07		
07/25/2005	71.1	60+	0.5	4.7	44,000	0.1		
03/14/2007	38.1	6	1.2	4.3	3,800	0.77		

Water quality samples collected in Trout Run following a rain event in 2000-2007. *Denotes a sample collection with a very high value of fecal coliform present.

Appendix D

Date	Site	*E. coli* (CFU/100mL)	Nitrate + Nitrite (mg/L)	OrthoP (mg/L)	Total P (mg/L)	TKN (mg/L)	TSS (mg/L)	TVSS (mg/L)
7/14/2022	TR1	850	8.8	0.09	0.12	<0.20	13	3
	TR2	580	8.8	0.09	0.14	0.48	10	2
	TR3	1,600	8.3	0.08	0.11	0.48	7	2
	TR4	31	8.9	0.07	0.09	0.48	10	2
	TR5	1,300	8.2	0.05	0.11	0.58	37	8
	TR6	2,100	8.7	0.07	0.12	0.57	19	4
	TR7	10,000	9	0.08	0.11	0.34	11	3
	TR8	NA	NA	NA	NA	NA	NA	NA
7/25/2022*	TR1	2,900	9.7	0.1	0.39	0.83	250	28
	TR2	2,900	9.5	0.11	0.26	0.77	130	18
	TR3	6,100	8	0.13	0.26	0.71	91	18
	TR4	6,900	7.8	0.17	0.29	0.74	45	10
	TR5	6,900	7.5	0.12	0.24	0.81	54	10
	TR6	3,400	9.5	0.14	0.26	0.82	51	9
	TR7	9,800	8.4	0.15	0.25	0.79	40	8
	TR8	2,500	14	0.12	0.27	0.71	67	12
8/8/2022*	TR1	>24,000	7.3	0.17	0.24	0.41	18	9
	TR2	24,000	7.1	0.18	0.27	1.1	14	8
	TR3	>24,000	6.4	0.18	0.27	0.88	26	9
	TR4	>24,000	6.3	0.23	0.4	1.1	49	15
	TR5	>24,000	5.6	0.18	0.33	0.99	37	12
	TR6	>24,000	6.9	0.22	0.36	1.1	39	12

	TR7	>24,000	5	0.45	0.87	2.1	80	20
	TR8	24,000	9.6	0.18	0.23	0.61	15	6
8/29/2022*	TR1	5,800	9.3	0.11	0.69	0.32	300	31
	TR2	4,600	9.2	0.13	0.83	0.29	160	18
	TR3	>24,000	7.4	0.17	0.62	0.28	48	10
	TR4	>24,000	5.9	0.34	1	0.43	12	3
	TR5	9,800	8	0.13	0.85	0.24	28	8
	TR6	>24,000	6.5	0.49	1.7	0.64	13	5
	TR7	24,000	6.9	0.19	0.98	0.27	18	4
	TR8	4,600	13	0.13	1.2	0.29	88	16
9/6/2022	TR1	1,000	8	0.08	0.37	0.13	11	2
	TR2	840	7.9	0.1	0.55	0.16	9	3
	TR3	680	6.7	0.08	0.38	0.1	2	1
	TR4	2,000	6.8	0.08	0.64	0.11	3	1
	TR5	2,000	6.6	0.04	0.52	0.08	11	3
	TR6	5,500	6.4	0.06	0.56	0.11	9	2
	TR7	8,200	6.8	0.08	0.71	0.15	14	3
	TR8	840	6.7	0.03	0.35	0.05	4	1
9/20/2022	TR1	1,000	6.8	0.08	0.29	0.1	7	2
	TR2	530	6.7	0.08	0.54	0.12	10	3
	TR3	430	6.6	0.07	0.4	0.09	3	1
	TR4	500	6.3	0.09	0.45	0.12	2	1
	TR5	930	5.5	0.04	0.29	0.06	3	1
	TR6	1,600	4.6	0.05	0.94	0.1	4	2
	TR7	>24,000	6	0.11	1.1	0.19	6	2

	TR8	NA	NA	NA	NA	NA	NA	NA
10/4/2022	TR1	710	6.5	0.07	0.47	0.11	6	2
	TR2	390	6.5	0.07	0.52	0.11	8	3
	TR3	260	6.8	0.05	0.2	0.07	<1	<1
	TR4	170	6	0.12	0.49	0.15	1	1
	TR5	910	5.2	0.03	0.59	0.05	2	2
	TR6	4,000	4.1	0.04	0.56	0.07	3	1
	TR7	16,000	5.7	0.07	0.58	0.11	4	2
	TR8	NA	NA	NA	NA	NA	NA	NA
10/27/2022	TR1	24,000	5.9	0.11	0.61	0.16	8	4
	TR2	20,000	5.8	0.12	0.8	0.19	4	2
	TR3	5,800	6.9	0.06	0.51	0.08	<1	<1
	TR4	NA	NA	NA	NA	NA	NA	NA
	TR5	200	4.4	0.06	0.56	0.1	1	<1
	TR6	1,300	3.5	0.08	0.62	0.13	6	5
	TR7	14,000	4.4	0.22	1.1	0.34	7	3
	TR8	NA	NA	NA	NA	NA	NA	NA
11/7/2022*	TR1	24,000	6.4	0.23	0.92	0.28	10	3
	TR2	24,000	6.3	0.24	1.2	0.31	9	3
	TR3	8,700	6.8	0.1	0.6	0.12	2	1
	TR4	>24,000	5.2	0.39	1.3	0.5	4	2
	TR5	16,000	6.1	0.24	1.1	0.33	3	2
	TR6	>24,000	5.1	0.59	2.3	0.98	12	7
	TR7	14,000	6.1	0.21	0.8	0.27	5	2
	TR8	NA	NA	NA	NA	NA	NA	NA

11/22/2022	TR1	260	6.3	0.07	0.6	0.08	4	2
	TR2	130	6.3	0.09	0.88	0.11	5	2
	TR3	840	6.8	0.06	1.4	0.08	<1	<1
	TR4	NA	NA	NA	NA	NA	NA	NA
	TR5	NA	NA	NA	NA	NA	NA	NA
	TR6	86	6.6	0.04	0.88	0.07	5	2
	TR7	250	6.2	0.05	1.1	0.09	8	3
	TR8	NA	NA	NA	NA	NA	NA	NA

Results of surface water sites collected biweekly and for rain events (denoted with *) in the Trout Run Watershed. Note UHL Lab counts bacteria up to 24,000. Any number exceeding is labeled as >24,000.

Appendix E

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
34	97.00	0%	11%	9%	71%	9%	0%	47.3%	213.5
76	65.04	0%	0%	7%	88%	5%	0%	49.9%	206.3
87	59.99	0%	0%	20%	73%	6%	0%	50.5%	160.8
55	72.29	0%	11%	33%	52%	4%	0%	49.2%	153.9
77	40.49	0%	0%	4%	96%	0%	0%	53.6%	152.5
237	102.54	0%	7%	44%	44%	5%	0%	47.0%	150.9
80	44.73	0%	0%	3%	97%	0%	0%	52.8%	149.7
128	45.77	0%	0%	9%	86%	5%	0%	52.6%	125.0
17	28.82	0%	0%	25%	50%	25%	0%	56.4%	96.8
91	22.52	0%	1%	16%	83%	0%	0%	58.5%	88.4
146	23.96	0%	0%	7%	93%	0%	0%	58.0%	87.2
145	16.18	0%	14%	13%	74%	0%	0%	61.5%	65.2
113	28.84	0%	0%	14%	79%	7%	0%	56.4%	63.9

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
78	9.36	2%	0%	30%	67%	0%	0%	66.8%	55.8
152	12.08	0%	11%	2%	87%	0%	0%	64.3%	54.4
42	27.07	0%	0%	30%	70%	0%	0%	56.9%	54.3
13	58.96	0%	0%	28%	21%	49%	2%	50.6%	52.5
50	21.10	0%	7%	41%	40%	11%	0%	59.1%	50.9
151	13.19	0%	0%	0%	100%	0%	0%	63.4%	48.3
35	38.52	0%	3%	35%	44%	17%	0%	54.0%	42.8
94	4.84	0%	0%	25%	75%	0%	0%	73.7%	41.8
11	12.62	0%	0%	36%	38%	27%	0%	63.8%	34.0
117	18.97	0%	0%	21%	67%	12%	0%	60.0%	31.2
57	11.54	0%	9%	68%	23%	0%	0%	64.7%	29.1
36	12.73	0%	2%	12%	67%	19%	0%	63.8%	24.5
61	12.61	0%	18%	32%	51%	0%	0%	63.8%	23.9
83	4.13	0%	0%	10%	90%	0%	0%	75.5%	22.3
110	21.78	0%	0%	24%	76%	0%	0%	58.8%	21.5
81	5.65	0%	0%	35%	65%	0%	0%	72.0%	21.5

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
93	3.23	0%	0%	40%	60%	0%	0%	78.4%	21.3
39	25.91	0%	0%	39%	50%	11%	0%	57.3%	19.4
84	2.91	0%	0%	23%	77%	0%	0%	79.6%	17.0
236	8.93	2%	22%	34%	22%	20%	0%	67.3%	16.8
18	2.36	0%	0%	0%	100%	0%	0%	82.2%	15.7
259	9.21	0%	0%	44%	56%	0%	0%	66.9%	15.4
173	18.50	0%	10%	90%	0%	0%	0%	60.3%	15.1
126	6.76	0%	38%	3%	59%	0%	0%	70.1%	15.1
165	43.59	0%	0%	83%	10%	7%	0%	53.0%	14.6
101	1.80	0%	0%	71%	29%	0%	0%	85.6%	14.4
182	0.66	0%	0%	50%	50%	0%	0%	99.4%	12.9
56	15.14	0%	18%	53%	27%	3%	0%	62.1%	12.7
60	8.22	0%	17%	33%	36%	14%	0%	68.1%	12.5
47	12.33	0%	7%	42%	49%	2%	0%	64.1%	11.5
21	12.43	0%	22%	46%	24%	7%	0%	64.0%	10.6
115	3.02	0%	0%	47%	40%	13%	0%	79.2%	10.5

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
137	16.85	0%	46%	10%	44%	0%	0%	61.1%	10.4
123	7.10	0%	70%	3%	27%	0%	0%	69.6%	10.2
180	9.08	0%	10%	77%	0%	13%	0%	67.1%	10.2
109	1.87	0%	0%	25%	75%	0%	0%	85.1%	9.8
251	1.38	0%	0%	33%	67%	0%	0%	89.1%	9.6
58	3.65	0%	7%	64%	29%	0%	0%	76.9%	9.1
144	1.54	0%	17%	0%	83%	0%	0%	87.7%	8.2
3	5.57	0%	65%	35%	0%	0%	0%	72.2%	8.1
119	5.88	0%	84%	4%	12%	0%	0%	71.6%	8.0
105	1.19	0%	40%	40%	20%	0%	0%	91.1%	8.0
142	1.53	0%	17%	0%	83%	0%	0%	87.7%	7.8
125	4.47	0%	39%	6%	56%	0%	0%	74.6%	7.6
59	2.58	0%	18%	27%	55%	0%	0%	81.1%	7.6
70	9.61	0%	14%	86%	0%	0%	0%	66.5%	7.6
114	4.84	0%	0%	57%	17%	26%	0%	73.7%	7.2
176	4.21	0%	64%	14%	0%	23%	0%	75.3%	6.9

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
4	6.03	0%	22%	78%	0%	0%	0%	71.3%	5.8
230	2.53	0%	36%	0%	64%	0%	0%	81.3%	5.4
51	4.64	0%	62%	29%	0%	10%	0%	74.2%	5.0
54	6.08	0%	36%	52%	12%	0%	0%	71.3%	4.8
82	0.41	0%	0%	100%	0%	0%	0%	100.0%	4.7
107	1.04	0%	0%	25%	75%	0%	0%	93.0%	4.7
64	5.69	0%	4%	17%	58%	21%	0%	72.0%	4.2
195	4.84	0%	100%	0%	0%	0%	0%	73.8%	4.1
186	1.58	0%	33%	11%	56%	0%	0%	87.3%	3.6
38	3.81	0%	0%	37%	63%	0%	0%	76.5%	2.9
190	2.03	0%	100%	0%	0%	0%	0%	84.0%	2.8
204	2.12	0%	0%	27%	73%	0%	0%	83.5%	2.8
134	4.63	0%	0%	40%	60%	0%	0%	74.2%	2.8
10	1.65	0%	100%	0%	0%	0%	0%	86.7%	2.7
175	2.26	0%	8%	92%	0%	0%	0%	82.7%	2.5
100	3.19	0%	7%	53%	40%	0%	0%	78.5%	2.5

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
72	1.72	0%	0%	100%	0%	0%	0%	86.2%	2.5
154	3.39	0%	0%	86%	14%	0%	0%	77.8%	2.4
43	1.50	0%	14%	29%	57%	0%	0%	87.9%	2.3
88	0.49	0%	0%	50%	50%	0%	0%	100.0%	2.2
133	3.02	0%	0%	25%	75%	0%	0%	79.2%	2.2
158	3.26	0%	0%	63%	38%	0%	0%	78.3%	2.1
5	2.23	0%	78%	22%	0%	0%	0%	82.9%	2.1
166	2.50	0%	0%	80%	20%	0%	0%	81.5%	1.9
6	1.76	0%	13%	75%	13%	0%	0%	85.9%	1.9
71	1.54	0%	50%	50%	0%	0%	0%	87.6%	1.9
46	2.22	0%	9%	27%	64%	0%	0%	82.9%	1.8
102	0.68	0%	67%	0%	33%	0%	0%	99.1%	1.8
48	1.28	0%	0%	40%	60%	0%	0%	90.1%	1.8
20	2.07	0%	9%	64%	9%	18%	0%	83.8%	1.7
45	2.39	0%	13%	38%	50%	0%	0%	82.0%	1.7
181	1.24	0%	0%	100%	0%	0%	0%	90.6%	1.5

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
129	0.48	0%	0%	33%	67%	0%	0%	100.0%	1.5
73	0.67	0%	100%	0%	0%	0%	0%	99.4%	1.3
194	0.80	0%	100%	0%	0%	0%	0%	96.6%	1.3
191	0.95	0%	50%	50%	0%	0%	0%	94.2%	1.3
37	1.27	0%	0%	60%	40%	0%	0%	90.2%	1.2
205	0.62	0%	0%	67%	33%	0%	0%	100.0%	1.2
108	0.73	0%	0%	100%	0%	0%	0%	98.1%	1.0
156	0.82	0%	0%	75%	25%	0%	0%	96.3%	1.0
74	0.44	0%	100%	0%	0%	0%	0%	100.0%	1.0
53	0.75	0%	100%	0%	0%	0%	0%	97.7%	0.9
44	0.42	0%	50%	50%	0%	0%	0%	100.0%	0.9
160	1.33	0%	40%	60%	0%	0%	0%	89.6%	0.9
197	0.51	0%	67%	33%	0%	0%	0%	100.0%	0.9
141	0.99	0%	100%	0%	0%	0%	0%	93.6%	0.8
192	0.84	0%	100%	0%	0%	0%	0%	96.0%	0.8
193	0.85	0%	100%	0%	0%	0%	0%	95.8%	0.8

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
121	0.63	0%	75%	25%	0%	0%	0%	100.0%	0.7
172	0.96	0%	20%	80%	0%	0%	0%	94.1%	0.7
201	1.08	0%	67%	0%	0%	33%	0%	92.4%	0.7
187	0.64	0%	0%	100%	0%	0%	0%	100.0%	0.6
183	0.63	0%	0%	100%	0%	0%	0%	100.0%	0.6
203	1.04	0%	25%	50%	0%	25%	0%	93.0%	0.6
122	0.44	0%	100%	0%	0%	0%	0%	100.0%	0.5
103	0.25	0%	100%	0%	0%	0%	0%	100.0%	0.5
164	0.67	0%	0%	67%	33%	0%	0%	99.4%	0.5
223	0.68	0%	67%	33%	0%	0%	0%	99.2%	0.5
189	0.24	0%	100%	0%	0%	0%	0%	100.0%	0.4
136	0.48	0%	0%	50%	50%	0%	0%	100.0%	0.4
202	0.67	0%	67%	0%	0%	33%	0%	99.3%	0.4
159	0.36	0%	0%	100%	0%	0%	0%	100.0%	0.4
161	0.47	0%	0%	100%	0%	0%	0%	100.0%	0.4
104	0.15	0%	100%	0%	0%	0%	0%	100.0%	0.4

Catchment ID	Catchment Acres	Water (%)	Forest (%)	Grassland (%)	Cropland (%)	Artificial (%)	Barren (%)	Sediment Delivery Ratio	Total Sediment Delivery (tons/yr.)
106	0.43	0%	100%	0%	0%	0%	0%	100.0%	0.3
248	0.17	0%	0%	100%	0%	0%	0%	100.0%	0.3
130	0.40	0%	0%	100%	0%	0%	0%	100.0%	0.3
120	0.23	0%	100%	0%	0%	0%	0%	100.0%	0.3
171	0.28	0%	0%	100%	0%	0%	0%	100.0%	0.2
97	0.20	0%	0%	100%	0%	0%	0%	100.0%	0.1
124	0.21	0%	0%	100%	0%	0%	0%	100.0%	0.1
111	0.20	0%	0%	100%	0%	0%	0%	100.0%	0.1

Summary statistics for active sinkholes in the Trout Run watershed.

Trout Run, Winneshiek County In-Stream RASCAL Assessment Summary
Stream Miles Assessed: 6.18

Flow at time of survey	*Stream Miles*	*% of Total*
Normal	5.31	86.0%
High	0.00	0.0%
Low	0.15	2.4%
No Flow	0.72	11.6%
Backflow	0.00	0.0%
No Data	0.00	0.0%

Hydrologic Variability		
Dry Channel	0.30	4.9%
Pond	0.03	0.5%
Pool/Glide	0.51	8.2%
Riffle/Pool	3.73	60.4%
Riffle	0.00	0.0%
Riffle/Run	1.43	23.1%
Run	0.06	1.0%
No Data	0.12	1.9%

Substrate		
Bedrock	0.72	11.7%
Boulder	0.74	11.9%
Cobble	3.97	64.3%
Gravel	0.09	1.5%
Sand	0.00	0.0%
Silt/Mud	0.65	10.6%
Clay/Hard Pan	0.00	0.0%
Rock/RipRap	0.00	0.0%
Concrete	0.00	0.0%
No Data	0.01	0.1%

Sediment Coverage		
Entire Segment	0.95	15.3%
75-90% of Segment	0.44	7.1%
50-75% of Segment	1.39	22.6%
25-50% of Segment	1.21	19.6%
0-25% of Segment	1.71	27.7%
No Sediment	0.48	7.7%
No Data	0.00	0.0%

Left Riparian Zone Width	*Stream Miles*	*% of Total*
< 10 Feet	0.48	7.8%
10-30 Feet	0.98	15.9%
30-60 Feet	1.09	17.7%
> 60 Feet	3.62	58.6%
No Data	0.00	0.0%

Right Riparian Zone Width		
< 10 Feet	0.36	5.9%
10-30 Feet	1.85	29.9%
30-60 Feet	0.75	12.1%
> 60 Feet	3.22	52.1%
No Data	0.00	0.0%

Left Riparian Zone Cover		
Row Crop	0.00	0.0%
CRP-Grass	0.24	3.9%
CRP-Trees	0.12	1.9%
Grass	1.13	18.3%
Pasture	1.70	27.5%
Residential	0.00	0.0%
Trees	2.99	48.4%
Rec Trail	0.00	0.0%

Right Riparian Zone Cover		
Row Crop	0.00	0.0%
CRP-Grass	0.27	4.4%
CRP-Trees	0.28	4.5%
Grass	0.57	9.3%
Pasture	1.62	26.2%
Residential	0.09	1.4%
Trees	3.35	54.2%
Rec Trail	0.00	0.0%

Left Adjacent Land Cover		
Row Crop	2.67	43.2%
Lawn-Turf Grass	0.00	0.0%
Commercial	0.00	0.0%

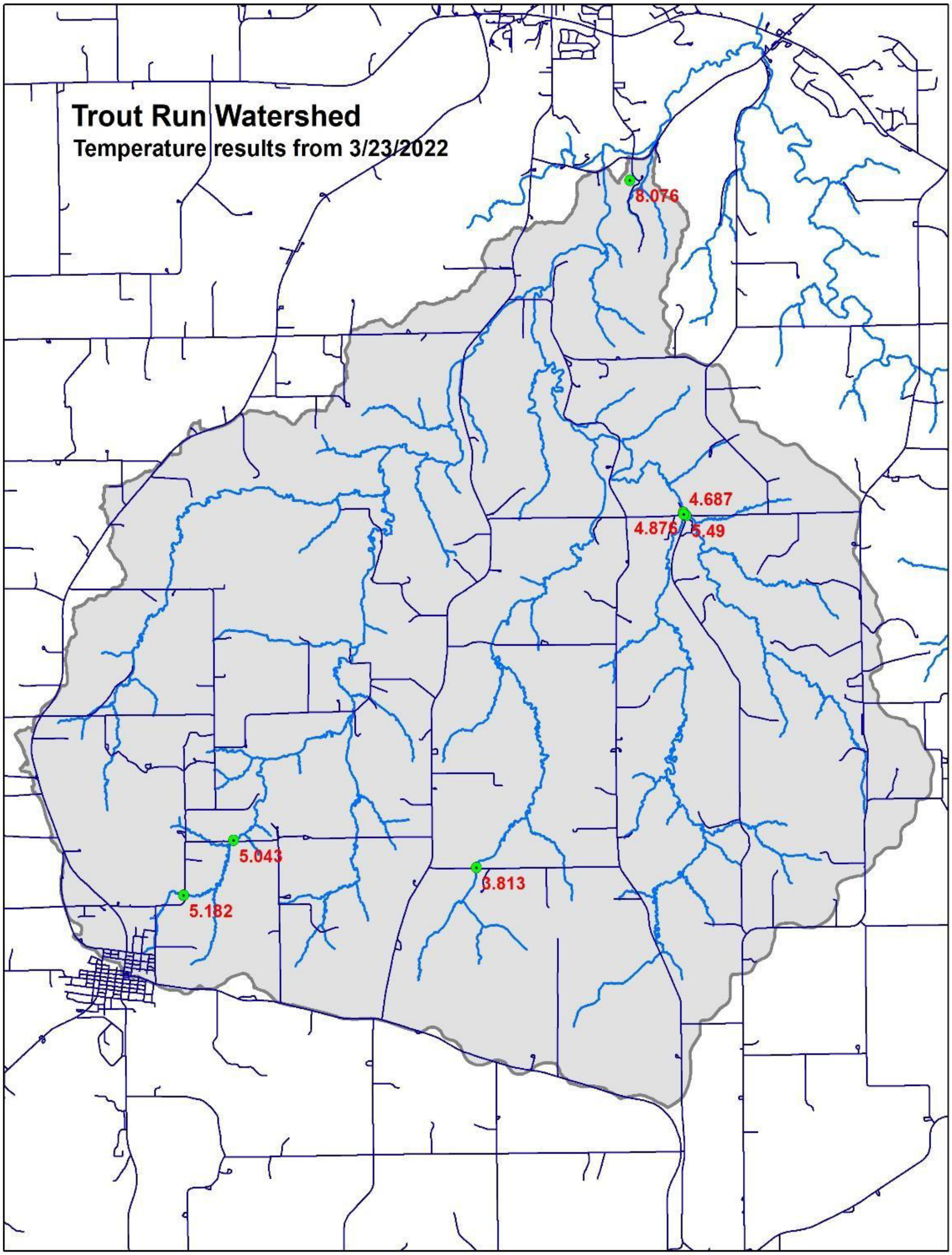
Pool Frequency		
None	1.62	26.2%
1 Pool	1.98	32.1%
2 Pools	2.05	33.2%
3 Pools	0.16	2.5%
4 Pools	0.08	1.4%
5 or More	0.00	0.0%
No Data	0.28	4.5%
Riffle Frequency		
None	0.76	12.4%
1 Riffle	1.53	24.7%
2 Riffles	1.87	30.3%
3 Riffles	1.13	18.3%
4 Riffles	0.15	2.5%
5 or More	0.45	7.3%
No Data	0.28	4.5%
Losing Flow		
Yes	0.62	10.1%
No	5.55	89.9%
No Data	0.00	0.0%
Stream Habitat		
Poor	0.58	9.5%
Average	5.05	81.7%
Excellent	0.35	5.6%
No Data	0.20	3.2%
Bank Stability		
Stable	0.38	6.1%
Minor Erosion	2.39	38.7%
Moderate Erosion	3.14	50.8%
Severe Erosion	0.27	4.3%
Artificially Stable	0.00	0.0%
No Data	0.00	0.0%
Bank Height		
0 - 3'	0.39	6.3%
3 - 6'	1.26	20.4%
6 - 10'	3.66	59.2%
10 - 15'	0.81	13.1%
15' +	0.06	1.0%

Woodland	0.66	10.6%
Parkland	0.00	0.0%
Industrial	0.00	0.0%
Tree Planting	0.23	3.7%
Rec Trail	0.00	0.0%
Road or Street	1.10	17.8%
Grassland-Idle	0.16	2.6%
Golf Course	0.00	0.0%
Railroad	0.00	0.0%
Pasture	0.80	12.9%
Feedlot	0.00	0.0%
Wetland or Pond	0.00	0.0%
Alfalfa or Hay	0.28	4.5%
Farmstead	0.00	0.0%
Lagoon	0.00	0.0%
CRP	0.00	0.0%
Residential	0.00	0.0%
Cliff	0.28	4.5%
Other	0.00	0.0%
No Data	0.00	0.0%
Right Adjacent Land Cover		
Row Crop	3.74	60.6%
Lawn-Turf Grass	0.16	2.6%
Commercial	0.00	0.0%
Woodland	0.17	2.7%
Parkland	0.00	0.0%
Industrial	0.00	0.0%
Tree Planting	0.25	4.1%
Rec Trail	0.35	5.6%
Road or Street	0.18	2.9%
Grassland-Idle	0.04	0.7%
Golf Course	0.00	0.0%
Railroad	0.00	0.0%
Pasture	0.13	2.0%
Feedlot	0.00	0.0%
Wetland or Pond	0.00	0.0%
Alfalfa or Hay	0.35	5.6%
Farmstead	0.07	1.2%
Lagoon	0.00	0.0%
CRP	0.30	4.9%
Residential	0.18	3.0%
Cliff	0.19	3.1%
Other	0.06	1.0%

No Data	0.00	0.0%
Bank Erosion		
None	0.30	4.9%
Both Banks	1.12	18.1%
Alternate Banks	2.74	44.3%
Random	2.02	32.6%
No Data	0.00	0.0%
Bank Material		
Rock/RipRap	0.44	7.1%
Soil/Silt	5.50	89.0%
Concrete	0.00	0.0%
Cobble/Gravel	0.24	3.9%
Sand	0.00	0.0%
No Data	0.00	0.0%
Bank Vegetation		
None	0.00	0.0%
Overhanging Only	0.36	5.9%
Dislodged	0.00	0.0%
Partially Established	5.41	87.6%
Well Established	0.35	5.7%
No Data	0.05	0.8%

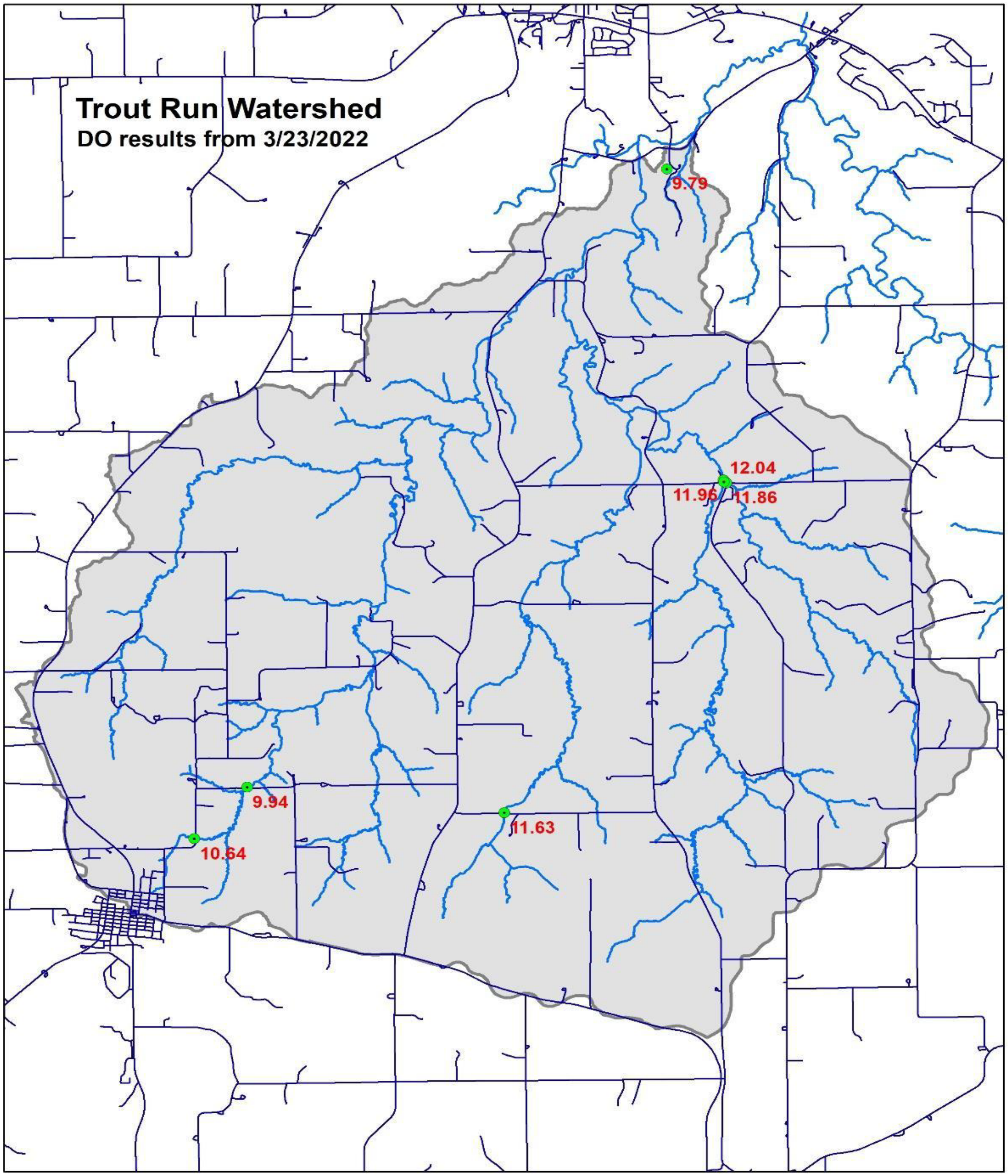
No Data	0.00	0.0%
Canopy Cover		
0-10%	1.58	25.6%
10-25%	0.97	15.8%
25-50%	1.22	19.8%
50-75%	2.05	33.3%
75-100%	0.34	5.5%
No Data	0.00	0.0%
Right Livestock Access		
Yes	1.93	31.2%
No	4.25	68.8%
No Data	0.00	0.0%
Left Livestock Access		
Yes	2.07	33.5%
No	4.10	66.5%
No Data	0.00	0.0%
Channel Pattern		
Straight	0.77	12.4%
Meandering	5.41	87.6%
Braided	0.00	0.0%
No Data	0.00	0.0%
Channel Condition		
Artificial	0.00	0.0%
Natural Channel	4.55	73.7%
Past Channel Alteration	1.62	26.3%
Recent Alteration	0.00	0.0%
No Data	0.00	0.0%

Appendix G

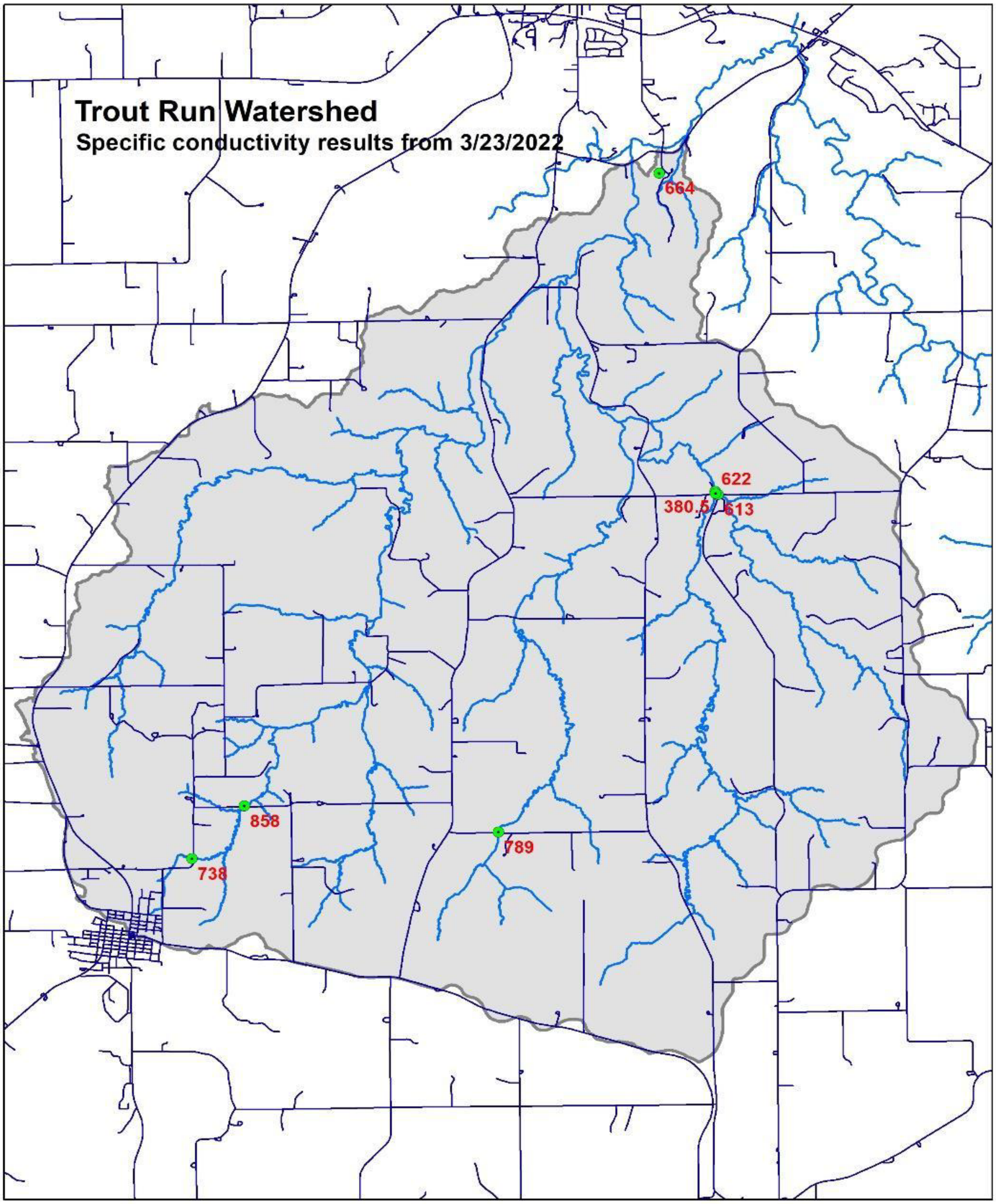


Trout Run Watershed
Temperature results from 3/23/2022
8.076
4.687
4.876
5.49
5.043
3.813
5.182

Appendix H

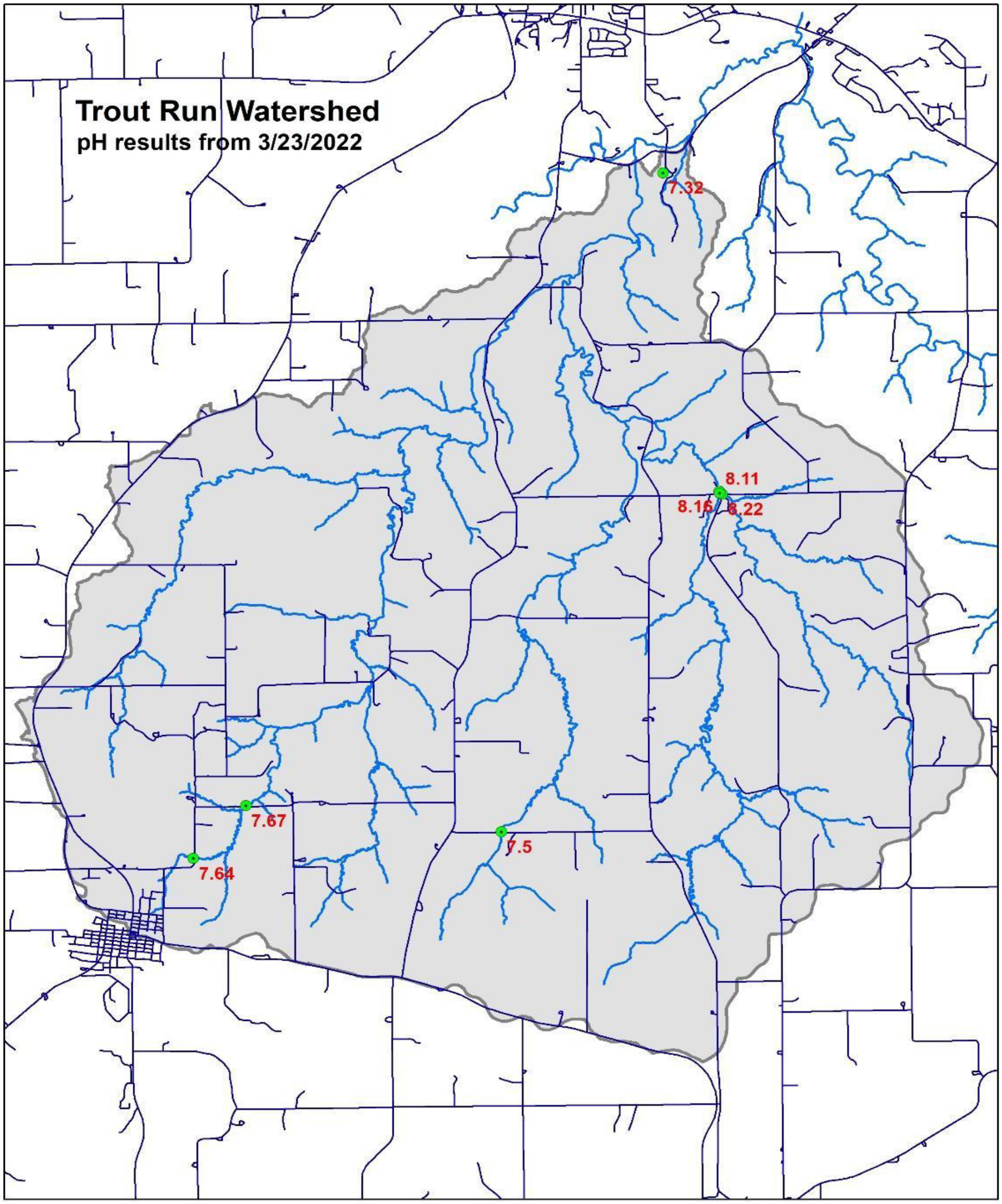

Trout Run Watershed
DO results from 3/23/2022
9.79
12.04
11.96
11.86
9.94
10.64
11.63

Appendix I

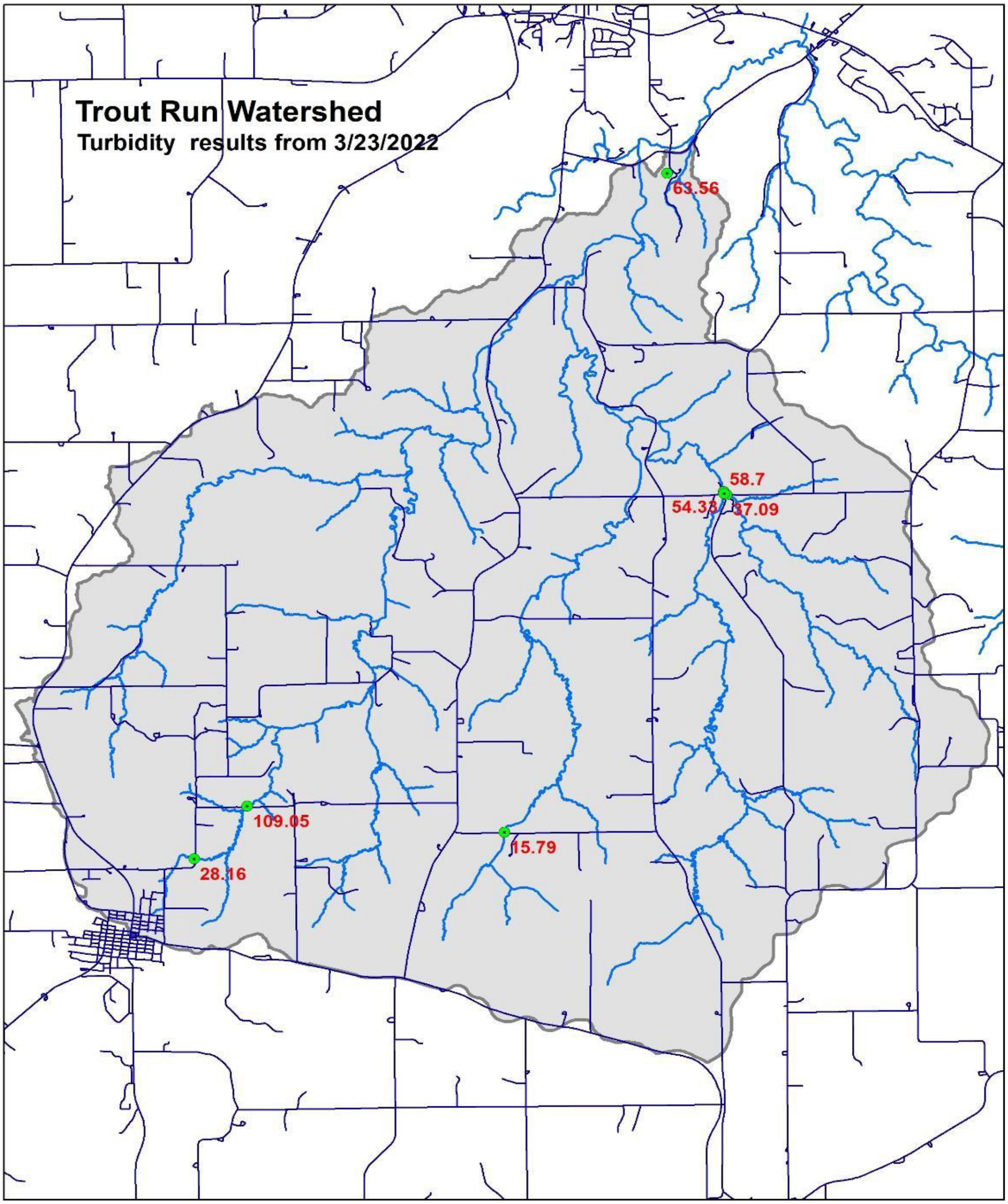


Trout Run Watershed
Specific conductivity results from 3/23/2022
664
622
380.5
613
858
789
738

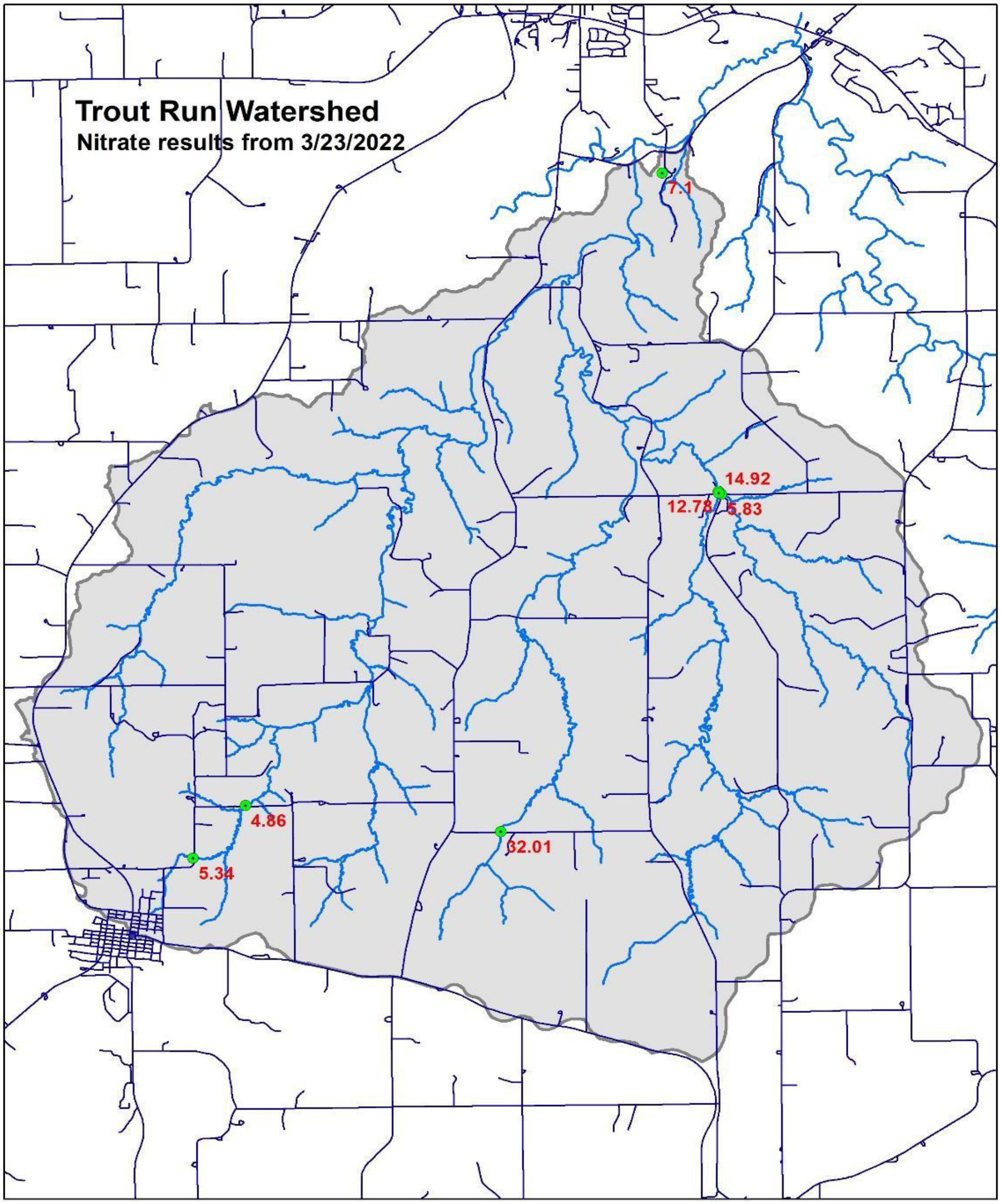
Appendix J


Trout Run Watershed
pH results from 3/23/2022
7.32
8.11
8.16
8.22
7.67
7.5
7.64

Appendix K

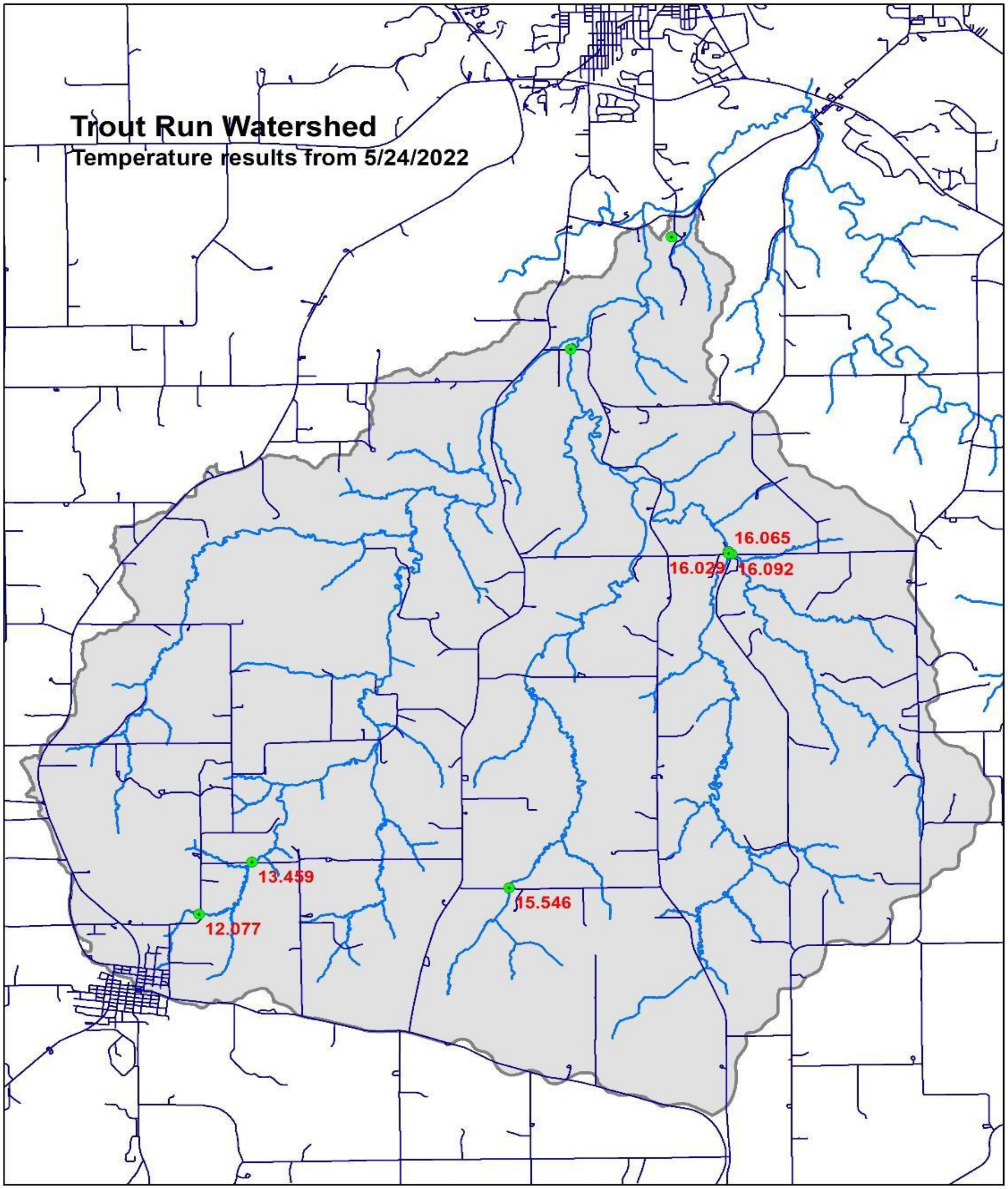

Trout Run Watershed
Turbidity results from 3/23/2022
63.56
58.7
54.33
37.09
109.05
15.79
28.16

Appendix L



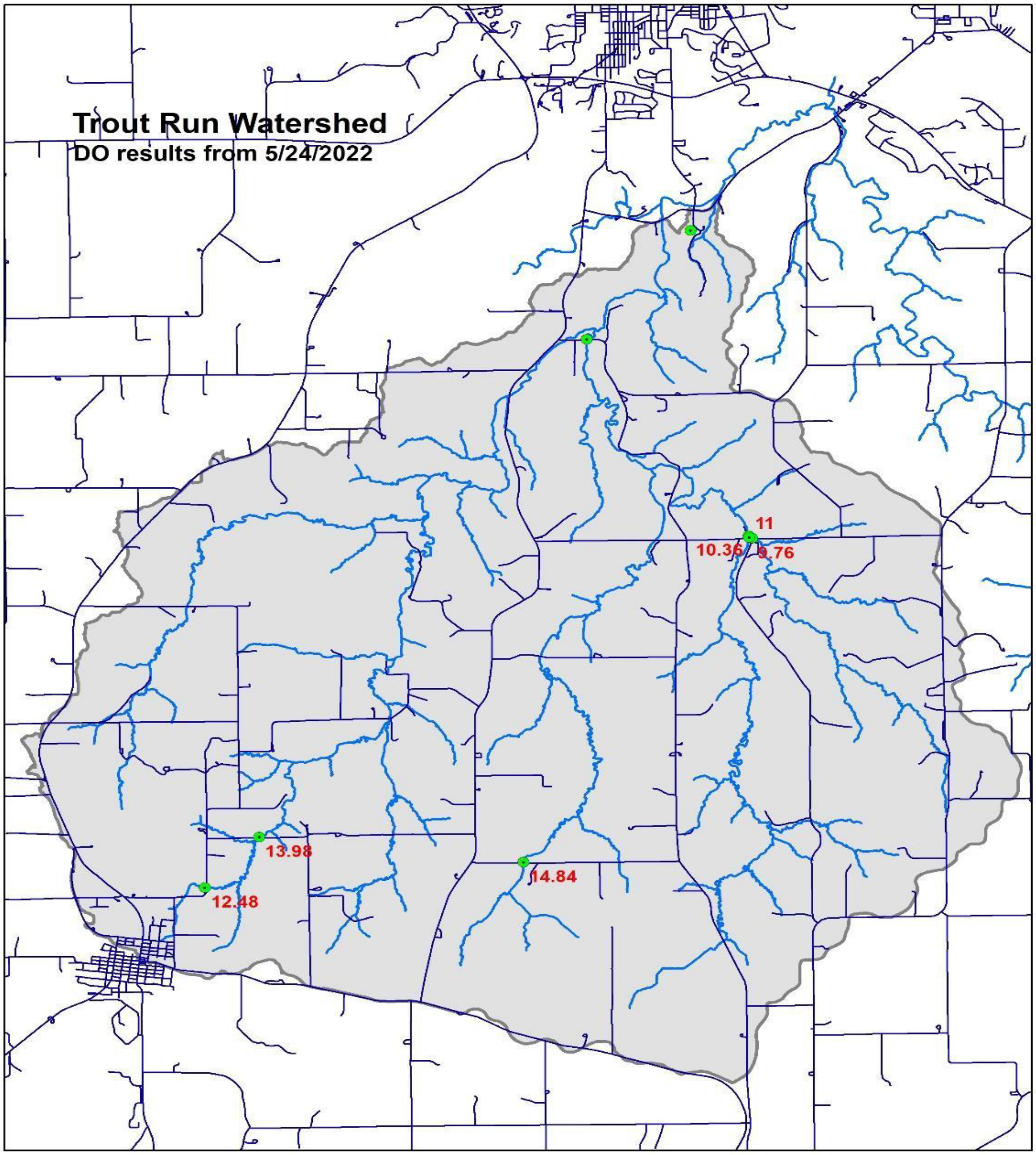
Trout Run Watershed
Nitrate results from 3/23/2022
7.1
14.92
12.78
5.83
4.86
5.34
32.01

Appendix M



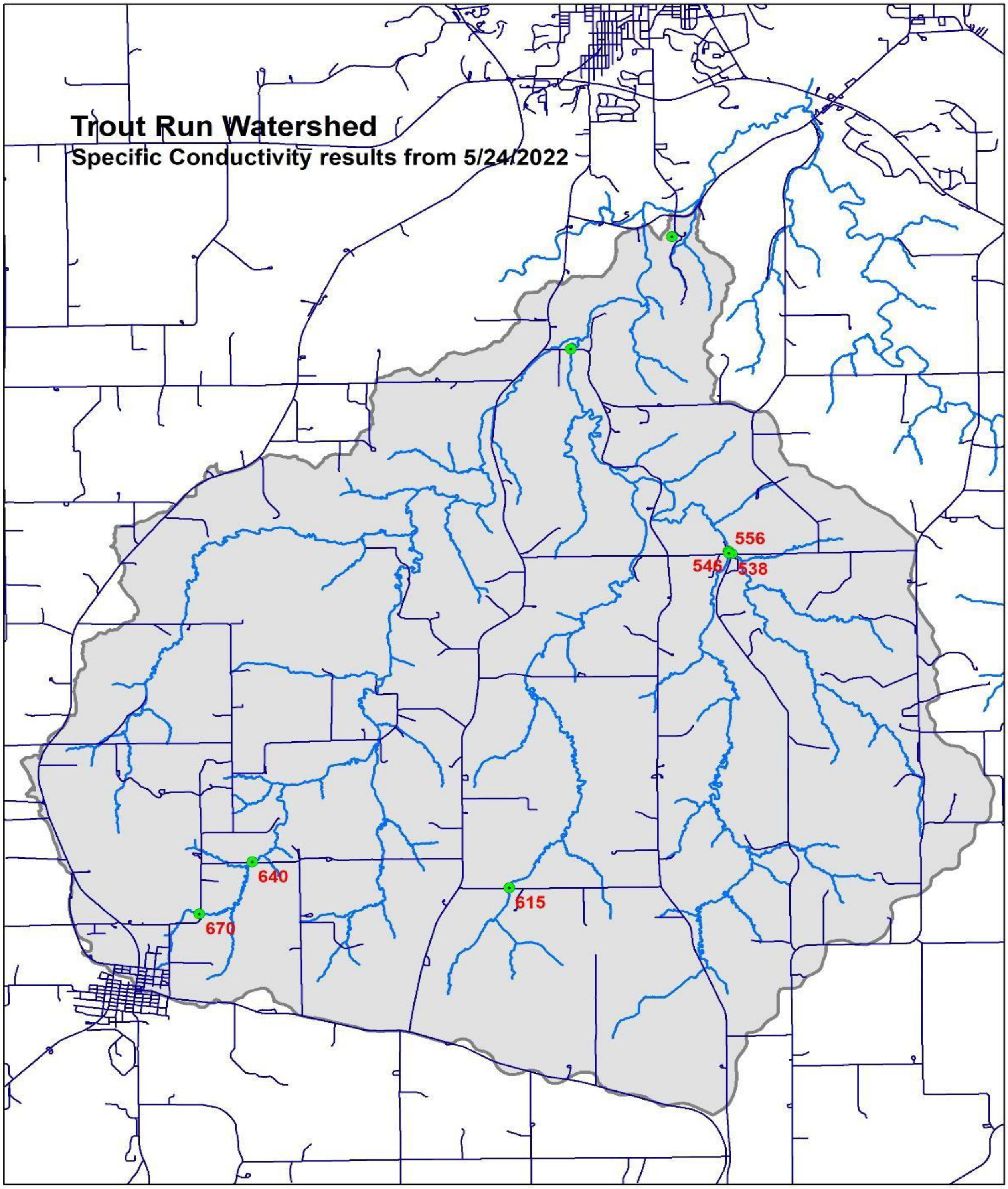
Trout Run Watershed
Temperature results from 5/24/2022
16.065
16.029
16.092
13.459
12.077
15.546

Appendix N

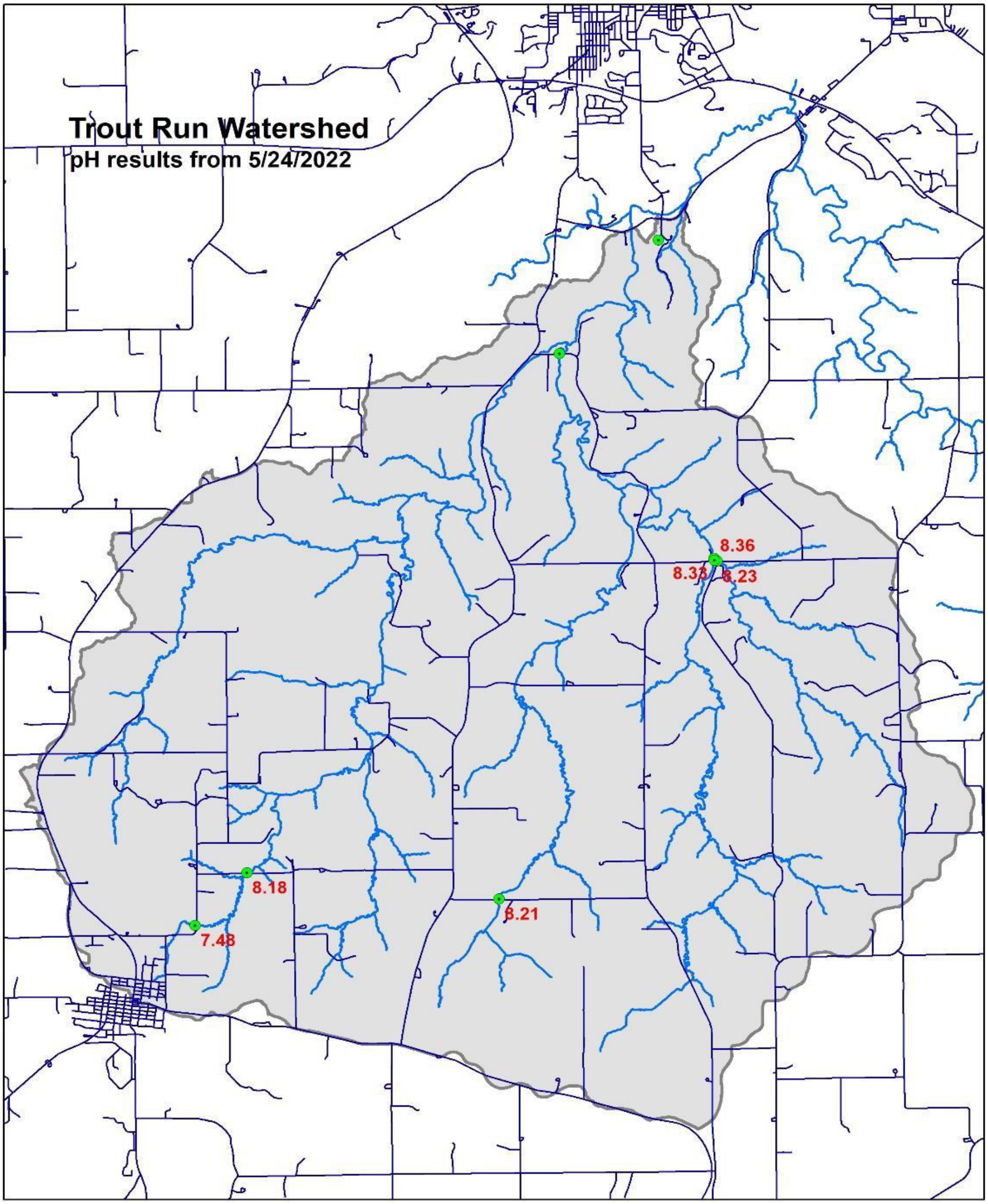


Trout Run Watershed
DO results from 5/24/2022
11
10.36
9.76
13.98
12.48
14.84

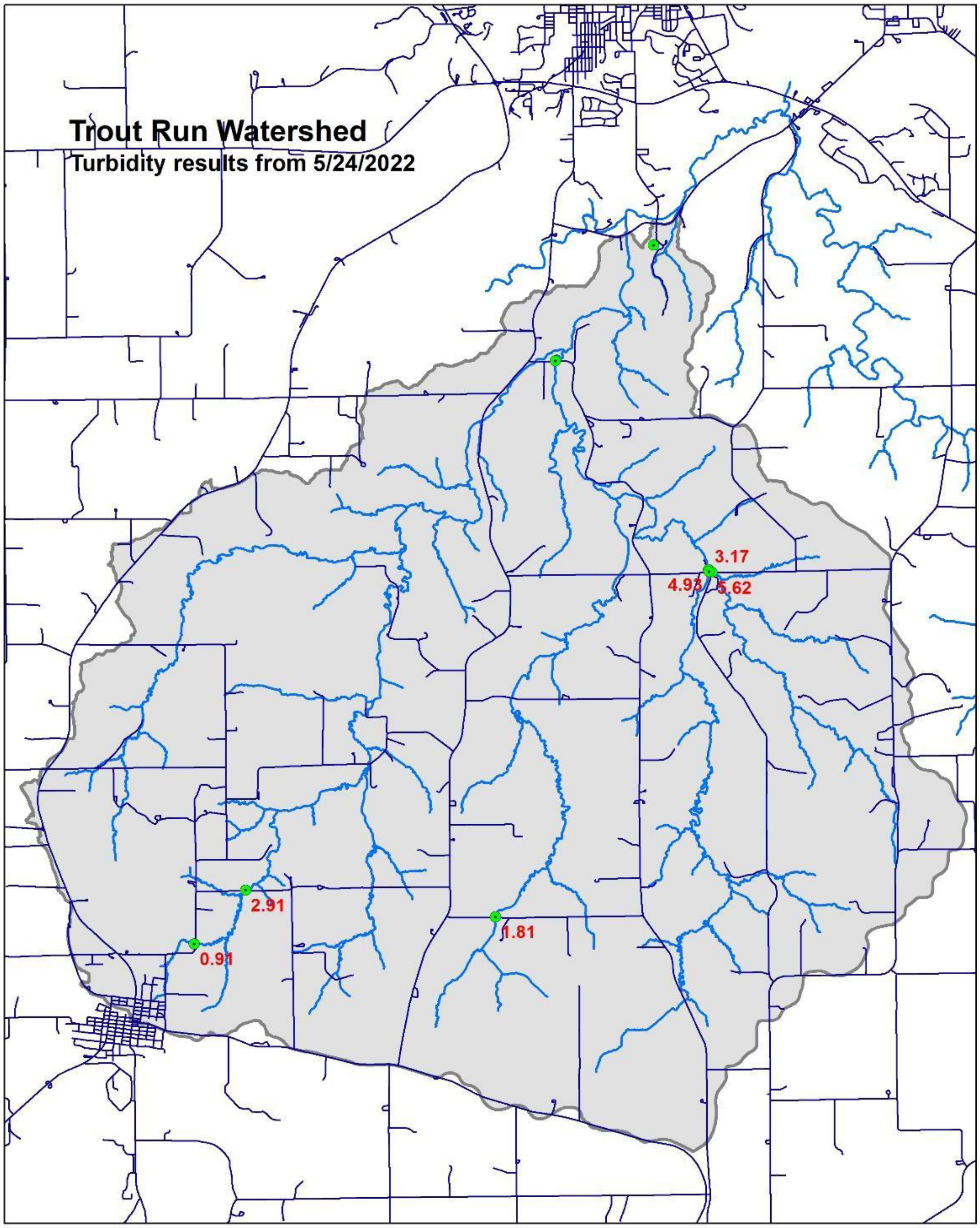
Appendix O


Trout Run Watershed
Specific Conductivity results from 5/24/2022
556
546
538
640
615
670

Appendix P

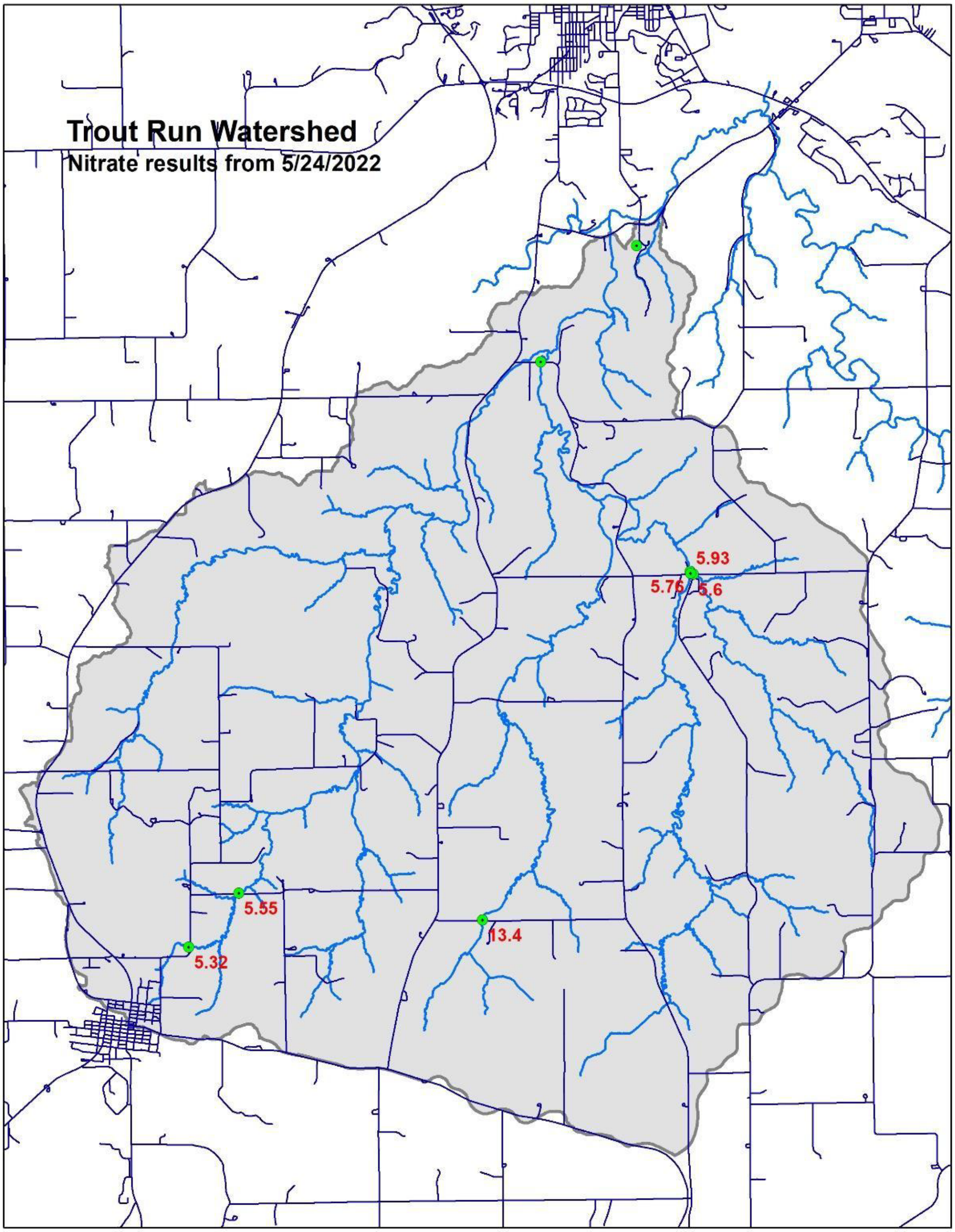

Trout Run Watershed
pH results from 5/24/2022
8.36
8.33
8.23
8.18
8.21
7.48

Appendix Q



Trout Run Watershed
Turbidity results from 5/24/2022
3.17
4.93
5.62
2.91
0.91
1.81

Appendix R



Trout Run Watershed
Nitrate results from 5/24/2022
5.93
5.76
5.6
5.55
5.32
13.4

References

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