

ANALYSIS

PATTEE CREEK
AND
UNNAMED TRIBUTARY OF PATTEE CREEK

SIoux RIVER ETHANOL, L. L. C

LINCOLN COUNTY, SOUTH DAKOTA

October 2007

South Dakota
Department of Environment and Natural Resources
Division of Environmental Services
Pierre, South Dakota

Executive Summary

Name of Waterbody: Pattee Creek and unnamed tributary of Pattee Creek (unnamed tributary).

Location: Lincoln County, South Dakota

Boundaries of Waterbody under Assessment:

- Pattee Creek from the Big Sioux River to Lake Lakota; and
- Unnamed tributary of Pattee Creek from Section 33, Township 96 North, Range 48 West, to the confluence with Pattee Creek.

Condition/Description of Creek Segment: Pattee Creek and the unnamed tributary of Pattee Creek are located in Lincoln County in southeastern South Dakota. The surface topography in this part of the state is characterized by well drained, gently undulating hills, with streams and drainages spilling onto the flat floodplain of the Big Sioux River. As compared to much of the state, the area receives an abundance of rainfall so the general impression is one of a landscape dense with vegetation. For the most part, farmland in this area is dedicated to row crops. At the time of the study, fields along the creeks were planted with corn and soybeans.

The unnamed tributary of Pattee Creek is channelized for much of its length, lacking typical surface stream characteristics in many places, and one branch of the tributary actually originates at the outfall of an old tile system. Overall, much of the tributary appears to function more as a drainage system than an established stream. This is a small creek that appears to have some intermittent flow through some parts of the summer. However, flow is quite limited, the habitat is not conducive to sustaining a typical spectrum of aquatic life, and fish found in the creek appear to have migrated upstream with high spring flows. Broad reaches of inhospitable channelized stretches separate what temporal habitat exists. It does not appear that the unnamed tributary provides adequate habitat or refuge for year-round existence of any fish population.

Pattee Creek is a much larger waterbody than the unnamed tributary. It appears that segments of Pattee Creek have also been significantly altered by channelization. The channelized segments of Pattee Creek lack typical surface stream characteristics including meandered bends that provide depth and habitat, and shoreline riparian vegetation including shrubs, trees, and other stable plants. During the spring runoff period, Pattee Creek has the capacity and does carry quantities of water. During the midsummer, when flow is steady but far below spring highs, the channel may measure as much as 10 feet wide in some locations. During this time of the year, the channel may have a mid-stream depth of only one or two feet. However, as is the case with most creeks, depth varies, so there are locations where depth is greater and provides localized refuge and habitat. Pattee Creek appears to support a broad base and age classes of fish, but the habitat is limited by channelized segments and localized winter freezing. This appears to restrict designation as a warmwater permanent fishery and clearly suggests designation as a warmwater semipermanent fishery.

Sampling was conducted in Pattee Creek during the years of 2002, 2003, and 2004. Some of this sampling was performed to gather data for this assessment, but some of the data was collected as part of the lower Big Sioux River watershed study. There was always flow and a significant quantity of water in Pattee Creek during these sampling events.

Based upon available information, Pattee Creek has flow throughout even the warmest and driest months of the year. Sampling was not performed in the winter, so it is not known if there is flow during the winter. Flow comes from several different sources including rainfall and snow melt runoff, possible discharges from the Newton Hills aquifer (upper Pattee Creek), and seepage from Lake Lakota.

Two fish species, creek chub and fathead minnow, were collected from the unnamed tributary at Site #1. This appeared to represent the best potential habitat found during this sampling event. This site is upstream of the Sioux River Ethanol L.L.C. (Sioux River Ethanol) discharge outfall. Based upon data collected for the Pattee Creek assessment in August 2003 and data collected for the lower Big Sioux River watershed study in July 2003, seventeen fish species were identified in the assessed segments of Pattee Creek. These included red shiner, stoneroller, river carp sucker, bluntnose minnow, bigmouth shiner, common shiner, sand shiner, plains killifish, creek chub, blacknose dace, shorthead redhorse, green sunfish, orange spotted sunfish, white sucker, largemouth bass, yellow perch, and fathead minnow.

Recommendation:

- It is recommended the assigned beneficial uses for Pattee Creek from the Big Sioux River to Lake Lakota be changed to (5) Warmwater semipermanent fish life propagation waters; (8) Limited contact recreation waters; (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters; and
- It is recommended the assigned beneficial uses for the unnamed tributary from the Pattee Creek confluence to Section 33, Township 96 North, Range 48 West, remain (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters.

Introduction

Sioux River Ethanol is an ethanol plant with an estimated production capacity of 45 million gallons of ethanol and 135,000 tons of distillers grain per year. The business began operation on May 17, 2004, and has been operating at full capacity since that time. The legal description for the facility is the Northeast quarter of Section 35, Township 96 North, Range 48 West.

Wastewater generated on-site can be divided into two categories: process and non-process. The process wastewater comes from starch conversion, batch fermentation, distillation/dehydration, and byproduct processing. The plant has been designed to recycle all process wastewater back into the system. Non-process wastewater consists of 72,000 gallons per day (gpd) of cooling tower blowdown water and 192,000 gpd of reverse osmosis reject water. Sioux River Ethanol discharges this water on a continuous basis. This water goes directly into the unnamed tributary,

and from there, to Pattee Creek. This outfall, known as Outfall 001, is located in the northwest corner of the section (see the map in Attachment 39).

General Waterbody/Drainage Area Description

Surface Water

The unnamed tributary of Pattee Creek has a north and south fork that drain an area upstream from Sioux River Ethanol. The drainage area extends due west for up to a mile and one-half and northwest for up to three miles from Sioux River Ethanol. The unnamed tributary flows into Pattee Creek in the Northeast $\frac{1}{4}$ of the Southeast $\frac{1}{4}$ of the Southeast $\frac{1}{4}$ of Section 26, Township 96 North, Range 48 West. The confluence is about one-fourth of a mile downstream from Sioux River Ethanol Outfall 001. Attachment 39 shows the unnamed tributary, Pattee Creek, Outfall 001, and the Sioux River Ethanol facility.

Pattee Creek originates about four miles west of Lake Lakota (see Attachment 41). The lake is a man-made reservoir fed by upper Pattee Creek and discharging to lower Pattee Creek. It is located at Newton Hills State Park in Section 19, Township 97 North, Range 48 West. Downstream of Lake Lakota, Pattee Creek flows for about ten miles to the confluence with the Big Sioux River, in the southeast $\frac{1}{4}$ of the northwest $\frac{1}{4}$ of Section 36, Township 96 North, Range 48 West. Attachments 39 through 41 show this segment of Pattee Creek.

Lake Lakota is situated over layers of weathered till and glacial outwash material, and it has a significant seepage problem. This fact was confirmed by South Dakota Geological Survey staff who have studied the seepage problem at the request of the South Dakota Department of Game, Fish, and Parks but have not prepared a published report. No economically feasible repair option has been found. Therefore, the seepage continues and is expected to continue for the foreseeable future. One rough estimate made by South Dakota Geological Survey in the 1970's indicates the lake loses up to 986 gallons per minute (gpm) to seepage. More recent data indicate a seepage rate of less than 750 gpm. According to the South Dakota Geological Survey, some of this seepage water enters Pattee Creek.

Current Assigned Beneficial Uses

Lake Lakota is assigned the beneficial uses for (4) Warmwater permanent fish life propagation waters; (7) Immersion recreation waters; (8) Limited contact recreation waters; and (9) Fish and wildlife propagation, recreation, and stock watering waters.

Pattee Creek and the unnamed tributary are currently assigned the beneficial uses for (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters.

The Big Sioux River is assigned the beneficial uses for (5) Warmwater semipermanent fish life propagation waters; (7) Immersion recreation waters; (8) Limited contact recreation waters; (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters.

Ground Water

All of the upper segment of Pattee Creek, extending upstream from near sample Site # 4 (see Attachment 40), is underlain by the Newton Hills aquifer. The aquifer is under artesian conditions except in places where it is near the land surface. The aquifer is near land surface near its extreme northeastern and southeastern boundaries. Pattee Creek below Lake Lakota to near sample Site # 4, runs along the eastern boundary of the Newton Hills aquifer. The United States Geological Survey (USGS) report entitled, "Water Resources of Lincoln and Union Counties, South Dakota" indicates discharge from the Newton Hills aquifer is through wells, seepage and flow from springs, evapotranspiration, and discharge to the Big Sioux aquifer. Based upon this information, the Newton Hills aquifer is a possible source of base flow for Pattee Creek.

The Big Sioux aquifer underlies a segment of lower Pattee Creek extending from west of the town of Hudson to the Big Sioux River confluence. The aquifer also appears to underlie the last mile of the unnamed tributary of Pattee Creek and underlies the floodplain of the Big Sioux River. In most areas, the aquifer is at or near land surface. Discharge from the aquifer is through wells, evapotranspiration, discharge to the Missouri aquifer, and discharge to the Big Sioux River. Based upon available information, it is possible the Big Sioux aquifer contributes some flow to lower Pattee Creek.

Lower Big Sioux River Watershed Project

The DENR Water Resources Assistance Program (WRAP) is performing a study of the lower Big Sioux River watershed. One of the study sample sites is on Pattee Creek. The site is referred to as WRAP Site LBST10 (see Attachment 39). The sample site includes a 100-meter segment of the creek. Attachments 31 through 34 are July 2003 photographs of the creek segment taken from four distinct locations along this segment.

A report has not been completed for the study, but preliminary field and laboratory data are available. Fish collection was performed by WRAP personnel at Site LBST10 in 2003. The fish data and water chemistry data taken at the time of fish collection is summarized in Attachments 35 and 36. Fish data indicate the creek had species diversity multiple age classes of fish were present for several species.

Water chemistry was collected independently of fish collection. Samples were collected for several months during the years of 2002, 2003, and 2004. The goal was to obtain three base flow samples and three storm event samples per season. Winter sampling was not performed. However, based upon the available data and staff observations, Pattee Creek has flow throughout the warm months. It is not known if there is flow under the ice during the winter.

The water chemistry data are summarized in Attachments 37 and 38. The water quality of Pattee Creek meets water quality standards for the existing (9) and (10) beneficial uses. However, it appears water quality criteria could be exceeded in Pattee Creek due to total suspended solids

and bacteria levels, should the beneficial uses for this segment of Pattee Creek be upgraded. These exceedances are similar to problems seen in the Big Sioux River, as outlined in South Dakota's 2006 Integrated Report.

Stream Analysis Completed in Accordance with 74:51:01:02.01

On August 18, 2003, DENR personnel visited the Sioux River Ethanol facility construction site to perform an assessment of Pattee Creek and the unnamed tributary. Access to the unnamed tributary was gained from Sioux River Ethanol property and from the road right of way. All access to Pattee Creek was gained from the road right of way. Public access would be expected to be severely limited. At the time of the visit, there was significant flow in Pattee Creek and minor flow in the unnamed tributary. It is believed this sampling occurred during relatively high flows for this tributary. While access is somewhat limited, it is further believed that the sampling location represent the best available habitat for much of this reach. Most of the other habitat visually observed appeared far less hospitable to sustaining aquatic life or recreation. Details pertaining to sampling, flow measurements, and fish collection are discussed below.

Unnamed tributary:

Site # 1 (on the unnamed tributary, between Sections 27 and 34, Township 96 North, Range 48 West):

Site # 1 is on the unnamed tributary along 296th Street. The site is about one and one-half miles upstream of the Sioux River Ethanol outfall. A map showing the sample site location is in Attachment 39.

Field water quality measurements were taken, and water samples were collected for laboratory analysis. Attachments 29 and 30 are summaries of the data. The water quality meets standards for the currently assigned (9) and (10) beneficial use designation.

Fish collection was performed using a seine net and an Engineering Technical Services (ET) Model APB-3 electrofisher. The distance covered was about 300 feet. Two species were present, the creek chub and fathead minnow. Attachment 4 is a summary of the fish collection data. Attachment 3 is a photograph of fish collected at Site # 1.

Despite the presence of a limited number of fathead minnows and 2 creek chub, the photographs of Site #1 indicate the seasonal flow of the unnamed tributary. The unnamed tributary was sampled and photographed during the wettest time of the year and represents best case conditions. There is likely minimal or no water during most months. The fish were collected from a small pool of water near an old bridge. It is believed that these fish migrated into this location during a high flow, and would not be sustained at this location. Therefore, this collection is considered an anomaly and not representative of typical expectations for this site.

Upstream and downstream of the sample location, the channel is poorly defined, inundated with macrophytes, and shows evidence of seasonal or ephemeral flow. The majority of the unnamed tributary provides poor habitat and is not a waterbody capable of supporting a fishery beneficial use.

At the sample site, the width of the creek was 4.5 feet, depth was 0.7 feet, and the velocity at mid-channel was 0.28 feet per second. Attachment 5 summarizes the flow data.

Because the maximum water depth is very shallow, and access appears limited, recreational use of the unnamed tributary is not supported at this location.

Site # 1A (on the unnamed tributary, between Sections 33 and 34, Township 96 North, Range 48 West):

Site # 1A is on the unnamed tributary along 485th Avenue. The site is about two miles upstream of the Sioux River Ethanol outfall. A map showing the sample site location is in Attachment 39. Photographs of the unnamed tributary at this site are in Attachments 1 and 2. There was flow at this site from what appeared to be an old field drain tile system.

At this site, water quality samples were not taken, fish were not collected, and flow was not measured. Information was collected at Site # 1 (discussed above), which is about one-half mile downstream.

Because the maximum water depth appears to be very shallow, and access appears limited, recreational use of the unnamed tributary is not supported at this location.

Site # 2 (on the unnamed tributary, in Section 35, Township 96 North, Range 48 West):

Site # 2 is on the unnamed tributary about one-thirds of a mile upstream of the Sioux River Ethanol outfall. A map showing the sample site location is in Attachment 39. Photographs of the unnamed tributary at this site are in Attachments 6 and 7. The photograph in Attachment 8 shows the Sioux River Ethanol construction site as it appeared on August 18, 2003. Water quality samples were not taken, and flow was not measured.

Fish collection was not attempted because shocking and netting was not possible due to mud and hydrophytes that filled the entire channel. These obstructions were dense enough, and the habitat of such poor quality, that the conditions likely limit the movement of fish through the unnamed tributary. These visual observations are evidence that adequate habitat and refuge are not present in the unnamed tributary. These physical conditions appear to preclude attainment of aquatic life uses.

Because public access is limited, the channel is filled with mud, overgrown with

aquatic plants, and has very little depth. Recreational use of the unnamed tributary is not possible at this location.

Site # 3A (on the unnamed tributary, in Section 35, Township 96 North, Range 48 West):

Site # 3A is on the unnamed tributary along the north edge of Section 35. The site is less than one-quarter mile upstream from the Sioux River Ethanol outfall. A map showing the sample site location is in Attachment 39. A photograph of the site is in Attachment 9.

Field water quality measurements were taken and water samples were collected for laboratory analysis. Attachments 29 and 30 are summaries of the data. The water quality meets standards for the currently assigned (9) and (10) beneficial use designation.

Fish collection was not attempted because there were too many obstructions for nets and shocking equipment. Visual observations confirmed the aquatic habitat to be of very poor quality. Even when sufficient flow occurs, the shallow water and the obstructions, such as dead branches and plant growth, may impede the movement of fish in the stream channel.

One velocity reading was obtained at Site # 3A. The width of the channel was 3.5 feet, depth was 0.6 feet, and velocity at mid-channel was 0.38 feet per second. Attachment 10 is a summary of the flow data.

The unnamed tributary is not used for recreational use at this location because the site is on private property, the water is very shallow, and the channel is overgrown with grass and filled with obstructions such as rocks and dead tree branches.

Site # 3B (on the unnamed tributary, in Section 35, Township 96 North, Range 48 West):

Site # 3B is on the unnamed tributary a short distance downstream from Site # 3A. The site is also a short distance upstream from the Sioux River Ethanol outfall. A map showing the sample site location is in Attachment 39. A photograph of the site is in Attachment 11. Water quality samples were not taken, and velocity was not measured.

As at Site #3A, fish collection was not attempted due to obstructions to nets and shocking equipment. Visual observations confirmed the aquatic habitat to be of very poor quality. Again, it appeared the shallow water and obstructions such as dead branches and plant growth may restrict the movement of fish.

The unnamed tributary is not used for recreation use at this location because the site is on private property, the water is very shallow, and the channel is overgrown with grass and filled with obstructions such as rocks and dead tree branches.

Site # 3C (on the unnamed tributary, in Section 35, Township 96 North, Range 48 West):

Site # 3C is on the unnamed tributary a short distance downstream from Site # 3B. The site is also very close to the location where Sioux River Ethanol placed its outfall. The outfall was not in place at the time of this site visit. A map showing the sample site location is in Attachment 39. A photograph of the site is in Attachment 12. No water quality samples were taken or velocity measured.

Visual observations confirmed the aquatic habitat to be of very poor quality. Water was shallow, and the channel was narrow so fish collection was attempted using a dip net. No fish were observed or collected. The shallow water may impede the movement of fish through the unnamed tributary.

The unnamed tributary is not used for recreational use because the site is on private property, the water is very shallow, and the channel is overgrown with grass and filled with obstructions such as rocks and dead tree branches.

Pattee Creek:

Site # 4 (on Pattee Creek, between Sections 10 and 15, Township 96 North, Range 48 West):

Site # 4 is on Pattee Creek along 293rd Street about five miles downstream from Lake Lakota. A map showing the sample site location is in Attachment 40.

Field water quality measurements were taken and water samples were collected for laboratory analysis. Attachments 29 and 30 are summaries of the data. The water quality at the time of sampling met standards for the currently assigned (9) and (10) beneficial use designation and for the proposed (5) and (8) beneficial uses.

Fish collection was performed using a seine net. A total of six different species were found. These included sand shiner, plains killifish, red shiner, creek chub, white sucker, and fathead minnow. Of these species, the sand shiner, creek chub, and fathead minnow appeared to be present in multiple age classes. Attachments 13 and 14 are photographs of fish collected at Site # 4. Attachment 15 is a summary of the fish collection data.

At the sample site, the average width of the creek was nine feet. The maximum depth was 1.3 feet and flow was 2.81 cfs. The generally shallow, slow moving water will likely provide seasonal refuge to fish. During cold winter months, upper segments of Pattee Creek below Lake Lakota are likely to freeze solid and have the potential to cause fish kills. The (5) Warmwater semipermanent fish life propagation waters beneficial use is the appropriate beneficial use as defined in the Administrative Rules of South Dakota (ARSD) 74:51:01:01(62). "Warmwater semipermanent fish life propagation waters," a beneficial use assigned to surface waters of the state which support aquatic life and are suitable for the propagation or maintenance, or both, of warmwater fish but which may suffer occasional fish kills because of critical natural conditions. Attachment 16

summarizes the flow data.

Due to the presence of “game” fish species in the creek both upstream in Lake Lakota and downstream at Site # 5, it is possible that limited contact recreation activities such as fishing occur in the creek at this location. However, because the water is only one foot deep, the only points of access are from road right-of-ways, and the public tend to use other available alternatives for recreation, Pattee Creek is not used for immersion recreation.

Site # 5 (on Pattee Creek, in Section 26, Township 96 North, Range 48 West):

Site # 5 is on Pattee Creek along Spur Avenue. The site is about one mile upstream from the Pattee Creek/unnamed tributary confluence. A map showing the sample site location is in Attachment 39. Photographs of the site are in Attachments 17 and 18.

Field water quality measurements were taken and water samples were collected for laboratory analysis. Attachments 29 and 30 are summaries of the data. The water quality meets standards for the currently assigned (9) and (10) beneficial use designation and for the proposed (5) and (8) beneficial uses.

Fish collection was performed using a seine net. A total of eleven different species were found. These included sand shiner, plains killifish, creek chub, white sucker, shorthead redhorse, green sunfish, orange spotted sunfish, largemouth bass, yellow perch, blacknose dace, and one unidentified species. Of these species, multiple age classes of white sucker, shorthead redhorse, and sand shiner were collected. Attachments 19 through 26 are photographs of fish collected at Site # 5. Attachment 27 is a summary of the fish collection data.

The average width of the creek at Site # 5 was 10.5 feet. The maximum depth was 1 foot. Flow was 5.77 cfs. Attachment 28 summarizes the flow data.

Recreation Waters

Due to the presence of game fish species, it is possible that limited contact recreation activities such as fishing occur in Pattee Creek. However, because the water is only one foot deep, has limited public access, and the public tend to use other available alternatives for recreation, Pattee Creek is not used for immersion recreation. In addition, low water levels in Pattee Creek prevent the attainment of the immersion recreation use. These limiting factors are congruent with 40 CFR 131.10(g)(2). DENR recommends the (8) Limited contact recreation beneficial use be assigned for this reach of Pattee Creek.

Summary

The unnamed tributary of Pattee Creek has a minimally incised channel and is inundated with dense plants, mud, and debris. The channel is poorly defined and appears to carry only limited quantities of water. The regular lack of water along the unnamed tributary limits aquatic life habitat to temporary, intermittently pooled areas. The majority of the unnamed tributary does not contain adequate habitat or refuge to sustain aquatic life from extreme heat and cold on an annual basis. During the winter months, it is likely that the tributary does not flow and that any remaining water in the creek will freeze solid. The unnamed tributary was sampled during the wettest time of the year and results depict best case conditions. There is likely minimal or no water during most of the year. The unnamed tributary does not contain adequate flow, depth, or pools to attain a fishery beneficial use. It appears that fish moved into the channel during a period of high flow and were sampled at a pooled area. This sample does not appear to be representative of the typical conditions of this site. Based upon visual reconnaissance of the tributary, it appears that significant obstructions in the channel, such as dead wood and plant growth combined with low flow, limit migration of fish. Severe winter conditions would appear to further limit the ability to support fish. Due to limited public access and shallow water depth, the unnamed tributary is not used for recreational purposes. Therefore, it is recommended the assigned beneficial uses of the unnamed tributary from Pattee Creek to Section 33, Township 96 North, Range 48 West, remain (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters.

Pattee Creek is a waterbody that normally flows throughout most months of the year. Because the creek receives base flow from Lake Lakota and possibly from the Newton Hills and Big Sioux aquifers, Pattee Creek supports at least seventeen different fish species and clearly serves a warmwater fish life propagation use. However, the average channel depth in Pattee Creek is generally less than one foot. This shallow depth does not provide adequate habitat or refuge for a permanent fishery. During winter months, the shallow depth has the potential to occasionally freeze solid in localized areas. DENR believes Pattee Creek occasionally experiences harsh conditions in localized areas and is being recolonized from better habitats upstream and downstream. Therefore, Pattee Creek is not capable of attaining permanent aquatic life uses, but is better suited as a warmwater semipermanent fishery as allowed by 40 CFR 131.10(g)(5) and defined by ARSD 74:51:01:01(62).

Considering the presence of multiple fish species, including “game” fish species, it is likely that Pattee Creek is occasionally used for limited contact recreation such as fishing. For these reasons, it is recommended the assigned beneficial uses for Pattee Creek from the Big Sioux River to Lake Lakota be changed to (5) Warmwater semipermanent fish life propagation waters; (8) Limited contact recreation waters; (9) Fish and wildlife propagation, recreation, and stock watering waters; and (10) Irrigation waters. If the beneficial uses of Pattee Creek are changed as recommended, some violations of surface water quality standards are possible.

Reference Documents

United States Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020. Cincinnati, Ohio.

South Dakota Department of Environment and Natural Resources. 1999. Recommended Procedures for Reviewing Beneficial Use Designations, With Special Emphasis on Fishery and Recreational Uses.

South Dakota Department of Environment and Natural Resources. Chapters 74:51:01 and 74:51:03, Surface Water Quality Standards.

South Dakota Department of Environment and Natural Resources. Sioux River Ethanol, L.L.C. Permit file.

South Dakota Department of Transportation, 1988. General Highway Map, Lincoln County, South Dakota.

DeLorme, 1997. South Dakota Atlas and Gazetteer.

United States Department of the Interior, Geological Survey, 1968 Fairview, Iowa – South Dakota Quadrangle.

United States Department of the Interior, Geological Survey, 1968 Alcester NE, South Dakota - Iowa Quadrangle.

United States Department of the Interior, Geological Survey, 1968 Hawarden North, Iowa – South Dakota Quadrangle.

United States Department of the Interior, Fish and Wildlife Service, 1990. National Wetlands Inventory Map, Fairview, Iowa – South Dakota.

United States Department of the Interior, Fish and Wildlife Service, 1990. National Wetlands Inventory Map, Alcester NE, South Dakota –Iowa.

United States Department of the Interior, Fish and Wildlife Service, 1990. National Wetlands Inventory Map, Alcester SE, South Dakota –Iowa.

United States Department of the Interior, Fish and Wildlife Service, 1990. National Wetlands Inventory Map, Hawarden North, Iowa – South Dakota.

United States Geological Survey. 1994. Water Resources of Lincoln and Union Counties, South Dakota. Water-Resources Investigations Report 93-4195.

U.S. Department of Commerce. Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1961-90. January 1992.

National Oceanic and Atmospheric Administration. Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1971-2000.

ATTACHMENT 1



Unnamed tributary of Pattee Creek

Site # 1A

This photograph was taken on August 18, 2003, from the road bridge at Site # 1A and looking west. The unnamed tributary had flow.

ATTACHMENT 2

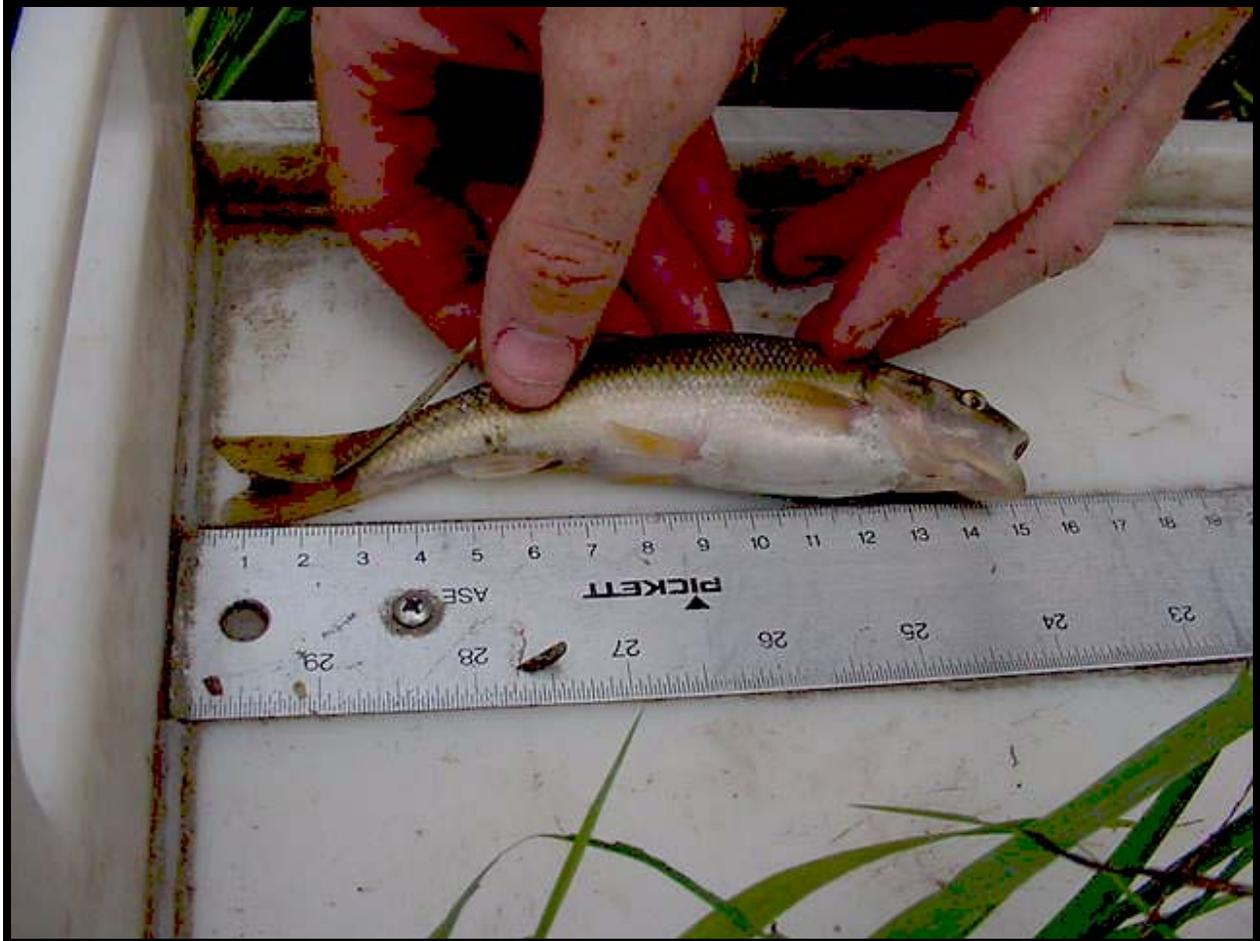


Unnamed tributary of Pattee Creek

Site # 1A

This photograph was taken on August 18, 2003, from the road bridge at Site # 1A and looking east. The unnamed tributary had flow.

ATTACHMENT 3



Unnamed tributary of Pattee Creek

Site # 1

This photograph was taken on August 18, 2003, at Site # 1. The photograph shows a creek chub.

ATTACHMENT 4

<p>SITE # 1 UNNAMED TRIBUTARY OF PATTEE CREEK FISH SPECIES</p>		
<p>Length August 18, 2003</p>		
Electroshocked and seined for a combined distance of 300 feet		
	<u>Creek Chub</u>	<u>Fathead Minnow</u>
	14.5 cm	*
Number of fish:	-	30
<p>Comments: * Lengths were not recorded but field personnel noted there were multiple age classes.</p>		

ATTACHMENT 5

UNNAMED TRIBUTARY		
SITE # 1		
VELOCITY MEASUREMENTS AND CALCULATED FLOW RATE*		
Field Data		
LOCATION	WATER DEPTH (FEET)	VELOCITY (FEET/SECOND)
Center (total width is 4.5 feet)	0.7	0.28

*As Determined Using A Marsh McBirney Model-201E Flow Meter.

ATTACHMENT 6



Unnamed tributary of Pattee Creek

Site # 2

This photograph was taken on August 18, 2003, from the road bridge at Site # 2 and looking east. There is water and limited flow.

ATTACHMENT 7



Unnamed tributary of Pattee Creek

Site # 2

This photograph was taken on August 18, 2003, from the road bridge at Site # 2 and looking west. There is water and limited flow. The presence of plants lining the creek bed indicate the channel is not inundated with water for any length of time or that the creek does not carry large amounts of water on a routine basis.

ATTACHMENT 8



Sioux River Ethanol L.L.C.

Site # 2

This photograph was taken on August 18, 2003, from the road bridge at Site # 2 and looking southeast. The Sioux River Ethanol facility is under construction.

ATTACHMENT 9



Unnamed tributary of Pattee Creek

Site # 3A

This photograph was taken on August 18, 2003, along the bank of the unnamed tributary. The unnamed tributary had a velocity of 0.38 feet per second.

ATTACHMENT 10

UNNAMED TRIBUTARY		
SITE # 3A		
VELOCITY MEASUREMENTS AND CALCULATED FLOW RATE*		
Field Data		
LOCATION	WATER DEPTH (FEET)	VELOCITY (FEET/SECOND)
Center (total width is 3.5 feet)	0.6	0.38

*As Determined Using A Marsh McBirney Model-201E Flow Meter.

ATTACHMENT 11



Unnamed tributary of Pattee Creek

Site # 3B

This photograph was taken on August 18, 2003, along the bank of the unnamed tributary. The unnamed tributary had some flow.

ATTACHMENT 12



Unnamed tributary of Pattee Creek

Site # 3C

This photograph was taken on August 18, 2003, along the bank of the unnamed tributary.

ATTACHMENT 13



Pattee Creek

Site # 4

This photograph was taken on August 18, 2003. The photograph shows a sand shiner found at the site.

ATTACHMENT 14



Pattee Creek

Site # 4

This photograph was taken on August 18, 2003. The photograph shows a red shiner found at the site.

ATTACHMENT 15

SITE # 4 PATTEE CREEK FISH SPECIES Length in Millimeters August 18, 2003						
Seined short segment of channel spanning from ditch to ditch and under part of the bridge						
	<u>Red Shiner</u>	<u>Plains Killifish</u>	<u>Creek Chub</u>	<u>Sand Shiner</u>	<u>Fathead Minnow</u>	<u>White Sucker</u>
	60	50	83	82	65	65
	50		90	60	65	60
	40		70	52	60	
	40		100	70	65	
	40		80	47	70	
	40		80		55	
	55		80		65	
	40		95		65	
	40		85		70	
	40				60	
	40				60	
	40				60	
	40				60	
	50 - 55 (4 fish)					
	60 - 65 (3 fish)					
Number of fish:	20	1	9	5	12	2
Maximum Length:	65	50	100	82	70	65
Minimum Length:	40	50	70	47	55	60
Average Length:	48	50	85	62	63	63
Comments: Due to weather conditions (lightening), field personnel did not measure an additional 50 to 70 dozen minnows. It appears there are multiple age classes of creek chub, sand shiner, and fathead minnow.						

ATTACHMENT 16

PATTEE CREEK			
SITE # 4			
VELOCITY MEASUREMENTS AND CALCULATED FLOW RATE*			
Field Data			CALCULATED FLOW RATE (CUBIC FEET/SECOND)
LOCATION	WATER DEPTH (FEET)	VELOCITY (FEET/SECOND)	
1	0.6	0.01	0.00
2	1.0	0.02	0.02
3	0.6	0.17	0.10
4	1.3	0.26	0.34
5	1.3	0.59	0.77
6	1.3	0.59	0.77
7	1.3	0.55	0.72
8	1	0.09	0.09
9	-	-	-
August 18, 2003 Flow Rate:			2.81

*As Determined Using A Marsh McBirney Model-201E Flow Meter.

ATTACHMENT 17



Pattee Creek

Site # 5

This photograph was taken on August 18, 2003, from the road bridge over Pattee Creek and looking northwest. The site had a flow of 5.77 cubic feet per second. Numerous fish species were found at this location. Note tree branches packed up against the top of the bridge by some previous high flow event.

ATTACHMENT 18



Pattee Creek

Site # 5

This photograph was taken on August 18, 2003, from the road bridge over Pattee Creek and looking east. The site had a flow of 5.77 cubic feet per second. Numerous fish species were found at this location.

ATTACHMENT 19



Pattee Creek

Site # 5

This photograph was taken on August 18, 2003. The photograph shows a shorthead redhorse found at the site.

ATTACHMENT 20



Pattee Creek

Site # 5

This photograph was taken on August 18, 2003. The photograph shows a green sunfish found at the site.

ATTACHMENT 21



Pattee Creek

Site # 5

This photograph was taken on August 18, 2003. The photograph shows a white sucker found at the site.

ATTACHMENT 22



**Pattee Creek
Site # 5**

This photograph was taken on August 18, 2003. The photograph shows a largemouth bass found at the site.

ATTACHMENT 23



**Pattee Creek
Site # 5**

This photograph was taken on August 18, 2003. The photograph shows an unidentified fish found at the site.

ATTACHMENT 24



**Pattee Creek
Site # 5**

This photograph was taken on August 18, 2003. The photograph shows a blacknose dace found at the site.

ATTACHMENT 25



**Pattee Creek
Site # 5**

This photograph was taken on August 18, 2003. The photograph shows a creek chub found at the site.

ATTACHMENT 26



**Pattee Creek
Site # 5**

This photograph was taken on August 18, 2003. The photograph shows a white sucker found at the site.

ATTACHMENT 27

<p align="center">SITE # 5 PATTEE CREEK FISH SPECIES</p> <p align="center">Length in Millimeters August 18, 2003</p>												
Seined short segment of channel spanning from ditch to ditch and under part of the bridge												
	Sand Shiner	Plains Killifish	Creek Chub	White Sucker	Shorthead Redhorse	Green Sunfish	Orange spotted Sunfish	Largemouth Bass	Yellow Perch	Blacknose Dace	Unidentified Species	
	50 60 65 55 60 60 70 55 55 66 70	55	125	134 130 74 250 202	115 105 160	75	60	70	115	93 85	87	
Number of fish:	11	1	1	5	3	1	1	1	1	2	1	
Maximum Length:	70	55	125	250	160	75	60	70	115	93	87	
Minimum Length:	50	55	125	74	105	75	60	70	115	85	87	
Average Length:	61	55	125	158	127	75	60	70	115	89	87	
Comments:	<p>There appears to be more than one age class of white sucker, shorthead redhorse, and sand shiner.</p> <p>There are at least 11 different species of fish found in this segment of Pattee Creek.</p>											

ATTACHMENT 28

PATTEE CREEK			
SITE # 5			
VELOCITY MEASUREMENTS AND CALCULATED FLOW RATE*			
Field Data			CALCULATED FLOW RATE (CUBIC FEET/SECOND)
LOCATION	WATER DEPTH (FEET)	VELOCITY (FEET/SECOND)	
1	0.7	0.61	0.21
2	1.0	1.39	1.39
3	0.9	1.43	1.29
4	0.8	0.16	0.13
5	0.7	1.50	1.05
6	0.7	1.64	1.15
7	0.7	0.60	0.42
8	0.7	0.11	0.13
10.5	-	-	-
August 18, 2003 Flow Rate:			5.77

*As Determined Using A Marsh McBirney Model-201E Flow Meter.

ATTACHMENT 29

FIELD ANALYSIS PARAMETERS, INSTRUMENTS, AND RESULTS

AUGUST 18, 2003

PARAMETER	INSTRUMENT / REFERENCE METHOD	RESULTS			
		Unnamed Tributary Site # 1	Unnamed Tributary Site #3A	Pattee Creek Site # 4	Pattee Creek Site # 5
Temperature Air (°C)	Thermometer / EPA (170.1)	33.3	32.2	--	--
Temperature Water (°C)	Thermometer / EPA (170.1)	19.4	25	17.4	22.3
Dissolved oxygen (mg/L)	Azide Modification of Winkler / EPA (360.2)	8.1	7.6	7.9	8.05

mg/L = *Milligrams per liter;*
 -- = *No measurement;*
 su = *Standard Unit; and*
 EPA = *Environmental Protection Agency.*

ATTACHMENT 30

LABORATORY ANALYSIS PARAMETERS, METHODS, AND RESULTS

AUGUST 18, 2003

PARAMETER	METHOD / REFERENCE	RESULTS			
		Unnamed Tributary Site # 1	Unnamed Tributary Site #3A	Pattee Creek Site # 4	Pattee Creek Site # 5
Ammonia (mg/L)	SM 4500 NH3 H	<0.02	<0.02	<0.02	<0.02
Nitrate (mg/L)	SM 4500 NO3 F	13.4	13.0	0.7	1.3
TKN (mg/L)	EPA 351.2	0.51	0.50	0.32	0.43
Hardness (mg/L)	EPA 130.2	640	540	520	540
Biochemical Oxygen Demand (mg/L)	5 day incubation, 20°C / EPA Method (405.1)	<2	<2	<2	<2
Total Suspended Solids (mg/L)	SM 2540 D	6	2	1	14
Total Dissolved Solids (mg/L)	SM 2540 C	812	796	752	747
Total Solids (mg/L)	SM 2540 B	818*	798*	753*	761*
Total Phosphorous (mg/L)	EPA 365.2	0.134	0.134	0.117	0.113
Sulfate (mg/L)	SM 4500	--	--	278	264
Alkalinity – M (mg/L)	SM 2320 B	373	360	302	322
Conductivity (umhos/cm)	EPA 120.1	1090	1090	1010	994

umhos/cm = *Micro mhos per centimeter;*

< = *Not detected, followed by a number documenting the detection limit;*

* = *Calculated - not directly determined by laboratory analysis;*

SM = *Standard Method;*

EPA = *Environmental Protection Agency;*

-- = *Not measured; and*

mg/L = *Milligrams per liter.*

ATTACHMENT 31

Water Resources Assistance Program Photograph



Pattee Creek
WRAP Site LBST10

This photograph was taken on July 3, 2003. Water chemistry data for the site is available in Attachment 35. Flow data is available in Attachment 36.

ATTACHMENT 32

Water Resources Assistance Program Photograph



Pattee Creek
WRAP Site LBST10

This photograph was taken on July 3, 2003. Water chemistry data for the site is available in Attachment 35. Flow data is available in Attachment 36.

ATTACHMENT 33

Water Resources Assistance Program Photograph



Pattee Creek
WRAP Site LBST10

This photograph was taken on July 3, 2003. Water chemistry data for the site is available in Attachment 35. Flow data is available in Attachment 36.

ATTACHMENT 34

Water Resources Assistance Program Photograph



Pattee Creek
WRAP Site LBST10

This photograph was taken on July 3, 2003. Water chemistry data for the site is available in Attachment 35. Flow data is available in Attachment 36.

ATTACHMENT 35

Water Resources Assistance Program Fish Collection Data

**SITE LBST10
PATTEE CREEK
FISH SPECIES**

**Length in millimeters
JULY 3, 2003**

Seined 100 m														
	Sand Shiner	Red Shiner	Creek Chub	White Sucker	Stone-roller	River Carp-Sucker	Orange Spotted Sunfish	Bluntnose Minnow	Bigmouth Shiner	Common Shiner				
	45	49	61	160	76	240	112	105	56	75	45	67	56	55
	49	49	50	79	110	122	67	103	60	61	56	56	42	45
	42	40	55	61	170	110	76	105	70	59	47	76	46	45
	42	40	62	76	60	240	75	103	56	52	59	56	70	55
	50	50	62	110	66	122	51		56	52	46	72	43	45
	52	45	59	170	68	110	112		60	55	56	56	43	
	47	46	56	60	82		67		70	57	59	42	74	
	45	45	60	66	58		76		56	53	53	46	58	
	45	45	65	68	60		75			60	53	43	50	
	60	49	60	82	56		57			52	59	43	52	
	50	45	61	58	60					59	53	74		
	50	46	50	60	80					45	49	58		
	49	50	55	56	59					58	52	50		
	50	52	62	60	52					58	57	52		
	45	45	62	80						53	54	67		
	60	60	59	59						53	51	56		
	49	60	56	52						57	51	76		
	48	60	60	160						55	64	56		
	45	60	65	79						47	53	54		
	49	60	60	61						60	75	72		
Number of fish:	110	20	34	6	10	4	8	90	30	5				
Maximum Length:	60	65	170	240	112	105	70	75	76	55				
Minimum Length:	40	50	52	110	51	103	56	45	42	45				
Average Length:	48	59	80	157	77	104	61	54	57	49				

Comments: A maximum of 40 fish lengths per specie are listed on the table, however more fish were measured. The maximum, minimum, and average lengths are based on the entire data set.

ATTACHMENT 36

Water Resources Assistance Program Water Quality Data

**SITE LBST10
PATTEE CREEK
WATER CHEMISTRY AT TIME OF FISH COLLECTION**

July 3, 2003 – 8:00 A.M.

Parameter Name	Result
Air Temperature	25° C
Water Temperature	16.80° C
Specific Conductance	895 μ S/cm
Dissolved Oxygen	7.9 mg/L
pH	7.77 s.u.

ATTACHMENT 37

Water Resources Assistance Program Laboratory Analysis Data for Site LBST10

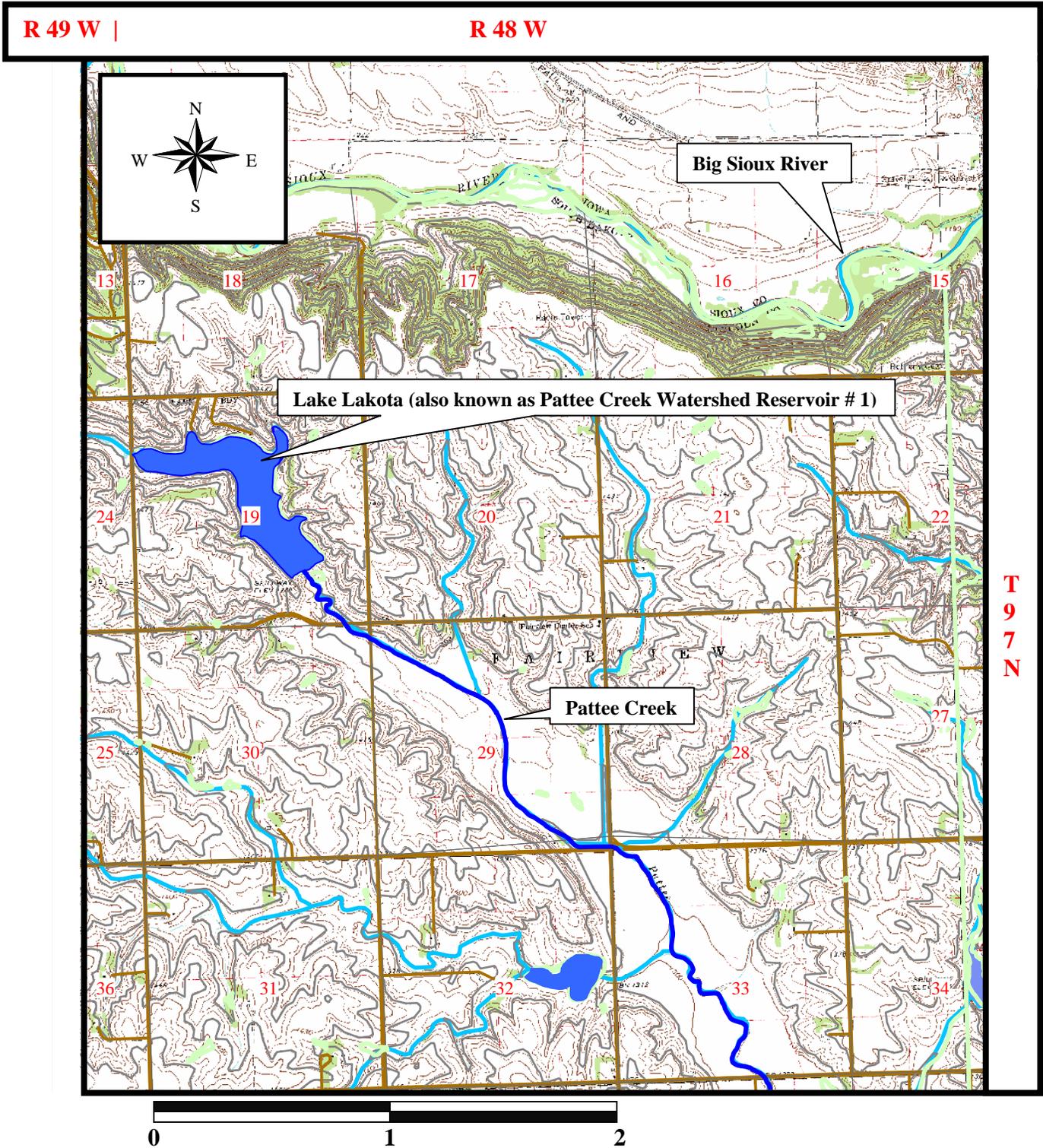
Date	Time	Fecal Coliform (col/100 ml)	E-Coli (col/100 ml)	Alkalinity (mg/L)	Total Solids (mg/L)	TDS (mg/L)	TSS (mg/L)	Ammonia (mg/L)	NO2 + NO3 (mg/L)	TKN (mg/L)	Total Phos (mg/L)	Total Dissolved Phos (mg/L)
4/18/02	10:00	120	162	292	744	721	23	0.02	1.5	1.5	0.1	0.022
5/2/02	14:30	10	7.4	303	778	744	34	0.02	2.1	2.1	0.069	0.016
5/29/02	14:00	420	921	302	820	755	65	0.02	1.6	1.6	0.122	0.046
6/20/02	7:30	1400	2420	284	743	710	33	0.02	1.6	1.6	0.106	0.056
7/2/02	12:25	370	687	304	805	791	14	0.02	1.3	1.3	0.077	0.049
7/10/02	7:30	9600	2420	257	1078	694	384	0.06	1.1	1.1	0.483	0.086
7/17/02	14:00	610	1046	304	785	760	25	0.02	1.3	1.3	0.116	0.062
7/25/02	8:30	1700	2420	292	738	701	37	0.02	1.3	1.3	0.134	0.067
8/19/02	17:00	560										
8/19/02	17:00			323	825	784	41	0.02	1.7	1.7	0.129	0.069
8/19/02	17:00		410									
8/22/02	10:30			291	797	705	92	0.04	1.5	1.5	0.234	0.101
9/9/02	13:30	810	1410	318	831	794	37	0.02	1.2	1.2	0.11	0.054
9/24/02	14:30	240	238	318	822	796	26	0.02	1.4	1.4	0.79	0.037
10/14/02	17:00			294	775	761	14	0.02	1.6	1.6	0.055	0.034
10/14/02	17:00	220	387									
3/19/03	13:00	10	10.9	259	653	630	23	0.37	1.8	1.8	0.277	0.166
3/26/03	10:00	2	3.1	288	693	679	14	0.02	1.6	1.6	0.144	0.071
4/1/03	12:00	2	2	291	718	703	15	0.02	1.2	1.2	0.117	0.04
4/9/03	12:00	10	12.2	300	738	730	8	0.02	1.2	1.2	0.076	0.024
4/15/03	17:00	46	43.2	277	712	690	22	0.02	0.9	0.9	0.091	0.029
4/16/03	15:00	90	115	289	720	702	18	0.02	1.1	1.1	0.103	0.042
4/21/03	13:00	13.5	20	292	755	748	7	0.02	1.5	1.5	0.09	0.042
4/30/03	12:00	200	192	295	710	692	18	0.02	1.1	1.1	0.125	0.042
5/14/03	10:00	150	179	332	880	814	66	0.02	2.1	2.1	0.172	0.07
5/21/03	11:00	50	147	325	803	749	54	0.02	1.7	1.7	0.14	0.031
6/11/03	14:00	440	727	320	815	769	46	0.02	1.4	1.4	0.127	0.052
6/19/03	11:20	1500	1410									
4/5/04	12:00	10	4.1	289	735	714	21	0.02	1.4	1.4	0.091	0.015
5/3/04		10	12.2	307	799	779	20	0.02	1.8	1.8	0.088	0.023
5/12/04	12:00	450	613	307	806	759	47	0.02	1.4	1.4	0.129	0.057
5/24/04	12:30	7100	2420	243	832	664	168	0.04	1.8	1.8	0.398	0.085
6/2/04	17:00	280	308	273	787	708	79	0.02	2.6	2.6	0.213	0.074
6/14/04	20:30	90	127	300	782	741	41	0.02	1.9	1.9	0.066	0.038
6/29/04	16:00	1900	1300	303	823	721	102	0.02	1.7	1.7	0.159	0.035

ATTACHMENT 38

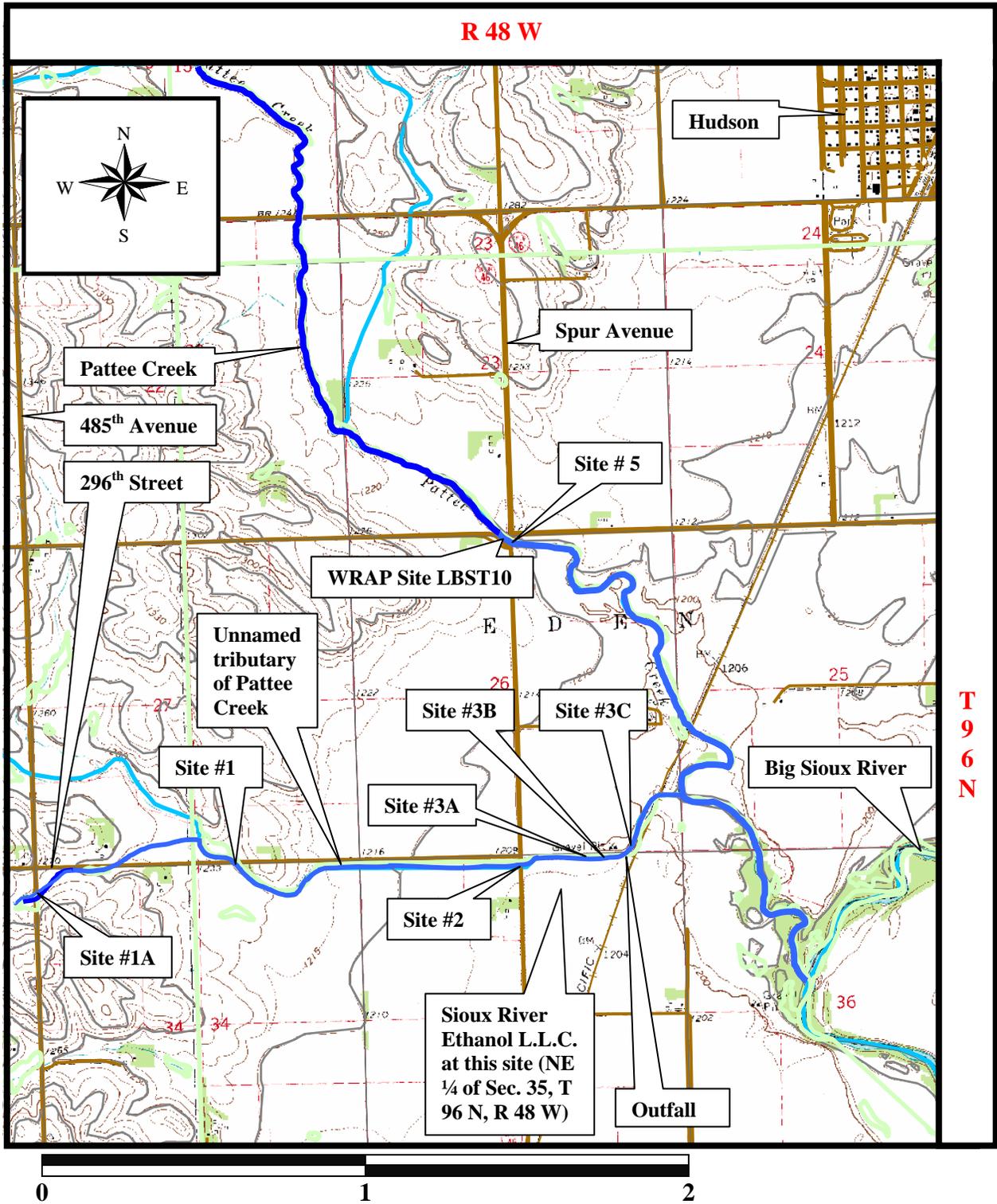
Water Resources Assistance Program Field Data for Site LBST10

Date	Water Temp F	Conductance (µS-cm-1)	Dissolved Oxygen (mg/L)	pH (s.u.)	Discharge	Stage	Mean Stage
4/18/02	58.92	962.0	11.04	8.00	9.186		0.85
5/02/02	56.15	965.0	14.24	8.28	9.7525	0.85	0.85
5/29/02	73.78	965.0	14.65	8.14	8.143	0.91	0.91
6/20/02	61.96	882.0	9.17	7.91	7.77	1.05	1.05
7/02/02	68.35	978.0	13.29	8.19	4.913	0.95	0.95
7/10/02	66.73	873.0	12.50	7.81	17.6025	1.75	1.75
7/17/02	75.12	1005.0	10.48	8.11	3.644	0.86	0.89
7/25/02	63.40	953.0	8.35	8.00	5.8335	0.98	1.04
8/13/02	70.35	910.0	9.72	8.02	6.227	0.86	0.91
8/19/02	70.59	943.0	11.92	8.06	3.1135	0.86	0.91
8/22/02	65.37	921.0	8.84	7.80	8.751	1.05	1.06
9/04/02	66.91	940.0	10.24	8.00	5.219	0.84	0.84
9/09/02	72.21	1177.0	9.99	7.93	3.9945	0.8	0.8
9/17/02					4.1345	0.79	0.8
9/24/02	53.86	1075.0	13.91	8.14	3.86	0.77	0.79
9/30/02	63.49	1938.0	0.12	8.17	4.076	0.7	0.79
10/14/02	53.87	1026.0	16.99	8.11	4.9645	0.81	0.81
3/19/03					8.056		
3/26/03	44.82	857.0	14.88	8.16	6.516	1.22	
4/01/03	54.13	944.0	11.98	8.51	6.113	1.22	
4/9/03	43.21	938.0	15.06	8.05	6.0115	1.14	
4/15/03	65.79	889.0	13.36	8.15	7.021	1.2	
4/16/03	62.91	907.0	15.79	8.19	7.3675	1.24	
4/21/03	54.85	927.0	16.66	8.13	9.97175	1.25	1.26
4/30/03	51.39	878.0	13.17	7.82	8.624	1.32	1.32
5/14/03	52.46	1004.0	10.22	7.83	14.1525	1.67	
5/21/03	50.72	941.0	11.59	7.77	12.30025	1.52	
6/11/03	63.14	948.0	11.10	7.88	7.75	1.53	
6/25/03	65.37	478.0	7.20	7.45	73.435	2.5	
7/8/03	64.06	329.0	8.76	7.27	no flow taken		
7/22/03	64.30	916.0	10.78	7.72	12.8975	2.51	
7/30/03	61.86	895.0	10.53	7.62	7.6595	2.36	
8/18/03	70.38	805.0	9.68	7.66	7.573	2.05	1.11
9/2/03	57.92	923.0	10.10	7.78	4.4135	2.26	1.76
9/10/03	61.86	864.0	8.16	7.40	9.9705	2.55	2.26
9/23/03	61.59	940.0	9.11	8.04	6.485	2.26	2.26
10/20/03	51.68	955.0	11.55	8.07	4.265	1.91	1.9
4/5/04	49.75	982.0	10.11	8.01	12.33	1.98	0.1
5/3/04	54.76	940.0	9.93	8.45	6.16	1.81	2.16
5/12/04	58.07	885.0	3.55	8.07	7.51	1.75	2.21
5/24/04	55.11	819.0	11.17	7.89	34.62	2.74	1.23
6/2/04	59.89	947.0	8.05	7.79	30.96	2.7	2.77
6/14/04	68.59	989.0	7.55	7.93	19.42	2.13	2.45
6/29/04	67.67	872.0	11.91	8.07	14.54	1.91	2.63
8/17/04	68.97	908.0	9.40	7.90	5.51	1.49	3.09

ATTACHMENT 41



ATTACHMENT 39



ATTACHMENT 40

