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#183

Mapping and Characterization of Springs in Brown and Calumet Counties

Final Report
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Bureau of Drinking Water and Groundwater

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UW Project # 144-NS04

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By
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Introduction

In April 2004 the State of Wisconsin enacted a new groundwater protection law, 2003 Wisconsin Act 310 (Wisconsin Legislature, 2004). Historically, natural springs have provided domestic and agricultural water supplies to many settlers in the area. Most residents in Brown and Calumet Counties, Wisconsin currently receive water from private wells or municipal water supplies. In some cases, springs are still used for both domestic purposes and commercial water bottling operations. One of the springs monitored in this study in southern Brown County is currently used as both domestic supply and commercial bottling.

Although springs are not commonly used for water supply anymore, the importance of these features remains. Springs provide habitat for many plant and invertebrate species throughout the state. Springs also contribute source water to streams, including many trout streams, which are important both ecologically and economically. Natural springs in Wisconsin also provide water for bottling plants, supporting a rapidly growing industry. In 1999, Wisconsin Department of Commerce began working with Nestle Waters North America (formerly Perrier Group) to site a bottling plant in Wisconsin. Strong disapproval from environmental organizations and citizens helped lead to the enactment of Wisconsin Act 310 and halted the construction of the bottling plant. Nestle Waters North America has since built a new bottling plant in Stanwood, Michigan (PR Newswire, 11/30/2005). They have also allowed their Wisconsin High Capacity Well Permits to expire and are no longer pursuing any locations within the state of Wisconsin (Murphy, 9/20/2002).

The ecological and cultural importance of springs has long been recognized. However, the extent and characteristics of springs in Wisconsin are not well known. Under Wisconsin Act 310, high capacity wells pumping more than 100,000 gallons per day (gpd) are required to be permitted by the Wisconsin Department of Natural Resources (WDNR). The permitting process is used to determine whether high capacity wells will impact groundwater or other important water resources. The WDNR specifies that high capacity wells must not be placed within 1200 feet of natural springs with outflow greater than 1 CFS. Currently, the WDNR does not have a centralized database of spring locations, and no comprehensive natural spring study exists for the area of concern.

In this project, we have performed reconnaissance work to determine the locations of natural springs in Brown and Calumet Counties, Wisconsin. Funding for this project was provided by a grant from the Wisconsin Department of Natural Resources. The grant proposal (Fermanich, et al, 2004) is the basis for this project.

Background

Springs and groundwater seeps are important hydrological and ecological features of landscapes in many parts of Wisconsin. The unique chemical, physical and hydrologic nature of groundwater discharging from springs provide critical habitat for rare and other wetland plant communities. Recent studies in Wisconsin have inventoried seep wetland communities that are critically dependent on groundwater discharge (Baird Creek, Brown County; Stoll, et al., 2003), have characterized the source of spring flow to wetland marshes (Dane County; Hunt and Steuer, 2000) and have assessed hydrologic controls on discharge to ecologically significant springs (Waukesha County; Gittings and Bahr, 2003). The extent and location of these springs within the state are well known locally, but have yet to be compiled into a central database.

Recognition of the hydrologic and ecologic importance of springs to the flora and fauna that are dependant on them is imperative if springflow is to be protected. As originally enacted, Wisconsin Act 310 states that springs discharging greater than 1 cubic feet per second (cfs) throughout 80% of the time are to be protected. The lack of a central database containing spring information will hamper the WDNR's ability to efficiently permit high capacity wells (J. Helmuth, 2005).

The new Groundwater Protection Act mandates the Wisconsin Department of Natural Resources (WDNR) to review proposed high capacity wells that may adversely impact natural springs. At this time, the term "adverse impact" is not defined. Efforts to quantify what changes in spring discharge will qualify as an adverse impact are currently in progress (Meyer, 2006). High capacity wells are defined as those wells that have the capacity to pump greater than 100,000 gallons per day (gpd). Due to increased groundwater withdrawals in Brown County, Act 310 classifies it as a groundwater management area. A groundwater management area is defined as an area where the water level in a new well is at least 150 feet less than it would have been if groundwater had not been pumped (Wisconsin Legislature, 2004). The intent of the designation of a groundwater management area is to promote coordinated management of groundwater resources between public and private groundwater users (Asplund, 2004).

The spring definition adopted by the Legislature for Act 310 is somewhat problematic. First, it is unclear what can be considered as an "area of concentrated discharge". Focused groundwater discharge areas can easily be identified as springs. However, areas may exist in which numerous small springs diffusely discharge to the surface. Swanson and Bahr (2004) define these areas as spring complexes. Also, the duration of flow at a rate above 1 CFS for 80% of the time lacks definition (80% of a day, week, month or year?). The cutoff of 1 CFS may, however, have an undesirable effect on spring ecology. Small, low-discharge springs may provide critical habitat for certain species, such as Hine's Emerald Dragonfly (USFWS, 2001). These smaller springs (many flowing less than 0.1 CFS) will be more susceptible to groundwater depletion than larger (> 1 CFS) springs. Once the spring is dried up, it is very difficult to re-establish the faunal and floral community that once existed there (Saber, 2005). These issues are currently being addressed in Draft Wisconsin Code Chapter NR 820 (Meyer, 2006).

Spring Classification

Springs are defined as "A place where underground water emerges onto the Earth's surface" by Copeland (2003). Numerous spring classification systems have been developed over the years. There have been several revisions of the work of Meinzer (1923) to develop a classification system (Springer and Stevens, 2005). Although physical characteristics of springs and their emergent environments have been described thoroughly in recent years, little attention has been paid to the ecological characteristics and downstream channel morphology of springs.

Recent work by Springer and Stevens (2005), attempts to create a universal classification system for springs and spring-related ecosystems. While Springer and Stevens have many strong points in their classification system, their work is based in the southwestern United States, and parts of it may not work well in the Upper Midwest. The Springer and Stevens classification system is used to characterize springs in this report because it is the most comprehensive system.

Geologic Setting

Location and characteristics of springs within Wisconsin are not well known. Spring locations are commonly mapped on U.S.G.S. 7.5' topographic maps, county soil survey maps and other publications, such as the Wisconsin Gazeteer (DeLorme, 2004). Although most springs in the study area are mapped, some smaller springs are not. Many of the springs shown on older map sources, such as county soil surveys, are no longer flowing.

Geologic units in Brown and Calumet Counties are characteristic of conditions in which springs form. The geology of Brown and Calumet Counties is conducive to the formation of springs. Three aquifers, the upper aquifer, the St. Peter aquifer and the Elk Mound aquifer, and three confining units, the Maquoketa confining unit, the St. Lawrence confining unit and the Precambrian confining unit, have been identified. The upper aquifer unit has been described as undifferentiated dolostone (along the eastern county margins) overlain by unlithified fluvial, lacustrine and till deposits (throughout the counties). The Maquoketa confining unit, located beneath the upper aquifer, is comprised mostly of shale and unfractured dolostone. The St. Peter aquifer, located beneath the Maquoketa confining unit, is composed mostly of sandstone, glauconitic sandstone and dolomitic sandstone. The St. Lawrence confining unit, beneath the St. Peter aquifer, consists of mostly silty, shaly dolomite. The third aquifer, the Elk Mound aquifer, is comprised of mostly sandstone units and has characteristics similar to those of the St. Peter aquifer. The final, and deepest, confining unit is the Precambrian confining unit composed of crystalline, igneous rock (Krohelski and Brown, 1986).

Groundwater Interactions in Northeast Wisconsin

Historically, groundwater was the sole source of water in Brown County (Drescher, 1953; Knowles, 1964). In 1957 the city of Green Bay began using water from Lake Michigan for most of their water needs (Krohelski and Brown, 1986). Groundwater levels in Green Bay have recovered somewhat since pumping stopped. However, other municipalities in Brown County still supply constituents with groundwater and a cone of depression has formed beneath the City of De Pere (Krohelski and Brown, 1986). Continued groundwater pumpage from the lower aquifer will heighten the hydraulic gradient existing between the upper aquifer and the lower aquifer increasing the amount of potential leakage from the former to the latter.

Currently, numerous high capacity wells within Brown and Calumet Counties pump water from the St. Peter and Elk Mound aquifers (Krohelski and Brown, 1986). The Southeastern Wisconsin Regional Planning Commission (2003) suggest that increased groundwater withdrawal has lowered the potentiometric surface, thereby reversing the hydraulic gradient and inducing leakage from the upper aquifer to the lower aquifers through the Maquoketa confining layer. The leakage effectively decreases the amount of water flowing through the upper aquifer and hence the amount of water available to flow to the surface in the form of springs, seeps, stream baseflow, etc. High capacity wells are also used to pump groundwater from the upper aquifer, especially the dolomite units, within Brown and Calumet Counties (WDNR, 2004).

Spring flow in northeastern Wisconsin is fed by water flowing through the upper aquifer. Water infiltrating through the upper aquifer eventually comes into contact with the Maquoketa confining unit and. Due to the low hydraulic conductivity of the confining unit, groundwater flows along the upper surface toward discharge areas. If the Maquoketa confining layer intersects the surface, flowing groundwater will come to the surface creating a spring.

Studies conducted in Door County, WI (Johnson and Stieglitz, 1990) have found that springs also form along outcropping dolomite and along the Green Bay shoreline. The dolomite outcrops along the eastern margins of Brown and Calumet Counties forming karstic topographic features where bedrock is dissolved as slightly acidic water flows through the system reacting with soluble dolostone (Stieglitz and Dueppen, 1995).

The equilibrium chemistry of carbonate groundwater is affected by geologic, seasonal, and recharge factors (Drake, 1983). Total hardness, bicarbonate ion concentration, and calcium ion concentration often reflect seasonal effects (Schuster and White, 1971). In addition, calcium/magnesium ratios are influenced by the length of the flow path and whether a spring is primarily a diffuse or conduit flow system. Desmarais and Rojstaczer (2002) also used carbonate chemistry to infer the characteristics of flow and sources water of springs in Tennessee. An analysis of the ratios or the variances of major ions might provide information about land use and source area.

Relative Age Dating

Age-dating of groundwater discharge samples is a useful tool for estimating residence time in an aquifer (Plummer and Friedman, 1999; Busenberg and Plummer, 1992) and may be useful for differentiating between shorter or conduit flow systems and longer flow systems. Chlorofluorocarbons (CFC11, CFC12 and CFC113) are atmospheric trace gases that have been released into the atmosphere since the 1930's. Observed concentrations of CFCs in groundwater along with well-documented historical atmospheric concentrations have been successfully used to provide apparent recharge dates of groundwater (Browne, 2004; Busenberg and Plummer, 1992).

Study Approach

The main goal of this study was to inventory and characterize springs in Brown and Calumet Counties, Wisconsin. An inventory and assessment of springs in these counties was conducted between April, 2005 and August, 2006. Reconnaissance was performed to determine spring locations and discharge was qualitatively assessed. Water quality samples taken at selected spring outflows were used to determine anion (SO_4^{2-}, NO_3^-, NO_2^-, Cl^- and PO_4^{3-}) and element (Ca, Mg, Zn, Na, K, Fe) concentrations, and alkalinity. An apparent groundwater recharge age-date was determined for each site using ultra-trace concentrations of chlorofluorocarbons (CFCs).

This report also provides baseline information about spring characteristics. The baseline information includes basic chemical parameters such as pH, temperature, specific conductivity, oxidation-reduction potential and flow. The goal of this section is to determine the applicability of Wisconsin Act 310 in protecting springs in the study area.

The ecology supported by the spring's emergent environment was also assessed to determine the level of disturbance at the site, and also to determine if any significant species are present at any of the sites. A modified version of the classification system used by Springer and Stevens (2005) has been employed to assist in the characterization of the springs.

The results of this project are published in several forms. First, an ArcGIS map showing the location and characteristics of the springs has been created, and data has been shared with the Wisconsin Department of Natural Resources to add as a layer in the WADRS database.

Materials and Methods

Reconnaissance

Initial reconnaissance for spring locations was completed using existing map sources, such as USGS topographic maps, county soil survey maps (USDA, 1974) and the Wisconsin Gazeteer (DeLorme, 2004). Once found, locations were determined using a mapping-grade GPS with differential correction (e.g., Garmin GPS III) and information was translated to a base map of Brown and Calumet Counties.

Photographs were also taken to aid in characterization and as a reference for supported vegetation at the springs during different seasons. A subset of five springs was selected for further study. An intermittently flowing spring close to one of the sites was also monitored when discharging. Discharge was the primary characteristic used for selecting which sites would be sampled, using the 1 CFS flow rate prescribed by Wisconsin Act 310. Springs with the greatest discharge in the study area were selected for sampling. Other factors considered for site selection include land use, level of site disturbance and ease of site access.

Discharge Measurement

Rate of spring flow was determined in concentrated flow channels down-gradient from focused or diffused groundwater discharge areas. Discharge measurements were made using the volumetric measurement method, measuring stream cross section and velocity, or using a calibrated portable weir plate (Rantz, *et al.* 1982).

Water Quality Sampling

Biweekly monitoring began in September 29, 2005 and concluded August 28, 2006. During several periods over the winter of 2005-06, site access was limited due to weather conditions. A total of six grab samples were taken at each site for lab analysis. These samples were taken in September 2005, January 2006, March 2006, June 2006, July 2006 and August 2006.

Sampling procedures and sample handling followed procedures described in the DNR field methods manual (Karklins, 1996). Samples were collected as close to the outlet of springs as possible in clean 250 mL bottles. Anion sample bottles were rinsed with sample water three times before filling. Cation samples were preserved with nitric acid. Samples were transported to the laboratory on ice and stored at 4° C until analysis. Analysis for anions, alkalinity and cations took place within 48 hours, two weeks and six months of sample collection, respectively. *In situ* temperature, specific conductance, DO, ORP and pH were performed on a bi-weekly basis using a HYDROLAB Quanta G multi-probe. The multi-probe was calibrated prior to use with analytical graded standards following the manufactures procedures.

Chemical Analysis

Water quality samples were analyzed following standard methods (APHA, 1998) for ion chromatography and inductively coupled plasma (ICP) spectroscopy at the Instrumental Analysis Laboratory at UW Green Bay. The concentrations of NO_3^-, NO_2^-, Cl^- and SO_4^{-2} were determined on a Dionex DX-120 ion chromatograph. A suite of elements (Ca, Mg, Zn, Na, K, Fe) in filtered and acidified samples were analyzed on a Varian Liberty Series II Sequential ICP-OES system. Phosphorus concentrations were below the detection limit of both the Varian ICP-OES and the Dionex IC. A set of water samples collected August 27, 2006 were sent to the Analytical Laboratory at Green Bay Metropolitan Sewerage District (GBMSD) and analyzed for total dissolved phosphorus (TDP). Alkalinity was determined using standard titration techniques (APHA, 1998).

CFC Sampling

Water samples to be analyzed for CFC's were collected using the Pumping-Induced Ebullition (PIE) technique described in Browne (2004). Custom-made ultra-trace gas sampling equipment was rented from the UW Stevens Point Trace Gas Analysis Lab to collect CFC samples. The concentration of CFC11, CFC12 and CFC113 in gas samples collected from spring water samples was determined by gas chromatography-electron capture detection at the UW Stevens Point Trace Gas Analysis Lab. The apparent groundwater recharge age-date of spring samples was determined by the UW Stevens Point Trace Gas Lab using the methods of Browne (2004) and Busenberg and Plummer (1992). In this method, sample water is collected through a mini-piezometer inserted into the spring. The sample water is then drawn through a restrictor tube (2mm I.D.) by a peristaltic pump and then forced through another restrictor tube (2 mm I.D.). Water moving through the restrictor tubes is placed under considerable pressure due to the friction inside the tube. Once the water reaches an area of lower pressure (e.g., exiting the restrictor tube) the gas ebulates and can be collected. A glass collector tube is used to separate dissolved gases from water. The top of the glass collector is vented to the atmosphere to allow the system to be purged with sample water. Once the system has been purged and the sample is ready to be collected, a rubber septum is used to seal the top of the tube. The ebulated sample water then flows though an exhaust line from the bottom of the collection tube. Head in this line is maintained above the gas collection port to eliminate siphoning and contamination of the gas sample. The septum also serves as a port for sample collection using syringe and transferring the sample immediately to a sealed vial placed under vacuum.

Ecological and Geomorpholgical Assessments

Floral and fauna assessments were conducted by Juniper Sundance, of the Cofrin Center for Biodiversity at UW-Green Bay. Plant survey was done by meandering transect. Cover percents and distances were based on subjective visual estimate. Values in Bernthal (2003) were used to calculate average coefficient of conservatism and Floristic Quality Index for each site. Because all species may not have been detected during the single visit, these values should be used only as a general indication of site quality. The same source was used to list Wetland Indicator status for plants at each site. Nomenclature follows the Wisconsin State Herbarium, as available at http://www.botany.wisc.edu/wisflora/. Land use in Brown and Calumet Counties, WI was taken from WISCLAND.

Aquatic Invertebrate Sampling: Following Hilsenhoff (1988), invertebrates were sampled by kicknet until at least 100 individuals were collected, with a couple of exceptions. The decision to sample biota in this project was not made until June, and staff were not available until mid July. Although not developed for seeps or springs, Hauxwell, et al, recommend that macroinvertebrate sampling be performed in spring for best indices. Because of this, results of this survey may not be an accurate indication of the water quality or species richness.

Results

Climatic Data

There was persistent dry weather in the months leading up to and during the initial reconnaissance. Figure 1 shows precipitation data from weather stations in Green Bay, Brillion and Chilton from January 2005 to September 2006. Also shown is the 30-year average for Green Bay. Precipitation throughout the monitoring area was between 14 and 26% below the 30 year average from January, 2005 to the end of September, 2005. These conditions likely impacted spring discharge rates through the winter of 2005-06. For the 2006 water year (WY), all months were below normal except for November, January and May. May 2006 precipitation was between 5.5 and 7.5 inches of rain, more than twice the normal amount. Excluding May, WY2006 precipitation was 12-15% below normal. Above normal precipitation during May 2006 combined with snowmelt increased discharge rates beginning in March, 2006.

Spring Inventory

A total of 41 natural springs were found in Brown and Calumet counties during reconnaissance performed throughout the project. Springs found on existing maps were visited to determine if they were still flowing. Several unmapped springs were found during the reconnaissance. Springs that were found to be flowing are included in Table 2. Dry springs and mapped features that do not exist are not listed. Spring locations are shown on Figure 2 and Maps 1-10, and are shown over WISCLAND land-use base maps.

Bi-weekly Monitoring Data

Bi-weekly monitoring of the five selected springs began on September 30, 2005 and concluded August 28, 2006. All measurements except for discharge were taken with a Hydrolab Quanta-G multiprobe. Measured parameters included discharge (cfs), pH, dissolved oxygen (mg/L), specific conductance (mS/cm) and temperature (°C). Bi-weekly monitoring stopped between November 11, 2005 to January 3, 2006, and again from January 3, 2006 to March 24, 2006 due to winter weather conditions. Data collected at the sites can be found in Table 1 in Appendix B.

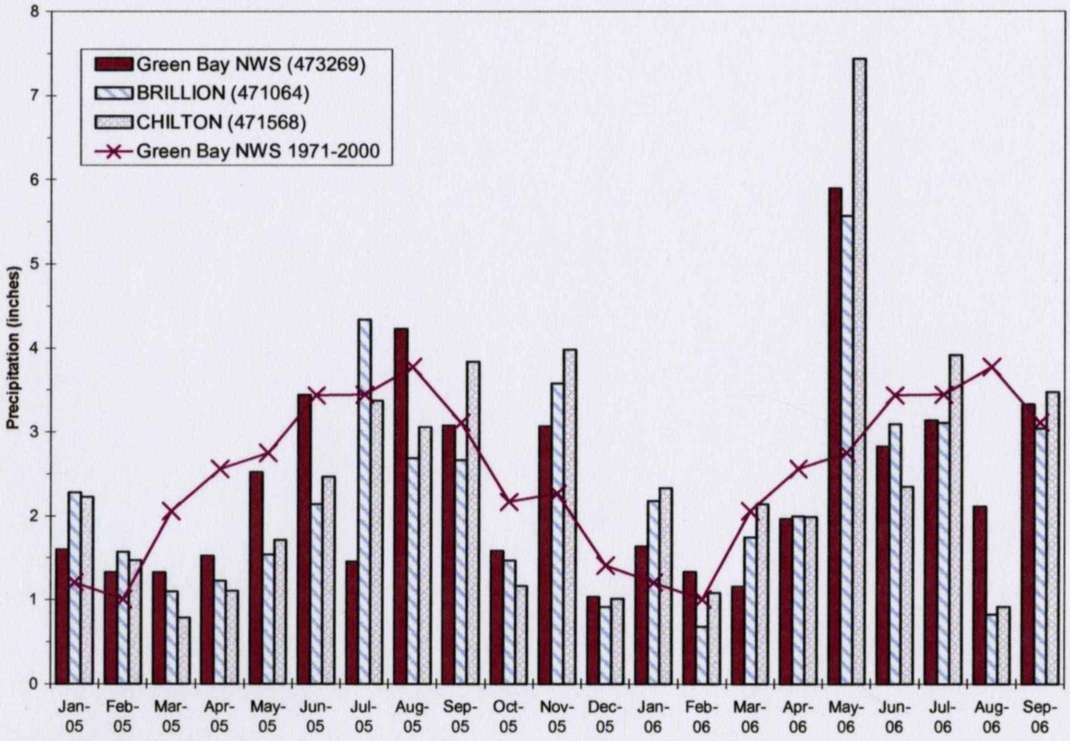


Figure 1. Regional precipitation data from January 2005 through September 2006 and 30-year average monthly data for Green Bay. Data from National Weather Service climate observation network.

Discharge measurements were taken at each site when possible. At site SB013, we were unable to quantify discharge due to the fact that there is no stream channel formed and that flow conditions were exceptionally low during the monitoring period. We were also unable to measure discharge at site SB011 due to the fact that the entire spring has been captured and flow was routed to a water bottling facility.

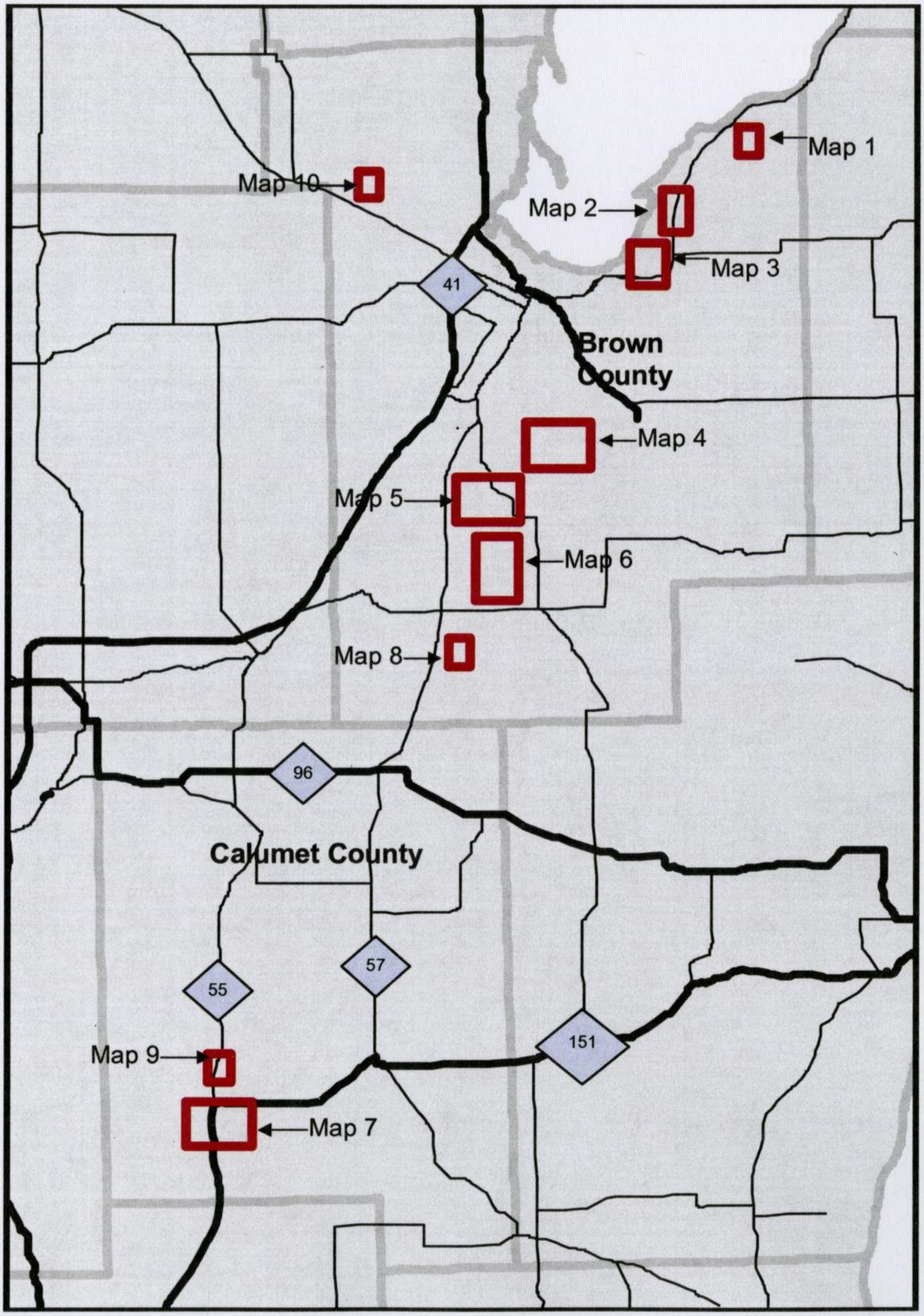
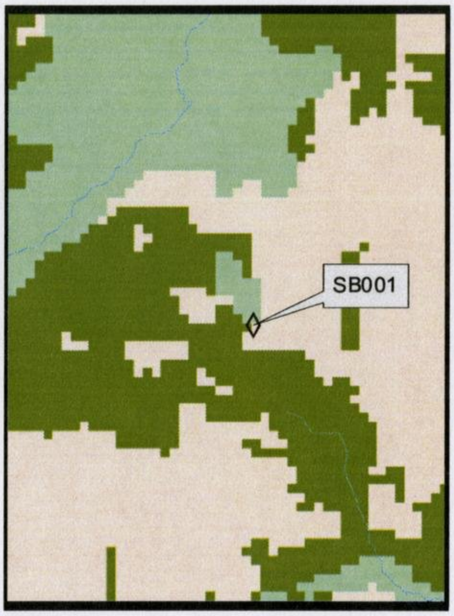
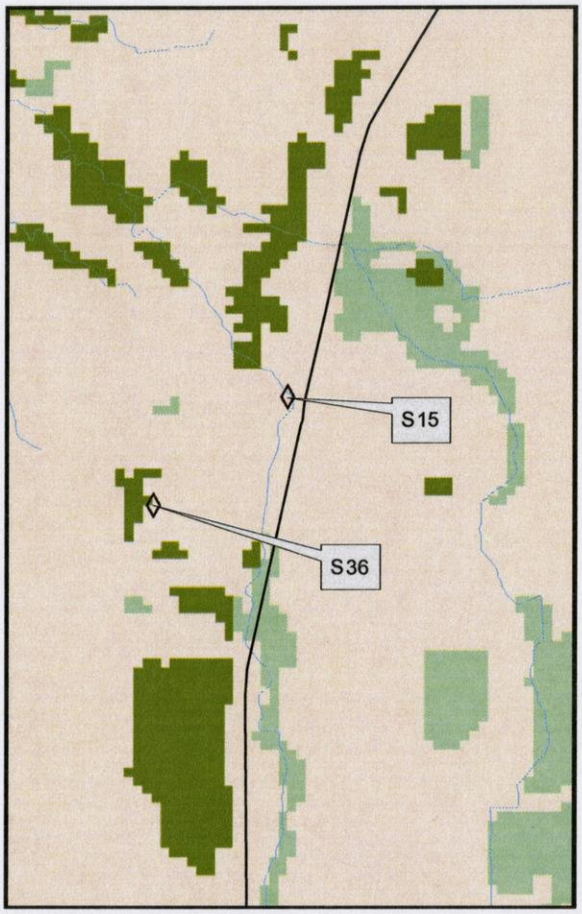


Figure 2. Site map overview. See maps 1-10 for spring locations and WISCLAND land use information.



Map 1.

Scale: 1 cm = 0.2 km



Map 2.

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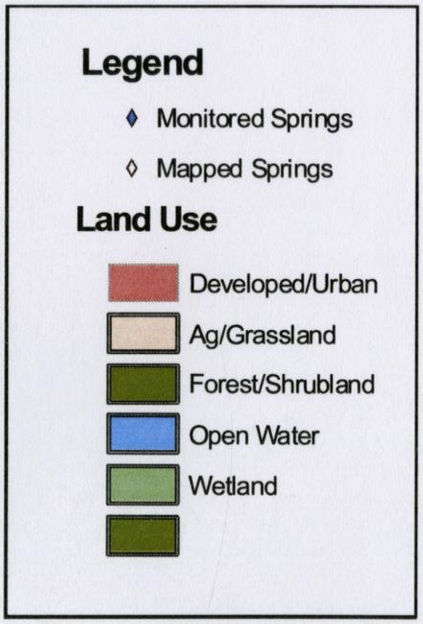
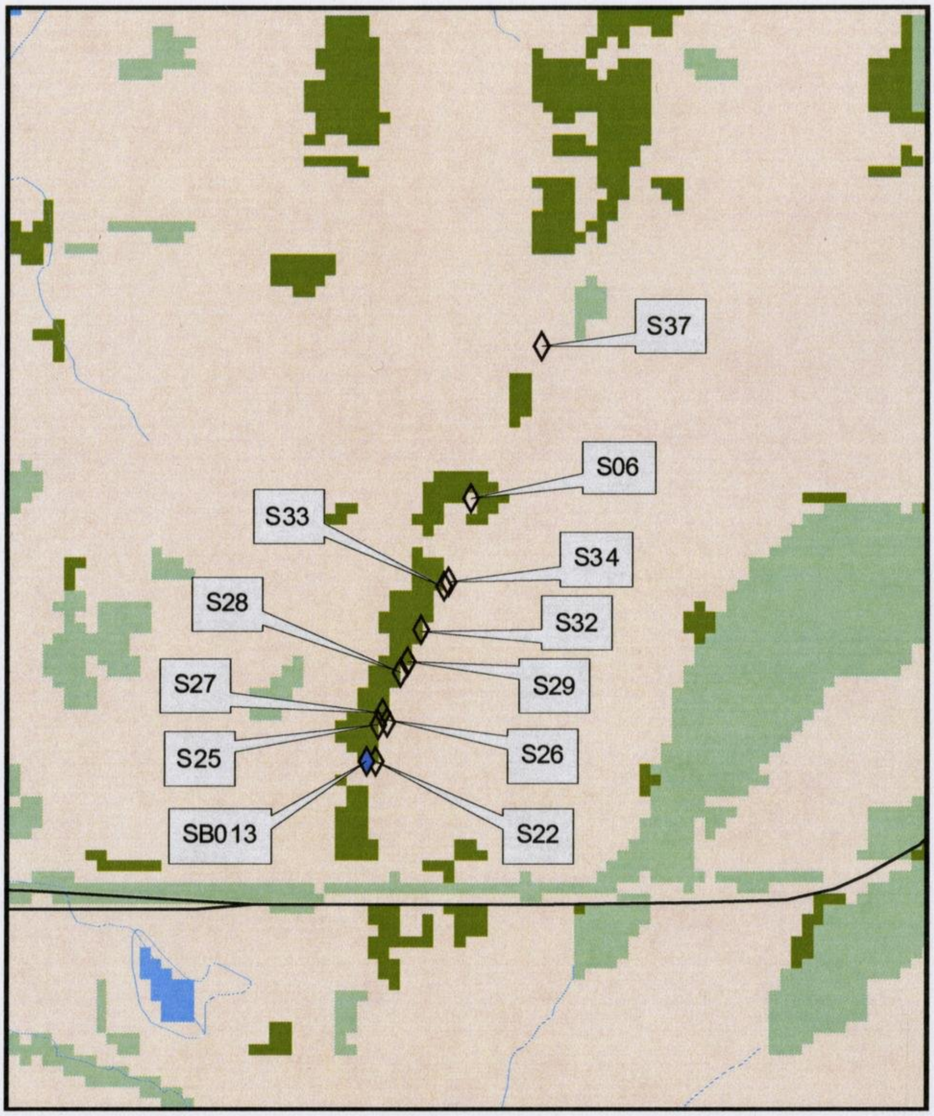
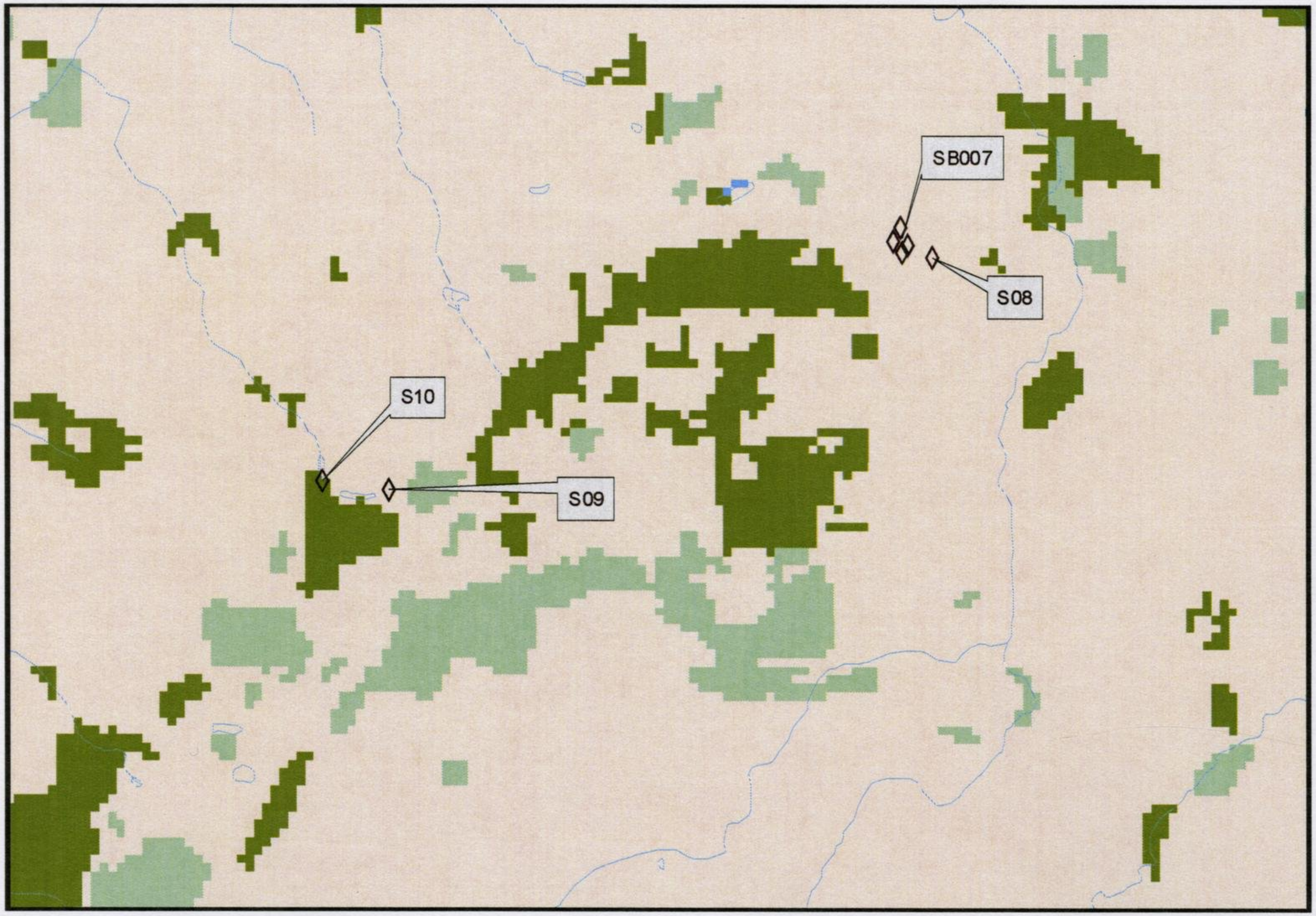




Map 3. Scale: 1 cm = 0.2 km



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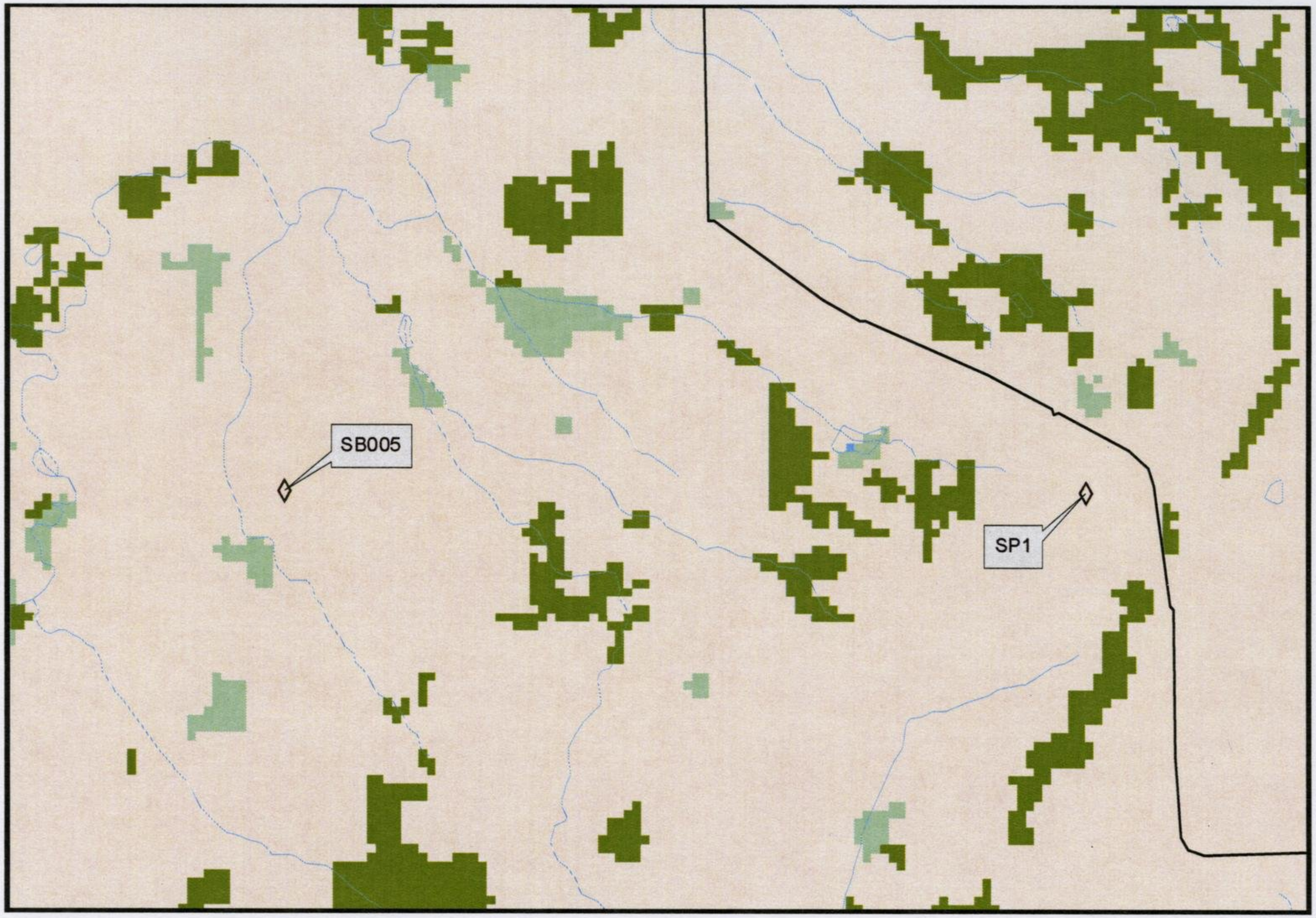
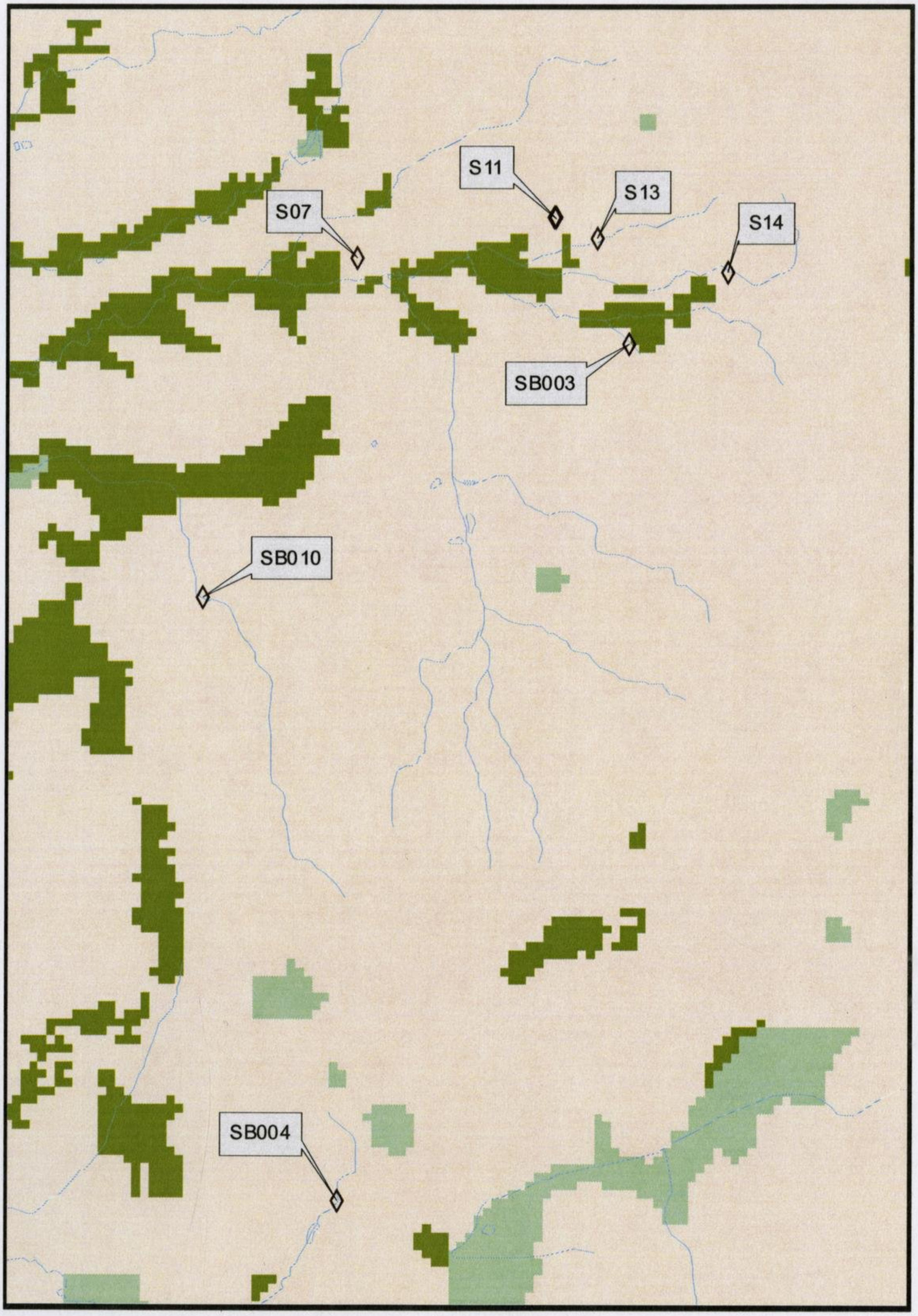
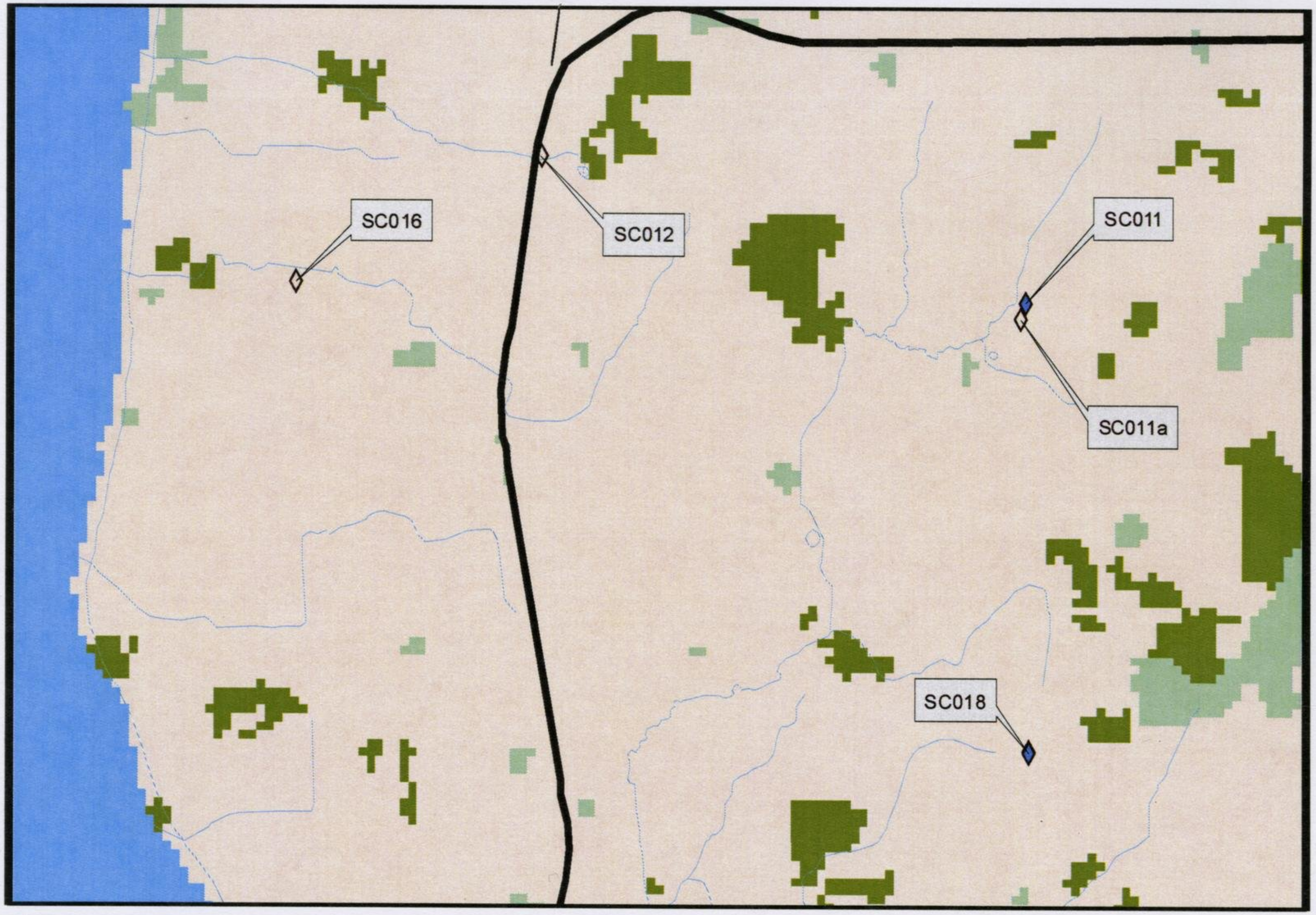


Map 5.

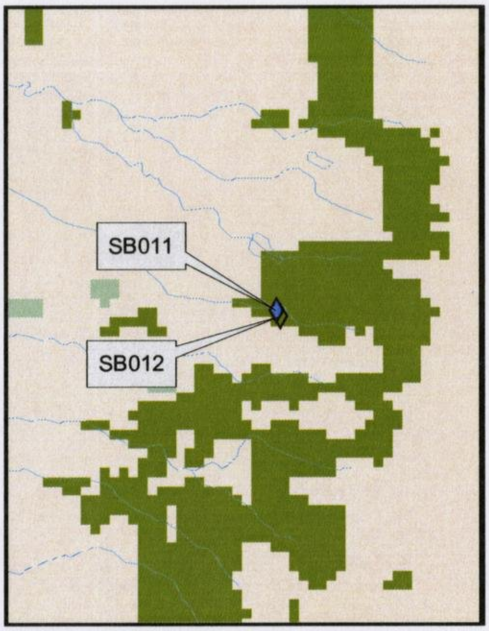
Scale: 1 cm = 0.2 km



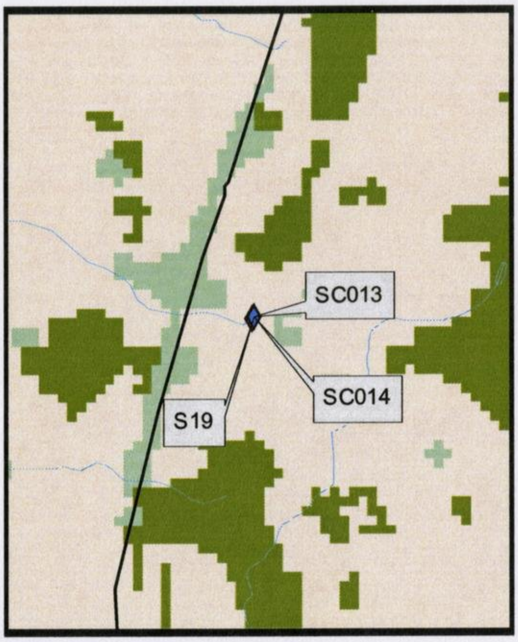
Map 6. Scale: 1 cm = 0.2 km



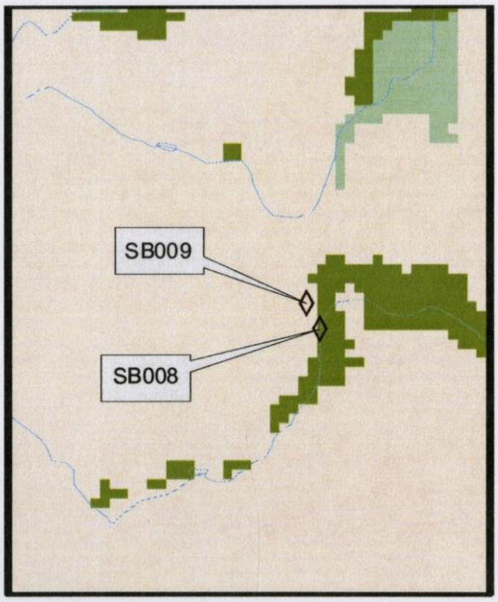
Map 7. Scale: 1 cm = 0.2 km



Map 8.



Map 9.



Map 10.

Scale: 1 cm = 0.2 km

Table 1. GPS coordinates for natural spring locations in Brown and Calumet Counties, WI. Sites listed in bold were selected for monitoring. Sites listed in italics are seepage complexes delineated by the coordinates shown in the table.

Springs Project GPS Points		**Springs Project GPS Points**	
Site ID	**Lat/Lon (WGS 84)**	**Site ID**	**Lat/Lon (WGS 84)**
6	N44 32.061 W87 54.241	37	N44 32.283 W87 54.086
7	N44 21.189 W88 02.974	**SB011**	**N44 17.226 W88 04.809**
8	N44 25.484 W87 58.568	SB001	N44 36.594 W87 48.664
9	N44 25.066 W88 00.024	SB003	N44 21.013 W88 02.262
10	N44 25.089 W88 00.198	SB004	N44 19.403 W88 03.082
11	N44 21.255 W88 02.449	SB005	N44 23.042 W88 04.103
12	N44 21.255 W88 02.453	*SB007A*	*N44 25.494 W87 58.649*
13	N44 21.215 W88 02.338	*SB007B*	*N44 25.508 W87 58.634*
14	N44 21.144 W88 01.998	*SB007C*	*N44 25.540 W87 58.653*
15	N44 34.095 W87 52.751	*SB007D*	*N44 25.516 W87 58.674*
18	N43 58.674 W88 17.182	SB008	N44 35.209 W88 08.980
19	N44 01.443 W88 18.116	SB009	N44 35.254 W88 09.013
20	N46 24.886 W77 48.490	SB010	N44 20.553 W88 03.403
22	N44 31.670 W87 54.457	SB012	N44 17.216 W88 04.799
25	N44 31.725 W87 54.450	**SB013**	**N44 31.669 W87 54.475**
26	N44 31.728 W87 54.431	SC012	N43 59.828 W88 18.444
27	*N44 31.742 W87 54.440*	**SC013**	**N44 01.447 W88 18.115**
28	*N44 31.802 W87 54.397*	SC014	N44 01.448 W88 18.111
29	*N44 31.817 W87 54.386*	SC016	N43 59.597 W88 19.096
30	*N44 31.816 W87 54.383*	**SC018**	**N43 58.671 W88 17.181**
32	N44 31.863 W87 54.354	SP1	N44 23.002 W88 01.983
33	N44 31.929 W87 54.306	**SC011**	**N43 59.529 W88 17.167**
34	N44 31.936 W87 54.294	SC011a	N43 59.499 W88 17.180
36	N44 33.908 W87 53.096		

Two different methods were used to measure discharge at site SC011. Initially, discharge was low enough to measure with a V-notch weir. During the spring thaw, discharge increased to the point where we were unable to seal the weir. Alternately, the cross section of the stream and discharge velocity were measured to calculate flow.

Discharge measurements taken at sites SC013 were performed using a small V-notch weir installed in the outfall channel approximately 150 meters downstream. The stage behind the weir was measured and recorded, then calculated at a later time using the Kindsvater-Shen equation (Edwards, 2006):

$$Q = 4.28 \tan(\theta/2) (h+k)^{2.5}$$

where Q = Discharge (cfs), C = Discharge coefficient, θ = Notch angle, h = Head (ft) and K = Head correction factor (ft).

Discharge measurements taken at sites SC018 were made using a calibrated bucket and stopwatch to determine the volume per time. The outfall at the junction box across the street from the captured spring was used to measure discharge, as it was the only available place to do so. During the spring and summer, discharge at this site increased enough to overflow the spring pond and junction box and cause a substantial portion of the water to flow into the drainage ditch beside the road. During these times, discharge was visually estimated. Spring discharge data for the selected sites are summarized in Figure 3 (except for site SB011).

Based on visual estimates, discharge at site SB013 remained at or below 0.01 CFS throughout the monitoring period. From October 2005 to March 2006, and June 2006 to August 2006, discharge at sites SC013 and SC018 was less than 0.2 CFS and greater than 0.04 CFS. Discharge increased for sites SC011, SC013 and SC018 following snowmelt and early spring precipitation. Peak flow occurred in mid-May 2006 in response to heavy precipitation.

Site SC011 showed a significant response to 5+ inches of rain from early to mid-May. Peak discharge was 3.34 CFS on June 2, 2006. Flow was greater than 1 CFS from April 1 to August 1, 2006.

pH

The pH at each site ranged from the high 6's to low 8's, indicating that the alkalinity of the outfall remained in the bicarbonate range throughout the monitoring period. This range of pH is also to be expected, given that the water is flowing though carbonate-rich sedimentary rocks. Also, there was a slight change in pH with the increase in discharge during the spring of 2006. pH data are shown in Figure 4.

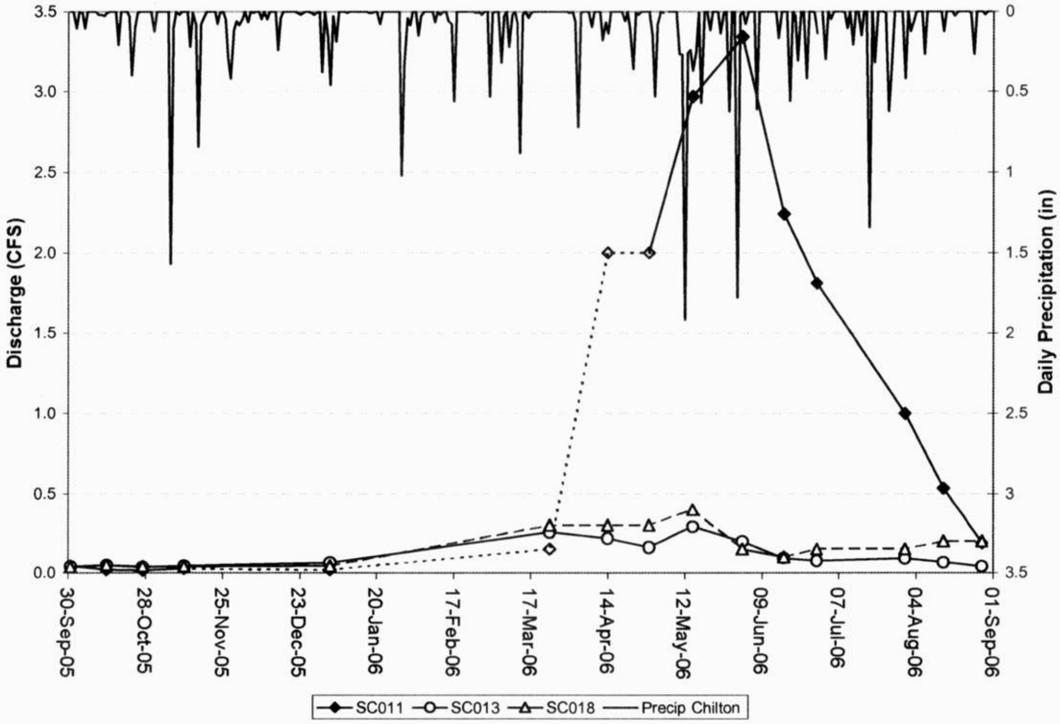


Figure 3. Spring discharge rates and daily precipitation for Chilton, WI NWS cooperative observation station. Dashed lines indicate estimated discharge rates.

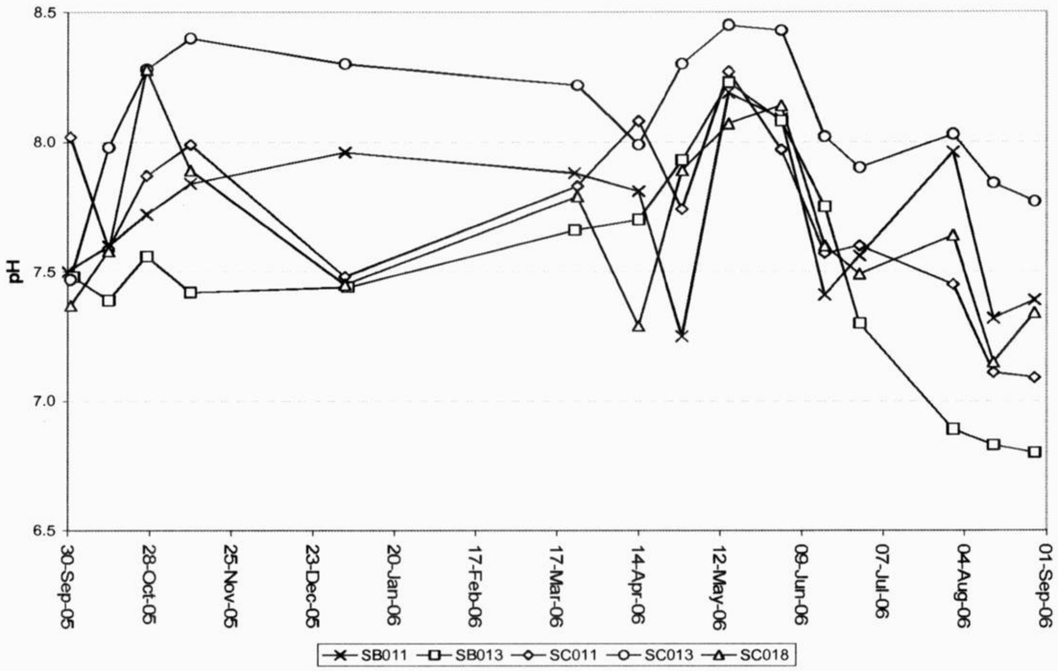


Figure 4. Spring pH levels, October 1, 2005 to August 28, 2006.

Dissolved Oxygen

Dissolved oxygen (DO) measurements varied widely between springs, as well as temporally. Most of the temporal changes in DO are a result of mixing surface water as well as atmospheric gasses. Measurements were made as close to the spring orifice as possible. However, several of the springs were fairly shallow at the point of discharge, allowing rapid mixing with the atmosphere. Dissolved oxygen measurements made in this study are most likely not indicative of actual groundwater conditions, as the measurements were made at the ground surface.

Spring SB011 had non-turbulent discharge because the spring orifice is an enlarged bedrock fracture and therefore showed fairly consistent DO levels. The measurement made on 5/15/06 should be treated as an outlier, as equipment problems during that site visit made the data unreliable. Dissolved oxygen data are displayed in Figure 5.

Specific Conductance

The specific conductance (SpC) measurements at each site remained fairly consistent through the monitoring period, with several exceptions (Figure 6). Specific conductance at site SB013 was approximately twice as high (~1.8mS/cm) as the other four sites (0.9 mS/cm). This is consistent with geochemical data (presented in later section). Peak SpC at SB013 occurred at the end of April 2006 following spring groundwater recharge. Conductivity decreased at all springs following the early May 2006 precipitation events.

Temperature

Temperature measurements were made as close to the spring orifice as possible. These temperature measurements did not necessarily reflect actual groundwater temperatures because water-air interactions and solar radiation can quickly affect surface water temperatures. Data show that there is a seasonal effect on water temperatures. Flow and temperature also seem to show similar trends at some of the sites. As discharge decreases, there is an increase in time for temperature exchange between the spring pool

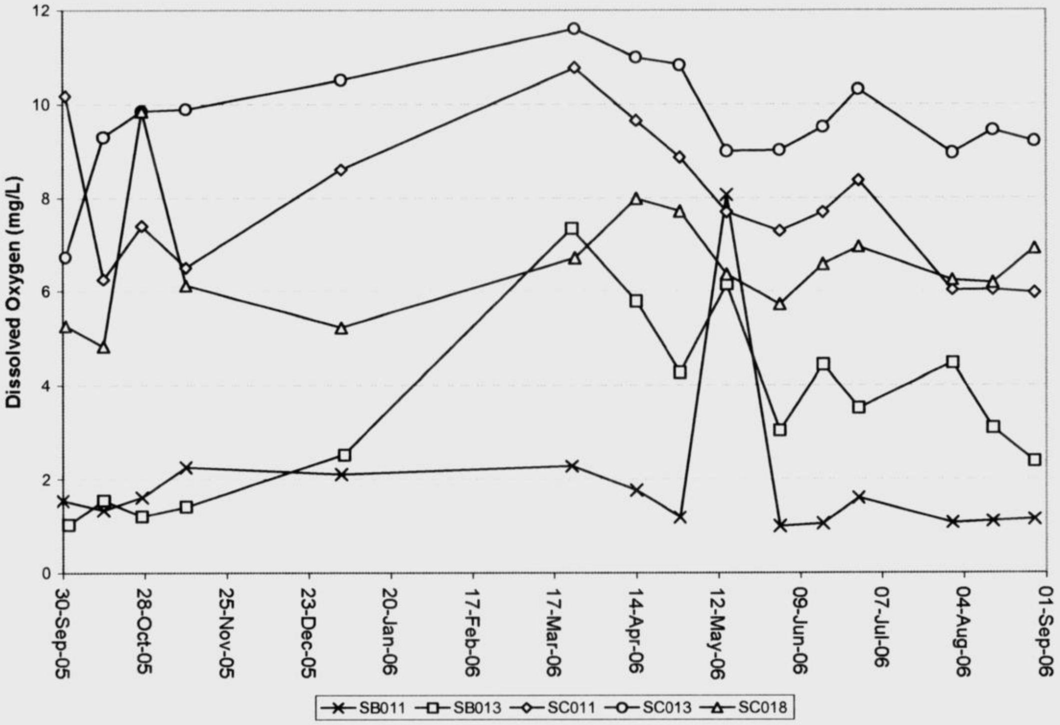


Figure 5. Spring dissolved oxygen concentrations, October 1, 2005 to August 28, 2006.

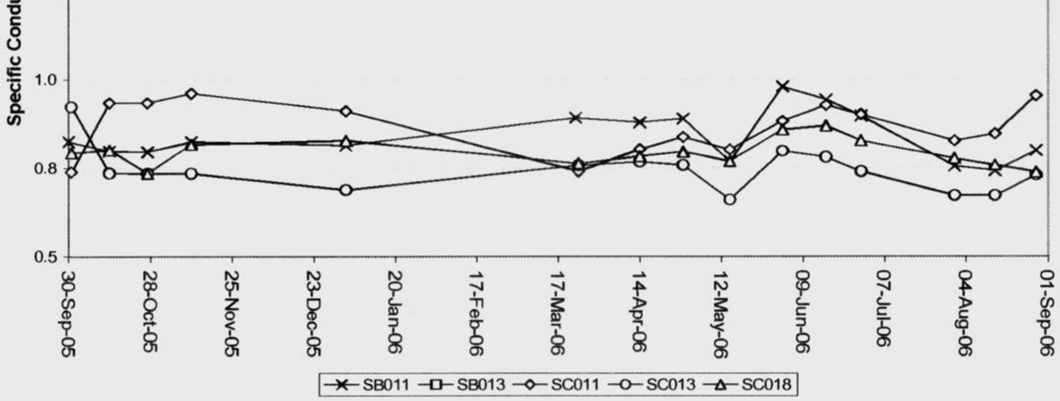


Figure 6. Spring specific conductance data (mS/cm), October 1, 2005 to August 28, 2006.

and the atmosphere. This trend is most prominent at sites where there is a spring pool (SC011, SC018, SB013), instead of direct discharge to a stream or underground piping. Figure 7 shows temperature data collected over the monitoring period, as well as daily high temperatures at the Chilton, WI weather monitoring station.

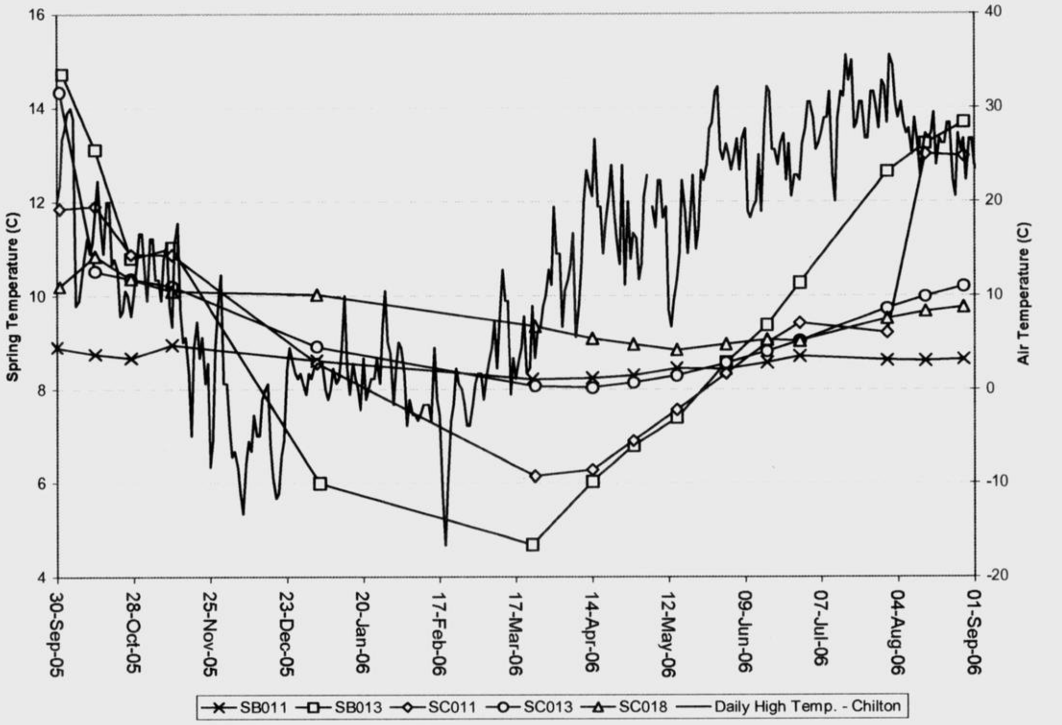


Figure 7. Spring water temperature data and Chilton, WI NWS cooperative observer station daily high air temperature, October 1, 2005 to August 28, 2006.

Anion Concentrations

Water samples were taken at each site to determine concentrations of sulfate, chloride, nitrate and nitrite. Concentrations are expressed on an anionic basis (NO_3^-, SO_4^{-2}, Cl^- and PO_4^{3-}). Total dissolved phosphorus results of August 27 samples analyzed at GBMSD were between 0.05 and 0.09 mg/L as P (Table 2). These concentrations are also likely related to agricultural landuses in spring recharge areas.

Results from GBMSD indicated that TDP concentrations (Table 2) were well below the sensitivity of the Varian ICP used for analysis at UW-Green Bay's Instrument

Table 2. Spring total dissolved phosphorus (TDP) concentrations (as P), 8/27/06.

Site ID	Date	TDP
SB011	8/27/2006	0.05 mg/L
SB013	8/27/2006	0.05 mg/L
SC011	8/27/2006	0.07 mg/L
SC013	8/27/2006	0.09 mg/L
SC018	8/27/2006	0.07 mg/L

Laboratory. Nitrite was not found in any of the water samples. This is confirmed by the CFC age dates, as nitrite typically converts to nitrate in a relatively short period of time. Equipment problems with the ion chromatograph delayed analysis for the March 15, 2006 samples. Due to potential bacterial activity which can affect nutrient concentrations, samples were run for only chloride and sulfate. Figures 6-8 show chloride, sulfate and nitrate concentrations in samples taken at each site. Anion concentration data can be found in Table 2 in Appendix B.

Geochemistry varied from site to site, as well as temporally within the same site. Anion concentrations at site SB011 showed considerable variation for sulfate, but remained relatively stable for chloride and nitrate. The variability of sulfate concentration at site SB011 is not well understood. Nitrate was detected in the October 1, 2006 sample, but in quantities below the calibration curve.

Anion concentrations were substantially higher at site SB013 than the rest of the sites. Nitrate (as NO_3^-) was detected in some of the samples at SB013, but all detected nitrate concentrations were below the lowest calibration standard (3 mg/L). Sulfate and chloride concentrations were 3-10 times higher at SB013 than all other sites. Chloride and nitrate concentrations were substantially lower during a 1998 study of the same spring (Rimal, 1998). The increased anion concentrations observed at this site may be due to aquifer disturbance caused by a large road construction project near the site from 2004 to 2005. Concentrations varied over the course of the year, with the highest value observed in the March 15, 2006 sample. All March 15, 2006 samples show a similar trend.

Anion concentrations at sites SC011, SC013 and SC018 show a very similar pattern in temporal changes, are close in proximity to each other and share similar landuse in upgradient areas (Maps 7 and 9). Chloride concentrations showed a substantial drop in the January 3, 2006 sample, and then rose again in the March sample. Sulfate concentrations varied throughout the year, and showed an increase in concentration

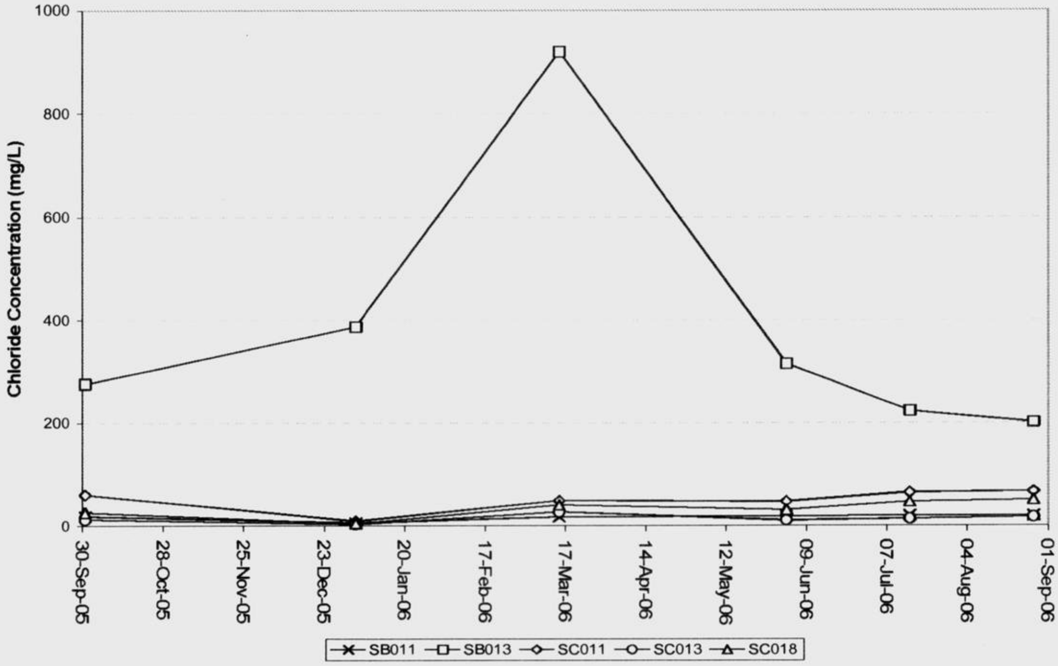


Figure 8. Spring chloride concentrations, October 1, 2005 to August 28, 2006.

during the winter, peaking in spring, and then gradually decreasing through the summer. Nitrate concentrations ranged from 4.5 to 51.5 mg/L for SC013, from 7.8 to 65.4 mg/L for SC011 and from 4.5 to 66.3 for SC018. Peak concentrations for SC013 occurred in January and peak concentrations for SC011 and SC013 occurred in July. The high concentrations (>44 mg/L) followed the unusually wet May and may reflect nutrient applications on agricultural land in close proximity to the springs.

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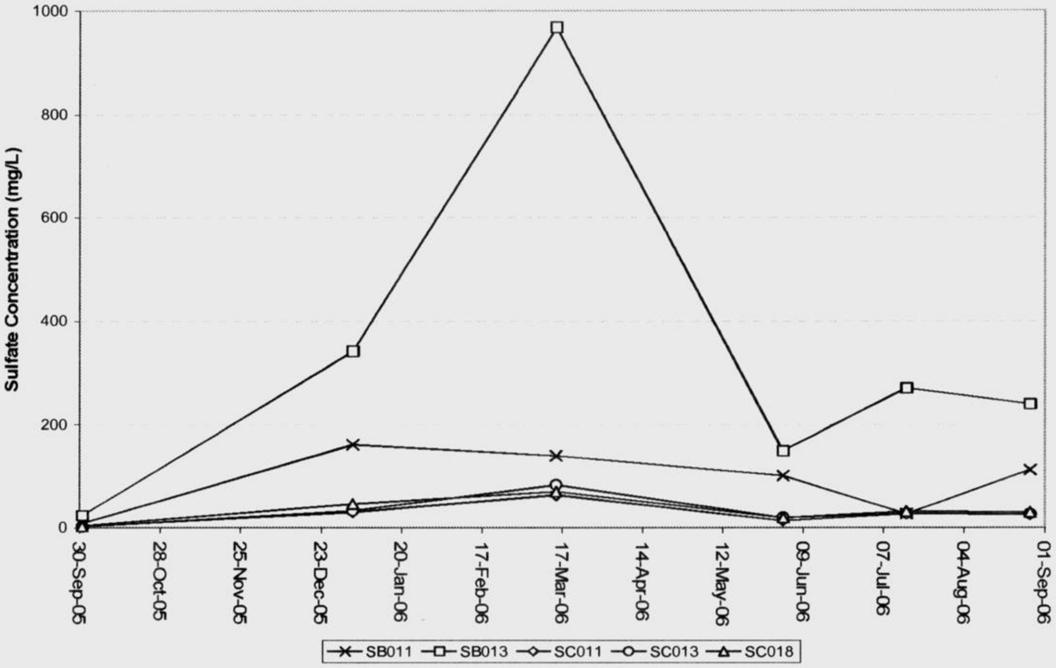

Figure 9. Spring sulfate concentrations, October 1, 2005 to August 28, 2006.

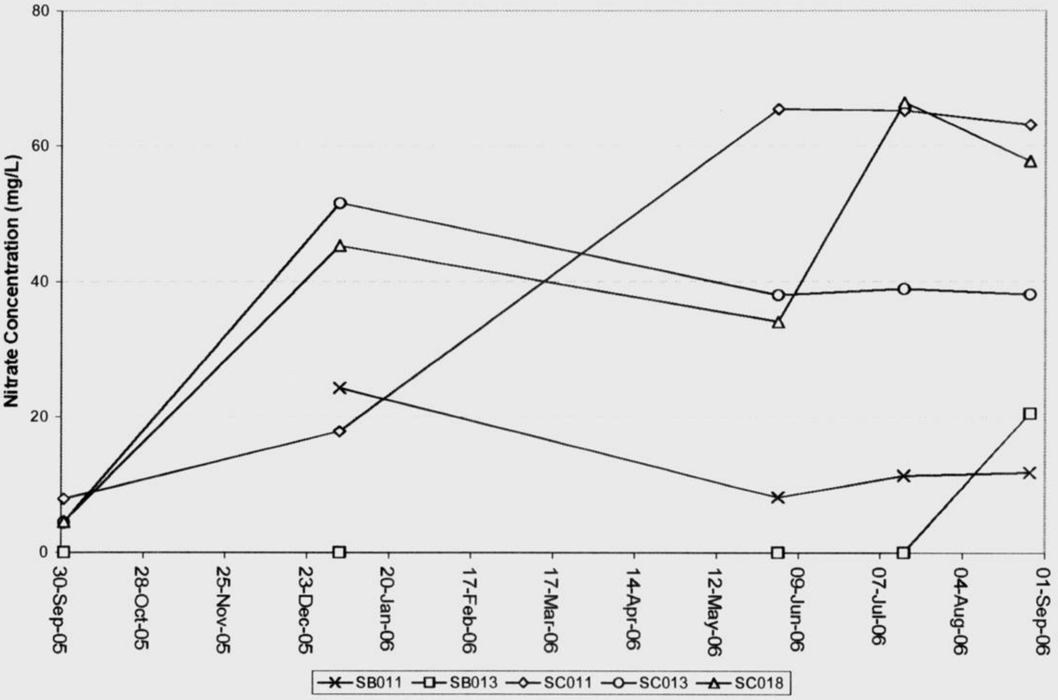

Figure 10. Spring nitrate concentrations, October 1, 2005 to August 28, 2006.

January and peak concentrations for SC011 and SC013 occurred in July. The high concentrations (>44 mg/L) followed the unusually wet May and may reflect nutrient applications on agricultural land in close proximity to the springs.

Total dissolved phosphorus results of August 27 samples analyzed at GBMSD were between 0.05 and 0.09 mg/L as P (Table 2). These concentrations are also likely related to agricultural landuses in spring recharge areas.

Cation concentrations

Water samples were taken at each site to determine concentrations of calcium, magnesium, potassium, sodium, zinc and iron by ICP. Zinc and iron were either not detected or were detected at levels below the calibration curve. Results from GBMSD indicated that TDP concentrations (Table 2) were well below the sensitivity of the Varian ICP used for analysis at UW-Green Bay's Instrument Laboratory. Geochemistry varied from site to site, as well as temporally within the same site. However, there was far less variability in cation concentrations than in anion concentrations. Currently, there is insufficient data to explain the difference in cation and anion concentrations. Alkalinity measurements seem to support the trends seen in temporal cation concentration changes. Alkalinity data are shown in Figure 11, and tabular data are shown in Table 3. Figures 12-15 show cation concentrations for all sites. Cation concentration data is in Appendix B Table 3.

Table 3. Spring outflow alkalinity concentrations (mg/L $CaCO_3$)

Date	SB011	SB013	SC011	SC013	SC018
10/1/2005	332	401	350	340	339
1/3/2006	365	402	320	337	380
3/14/2006	393	396	276	378	332
6/2/2006	389	370	296	368	324
7/15/2006	375	377	323	356	319
8/27/2006	359	401	332	341	334

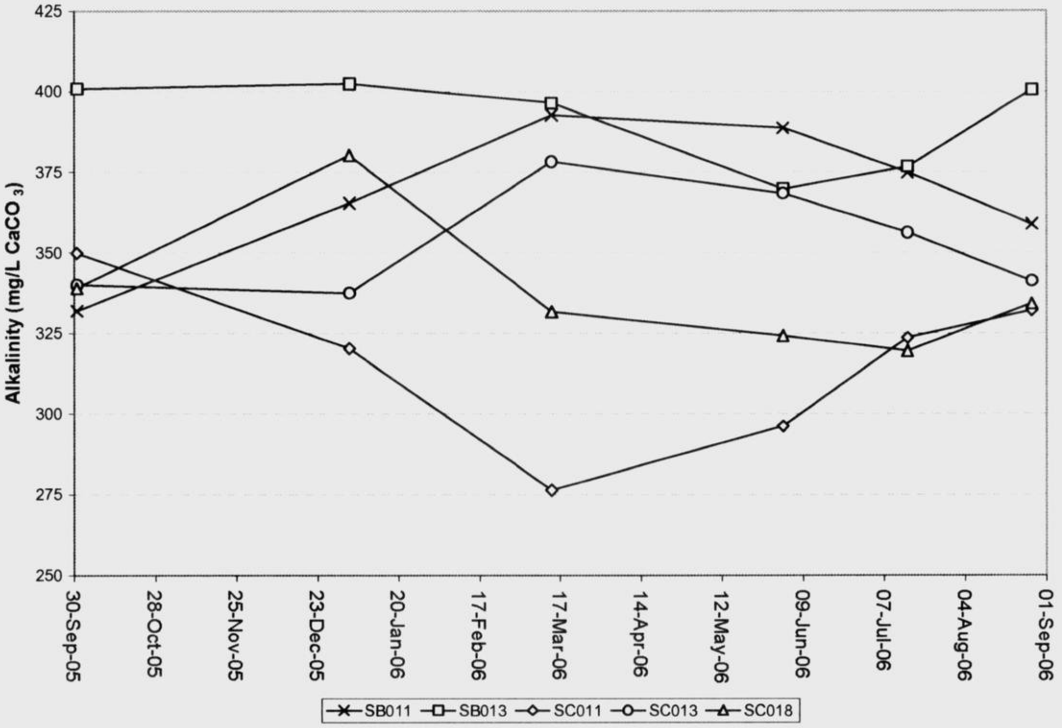

Figure 11. Spring alkalinity concentrations, October 1, 2005 to August 28, 2006.

Cation concentrations at sites SB011 and SC013 show a seasonal trend that increases during the spring and summer, then decreases during the fall and winter. This trend seems to agree with spring discharge data. Alkalinity at this site also follows this trend. Geologically, these sites are very similar, in that they both discharge from the Mayville Formation and have no soil-water interaction.

Cation concentrations at sites SC011 and SC018 show a much different trend than sites SB011 and SC013. The cation concentrations at these sites seem to have an inverse relationship to discharge, where peak cation concentrations occur at low flow times, and low concentrations occur during peak discharge. Alkalinity at these sites also follows this trend. These sites are close to each other (within 1 mile) and are similar

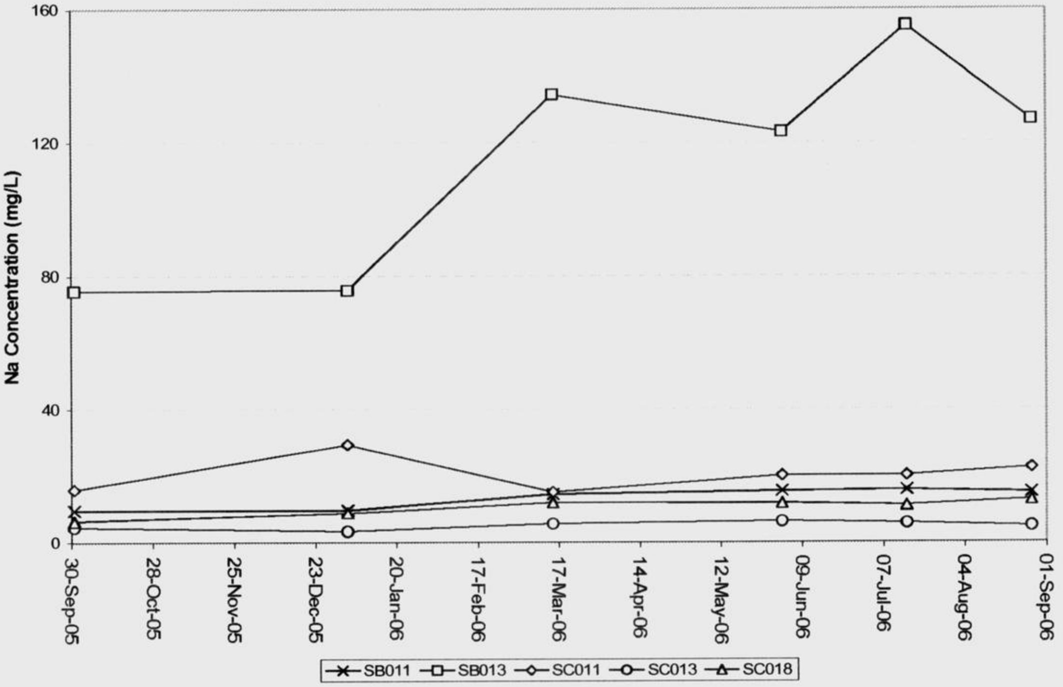

Figure 12. Spring sodium concentrations, October 1, 2005 to August 28, 2006.

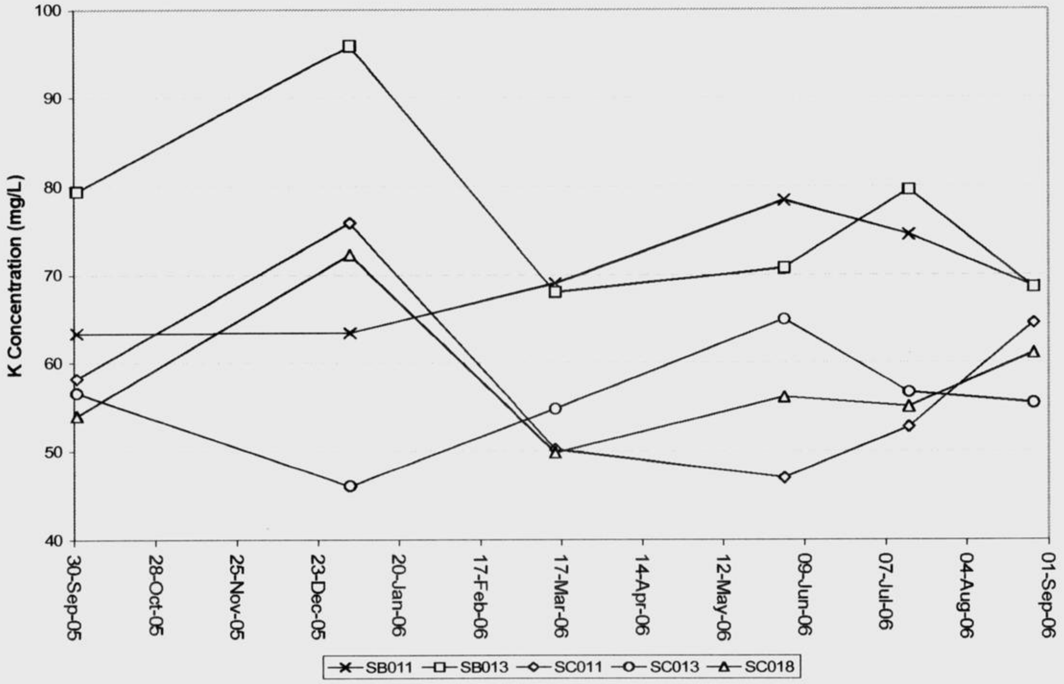

Figure 13. Spring potassium concentrations, October 1, 2005 to August 28, 2006.

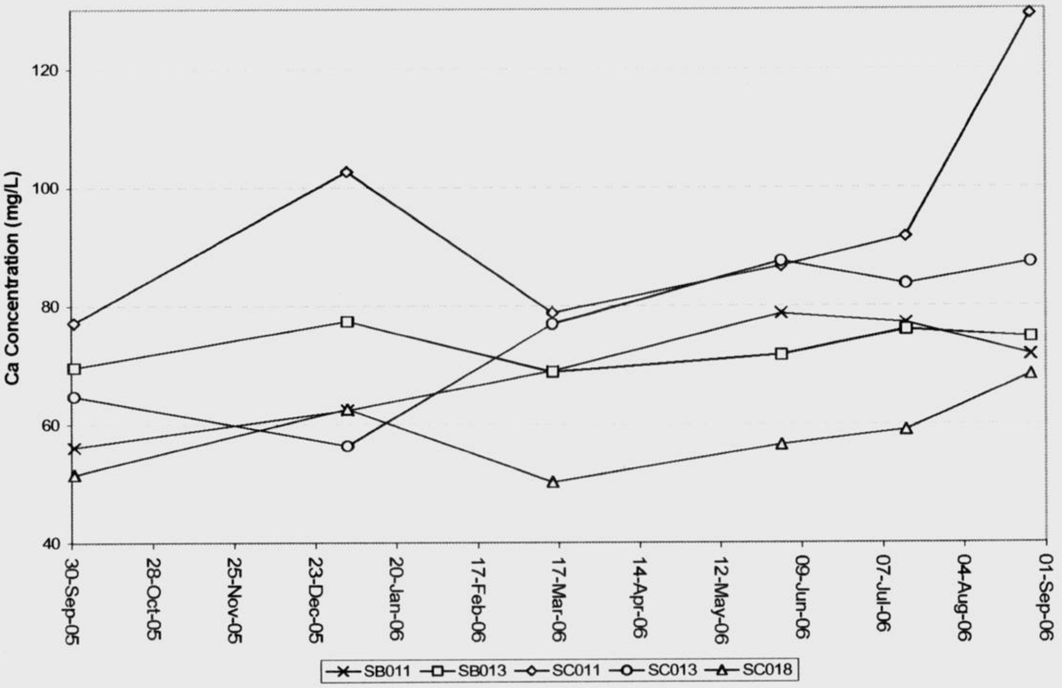

Figure 14. Spring calcium concentrations, October 1, 2005 to August 28, 2006.

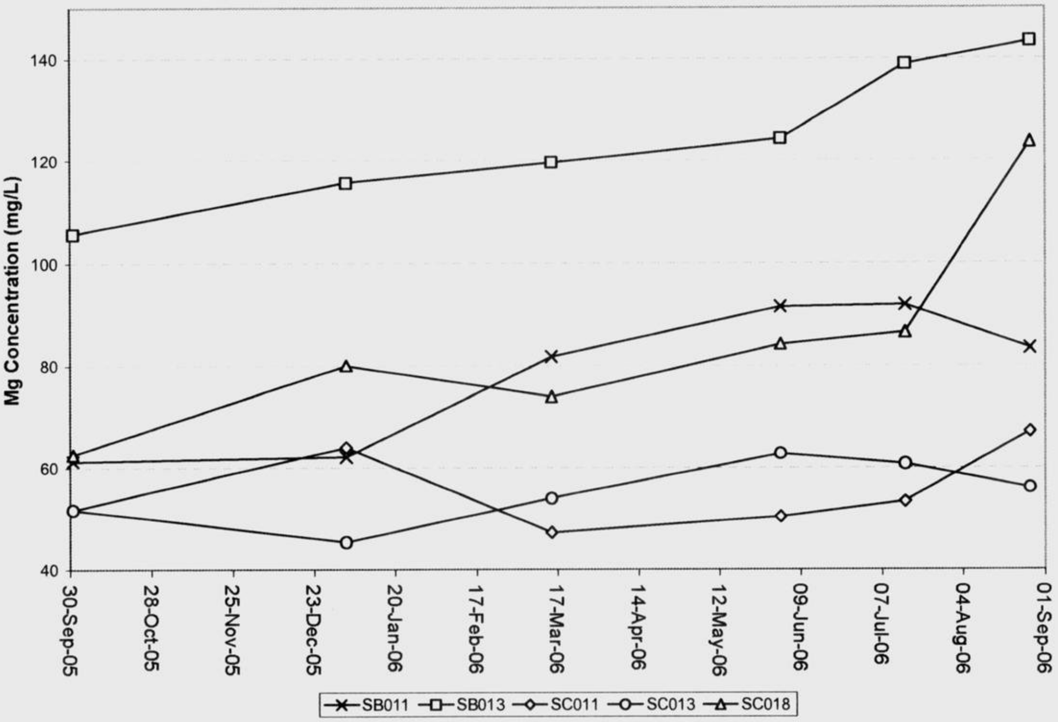

Figure 15. Spring magnesium concentrations, October 1, 2005 to August 28, 2006.

geologically. Both springs flow through layers of gravel, sand and muck before reaching the surface.

Site SB013 cation concentration data do not show any trends. Discharge rates remained at a trickle throughout the monitoring period and cannot be used as a comparison. Significant ground disturbance near the spring during a recent road construction project may have impacted the geochemistry at this site. Winter deicing salts applied to a road approximately 50 meters upgradient from the spring may also impact the geochemistry at this site.

Piper Plots

Piper plots were used to compare cation, anion and alkalinity concentrations found in the samples (Figures 13-18). Species concentrations are converted to milliequivalents, and are then totaled and compared by the percentage of the total for each species. Rockworks© was used to create the Piper plots and display the data.

Ionic balance for all sites differences range from 3.3% to 46.5%. This indicates that there is either a problem with the analytical techniques used or that there are other unidentified ions present in the sample. Calculations and procedures were double-checked to eliminate the possibility of analytical error. Samples have only 48 hours hold time before expiration, eliminating the possibility of re-running the samples.

The Piper plots for sites SB011, SC011 and SC013 show that Mg accounts for approximately 60% of the total cationic species, with Ca and Na+K each accounting for approximately 20%. Temporal distribution of a cationic species show little change. The samples are all bicarbonate-dominated, with sulfate and chloride concentrations varying over time. Anions show far more variability with a wide range in values.

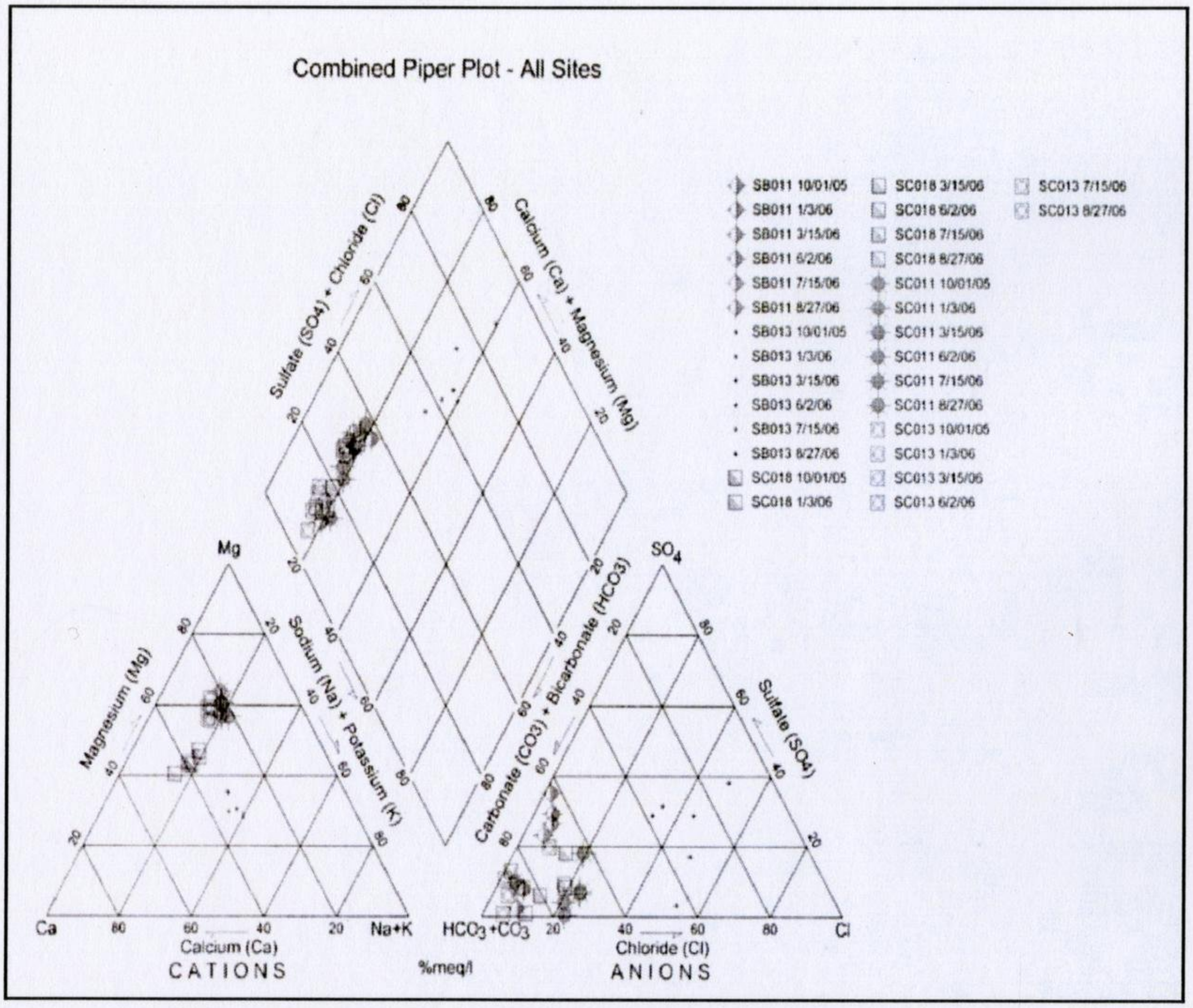

Figure 16. Spring geochemical piper plot. All sites and sampling events included.

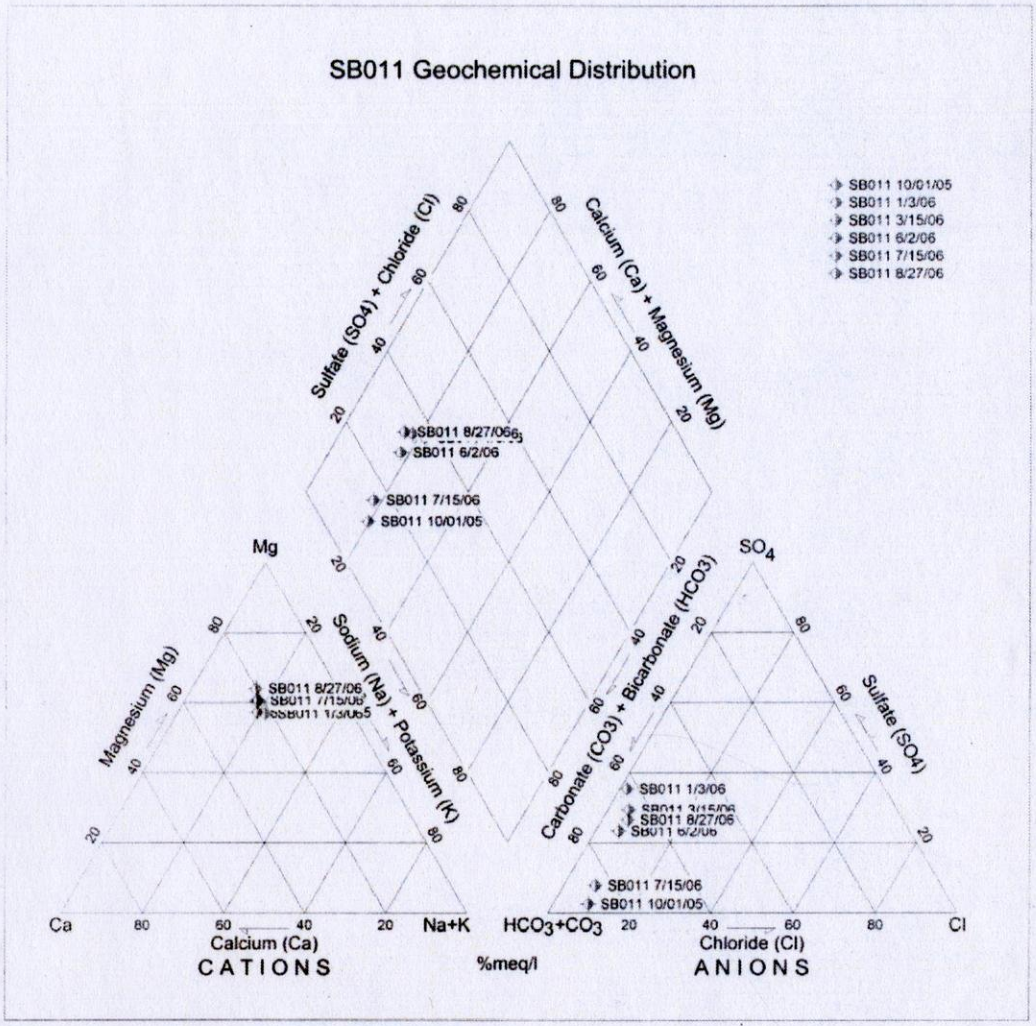

Figure 17. Site SB011 Piper Plot.

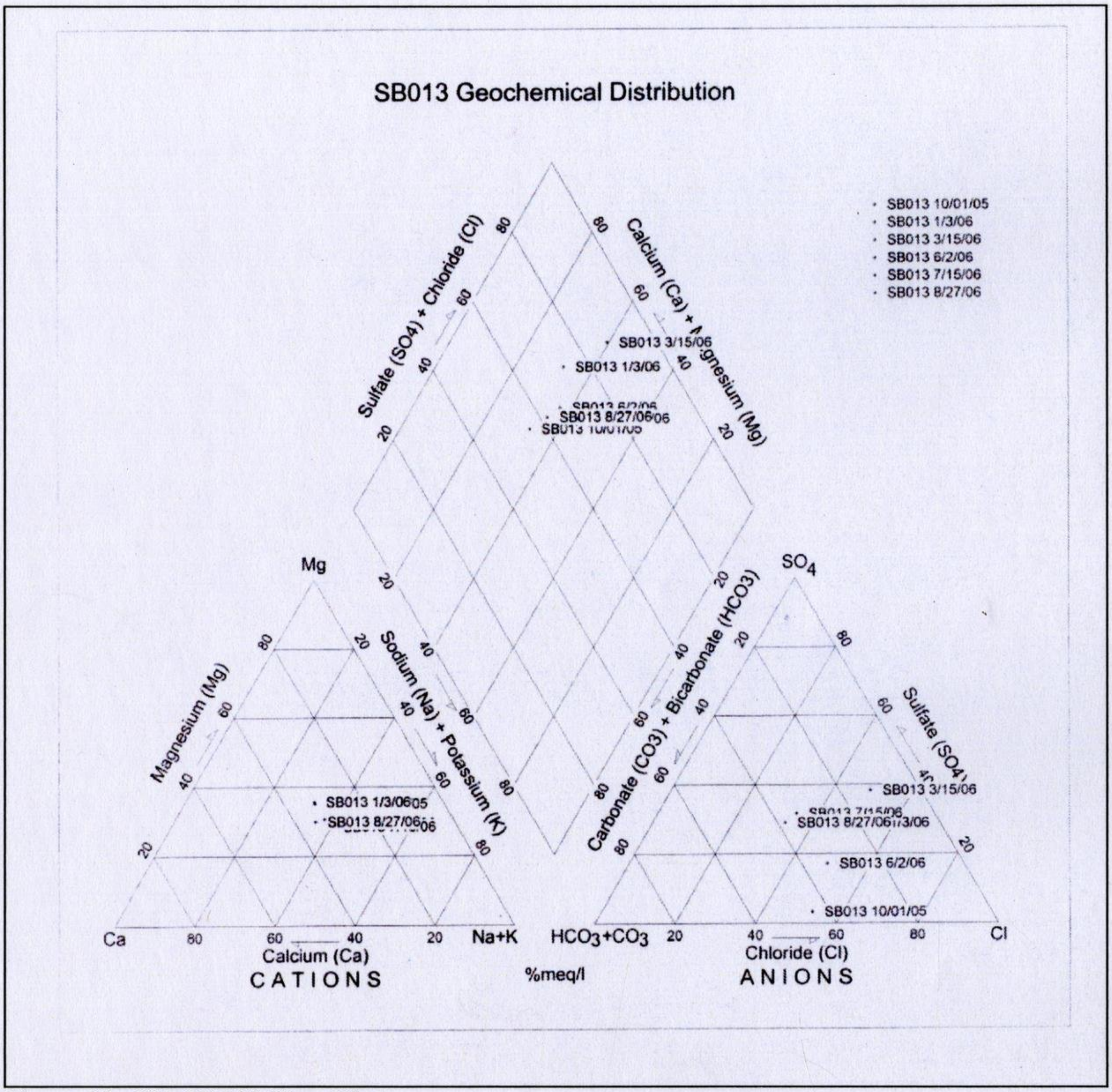

Figure 18. Site SB013 Piper Plot.

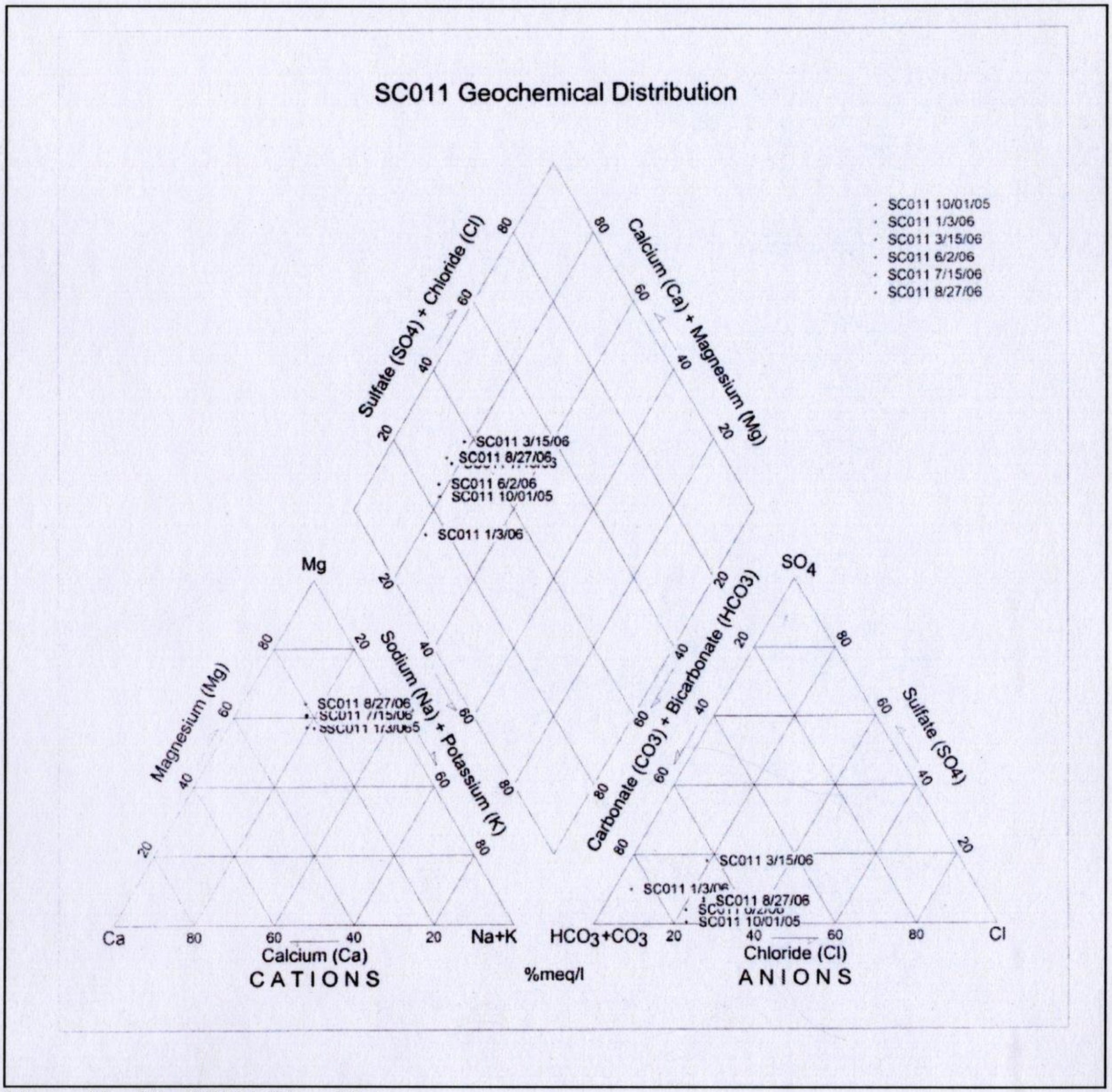

Figure 19. Site SC011 Piper Plot.

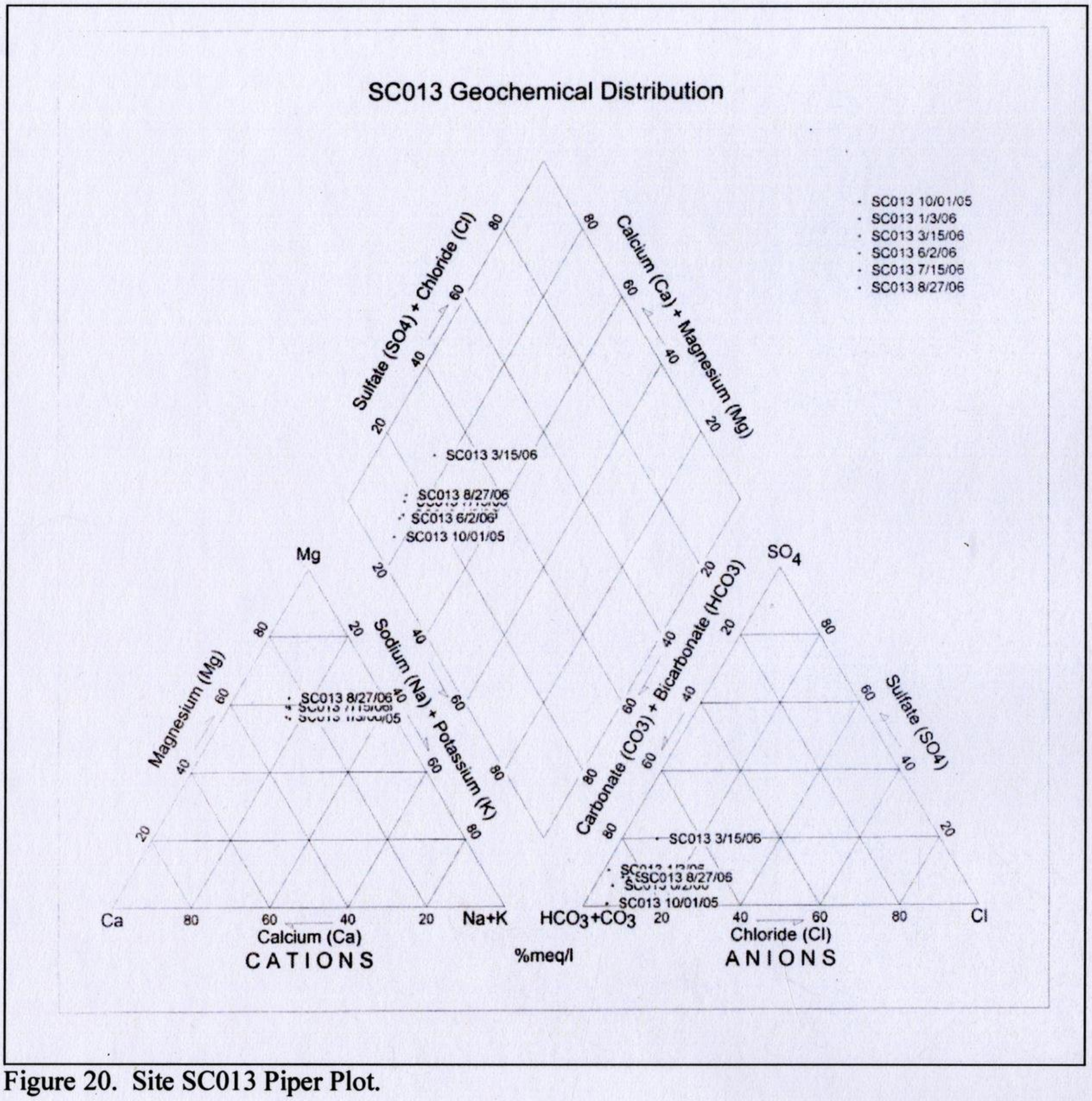

Figure 20. Site SC013 Piper Plot.

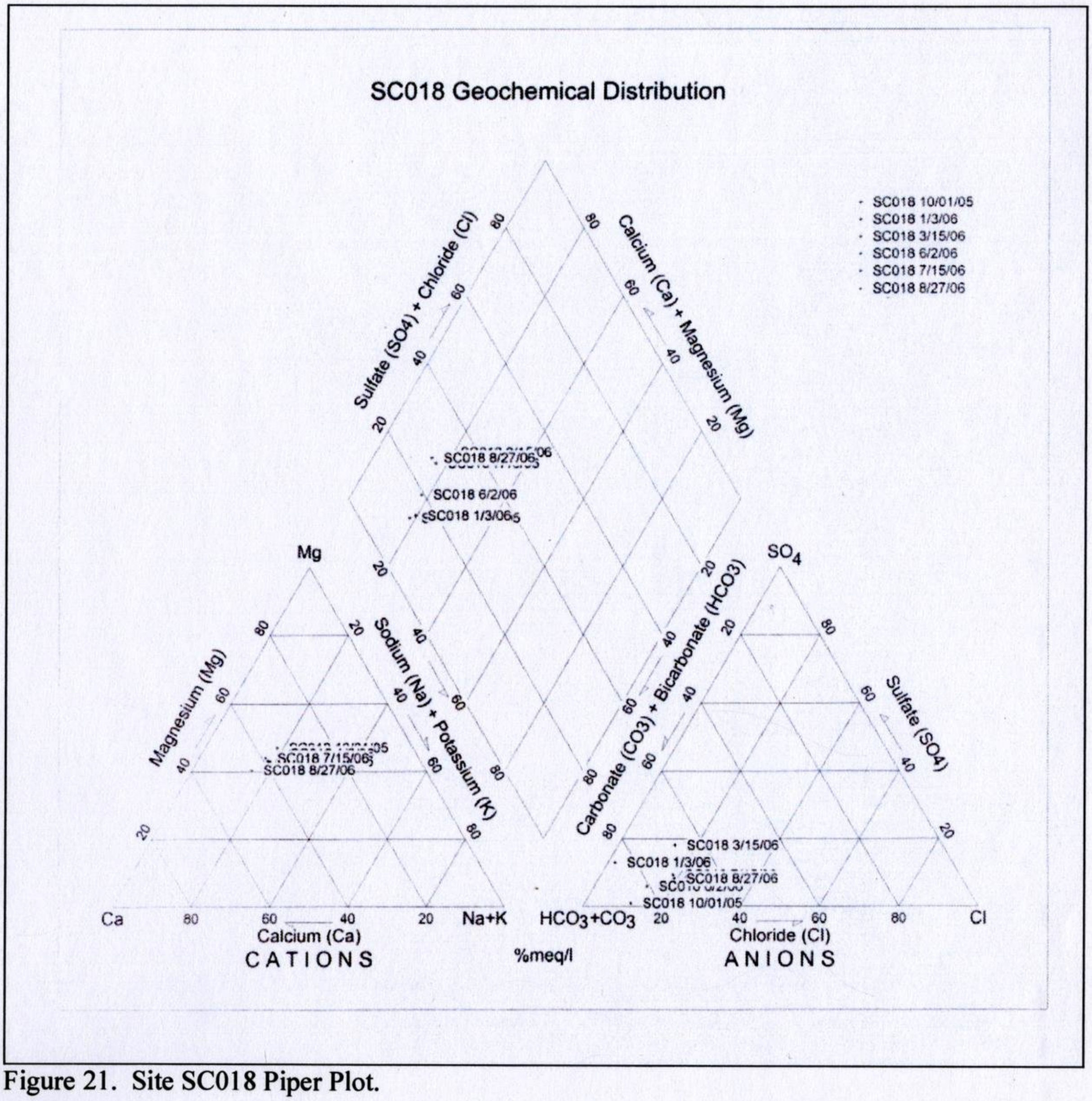

Figure 21. Site SC018 Piper Plot.

Outliers are present for each site. However, the sample dates for the outliers vary from site to site. This indicates that there is no analytical bias.

The Piper plot for site SB013 (Figure 18) shows cation concentrations that are roughly equivalent for Ca, Mg and Na+K. Anion concentrations are widely scattered and are split between sulfate-dominated and chloride-dominated. Outliers at site SB013 are samples taken on 1/3/06 and 3/15/06. The two highest ionic balance difference values (15.8% and 46.5%) are associated with these two samples, respectively. Ionic balance for the other four samples ranged from 3.3% to 9.4%.

Cation concentrations for all SC018 (Figure 21) samples are approximately 40% Mg, 40% Ca and 20% Na+K. All samples show very similar milliequivalent concentrations for cations. Anion concentrations vary much more than cation concentrations, and are all bicarbonate-dominated, with varying amounts of chloride and sulfate. Ionic balance differences vary between 8.8% and 29.7%.

Sites SB011, SC011 and SC013 have very similar geochemistry. Site SC018 is slightly different than the three previously mentioned sites, in that it has a Mg:Ca:Na+K ratio of approximately 40:40:20, instead of the 60:20:20 ratio seen at the other sites. Anions at all four of these sites are very similar, and are all bicarbonate-dominated.

Site SB013 is substantially different from the other four sites (Figure 16). Cations are almost evenly proportioned, and anions are chloride and sulfate-dominated (Figure 18).

CFC Age-Dating

CFC age-date samples were taken October 1, 2005 and June 3, 2006 to determine the residence time of groundwater in this system. Gas samples were taken using the Pumping-Induced Ebullition (PIE) method developed by Browne (2004). Samples were collected and shipped to the Trace Gas Analysis Laboratory at UW-Stevens Point for analysis. Results varied by site, with a range in age dates from 1966 to 1985 for the October samples, and 1976 to 1986 for the June samples. Difference in age date also showed a wide range, from -2.6 years for site SC018 to +9.8 years for site SB011. CFC age-date results are listed in Table 4. Average apparent age-dates for groundwater at the Calumet County sites are within approximately two years of each other.

Table 4. Apparent CFC Age-date results.

Site ID	**Average Oct 2005**	**Average June 2006**	**Difference Jun-Oct**	**Average**
SB011	1966.3	1976.0	9.8	**1971.1**
SC013	1983.2	1981	-2.2	**1982.1**
SC018	1985.8	1983.3	-2.6	**1984.5**
SC011	1981.0	1986.3	5.3	**1983.7**
SB013	1977.5	1976.8	-0.8	**1977.1**

Several factors may be responsible for the difference in age-dates. Groundwater flow through a fractured dolostone aquifer can have dramatic changes in flow rate over short periods of time. This will also affect residence time, which the CFC age-date measures.

Contamination of the samples with modern atmospheric gasses can also affect CFC age-date results. Samples were taken with care to avoid contamination. However, groundwater interaction with the atmosphere is possible in shallow aquifers, especially in areas where sink holes are common and there is thin soil covering the bedrock.

Lastly, mixing groundwater of different ages can also affect age dates. An increase in water table elevation can cause two previously unmixed parts of an aquifer to contact each other in a fractured dolostone aquifer.

Ecological Assessments

Site landscape context, environment, habitat

Site SB013

Landscape context

Within a mesic upland forest along the Niagara escarpment near the Green Bay of Lake Michigan, in a suburban setting on a university campus. Increasing development to the east could possibly impact the water table. A Typha/Phalaris marsh is located to the west, a spring fed pond to the NW, and additional ponds on the campus.

Site description

Evidence of a historic dwelling includes a stone wall, cellar pit and bermed pool at spring. Current anthropogenic disturbance is from frequent hiking, biking and occasional maintenance vehicle use of a trail routed along the channel. There are roads within 50 m of the site. At the time of the survey, there was no flow out of the dug pool, and flow within the channel was quickly dissipated. The channel was unvegetated.

Wildlife observations

5 *Rana Clamitans* within the dug pool.

Site SB011

Landscape context

Within a mesic upland forested valley within a matrix of agricultural fields (currently closest fields are planted to alfalfa).

Site description

Valley is approximately 100 m wide, with a flat terraced bottom & steep sides. A dirt road accesses the spring area. Spring flow has been diverted to a bottling plant piping accessible through a vertical culvert. Forested hillsides have been cutover, and the area near spring culverts suggests recent grading, which may explain the lack of tall trees in the immediate area. Hillsides have sparse undercover, however the presence of a few spring flowering plants suggests more undercover may be present before leafout. The sparse layer of leaf litter suggests a high degree of runoff during rain events. The channels are primarily unvegetated but, at the time of the plant survey, mostly moist with only short stretches of water flow.

Wildlife observations

Numerous deer tracks, a few raccoon tracks, Catbird heard, Red-tailed Hawk (*Buteo jamaicensis*) seen overhead, 5 *Rana clamitans* seen in inundated ruts of access road.

Site SC013

Landscape context

Within a matrix of fields and agricultural fields below the Niagara escarpment within 1 mile of Lake Winnebago. Stream channel flows into the lake, passing through a culvert under the 2-lane highway crossing at the foot of the site.

Site description

This site has a high degree of disturbance, both anthropogenic and by livestock. The site is located within an active pasture, near corn fields. Habitat changes from east to west. Three springs, and likely more seeps, emerge within 15 m of each other near the base of the steep escarpment within a shrubby woods. There are narrow animal trails lacing the hillside. Fine soil has been washed out in this area, before the flow merges into a narrow channel. An additional spring, with a narrow swath of riparian vegetation, joins the channel about 30 m downstream. Scattered low trees grow along the middle length of channel. The lower channel, just east of the highway, is extremely muddied and trampled by cattle. The farm residence makes use of piped spring water for garden watering.

Wildlife observations

1 *Rana pipiens* seen near the muddied lower channel.

Site SC011

Landscape context

Primarily agricultural, with additional riparian vegetation (Typha/sedge meadow to the north) near the site. Channel flows approximately 2 miles to enter Lake Winnebago.

Site description

The springs are in a farmyard, emerging within 30 m of a road. Several springs emerge into a large pool which flows into a channel passing through a culvert under the road where it joins an additional channel from a spring to the south emerging in the lawn, with channel passing through a second culvert and routed along the road. There is a very wide buffer (>100m) of Salix swamp (to the north)/meadow (to the south) along the channel to the west of the road. Although there is a great deal of anthropogenic disturbance near the springs (mowed lawn, corn fields), the channels appear to be more or less left alone. The buffer around the pool varies from ~3m to the south to >50m to the north, while the buffer around the southern spring is ~1 m each side. Mid-canopy trees are on the north side of the pool only, and corn field to the east of the pool and to the south of the southern spring.

Wildlife observations

Rana clamitans observed in the pool.

Site SC018

Landscape context

Within a matrix of agricultural fields. Channel flows approximately 2 miles to enter Lake Winnebago.

Site description

Spring emerges into a dug pool just below a corn field, with a channel crossing within 10 m through a culvert under a road and then immediately captured by piping. This enters a trough within a mowed yard. In the past, the water was used by the farm and house, but is now let free east of the barnyard. This site has a high degree of anthropogenic disturbance. The slope between the pool and the corn field was pretty bare at a mid-June visit, indicating no recent filtration of runoff from the field. By the time of the plant survey, a number of adventive plants had begun colonizing the area. Apparently a tree (*Salix sp.*) was recently cut down and some burning was done. This disturbance likely had a great effect on water quality, and the lack of shade and leaf litter input may create a different future aquatic environment than previously present. A visit in mid-August showed adventive species had covered >90% of the bare soil.

Wildlife observations

3 *Rana clamitans* seen in the pool, and more unidentified frogs glimpsed.

Aquatic Invertebrates

The spring at site SB011 was not sampled due to the fact that the spring discharge is captured and diverted to a bottling facility. Because of the small pool size and low flow level, the spring at site SB013 was sampled by disturbing the bottom. Only a small number of invertebrates were obtainable. When a single taxa was dominant (i.e. Isopoda at SC018 pool), excess individuals were ignored while the tray was searched for additional taxa. Invertebrate species lists and data are located in Appendix B Tables 4-11. Plant survey lists are located in Appendix B Tables 12-21. Site description forms and geomorphology datasheets are located in Appendix C.

Summary

Based on our observations none of the sites meet the spring discharge rates (>1 CFS for 80% of the time) required for protection under Wisconsin Act 310.

Geochemistry of the spring waters is affected most by upgradient land use and interactions between groundwater and the substrate it flows through. Geochemically, spring flow at SB013 is significantly different from the other sites. The other sites show similar geochemical characteristics. Spatial and temporal trends can be seen in the data at some sites, while others seem to have less order. Alkalinity and cation concentrations seemed to follow the same trends, while anion concentration appears to be more independent.

All sites within the study area have some degree of anthropogenic disturbance, ranging from being close to recreational areas to capture and diversion for use as an economic resource. Site disturbances have had a significant impact on plant and invertebrate communities. All springs except for site SB013 are located in agricultural areas and are at risk of contamination from nutrients applied upgradient.

Conclusions

This study has provided a full year of baseline data, and should be followed up with long-term study. The use of continuous monitoring equipment, such as a Hydrolab MS4a or MS5 Datasonde, combined with continuous flow monitoring would improve data resolution and allow a better comparison of precipitation and discharge This would also make it possible to determine how flow rates affect basic spring water chemistry. Decreasing the amount of time between water quality sampling events would also help resolve the data.

Springs in the study area do not fall under the protection of Wisconsin Act 310 because none of the springs discharged at a rate of 1 CFS for 80% of the time. Site SC011 did reach discharge rates greater than 1 CFS, but only for approximately 25% of the monitoring period.

Anthropogenic disturbances at all sites have diminished habitat quality at all sites. None of the springs in the study area have a completely native ecology. However, many of the sites do retain some native species and provide needed habitat.

Acknowledgements

We would like to thank the Wisconsin Department of Natural Resources for funding this project and for their continued support. A special thanks goes out to Aleeca Forsberg for her diligent work preparing the funding proposal for this project. Juniper Sundance and Carolina Bacelis were instrumental in completing the biological and ecological portions of this study. Their work is truly appreciated. We would also like to thank Michael Stiefvater (Cofrin Center for Biodiversity) for his help preparing the site maps found in this report.

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APPENDIX A – DATA CD

APPENDIX B – GEOCHEMICAL AND BIOLOGICAL DATA

Table 1. Bi-weekly monitoring data.

Spring	Date	Temp C	SpC (mS/cm)	D.O. (mg/L)	pH	D.O. %	Stage (cm)	Q (CFS)
SB011	9/30/2005	8.90	0.825	1.54	7.50	13.1	N/A	*
SB011	10/14/2005	8.75	0.798	1.33	7.60	12.3	N/A	*
SB011	10/27/2005	8.67	0.796	1.61	7.72	15.0	N/A	*
SB011	11/11/2005	8.95	0.824	2.25	7.84	20.6	N/A	*
SB011	1/3/2006	8.61	0.814	2.10	7.96	19.3	N/A	*
SB011	3/23/2006	8.21	0.892	2.27	7.88	19.7	N/A	*
SB011	4/14/2006	8.24	0.879	1.76	7.81	14.6	N/A	*
SB011	4/29/2006	8.30	0.889	1.18	7.25	10.0	N/A	*
SB011	5/15/2006	8.45	0.769	8.06	8.19	67.7	N/A	*
SB011	6/2/2006	8.43	0.980	0.99	8.09	8.7	N/A	*
SB011	6/17/2006	8.57	0.943	1.05	7.41	9.3	N/A	*
SB011	6/29/2006	8.70	0.897	1.60	7.56	12.3	N/A	*
SB011	7/31/2006	8.62	0.755	1.07	7.96	9.1	N/A	*
SB011	8/14/2006	8.61	0.742	1.10	7.32	9.7	N/A	*
SB011	8/28/2006	8.64	0.799	1.14	7.39	9.9	N/A	*
Spring	**Date**	**Temp C**	**SpC (mS/cm)**	**D.O. (mg/L)**	**pH**	**D.O. %**	**Stage (cm)**	**Q (CFS)**
SB013	10/2/2005	14.72	1.770	1.03	7.48	10.2	N/A	**
SB013	10/14/2005	13.11	1.700	1.55	7.39	14.3	N/A	**
SB013	10/27/2005	10.79	1.690	1.20	7.56	11.0	N/A	**
SB013	11/11/2005	11.02	1.730	1.41	7.42	13.3	N/A	**
SB013	1/4/2006	5.99	1.910	2.52	7.44	21.0	N/A	**
SB013	3/23/2006	4.68	1.750	7.34	7.66	58.3	N/A	**
SB013	4/14/2006	6.03	1.840	5.78	7.70	47.1	N/A	**
SB013	4/29/2006	6.79	1.980	4.27	7.93	35.5	N/A	**
SB013	5/15/2006	7.38	1.660	6.14	8.23	51.3	N/A	**
SB013	6/2/2006	8.57	1.560	3.03	8.08	28.4	N/A	**
SB013	6/17/2006	9.37	1.640	4.43	7.75	40.2	N/A	**
SB013	6/29/2006	10.27	1.610	3.51	7.30	31.1	N/A	**
SB013	7/31/2006	12.63	1.530	4.47	6.89	42.6	N/A	**
SB013	8/14/2006	13.23	1.530	3.09	6.83	30.1	N/A	**
SB013	8/28/2006	13.68	1.720	2.38	6.80	23.5	N/A	**

Table 1. Continued

Spring	Date	Temp C	SpC (mS/cm)	D.O. (mg/L)	pH	D.O. %	Stage (cm)	Q (CFS)
SC011	10/1/2005	11.85	0.739	10.18	8.02	94.2	6.1	0.04
SC011	10/14/2005	11.90	0.934	6.25	7.59	58.6	4.4	0.02
SC011	10/27/2005	10.88	0.934	7.40	7.87	65.0	4.1	0.02
SC011	11/11/2005	10.87	0.961	6.50	7.99	61.9	5.1	0.03
SC011	1/3/2006	8.55	0.911	8.60	7.48	75.1		0.02[a]
SC011	3/24/2006	6.14	0.740	10.78	7.83	88.1		0.5[a]
SC011	4/14/2006	6.28	0.803	9.65	8.08	77.8		2[a]
SC011	4/29/2006	6.90	0.837	8.87	7.74	72.8		2[a]
SC011	5/15/2006	7.56	0.802	7.69	8.27	64.5		2.97
SC011	6/2/2006	8.33	0.882	7.29	7.97	65.1		3.34
SC011	6/17/2006	8.99	0.927	7.69	7.57	68.8		2.24
SC011	6/29/2006	9.41	0.901	8.37	7.60	72.4		1.81
SC011	7/31/2006	9.21	0.827	6.02	7.45	58.1		1[a]
SC011	8/14/2006	13.01	0.847	6.03	7.11	58.3		0.47
SC011	8/28/2006	12.97	0.954	5.96	7.09	57.8		0.19

Spring	Date	Temp C	SpC (mS/cm)	D.O. (mg/L)	pH	D.O. %	Stage (cm)	Q (CFS)
SC013	10/1/2005	14.33	0.924	6.73	7.47	67.3	6	0.04
SC013	10/14/2005	10.52	0.736	9.30	7.98	84.5	6.4	0.05
SC013	10/27/2005	10.36	0.735	9.85	8.28	87.6	5.8	0.04
SC013	11/11/2005	10.20	0.735	9.89	8.40	89.8	6.1	0.04
SC013	1/3/2006	8.91	0.688	10.52	8.30	92.9	7.1	0.07
SC013	3/24/2006	8.07	0.757	11.61	8.22	100.4	12.3	0.26
SC013	4/14/2006	8.03	0.768	11.00	7.99	93.3	11.5	0.22
SC013	4/29/2006	8.14	0.758	10.84	8.30	91.9	10.2	0.16
SC013	5/15/2006	8.29	0.660	9.00	8.45	76.7	12.8	0.29
SC013	6/2/2006	8.56	0.798	9.02	8.43	80.7	11	0.19
SC013	6/17/2006	8.81	0.781	9.51	8.02	84.6	8.1	0.09
SC013	6/29/2006	9.03	0.740	10.32	7.90	88.3	7.5	0.08
SC013	7/31/2006	9.72	0.672	8.96	8.03	79.1	8	0.09
SC013	8/14/2006	9.98	0.672	9.44	7.84	85.3	7.1	0.07
SC013	8/28/2006	10.20	0.730	9.21	7.77	83.7	6	0.04

Table 1. Continued

Spring	Date	Temp C	SpC (mS/cm)	D.O. (mg/L)	pH	D.O. %	Stage (cm)	Q (CFS)
SC018	10/1/2005	10.20	0.793	5.26	7.37	47.6	N/A	0.04
SC018	10/14/2005	10.84	0.801	4.82	7.58	45.5	N/A	0.05
SC018	10/27/2005	10.36	0.735	9.85	8.28	87.6	N/A	0.04
SC018	11/11/2005	10.09	0.817	6.12	7.89	54.0	N/A	0.04
SC018	1/3/2006	10.02	0.828	5.22	7.45	47.2	N/A	0.04
SC018	3/24/2006	9.34	0.762	6.71	7.79	59.0	N/A	0.3 [a]
SC018	4/14/2006	9.09	0.783	7.98	7.29	69.2	N/A	0.3 [a]
SC018	4/29/2006	8.96	0.796	7.71	7.89	65.0	N/A	0.3 [a]
SC018	5/15/2006	8.84	0.769	6.36	8.07	54.6	N/A	0.4 [a]
SC018	6/2/2006	8.96	0.858	5.72	8.14	52.0	N/A	0.15 [a]
SC018	6/17/2006	9.06	0.869	6.58	7.60	59.0	N/A	0.1[a]
SC018	6/29/2006	9.03	0.827	6.95	7.49	59.9	N/A	0.15[a]
SC018	7/31/2006	9.51	0.777	6.24	7.64	55.1	N/A	0.15[a]
SC018	8/14/2006	9.66	0.758	6.18	7.15	55.4	N/A	0.2[a]
SC018	8/28/2006	9.75	0.738	6.91	7.34	62.7	N/A	.2[a]

* Unable to measure flow – spring is captured and diverted to bottling plant.

** Spring discharge too low to measure and no channel is formed to contain flow.

[a] Discharge visually estimated.

Table 2. Anion concentration data.

SB011	Chloride	Nitrate	Sulfate
10/1/2005	18.8		7.6
1/3/2006	5.8	24.3	161.1
3/15/2006	18.1		139.1
6/2/2006	18.2	8.1	100.8
7/15/2006	20.1	11.3	26.9
8/27/2006	19.7	11.8	112.0
SC011	Chloride	Nitrate	Sulfate
10/1/2005	60.5	7.8	1.9
1/3/2006	9.5	17.8	29.5
3/15/2006	49.2		62.9
6/2/2006	47.9	65.4	12.9
7/15/2006	65.1	65.1	26.4
8/27/2006	67.0	63.0	24.8
SC018	Chloride	Nitrate	Sulfate
10/1/2005	26.6	4.5	3.0
1/3/2006	4.4	45.3	45.7
3/15/2006	41.0		70.0
6/2/2006	31.2	34.0	18.8
7/15/2006	47.0	66.3	31.8
8/27/2006	51.2	57.6	29.8
SB013	Chloride	Nitrate	Sulfate
10/1/2005	275.7	ND	23.5
1/3/2006	386.9	ND	341.1
3/15/2006	919.5		967.5
6/2/2006	314.8	ND	148.8
7/15/2006	223.4		270.2
8/27/2006	201.2	20.5	239.3
SC013	Chloride	Nitrate	Sulfate
10/1/2005	12.0	4.4	2.1
1/3/2006	2.7	51.5	32.3
3/15/2006	27.5		82.9
6/2/2006	10.6	38.0	19.7
7/15/2006	14.1	38.9	27.3
8/27/2006	17.4	38.1	26.4

Table 3. Cation concentration data.

SB011	Na (mg/L)	K (mg/L)	Mg (mg/L)	Ca (mg/L)
10/1/2005	9.6	63.4	61.3	56.1
1/3/2006	9.6	63.4	62.1	62.4
3/15/2006	14.4	69.0	81.8	69.0
6/2/2006	15.4	78.4	91.5	78.7
7/15/2006	15.6	74.5	91.9	77.1
8/27/2006	14.9	68.6	83.4	71.7

SC011	Na (mg/L)	K (mg/L)	Mg (mg/L)	Ca (mg/L)
10/1/2005	15.8	58.2	51.7	77.1
1/3/2006	29.3	75.9	64.0	102.7
3/15/2006	15.0	50.2	47.2	78.8
6/2/2006	20.0	47.0	50.4	86.6
7/15/2006	20.0	52.7	53.3	91.6
8/27/2006	22.3	64.5	67.1	129.1

SC018	Na (mg/L)	K (mg/L)	Mg (mg/L)	Ca (mg/L)
10/1/2005	6.3	54.0	62.6	51.5
1/3/2006	8.8	72.3	80.1	62.6
3/15/2006	11.8	49.8	73.9	50.2
6/2/2006	11.6	56.1	84.2	56.5
7/15/2006	11.0	55.0	86.5	59.0
8/27/2006	12.7	61.1	123.5	68.3

SB013	Na (mg/L)	K (mg/L)	Mg (mg/L)	Ca (mg/L)
10/1/2005	75.6	79.4	105.6	69.6
1/3/2006	75.6	95.9	115.6	77.4
3/15/2006	134.3	68.0	119.6	68.8
6/2/2006	123.1	70.7	124.2	71.7
7/15/2006	155.0	79.6	138.9	75.9
8/27/2006	126.7	68.5	143.4	74.7

SC013	Na (mg/L)	K (mg/L)	Mg (mg/L)	Ca (mg/L)
10/1/2005	4.5	56.6	51.7	64.7
1/3/2006	3.2	46.1	45.4	56.3
3/15/2006	5.5	54.8	53.9	76.9
6/2/2006	6.2	64.9	62.7	87.5
7/15/2006	5.6	56.6	60.7	83.7
8/27/2006	4.7	55.4	56.0	87.3

Table 4. Invertebrates at SC013, collected in channel east of road culvert in area frequently trampled by livestock, on July 14, 2006.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	61	-0.578454365	0.207228781
Isopoda	7	-0.017696494	0.002728893
Diptera/Chironomidae	43	-0.282319478	0.102973936
Diptera/Simuliidae	9	-0.024869955	0.004511027
Ephemeroptera/Baetidae	4	-0.008500743	0.000891067
Trichoptera/Odontoceridae	1	-0.001523669	5.56917E-05
Oligochaeta	2	-0.003549694	0.000222767
Coleoptera/Dytiscidae	6	-0.014415635	0.002004901
Gastropoda	1	-0.001523669	5.56917E-05
Total (Abundance)	134		
Richness	9		
Index		0.93	3.12
Heterogeneity		0.423	0.347

Table 5. Invertebrates at SC013, collected below confluence of seeps and springs, where channel narrows, on July 14, 2006.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	129	-11.26027577	0.849030612
Isopoda	2	-0.003362535	0.000204082
Trichoptera/Brachycentridae	3	-0.005575957	0.000459184
Trichoptera/Limnephilidae	1	-0.001445442	5.10204E-05
Oligochaeta	4	-0.008036183	0.000816327
Coleoptera/Dytiscidae	1	-0.001445442	5.10204E-05
Total (Abundance)	140		
Richness	6		
Index		11.28	1.18
Heterogeneity		6.295	0.197

Table 6. Invertebrates at SC011-Main channel, collected about 20 m west of the road on July 14, 2006. Site selected to have a minimum of overhanging plants straining the water and water level not overtopping net.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	105	-2.181666059	0.517217114
Isopoda	29	-0.122891054	0.039453931
Diptera/Chironomidae	4	-0.007616036	0.00075061
Diptera/Tipulidae	1	-0.001374369	4.69131E-05
Trichoptera/Lepidostomatidae	1	-0.001374369	4.69131E-05
Gastropoda	6	-0.012875269	0.001688872
Total (Abundance)	146		
Richness	6		
Index		2.33	1.79
Heterogeneity		1.3	0.298

Table 7. Invertebrates at SC011, south spring, collected east of road edge, on July 14, 2006.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	16	-0.064559149	0.017199678
Isopoda	86	-2.015930666	0.496909433
Diptera/Chironomidae	2	-0.003987824	0.000268745
Diptera/Tipulidae	3	-0.006636289	0.000604676
Coleoptera/Elmidae	2	-0.003987824	0.000268745
Trichoptera/Brachycentridae	2	-0.003987824	0.000268745
Trichoptera/Limnephilidae	1	-0.001706221	6.71862E-05
Oligochaeta	1	-0.001706221	6.71862E-05
Coleoptera/Dytiscidae	9	-0.028299291	0.005442085
Total (Abundance)	122		
Richness	9		
Index		2.13	1.92
Heterogeneity		0.969	0.213

Table 8. Invertebrates at SC011, north spring, collected where pool enters channel, on July 14, 2006.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	64	-0.235602669	0.084628099
Isopoda	138	-1.344999751	0.393471074
Arachnida/Hydracarina	15	-0.025388142	0.00464876
Coleoptera/Hydrophilidae	3	-0.003174928	0.00018595
Total (Abundance)	220		
Richness	4		
Index		1.61	2.07
Heterogeneity		1.161	0.518

Table 9. Invertebrates at SB013, collected in the pool, on July 14, 2006.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	27	-0.318338911	0.116808204
Isopoda	34	-0.510480626	0.185226726
Diptera/Chironomidae	4	-0.016972949	0.002563692
Ephemeroptera/Ephemeridae	1	-0.002896986	0.000160231
Hirudinea	1	-0.002896986	0.000160231
Oligochaeta	7	-0.036561261	0.007851306
Coleoptera/Dytiscidae	4	-0.016972949	0.002563692
Mollusca	1	-0.002896986	0.000160231
Total (Abundance)	79		
Richness	8		
Index		0.91	3.17
Heterogeneity		0.438	0.396

Table 10. Invertebrates at SC018, collected in pool (including within floating moss), on July 14, 2006.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	3	-0.003593917	0.000227267
Isopoda #	190	-20.630042	0.911593142
Coleoptera/Hydrophilidae	1	-0.000949336	2.52519E-05
Coleoptera/Dytiscidae	5	-0.006820449	0.000631297
Total (Abundance)	199		
Richness	4		
Index		20.64	1.1
Heterogeneity		14.889	0.275

Table 11. Invertebrates at SC018, collected in channel east of road culvert, on July 14, 2006.

Order/Family	Count	Shannon-Wiener	Simpson
Amphipoda	57	-0.088945186	0.026221914
Isopoda	214	-1.221638182	0.369608729
Diptera/Chironomidae	66	-0.112008745	0.03515625
Diptera/Tipulidae	2	-0.001098895	3.22831E-05
Plecoptera	1	-0.000484497	8.07076E-06
Coleoptera/Haliplidae	1	-0.000484497	8.07076E-06
Coleoptera/Dytiscidae	5	-0.003338952	0.000201769
Gastropoda	6	-0.004186147	0.000290548
Total (Abundance)	352		
Richness	8		
Index		1.43	2.32
Heterogeneity		0.688	0.29

Table 12. SB011 Vegetation survey.

Species	CS-H	CS-T	CH	Coefficient of Conservatism	Wetland Indicator
Acer saccharum	4	1		5	FACU
Agrimonia gryposepala		0		2	FACU+
Amphicarpaea bracteata		0		5	FAC
Anemone americana		0		7	
Arctium minus		1		0	
Arisaema triphyllum	0			5	FACW-
Aster macrophyllus	2	1		4	
Brachyelytrum erectum		0		7	
Carex pensylvanica	2			3	
Carex sp.	1	1		0	
Carpinus caroliniana	2	0		6	FAC
Circaea lutetiana	1	1		2	FACU
Fagus grandifolia	2	0		8	FACU
Fragaria virginiana		1		1	FAC-
Fraxinus pennsylvanica	3	2		2	FACW
Galium triflorum		1		5	FACU+
Geranium maculatum	1	1		4	FACU
Geum canadense		0		2	FAC
Hackelia virginiana	1			3	FAC-
Hamamelis virginiana	1			7	FACU
Elymus hystrix		0		6	
Impatiens capensis		1		2	FACW
Enemion biternatum		1		7	FAC
Lonicera canadensis		0		8	FACU
Maianthemum canadense		0		5	FAC
Onoclea sensibilis		1		5	FACW
Ostrya virginiana	0	0		5	FACU-
Oxalis stricta		0		0	FACU
Parthenocissus vitacea	0	2		4	FACU
Echinochloa crusgalli		1			FACW
Phryma leptostachya	0			5	UPL*
Pilea pumila		1		3	FACW
Polygonatum pubescens	1	0		6	
Prunus virginiana	1	0		3	FAC-
Quercus rubra	4			5	FACU
Rhus hirta		1		2	
Ribes missouriensis	1	1		4	
Rubus idaeus	1	3		3	FACW-
Rubus occidentalis		2		2	
Sambucus canadensis		1		3	FACW-
Sambucus racemosa		1		5	
Solanum dulcamara		1		0	FAC
Solidago sp	0	1		0	
Streptopus lanceolatus	0	0		7	FAC

Table 12 (continued)	CS-H	CS-T	CH	Coefficient of Conservatism	Wetland Indicator
Taraxacum officinale	0	1		0	FACU
Tilia Americana	0	2		5	FACU
Trillium grandiflorum	0	1		6	
Ulmus rubra	2			4	FAC
Urtica dioica		1		1	FAC+
Viburnum acerifolium	0			7	UPL*
Viola sp		1		0	
Vitis riparia	0	1		2	FACW-
Species richness	52				
mean C	3.711538				
FQI	26.76428				

Table 13. SB011 Strata percentage

Geomorphic Surface Type	Veg Strata cover						Soil Moisture	Substrate Cover												
	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	OT	Describe
CH							2-6	1	2	1	4	4	4							
CS-H	5	2	3	2			1	4	4	1	1	3	3	3	2	2				
CS-T	2	2	5	4			2	4	4	1	1	3	3	3			1			

Table 14. SB013 Vegetation survey.

Species	PL	CS-F	CS-WM	CH	Coefficient of Conservatism	Wetland Indicator
Acer negundo		4	1		0	FACW-
Ambrosia artemisiifolia		1			0	FACU
Aquilegia canadensis		1			5	FAC-
Arctium minus		1			0	
Arisaema triphyllum		0			5	FACW-
Asarum canadense		0			7	
Carya ovata		0			5	FACU
Circaea lutetiana		1			2	FACU
Cirsium arvense		1	3		0	FACU
Cornus racemosa		2			2	
Crataegus sp		2			0	
Fraxinus americana		4	1		5	FACU
Geum canadense		1	1		2	FAC
Glechoma hederacea		1			0	FACU
grasses		1				
Hackelia virginiana		0			3	FAC-
Impatiens capensis		1	5		2	FACW
Enemion biternatum		0			7	FAC
Lonicera x bella		1			0	NI
Maianthemum canadense		1			5	FAC
moss	5	1	1			
Oxalis stricta		1	2		0	FACU
Parthenocissus quinquefolia		2	1		5	FAC-
Phalaris arundinacea			4		0	FACW+
Prunus serotina		3			3	FACU
Quercus macrocarpa		0			5	FAC-
Ribes cynosbati		2	2		3	
Rosa blanda		0			4	FACU
Rubus occidentalis		0			2	
Rubus pubescens		0			7	FACW+
Sambucus racemosa		0			5	
sedge			2			
Solanum dulcamara		2			0	FAC
Solidago sp		2	1		0	
Taraxacum officinale		1			0	FACU
Thuja occidentalis		2			9	FACW
Tilia americana		2			5	FACU
Toxicodendron rydbergii		0			2	FAC
Vitis riparia		1	0		2	FACW-
Species richness	39					
mean C	2.615385					
FQI	16.33307					

Table 15. SB013 Strata percentage

Geomorphic Surface Type	Veg Strata cover						Soil Moisture	Substrate Cover												
	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	OT	Describe
PL					5		6						5	5			2			
CS-WM			1	6			4	2	2	2		3	3			2	2			
CS-F	2	5	5	4			1	2	2	2		3	3			2	2			

Table 16. SC011 Vegetation survey.

Species	PL	CS-upland	CS-riparian	CH	Coefficient of Conservatism	Wetland Indicator
Acer negundo		1			0	FACW-
Elytrigia repens		1			0	FACU
Agrostis gigantea			1		0	NI
Arctium minus		1			0	
Asclepias syriaca		1			1	
Aster sp.		1			0	
Caltha palustris			0		6	OBL
Carex hystericina			1		3	OBL
Carex scabrata			1		8	OBL
Cichorium intybus		1			0	
Cicuta maculata			0		6	OBL
Cirsium arvense		1			0	FACU
Cirsium vulgare		1			0	FACU-
Cornus stolonifera			1		3	FACW
Coronilla varia		1			0	
Echinochloa crusgalli			1		0	FACW
Epilobium angustifolium		0			3	FAC
Erigeron annuus		1			0	FAC-
Eupatorium perfoliatum		1			6	FACW+
Euthamia graminifolia		1			4	FAC
Fraxinus americana		1			5	FACU
Galium aparine		0			2	FACU
Geum canadense		0			2	FAC
Glechoma hederacea		1			0	FACU
Glyceria grandis		2			6	
grasses		4				
Impatiens capensis			4		2	FACW
Lactuca sp		1			0	
Leonurus cardiaca		1			0	
Lychnis vulgare		1			0	
Melilotus alba		1			0	FACU
Mentha x piperita	4				0	OBL

Table 16 (continued)	PL	CS-upland	CS-riparian	CH	Coefficient of Conservatism	Wetland Indicator
moss	2			2		
Nasturtium officinale	5			3	0	OBL
Oenothera biennis		0			1	FACU
Parthenocissus quinquefolia			1		5	FAC-
Echinochloa crusgalli			2			FACW
Phleum pratense		2			0	FACU
Phryma leptostachya		0			5	UPL*
Poa pratensis		2			0	FAC-
Polygonum aviculare		1			0	FAC-
Polygonum hydropiperoides			1		6	OBL
Potentilla sp		1			0	
Prunus serotina		0			3	FACU
Rubus idaeus		1			3	FACW-
Rumex crispus		1			0	FAC+
Salix exigua			4		2	OBL
Sambucus canadensis		1			3	FACW-
Scirpus atrovirens			1		3	OBL
sedge			2			
Solanum dulcamara		1	2		0	FAC
Solidago sp		1			0	
Thalictrum dioicum		0			7	FACU+
Trifolium hybridum		1			0	FAC-
Typha angustifolia			2		0	OBL
Typha latifolia			2		1	OBL
Urtica dioica		2			1	FAC+
Verbena hastata			1		3	FACW+
Veronica anagallis-aquatica				1	4	OBL
Vitis riparia		1	1		2	FACW-
Zea mays		4				
Species richness	61					
mean C	1.737705					
FQI	13.57191					

Table 17. SC011 Strata percentage.

Geomorphic Surface Type	Veg Strata cover						Soil Moisture	Substrate Cover												
	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	OT	Describe
PL					2	5	6			4	2	2							4	Muck
CS-upland		1	0	6			2	4	4		2	2								
CS-riparian			4	5			5			4	4	4	4							
CH					2	4	6			4	4	4	4							

Table 18. SC013 Vegetation survey.

Species	CH	CS-pasture	CS-woods	BW	Coefficient of Conservatism	Wetland Indicator
Acer saccharum			1	2	5	FACU
Agrostis gigantea		1			0	NI
Ambrosia artemisiifolia		1		0	0	FACU
Arctium minus		1			0	
Circaea lutetiana			2		2	FACU
Cirsium arvense		2			0	FACU
Cirsium vulgare		1			0	FACU-
Crataegus sp.		1				
Daucus carota		2			0	
Equisetum arvense		1			1	FAC
Fragaria virginiana		1		1	1	FAC-
Galium mollugo		0			0	
Geum canadense		0			2	FAC
grasses		4	3	4		
Impatiens capensis		2			2	FACW
Lonicera x bella			2		0	NI
Lychnis vulgare		1		0	0	
Medicago lupulina		0			0	FAC-
Morus alba			0		0	FAC
moss	1					
Nasturtium officinale	5				0	OBL
Nepeta cataria		2			0	FAC-
Oxalis stricta		1		0	0	FACU
Parthenocissus vitacea			0		4	FACU
Echinochloa crusgalli		0				FACW
Phleum pratense		2			0	FACU
Pilea pumila		0			3	FACW
Polygonum persicaria		1			0	FACW
Populus balsamifera			1	0		
Rhamnus cathartica			4		0	FACU
Ribes cynosbati			1		3	
Ribes missouriensis			1		4	

Table 18 (continued)	CH	CS-pasture	CS-woods	BW	Coefficient of Conservatism	Wetland Indicator
Rosa multiflora			2		0	FACU
Rosa rugosa			2		0	FACU*
Rubus occidentalis		1			2	
Rumex crispus		2			0	FAC+
Scirpus atrovirens		2			3	OBL
sedge		2				
Solanum dulcamara		1			0	FAC
Solidago sp		1			0	
Taraxacum officinale		0			0	FACU
Toxicodendron rydbergii			1		2	FAC
Tragopogon pratensis		1			0	
Trifolium sp		1			0	
Ulmus pumila		0		0	0	
Verbascum thapsus		2			0	
Veronica anagallis-aquatica	1				4	OBL
Zanthoxylem americanum			0		3	
Species richness	48					
mean C	0.854167					
FQI	5.91784					

Table 19. SC013 Strata percentage.

Geomorphic Surface Type	Veg Strata cover						Soil Moisture	Substrate Cover												
	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	OT	Describe
CH					1	4	6	3	3	3	3	3	3	3						
CS-pasture		1		5			1	2	2	2	2	2	2	2						
CS-woods	0	3	5	3			1	2	2	2	2	2	2	2		1	3			
BW		4	1	4			1	2	2	2	2	2	2		4					

Table 20. SC018 Vegetation survey.

Species	PL	CH	CS	Coefficient of Conservatism	Wetland Indicator
Abutilon theophrasti			1	0	FACU-
Amaranthus retroflexus			1	0	FACU+
Ambrosia artemisiifolia			1	0	FACU
Arctium minus			1	0	
Capsella bursa-pastoris			1	0	FAC-
Chenopodium album			1	0	FAC-
Cirsium arvense			1	0	FACU
Cirsium vulgare			0	0	FACU-
Fragaria virginiana			0	1	FAC-
Geum canadense			0	2	FAC
grasses			5		
Hordeum jubatum			1	0	FAC+
Leonurus cardiaca			1	0	
Lychnis vulgare			1	0	
Medicago lupulina			1	0	FAC-
moss	5				
Nasturtium officinale		6		0	OBL
Oxalis stricta			0	0	FACU
Echinochloa crusgalli	1		3		FACW
Phleum pratense			2	0	FACU
Ribes missouriensis			1	4	
Rosa blanda			1	4	FACU
Solidago sp			1	0	
Sonchus oleraceus			0	0	FACU
Sonchus asper			0	0	FAC
Taraxacum officinale			1	0	FACU
Thlaspi arvense			0	0	NI
Verbascum thapsus			1	0	
Zea mays			4	0	
Species richness	29				
mean C	0.37931				
FQI	2.042649				

Table 21. SC018 Strata percentage.

Geomorphic Surface Type	Veg Strata cover						Soil Moisture	Substrate Cover												
	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	OT	Describe
PL				0	5		6	3	3	3	3	3								
CH				6			5-6	3	3	3	3	3	3							
CS			2	5			1	3	5											

APPENDIX C – FIELD SHEETS

(not in electronic versions of this report)

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: ______-- S______ **SITE NAME:** SB011 **DATE:** 8-14-06

LOCATION - GPS (Take one reading at centroid of site) **START TIME** ________ **END TIME** ________

UTM's from (check one) : ☐ Map ☐ GPS **Datum NAD 83 Zone:** ________ GPS Name and Model: ________

GPS File Name	Field UTM X	Field UTM Y	PDOP	Error +/- (m)	3D Differential Y or N
	_ _ _ _ _ _ _ _ mE	_ _ _ _ _ _ _ _ _ mN			

GPS comments:

GEOLOGIC UNIT DESCRIPTION

Geologic Unit Name		Source Geologic Unit Code		Site Geologic Unit Code	Geologic Unit Comments:
Rock Sample Taken:	1	Maquville	1		
☐ yes ☒ no	2		2		
	3		3		

Rock Type and Rock Subtype for Primary Geologic Unit
(check one box for primary type and one box for primary subtype)

☒ Sedimentary	☐ Igneous	☐ Metamorphic
☐ shale	☐ granite	☐ marble
☐ mudstone	☐ granodiorite	☐ quartzite
☐ siltstone	☐ diorite	☐ slate
☐ sandstone	☐ gabbro	☐ schist
☐ conglomerate	☐ peridotite	☐ gneiss
☐ limestone	☐ rhyolite	Carbonate
☒ dolomite	☐ dacite	☐ yes ☐ no
☐ evaporites	☐ andesite	Strike ______ °
☐ coal	☐ basalt	Dip ______ °

Rock Type Characterization for Primary Geologic Unit

Percent Grain Size (total=100%)	
___	Clay (not visible, smooth)
___	Silt (not visible to eye, but gritty)
___	Sand (0.06-2mm, visible to eye)
___	Fine Gravel (2-15mm, lady bug to marble)
___	Coarse Gravel (15-65mm, marble to tennis ball)
___	Cobble (65-250mm, tennis ball to basketball)
___	Boulder (>250mm, basketball to car)

Rock Color
_ _ _ _ _ _/_

Grain Shape
☐ spherical
☐ oblong
☐ other:

Grain Orientation
☐ imbrication
☐ random
☐ other

Rock type comments:
covered by ~ 10 ft. soil, culvert to spring - joint visible

EMERGENCE ENVIRONMENT DESCRIPTION

Emergence Environment (check one): ☐ cave ☐ sub-aerial ☐ subaqueous-lentic ☐ subaqueous-lotic ☒ other (describe in comments)

Emergence environment comments:
diverted to spring water bottling plant

Subaerial Emergence Setting (ck one): ☐ channel ☑ floodplain ☐ terrace ☐ canyon wall ☐ prairie ☐ mountain side other (please describe)

Emergence Substrate Character (check one): ☐ organic ooze ☐ silt ☐ sand ☐ rock ☒ other (describe): glacial till

FLOW FORCING MECHANISMS

Flow Forcing Type (check one): ☒ gravity ☐ artesian ☐ geothermal ☐ natural pressure ☐ anthropogenic pressure ☐ undetermined

Flow forcing mechanism comments:

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: SB011-S______ **SITE NAME:** ______________________________ **DATE:** ____________________

SPRING TYPE AND ORIFICE CHARACTERIZATION

Orifice Number (check one): ☐ single ☒ multiple

Orifice Geomorphic Type (check one): ☐ seepage/filtration spring ☐ fracture spring ☐ tubular spring ☐ contact spring

Spring Type (check one): ☐ cave ☐ limnocrene ☐ rheochrene ☐ mound-form ☐ heleocrene ☒ hillslope ☐ gushette ☐ hanging garden ☐ exposure ☐ hypocrene

Spring type and orifice comments:

second spring emptying into culvert (~50 m upstream)

SPRING CHANNEL CHARACTERIZATION

Channel Present (check one): ☒ yes ☐ no

Number of Channels: 2 (join)

Meander Distance: _______ (m)

Flow Type (check one): ☐ perennial ☐ intermittent ☒ ephemeral

Channel Length: _____ (m)

Channel Slope: _____ deg.

Channel Width (m)

1m 1m _____ _____ _____

Channel Depth (m)

.5m - 1m _____ _____ _____ _____

Channel profile comments:

currently run off dominated, previously spring dominated

Channel substrate comments: sand & gravel ag deposit thru glacial till

Channel Type: ☐ spring discharge dominated ☒ run-off dominated ☐ mixed

Channel Type Comments:

- previously mixed, spring diverted to bottling plant

SITE DESCRIPTION FORM

SITE INFORMATION /PHOTOS

Site Code: ______-- S______ Site Name: SB011 Date: JL 6-06

Surveyors SITEDES: ________ GEO/H2O/CLIM: ________ VEG: J. Sundance INVERTS: ________

Start time: ______ End Time: ______ USGS quad map: ________ State: ____ Ownership: NPS BLM USFS [✓ Private]

Access Description:

Photos Taken: ☐ yes ☐ no Camera Name and Model: ________ Photo Kind (circle one): film (NCPN) digital(SCPN)

Extra Photo Log Sheet Used: ☐ yes ☐ no

Photo Pt#	Photo Type*	Roll#	Frame#	Time	Hgt (cm)	Photographer	Caption
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							

*Note: Photo Type Choices: Site; Landscape, Feature, Fieldwork, Fauna, Vegetation, Disturbance, Other

CLIMATE

Wind Code (enter number): ______

[0 = calm; 1 = smoke drifts; 2 = light breeze; 3 = breeze with constant motion; 4 = sm branches move, dust rises; 5 = small trees sway; 6 = lg branches moving, wind whistling]

Rain Code (enter number): _____ [0 = no rain; 1 = mist or fog; 2 = light drizzle; 3 = light rain; 4 = heavy rain; 5 = snow]

Cloud Cover (enter number): _____

Air Temperature: _____ °C _____ °C _____ °C

SITE ENVIRONMENTAL DESCRIPTION

Aspect: __________ deg. Slope: __________ deg. Slope variability (check one): ☒ high ☐ medium ☐ low ☐ none

Site Area (check one) ☐ < 2 m² ☐ 2–10 m² ☒ 10-100 m² ☐ 100-1,000 m² ☐ 0.1-1 ha ☐ 1-10 ha ☒ 10-100 ha ☐ >100 ha

Landscape context

Another spring within 500 m: ☒ yes ☐ no

Other riparian vegetation within 500m: ☐ yes ☒ no

Landscape context comments:
numerous small intermittent seepages along original channel
(which is now primarily a runoff dominated [illegible])
alfalfa field on ridgetop surrounding spring valley.

2005: APR 14

VEGETATION SURVEY FORM

SITE CODE: ________-- S________ SITE NAME: ______________________________ DATE: ________________

Veg Strata Classes

Code	Class Name
T	tall canopy (>10 m)
C	mid-canopy (4-10 m)
S	shrub (0-4 m)
H	herbaceous
M	moss/surface cover
A	Aquatic

Soil Moisture Classes (top 10 cm)

Code	Class Name	Definition
6	inundated	standing water in soil
5	saturated	completely wet, no standing water
4	wet	soil easily sticks together
3	damp	moderate moisture
2	moist	like after a light rain
1	dry	no moisture, soil easily separates

Prominence Scale

Code	Class Name	Code	Class Name
6	Dominant (>95%)	2	Uncommon (1-10%)
5	Abundant (50-95%)	1	Occasional (<1%)
4	Common (25-50%)	0	Rare (<<1%, few individuals
3	< common (10-25%)		

Substrate Classes

Code	Class Name	Definition
1	Clay	Not visible, smooth
2	Silt	Not visible, gritty
3	Sand (0.06-2 mm)	Visible, gritty, up to ladybug size
4	Fine gravel (2-15 mm)	Ladybug to marble
5	Coarse gravel (15-65 mm)	Marble to tennis ball
6	Cobble (65-250 mm)	Tennis ball to basketball
7	Boulder (>250 mm)	Basketball to car
8	Bedrock	Larger than a car
WD	Wood	Any size
LI	Litter	Dead organic matter
SL	Soil	Mineral soil
OT	Other	Use comments field

	Veg Strata Cover						Soil Moisture	Substrate Cover											
Geomorphic Surface Type	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	Describe

SITE DESCRIPTION FORM

SITE CODE: SB011 -- S________ SITE NAME: Ledgerock DATE: Jl 6 2006

Landform/Geomorphic Surface Characterization

Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)	Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)
CS-H	hillside	70%	3:1	low					
CS-T	stream								
	cut	25%	~10:1	low					
	terrace								
CH		5%	10:1	low					

Codes: BW= backwall; SB=sloping bedrock CS= colluvial slope; C=cave; CH=channel; HGC=hi gradient cienega; LGC= lo gradient cienega; SM=spring mound; PL=pool; TE=Terrace; TU=tunnel; MAD=madicolous flow; OTH=other

Habitats (check all that apply): ☐ cave ☐ orifice ☐ hyporheic ☐ wet wall ☐ madicolous ☐ spray zone ☐ pool ☐ stream
☐ cienega ☐ hillslope ☐ meadow ☐ riparian ☐ barren rock ☒ upland ☐ other (describe): ____________

Site Environmental Comments:
Channel unvegetated
Hillside has very little vegetation or leaf litter — primarily bare ground. Likely has some spring ephemerals, based on remnant ephemerals observed.

Solar Radiation:
Sunrise: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____
Sunset: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____

SITE CONDITION AND LAND USE

Overall site condition and disturbance (check appropriate boxes): ☐ pristine ☐ natural disturbance ☐ anthropogenic disturbance

Natural Disturbance (if box is checked above, then indicate the types of natural disturbance present on the site):
☐ recent flooding ☐ windthrow ☐ native ungulate grazing ☐ insect disturbance ☐ other (describe): ____________

Anthropogenic Disturbance (if box is checked above, then indicate the types of anthropogenic disturbance present on the site):
☐ roads/OHV trails ☐ hiking trails ☐ recreation use ☒ flow modification ☐ livestock grazing ☒ ~~historic~~ human occupation/use
☐ prehistoric human occupation/use ☐ other (describe): ____________

Site disturbance comments (use to describe all disturbance other than flow modification):
Unimproved dirt access road to encased spring head.

Flow Modification (if box checked above, enter 'PRE' or 'POST' in applicable fields): ☐ none X pipe diversion ____dam diversion
____open trough/tank ____pumping ____encasement ____excavation ____sealed cracks ____other (describe in comments)

Impact on flow (check appropriate box): ☐ none ☐ slowed ☐ stopped ☒ rerouted ☐ increased

Flow modification comments: Channel primarily dry, brief areas of seepage

SITE DESCRIPTION FORM

SITE CODE: SB011-- S______ SITE NAME: Ledgerock DATE: Jl 6, 2006

AMPHIBIAN AND OTHER WILDLIFE OBSERVATION

Amphibians Survey Conducted: ☐ yes ☒ no

Scientific Names:

Amphibian Comments:

5 Rana clamitans seen in inundated ruts of access road

Wildlife Observations - (check which groups were directly observed on the site):

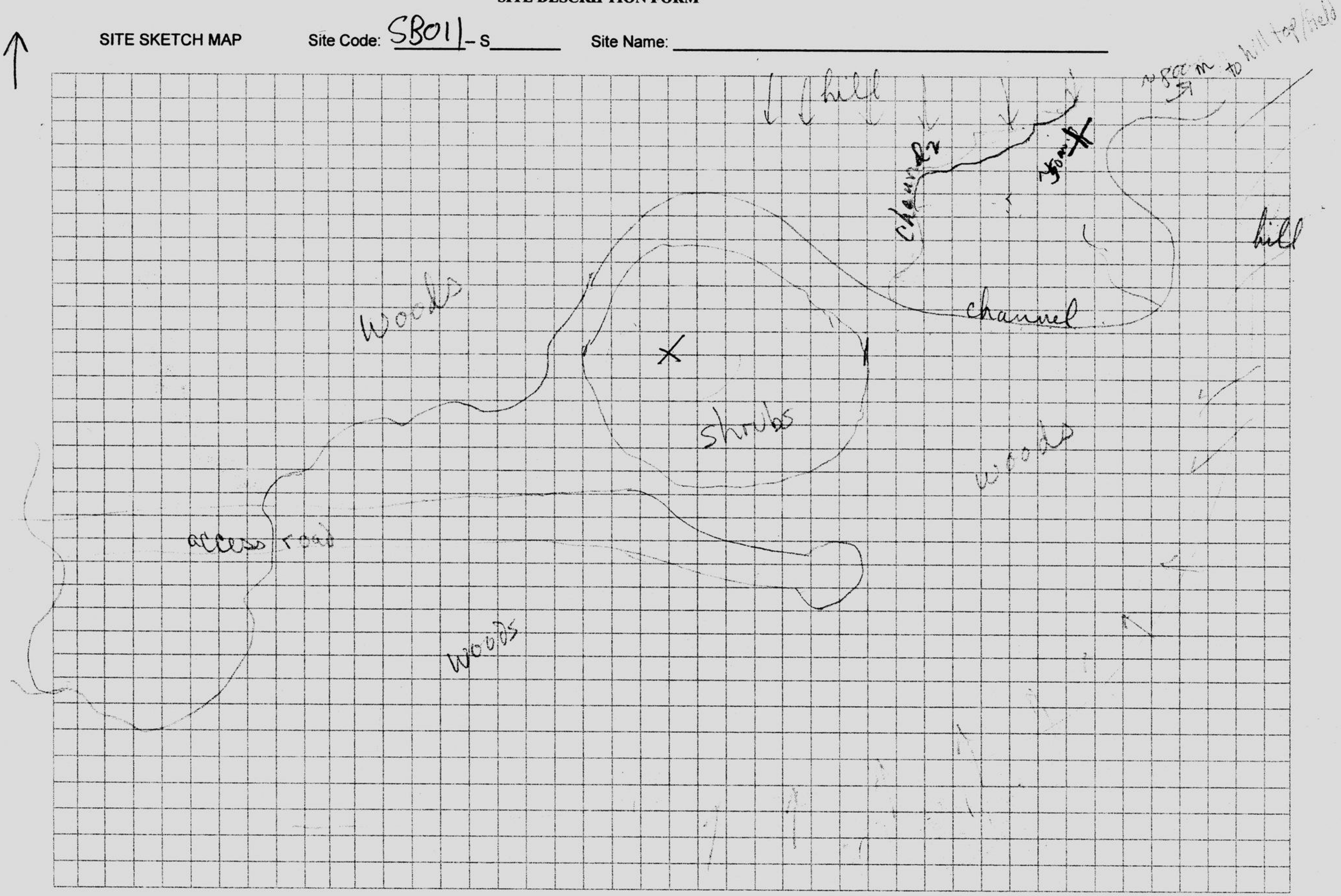
☒ Bird ☐ Mammal ☐ Reptile

Wildlife Comments (use this field to document species observed and indirect evidence of bird, mammal and reptile presence/use):

deer tracks
raccoon tracks
Catbird heard.
Buteo jamaicensis seen

SITE DESCRIPTION FORM

SITE SKETCH MAP Site Code: SB011 – S______ Site Name: ______________________________



SKETCH MAP CODES: WQ = water quality measurement site DI = discharge measurement site PP = photopoint (w/#) GPS = GPS reading site OR = spring orifice PL = pool location PO = paleo-orifice FM = flow modification CH = channel SR = solar radiation reading site

2005: APR 14


N
shrubs
X
woods
woods
alfalfa
alfalfa
woods
woods
alfalfa
Road
drainage ditch
dirt access road
gravel parking
woods
Typha marsh
stream
-dug pond

VEGETATION SURVEY FORM

SITE CODE: SB011 -- S________ **SITE NAME:** Ledgerock **DATE:** Jl 6 2006

Veg Strata Classes		Soil Moisture Classes (top 10 cm)		
Code	**Class Name**	**Code**	**Class Name**	**Definition**
T	tall canopy (>10 m)	6	inundated	standing water in soil
C	mid-canopy (4-10 m)	5	saturated	completely wet, no standing water
S	shrub (0-4 m)	4	wet	soil easily sticks together
H	herbaceous	3	damp	moderate moisture
M	moss/surface cover	2	moist	like after a light rain
A	Aquatic	1	dry	no moisture, soil easily separates

Prominence Scale			
Code	**Class Name**	**Code**	**Class Name**
6	Dominant (>95%)	2	Uncommon (1-10%)
5	Abundant (50-95%)	1	Occasional (<1%)
4	Common (25-50%)	0	Rare (<<1%, few individuals
3	< common (10-25%)		

Substrate Classes		
Code	**Class Name**	**Definition**
1	Clay	Not visible, smooth
2	Silt	Not visible, gritty
3	Sand (0.06-2 mm)	Visible, gritty, up to ladybug size
4	Fine gravel (2-15 mm)	Ladybug to marble
5	Coarse gravel (15-65 mm)	Marble to tennis ball
6	Cobble (65-250 mm)	Tennis ball to basketball
7	Boulder (>250 mm)	Basketball to car
8	Bedrock	Larger than a car
WD	Wood	Any size
LI	Litter	Dead organic matter
SL	Soil	Mineral soil
OT	Other	Use comments field

	Veg Strata Cover						Soil	Substrate Cover											
Geomorphic Surface Type	**T**	**C**	**S**	**H**	**M**	**A**	**Moisture**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**WD**	**LI**	**SL**	**Describe**
CH							2-6	1	2	1	4	3	4						
CS-4	6	2	3	2			1	4	4	1	1	3	3	3		2	1		
CS-7	2	2	5	5			2	4	4	1	1	3	3	3			1		

2005: April 14

VEGETATION SURVEY FORM

SITE CODE: SB011 -- S________ SITE NAME: Ledgerock DATE: Jl 6 2006

VEGETATION SPECIES FORM 2 OF 2 START TIME 13:30 END TIME 17:15

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

Full Scientific Name	Unknown Species Code	Cover Class by geomorphic surface type (enter one value for each surface code)													Was Collection Made ?	
		level CS	hill CS												Voucher ? ✓	ID Coll? ✓
Anemone americana		D														
Agrimonia gryposephala		0														
Amphicarpaea bracteata		0														
Arctium minor		1														
Aster macrophyllus		1	2													
Carpinus caroliniana		0	2													
Carex pensylvanica			2													
Carex sp.		1	1													
Galium triflorum		1														
Hackelia virginiana			1													
Isopyrum biternatum		1														
Hamamelis virginiana			1													
Lonicera canadensis		0														
Maianthemum canadense		0														
Viola sp		1														
Ostrya virginiana		0	0													
Oxalis stricta		0														
Phalaris arundinaceae		1														
Phryma leptostachya			0													
Polygonatum pubescens		0	1													
Rhus typhina		1														
Ribes missouriensis		1	1													
Solanum dulcamara		1														
Trillium grandiflora		1	0													
Pilea sp		1														

Prominence scale for estimating vegetation and substrate cover					
Number	Class Name	Definition	Number	Class Name	Definition
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Geomorphic Surface Type Code			
Code	Name	Code	Name
BW	Backwall	SM	Spring Mound
SB	Sloping Bedrock	PL	Pool
CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega	OTH	Other
LGC	Low Gradient Cienega		

Red-tail hawk [illegible]

VEGETATION SURVEY FORM

SITE CODE: SB011-- S______ SITE NAME: Ledgerock DATE: Jl 6 2006

VEGETATION SPECIES FORM 1 OF 2 START TIME 13:30 END TIME 17:15

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

Full Scientific Name Red [illegible]	Unknown Species Code	Cover Class by geomorphic surface type (enter one value for each surface code)													Was Collection Made ?	
		level CS	hill CS												Voucher ? ✓	ID Coll? ✓
Sambucus canadensis		1														
Sambucus racemosa		1														
Rubus idaeus		3	1													
Impatiens capensis		1														
Vitis riparia		1	0													
Onoclea sensibilis		1														
Fagus grandifolia		0	2													
Geranium maculatum		1	1													✓
Parthenocissus inserta		2	0													✓
Acer saccharum		1	4													
Fraxinus pennsylvanica		2	3													
Hystrix patula		0														✓
Solidago sp.		1	0													
Fragaria virginiana		1														
Urtica dioica		1														
Ulmus rubra			2													
Prunus virginiana		0	1													
Quercus rubra			4													
Rubus occidentalis		2														
Circaea lutetiana		1	1													
Taraxacum officinale		1	0													
Geum canadense		0														
Brachyelytrum erectum		0														
Tilia americana		2	0													
Streptopus lanceolatus		0	0													

Prominence scale for estimating vegetation and substrate cover

Number	Class Name	Definition	Number	Class Name	Definition
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Geomorphic Surface Type Code

Code	Name	Code	Name
BW	Backwall	SM	Spring Mound
SB	Sloping Bedrock	PL	Pool
CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega	OTH	Other
LGC	Low Gradient Cienega		

60°

VEGETATION SURVEY FORM

SITE CODE: SB011 -- S________ SITE NAME: ______________________ DATE: ______________

VEGETATION SPECIES FORM ______ OF ______ START TIME ______________ END TIME ______________

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

Full Scientific Name	Unknown Species Code	Cover Class by geomorphic surface type (enter one value for each surface code)													Was Collection Made ?	
															Voucher ? ✓	ID Coll? ✓
blackcap raspberry		2														
Viola sp		2														
Trillium		0														
Fraxinus	2	T2														
Fraxinus <1m		2														
Quercus sharp shallow		2														
Taraxacum		1														
Fragaria virginiana		2														
Rubus idaeus		2														
Ribes missouriense		2														
Polygonatum pubescens		0														
Hepatica deepbles		0														
Maianthemum		1														
Acer saccharum seedling		1														
Cirsium		0														
Geranium m		0														
Clearwort/impatiens		1														
Agrimonia gryposepala																
Ostrya		d1														
Viola	1															
Rubus allegheniensis	2															
Carex sp	2															
Streptopus	1															
Clearwort/impatiens	1															

Prominence scale for estimating vegetation and substrate cover

Number	Class Name	Definition	Number	Class Name	Definition
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Geranium - 0
Acer saccharum seedling 0
Rubus idaeus 1
Fragaria virginiana 2
amphicarpaea 1
Oxalis 0

Geomorphic Surface Type Code

Code	Name	Code	Name
BW	Backwall	SM	Spring Mound
SB	Sloping Bedrock	PL	Pool
CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega	OTH	Other
LGC	Low Gradient Cienega		

5(19)

dry

5 Burdock
3 Rubus idaeus
2 Brachyelytrum
2 Viola
1 Urtica dioica
2 Solanum
1 Hystrix (bottlebrush)
1 Impatiens/clearweed
1 Aster macr.
1 Rubus dewberry.
1 Geranium
1 Fragaria

5(24)

moist

2 Rubus idaeus
4 Clearweed
2 Geranium
1 Acer saccharum
2 Fraxinus - seedling
"
1 Ribes
2 Carpinus midcanopy seedling - ½
1 Solidago sp.

2(26)

on tipup. dry

3 Aster mac. (a flowering)
3 Clearweed/not impatiens
1 Fraxinus
1 ~~G~~ - bottlebrush - Hystrix
1 Geranium
1 Carpinus
1 Rubus blackberry
Hackelia virginiana
√ 2 unknown branched small white flr. alt. entire
1 Sedge

240°

VEGETATION SURVEY FORM

SITE CODE: SB011 -- S________ SITE NAME: ______________________________ DATE: ____________________

VEGETATION SPECIES FORM _______ OF _______ START TIME ______________ END TIME ____________

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

	Full Scientific Name	Unknown Species Code	Cover Class by geomorphic surface type (enter one value for each surface code)													Was Collection Made ?	
																Voucher ? ✓	ID Coll? ✓
1st	Echinochloa crusgalli	1															
annual	Rubus idaeus	5															
age	Galium triflorum bristly	1															
8	Dioscorea entire margin	1															
	Ribes	2															
	Rubus blackberry	1															
1(3)	Parthenocissus ✓	1															
1st	Rubus idaeus	2															
	Vitis	1															
	Sumac	1															
	bare soil	6															
17	Parthenocissus	3															
4	Rhus	1															
	Rubus idaeus	2															
)	Ribes	2															
✓	Isopyrum biternatum	2 -															
	Carpinus	0															
	Fraxinus	0															
3)	Tilia - Midcanopy =1	seedling=1															
	Phryma 1																
1	tree seedling alternate - 1	e apiculate = amelanchier or prunus															
y	Acer saccharum	3															
	Taraxacum	0															
	Streptopus lanceolatus	0															

Prominence scale for estimating vegetation and substrate cover

Number	Class Name	Definition	Number	Class Name	Definition
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Carex pen - 2

Solidago sp - 0

Fraxinus - 1

2006 April 14

Geranium - 1

1700

Geomorphic Surface Type Code

Code	Name	Code	Name
BW	Backwall	SM	Spring Mound
SB	Sloping Bedrock	PL	Pool
CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega	OTH	Other
LGC	Low Gradient Cienega		

5 Tilia - mid canopy - 3
Hammamelis - 1
Geranium - 1
Burdock - 2
Rubus idaeus 2
Taraxacum 1
Carex pen < 3
Vitis - 1
Parthenocissus - 1
Solidago
bare - leaves. 5

General.
5 green frogs seen
catbird heard
w/in 5 m - ~10% trees
20% shrub,
90% herbaceous
Arisaema - seeds

Channel clay & cobble
no distinct source - ? runoff
dry upstream
4" pool near
wellha

-10 : 2 7 41, 0, 9 9 9 2 3 3 4 8 6 5 7 4 8 5 6

-36 - 330 -180 240 150 60 SBC11

VEGETATION SURVEY FORM

SITE CODE: Takis -- S________ SITE NAME: Ledgerock DATE: Thurs. 7/6/06

N44.28709
W 88.08026

VEGETATION SPECIES FORM ______ OF ______ START TIME 1330 END TIME 1715

50

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

West
2
687 m. moist

Full Scientific Name	Unknown Species Code	Life form T-S-H	Cover Class by geomorphic surface type (enter one value for each surface code)												Was Collection Made ?	
			BW	CS	CH	PL									Voucher ? ✓	ID Coll? ✓
Sambucus canadensis + pubescens		S		2												
Rubus idaeus		H		5												
Impatiens				1												
Viola sp.				2												
Onoclea sensibilis				0												
Vitis				1												
Onoclea sensibilis				3												
Rubus idaeus				1												
Fagus grandifolia seedling				1												
✓ Geranium				2												
✓ Parthenocissus no pubs				2												
Acer saccharum				1												
Fraxinus				2												
✓ Clearwort or Impatiens				1												
✓ ~~Bottlebrush~~ - Hystrix patula				0												
Parthenocissus				3												
Onoclea				1												
Geranium				0												
Fagus seedling				0												
Solidago				2												
Rubus idaeus				1												
Fragaria virginiana				0												
Sedge Carex gracilima (top only staminate)				0												
Unknown herbaceous oblong alternate entire parallel vein upright		H		0												
Oenothera biennis	pubescent	H		1												

Prominence scale for estimating vegetation and substrate cover					
Number	Class Name	Definition	Number	Class Name	Definition
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Geomorphic Surface Type Code			
Code	Name	Code	Name
BW	Backwall	SM	Spring Mound
SB	Sloping Bedrock	PL	Pool
CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega - wet meadow	OTH	Other
LGC	Low Gradient Cienega		

+4(13) mostly bare ground, dry.
Acer saccharum 2
Clearwort / impatiens 1
Prunus - broad. ~~above~~ below middle

serotina 1
Geranium 0
Fraxinus - 2
Quercus - 1
bare ground. 5
dry

+7(20) hillside, dry, mostly bare -5
Acer saccharum tree - 2
" seedling - 1
Streptopus lanceolatus - 0
Fraxinus seedling 2
straight top
Viburnum - pubescent, veins to teeth 2

dry

+10(30) top of hill. on grassy road
beyond
dry
2 Viola sp.
1 Rubus idaeus
2 Fraxinus
1 Ribes
1 ~~unknown basal rosette~~ - Diphylla? Geum
3 Amphicarpaea
2 Rosa (wild)
1 Carex ? bebbii bristle balls
1 Galium 4 ~~leaf~~
1 Taraxacum
3 Brachyelytrum
1 Fragaria virginiana
1 Galium bristly
0 Oxalis stricta,
0 Plantago major
1 ?~~Aster shortii~~/ melampyrum
1 Clearwort / ~~Impatiens~~
0 Juncus tenuis
2 ~~[illegible]~~ lonicera canadensis
0 Acer saccharum

330
-180
150

5 @road edge
moist clay
1 blackcap rasp.
2 Sedge
1 Clearwort
0 Solidago.
0 ~~Taraxacum~~
1 ~~Ranunculus~~ Geum canadense
1 Impatiens
2 Brachyelytrum
5 bare soil

7(20)
6 leaf litter / DWD
dry
1 Polygonatum
1 Tilia
1 Ribes

4(9)
wet clay
2 blackcap.
1 ~~Ranunculus~~
1 ~~clearwort~~
1 Taraxacum
1 Solidago
0 Trillium
2 Rubus idaeus
Streptopus - sessile, axil fruit
0 Hepatica - shallow/round
2 Tilia
0 dry Polygonatum
0 Prunus sp

5(25) 1 Fraxinus
dry clay
0 Tilia
1 Ribes
0 Trillium
1 ~~Carpinus~~ Ostrya
0 Acer Sacc
leaf DWD

4(13) Fraxinus - Tree - 2
" seedling - 1
2 Clearwort
1 Trillium
2 Geranium
1 Rubus idaeus
1 Acer saccharum
5 bare soil 5

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: SB013 – S______ **SITE NAME:** ______________________ **DATE:** 8/14/05

LOCATION - GPS (Take one reading at centroid of site) **START TIME** 0815 **END TIME** ______

UTM's from (check one) : ☐ Map ☐ GPS **Datum NAD 83 Zone:** ______ GPS Name and Model: ______

GPS File Name	Field UTM X	Field UTM Y	PDOP	Error +/- (m)	3D Differential Y or N
	_ _ _ _ _ _ _ mE	_ _ _ _ _ _ _ _ mN			

GPS comments:

GEOLOGIC UNIT DESCRIPTION

Geologic Unit Name		Source Geologic Unit Code		Site Geologic Unit Code	Geologic Unit Comments:
MDG/MAY CONTACT	1		1		
Rock Sample Taken:	2		2		
☐ yes ☒ no	3		3		

Rock Type and Rock Subtype for Primary Geologic Unit
(check one box for primary type and one box for primary subtype)

☒ Sedimentary	☐ Igneous	☐ Metamorphic
☒ shale	☐ granite	☐ marble
☐ mudstone	☐ granodiorite	☐ quartzite
☐ siltstone	☐ diorite	☐ slate
☐ sandstone	☐ gabbro	☐ schist
☐ conglomerate	☐ peridotite	☐ gneiss
☐ limestone	☐ rhyolite	Carbonate
☒ dolomite	☐ dacite	☐ yes ☐ no
☐ evaporites	☐ andesite	Strike ______ °
☐ coal	☐ basalt	Dip ______ °

Rock Type Characterization for Primary Geologic Unit

Percent Grain Size (total=100%)	
___	Clay (not visible, smooth)
___	Silt (not visible to eye, but gritty)
___	Sand (0.06-2mm, visible to eye)
___	Fine Gravel (2-15mm, lady bug to marble)
___	Coarse Gravel (15-65mm, marble to tennis ball)
___	Cobble (65-250mm, tennis ball to basketball)
___	Boulder (>250mm, basketball to car)

Rock Color
BDFF_1GR84

Grain Shape
- ☐ spherical
- ☐ oblong
- ☒ other:

Grain Orientation
- ☐ imbrication
- ☒ random
- ☐ other

Rock type comments:

EMERGENCE ENVIRONMENT DESCRIPTION

Emergence Environment (check one): ☐ cave ☒ sub-aerial ☐ subaqueous-lentic ☐ subaqueous-lotic ☐ other (describe in comments)

Emergence environment comments:
SPRING DEVELOPED INTO SMALL POND 1mX3m

Subaerial Emergence Setting (ck one): ☐ channel ☐ floodplain ☐ terrace ☐ canyon wall ☐ prairie ☐ mountain side other (please describe)

Emergence Substrate Character (check one): ☐ organic ooze ☐ silt ☐ sand ☒ rock ☐ other (describe): ______

FLOW FORCING MECHANISMS

Flow Forcing Type (check one): ☒ gravity ☐ artesian ☐ geothermal ☐ natural pressure ☐ anthropogenic pressure ☐ undetermined

Flow forcing mechanism comments:

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: SB013-S **SITE NAME:** ______ **DATE:** ______

SPRING TYPE AND ORIFICE CHARACTERIZATION

Orifice Number (check one): ☒ single ☐ multiple

Orifice Geomorphic Type (check one): ☐ seepage/filtration spring ☒ fracture spring ☐ tubular spring ☒ contact spring

Spring Type (check one): ☐ cave ☐ limnocrene ☐ rheochrene ☐ mound-form ☐ heleocrene ☒ hillslope ☐ gushette ☐ hanging garden ☐ exposure ☐ hypocrene

Spring type and orifice comments: SEE OTHER PAGE, LOW FLOW, ANTHROPOGENIC DISTURBANCE

SPRING CHANNEL CHARACTERIZATION

Channel Present (check one): ☒ yes ☐ no

Number of Channels: 2

Meander Distance: NA (m)

Flow Type (check one): ☐ perennial ☐ intermittent ☒ ephemeral

Channel Length: 30 (m)

Channel Slope: 6:1

Channel Width (m): 0.1 0.3 ___ ___ ___

Channel Depth (m): .1 ___ ___ ___ ___

Channel profile comments: LOW Q SPRING, SHORT CHANNEL, TERMINATES W/ INFILTRATION APX 30 m DOWN SLOPE, 0.3M WIDE CHANNEL FLOWS DOWN REC PATH + IS INFLUENCED BY VEHICLE RUTS

Channel substrate comments: GRAVEL CHANNEL. SMALL CHANNEL INFILTRATES INTO MUCK/GRAVEL PATH. PATH IS WOOD CHIPS OVER MUCK OVER GRAVEL/CLAY. AREA IS CLOSE TO SATURATION

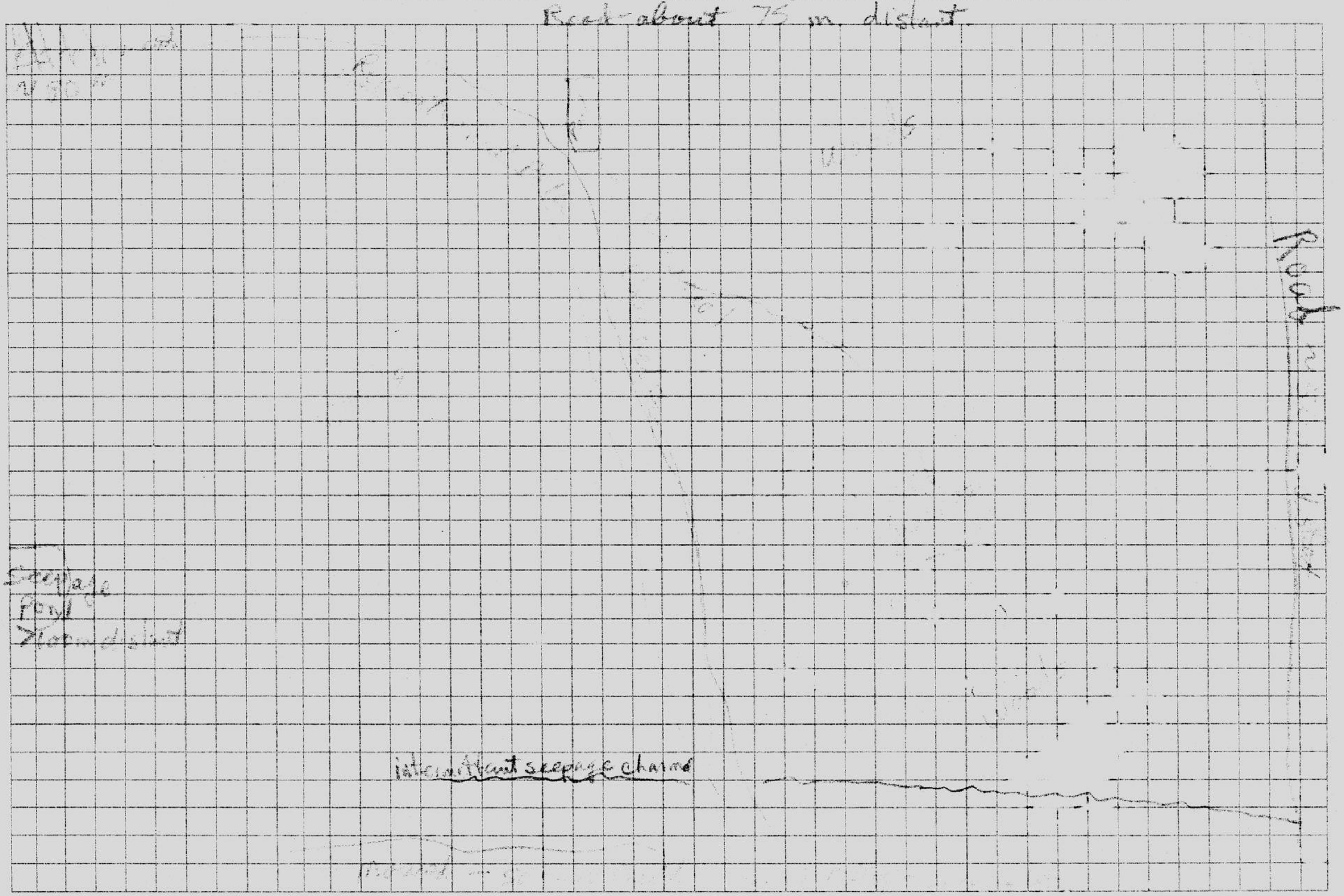
Channel Type: ☒ spring discharge dominated ☐ run-off dominated ☐ mixed

Channel Type Comments:

SITE DESCRIPTION [redacted]

← N

SITE SKETCH MAP Site Code: SB013 s______ Site Name: UWGB



SKETCH MAP CODES: WQ = water quality measurement site PP = photopoint (w/#) OR = spring orifice PO = paleo-orifice CH = channel
DI = discharge measurement site GPS = GPS reading site PL = pool location FM = flow modification SR = solar radiation reading site

Typha marsh >100 m

SITE DESCRIPTION FORM

SITE INFORMATION /PHOTOS

Site Code: SB013 -- S_____ Site Name: ______________________ Date: Jl 9, 2006

Surveyors SITEDES: ______________ GEO/H2O/CLIM: ______________ VEG: Juniper Sundance INVERTS: J Sundance * C. Bocc

Start time: _______ End Time: ______ USGS quad map: ________________ State: ____ Ownership: NPS BLM USFS Private

Access Description:

Photos Taken: ☐ yes ☐ no Camera Name and Model: ______________________ Photo Kind (circle one): film (NCPN) digital(SCPN)

Extra Photo Log Sheet Used: ☐ yes ☐ no

Photo Pt#	**Photo Type***	**Roll#**	**Frame#**	**Time**	**Hgt (cm)**	**Photographer**	**Caption**
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							

*Note: Photo Type Choices: Site; Landscape, Feature, Fieldwork, Fauna, Vegetation, Disturbance, Other

CLIMATE

Wind Code (enter number): ______

[0 = calm; 1 = smoke drifts; 2 = light breeze; 3 = breeze with constant motion; 4 = sm branches move, dust rises; 5 = small trees sway; 6 = lg branches moving, wind whistling]

Rain Code (enter number): _____ [0 = no rain; 1 = mist or fog; 2 = light drizzle; 3 = light rain; 4 = heavy rain; 5 = snow]

Cloud Cover (enter number): _____

Air Temperature: _____ °C _____ °C _____ °C

SITE ENVIRONMENTAL DESCRIPTION

Aspect: ___________ deg. Slope: _____________ deg. Slope variability (check one): ☐ high ☒ medium ☐ low ☐ none

Site Area (check one) ☐ < 2 m² ☐ 2–10 m² ☐ 10-100 m² ☒ 100-1,000 m² ☐ 0.1-1 ha ☐ 1-10 ha ☐ 10-100 ha ☐ >100 ha

Landscape context

Another spring within 500 m: ☒ yes ☐ no

Other riparian vegetation within 500m: ☒ yes ☐ no

Landscape context comments: Typha/Phalaris marsh <100m west

Pond Seepage <100m NW

Spring occurs along Niagara escarpment, within Upland mesic woods

2005: APR 14

SITE DESCRIPTION FORM

SITE CODE: ~~[illegible]~~ SB013 -- S________ SITE NAME: ______________________ DATE: Jl 9, 2006

Landform/Geomorphic Surface Characterization

Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)	Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)
PL		1%	6.1	m					
CS-wm	wet meadow	25%	↓	m					
CS-U	upland woods	74%	↓	m					
CH		1%	6.1						

Codes: BW= backwall; SB=sloping bedrock CS= colluvial slope; C=cave; CH=channel; HGC=hi gradient cienega; LGC= lo gradient cienega; SM=spring mound; PL=pool; TE=Terrace; TU=tunnel; MAD=madicolous flow; OTH=other

Habitats (check all that apply): ☐ cave ☐ orifice ☐ hyporheic ☐ wet wall ☐ madicolous ☐ spray zone ☒ pool ☐ stream
☒ cienega ☐ hillslope ☐ meadow ☐ riparian ☐ barren rock ☒ upland ☐ other (describe): ____________

Site Environmental Comments:
wet meadow very small 8x10 m
pool - extremely small 1x3 m
upland - surveyed only to 30 m distance
[illegible]

Solar Radiation:
Sunrise: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____
Sunset: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____

SITE CONDITION AND LAND USE

Overall site condition and disturbance (check appropriate boxes): ☐ pristine ☐ natural disturbance ☒ anthropogenic disturbance

Natural Disturbance (if box is checked above, then indicate the types of natural disturbance present on the site):
☐ recent flooding ☐ windthrow ☐ native ungulate grazing ☐ insect disturbance ☐ other (describe): ____________

Anthropogenic Disturbance (if box is checked above, then indicate the types of anthropogenic disturbance present on the site):
☒ roads/OHV trails ☒ hiking trails ☒ recreation use ☒ flow modification ☐ livestock grazing ☒ ~~historic~~ human occupation/use
☐ prehistoric human occupation/use ☐ other (describe): ____________

Site disturbance comments (use to describe all disturbance other than flow modification):
Trail use/rutting causes low flow levels to follow trailside rut rather than flowing into cienega.
Stone wall in woods above spring & walling of spring indicate historic use.
Current disturbance: roads within 100 m on 2 sides: university campus, hiking/biking trail alongside channel/pool.

Flow Modification (if box checked above, enter 'PRE' or 'POST' in applicable fields): ☐ none ____pipe diversion ____dam diversion
____open trough/tank ____pumping ____encasement _X_excavation ____sealed cracks _X_other (describe in comments)

Impact on flow (check appropriate box): ☐ none ☐ slowed ☐ stopped ☒ rerouted ☐ increased

Flow modification comments: excavated pool is walled/floored with loosely-laid rocks. At time of survey, there was no flow out of pool.

VEGETATION SURVEY FORM

SITE CODE: UW GB-- S______ SITE NAME: ________________ DATE: Jl 9, 2006

Veg Strata Classes

Code	Class Name
T	tall canopy (>10 m)
C	mid-canopy (4-10 m)
S	shrub (0-4 m)
H	herbaceous
M	moss/surface cover
A	Aquatic

Soil Moisture Classes (top 10 cm)

Code	Class Name	Definition
6	inundated	standing water in soil
5	saturated	completely wet, no standing water
4	wet	soil easily sticks together
3	damp	moderate moisture
2	moist	like after a light rain
1	dry	no moisture, soil easily separates

Prominence Scale

Code	Class Name	Code	Class Name
6	Dominant (>95%)	2	Uncommon (1-10%)
5	Abundant (50-95%)	1	Occasional (<1%)
4	Common (25-50%)	0	Rare (<<1%, few individuals
3	< common (10-25%)		

Substrate Classes

Code	Class Name	Definition
1	Clay	Not visible, smooth
2	Silt	Not visible, gritty
3	Sand (0.06-2 mm)	Visible, gritty, up to ladybug size
4	Fine gravel (2-15 mm)	Ladybug to marble
5	Coarse gravel (15-65 mm)	Marble to tennis ball
6	Cobble (65-250 mm)	Tennis ball to basketball
7	Boulder (>250 mm)	Basketball to car
8	Bedrock	Larger than a car
WD	Wood	Any size
LI	Litter humus layer	Dead organic matter
SL	Soil weathered	Mineral soil
OT	Other	Use comments field

Geomorphic Surface Type	Veg Strata Cover						Soil Moisture	Substrate Cover											
	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	Describe
PL					5		6						5	5			2		
CS-WM			1	6			4	2	2	2		3	3			2	2		
CS-F	2	5	5	4			1	2	2	2		3	3			2	2		
CH							4-6					4	4						

SITE DESCRIPTION FORM

SITE CODE: SB013 ~~[illegible]~~ - S________ SITE NAME: ________________________ DATE: 5 / 9 2006

AMPHIBIAN AND OTHER WILDLIFE OBSERVATION

Amphibians Survey Conducted: ☐ yes ☒ no

Scientific Names:

Amphibian Comments: on 2 separate visits, at least 5 Rana clamitans observed on stones of pool edge.

Wildlife Observations - (check which groups were directly observed on the site):

☐ Bird ☐ Mammal ☐ Reptile

Wildlife Comments (use this field to document species observed and indirect evidence of bird, mammal and reptile presence/use):

VEGETATION SURVEY FORM

SB013
SITE CODE: UWGB-- S______ SITE NAME: ____________________ DATE: Jul 9 2006

VEGETATION SPECIES FORM 2 OF 2 START TIME 15:00 END TIME 17:30

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

Full Scientific Name	Unknown Species Code	Cover Class by geomorphic surface type (enter one value for each surface code)													Was Collection Made ?	
		CH	PL	F CS	WM CS										Voucher ? ✓	ID Coll? ✓
Isopyrum biternatum				D												✓
Maianthemum canadense				1												
Aquilegia canadensis				1												
Quercus macrocarpon				D												
Carya ovata				0												
Taraxacum officinale				1												
Lonicera ×bella				1												✓
Tilia americana				2												
Asarum canadense				0												
Arisaema triphyllum				0												
Crataegus sp.				2												
Rosa blanda				0												
Sambucus racemosa				0												
Glechoma hederacea				1												
dupl ~~Rubus occidentalis~~				0												
Sedges					2											
grasses				1												

Prominence scale for estimating vegetation and substrate cover

Number	Class Name	Definition	Number	Class Name	Definition
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Geomorphic Surface Type Code

Code	Name	Code	Name
BW	Backwall	SM	Spring Mound
SB	Sloping Bedrock	PL	Pool
CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega	OTH	Other
LGC	Low Gradient Cienega		

VEGETATION SURVEY FORM

SITE CODE: SB013 ~~UW6B~~ -- S______ SITE NAME: ______________________ DATE: Jl 9 2006

Site is likely to have many spring ephemerals.

VEGETATION SPECIES FORM 1 OF 2 START TIME 15:00 END TIME 17:30

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

channel unvegetated (quickly spreads to wet meadow

Full Scientific Name	Unknown Species Code	Cover Class by geomorphic surface type (enter one value for each surface code)													Was Collection Made ?	
		CH	PL	Fam CS	WM CS										Voucher ? ✓	ID Coll? ✓
	moss		5	1	1											
Impatiens capensis				1	5											
Phalaris arundinaceae					4											
Cirsium arvensis				1	3											
Ribes cynosbati				2	2											✓
Solidago sp				2	1											
Oxalis stricta				1	2											
— Prunus serotina				3												
Fraxinus americana				4	1											
Acer negundo				4	1											
Thuja occidentalis				2												
Rubus occidentalis				0												
Vitis riparia				1	0											
Parthenocissus quinquefolia				2	1											
Cornus racemosa				2												
Solanum dulcamara				2												
— Arctium minus				1												
Circaea lutetiana				1												
dupl ~~Oxalis stricta~~				1												
Hackelia virginiana				0												✓
dupl ~~moss~~																
Geum canadense				1	1											✓
Ambrosia artemisiifolia				1												
Rubus pubescens				0												
Toxicodendron rydbergii				0												

Prominence scale for estimating vegetation and substrate cover

Number	Class Name	Definition	Number	Class Name	Definition
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Geomorphic Surface Type Code

Code	Name	Code	Name
BW	Backwall	SM	Spring Mound
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CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega	OTH	Other
LGC	Low Gradient Cienega		

Note: at time of survey no water standing in channel but
- vegetation indicates at least periodic flooding.

2006 April 14

- A second channel along the edge of the path had intermittent stretches of water. Unvegetated. Likely gets copious runoff flow with rains & snowmelt.

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: ______-- S______ **SITE NAME:** SC011 **DATE:** 8/14/06

LOCATION - GPS (Take one reading at centroid of site) **START TIME** ____________ **END TIME** ____________

UTM's from (check one) : ☐ Map ☐ GPS **Datum NAD 83 Zone:** ________ GPS Name and Model: ______________

GPS File Name	Field UTM X	Field UTM Y	PDOP	Error +/- (m)	3D Differential Y or N
	_ _ _ _ _ _ _ _ mE	_ _ _ _ _ _ _ _ _ mN			

GPS comments:

GEOLOGIC UNIT DESCRIPTION

Geologic Unit Name

Rock Sample Taken: ☐ yes ☒ no

	Source Geologic Unit Code		Site Geologic Unit Code
1	MAYVILLE	1	
2		2	
3		3	

Geologic Unit Comments: NEAR MAYVILLE / MAQUOKETA CONTACT

Rock Type and Rock Subtype for Primary Geologic Unit (check one box for primary type and one box for primary subtype)

☒ Sedimentary	☐ Igneous	☐ Metamorphic
☒ shale	☐ granite	☐ marble
☐ mudstone	☐ granodiorite	☐ quartzite
☐ siltstone	☐ diorite	☐ slate
☐ sandstone	☐ gabbro	☐ schist
☐ conglomerate	☐ peridotite	☐ gneiss
☐ limestone	☐ rhyolite	Carbonate
☒ dolomite	☐ dacite	☐ yes ☐ no
☐ evaporites	☐ andesite	Strike ______ °
☐ coal	☐ basalt	Dip ______ °

Rock Type Characterization for Primary Geologic Unit

Percent Grain Size (total=100%)	
___	Clay (not visible, smooth)
___	Silt (not visible to eye, but gritty)
___	Sand (0.06-2mm, visible to eye)
___	Fine Gravel (2-15mm, lady bug to marble)
___	Coarse Gravel (15-65mm, marble to tennis ball)
___	Cobble (65-250mm, tennis ball to basketball)
___	Boulder (>250mm, basketball to car)

Grain Shape
- ☐ spherical
- ☐ oblong
- ☐ other:

Grain Orientation
- ☐ imbrication
- ☒ random
- ☐ other

Rock Color
_ _ _ _ _/_

Rock type comments: UNSURE OF EXACT STRATIGRAPHIC POSITION - BELIEVED TO BE NEAR MAYVILLE/MAQUOKETA CONTACT

EMERGENCE ENVIRONMENT DESCRIPTION

Emergence Environment (check one): ☐ cave ☒ sub-aerial ☐ subaqueous-lentic ☐ subaqueous-lotic ☐ other (describe in comments)

Emergence environment comments: LARGE (80m²) POND. ROCK PILED UP TO CREATE DAM

STN-P
STNS SPRING FLOWS FROM FRONT YARD TO CHANNEL TO DITCH TO CHANNEL

Subaerial Emergence Setting (ck one): ☐ channel ☐ floodplain ☐ terrace ☐ canyon wall ☐ prairie ☐ mountain side other (please describe)

Emergence Substrate Character (check one): ☒ organic ooze ☐ silt ☒ sand ☐ rock ☐ other (describe): ____________

FLOW FORCING MECHANISMS

Flow Forcing Type (check one): ☒ gravity ☐ artesian ☐ geothermal ☐ natural pressure ☐ anthropogenic pressure ☐ undetermined

Flow forcing mechanism comments: NUMEROUS SAND BOILS ALONG SOUTH + EAST EDGES OF POND

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: SC011 - S______ SITE NAME: ______________________ DATE: ______________

SPRING TYPE AND ORIFICE CHARACTERIZATION

Orifice Number (check one): ☐ single ☒ multiple

Orifice Geomorphic Type (check one): ☒ seepage/filtration spring ☐ fracture spring ☐ tubular spring ☐ contact spring

Spring Type (check one): ☐ cave ☐ limnocrene ☐ rheochrene ☐ mound-form ☐ heleocrene ☒ hillslope ☐ gushette ☐ hanging garden ☐ exposure ☐ hypocrene

Spring type and orifice comments:

SEE PREVIOUS PAGE

SPRING CHANNEL CHARACTERIZATION

Channel Present (check one) : ☒ yes ☐ no

Number of Channels: 2

Meander Distance: _______ (m)

Flow Type (check one): ☒ perennial ☐ intermittent ☒ ephemeral

Channel Length: 2 KM (m)

Channel Slope: _____ deg.

Channel Width (m)

2 ______ ______ ______ ______

Channel Depth (m)

1m ______ ______ ______ ______

Channel profile comments:

STN-P IS EPHEMERAL, STN-S IS PERENNIAL

Channel substrate comments:

PRIMARILY SAND, ROCK & GRAVEL

Channel Type: ☒ spring discharge dominated ☐ run-off dominated ☐ mixed

Channel Type Comments: DISCHARGE TO LK WINNEBAGO THRU FARMLAND RIPARIAN ZONE 20-100M ON EITHER SIDE OF STREAM

SITE DESCRIPTION FORM

SITE INFORMATION /PHOTOS

Site Code: ______-- S______ Site Name: SC011 Date: JL 7, 2006

Surveyors SITEDES: ________ GEO/H2O/CLIM: ________ VEG: ________ INVERTS: ________

Start time: ______ End Time: ______ USGS quad map: ________ State: ____ Ownership: NPS BLM USFS Private

Access Description:

Photos Taken: ☐ yes ☐ no Camera Name and Model: ________ Photo Kind (circle one): film (NCPN) digital(SCPN)

Extra Photo Log Sheet Used: ☐ yes ☐ no

Photo Pt#	Photo Type*	Roll#	Frame#	Time	Hgt (cm)	Photographer	Caption
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							

*Note: Photo Type Choices: Site; Landscape, Feature, Fieldwork, Fauna, Vegetation, Disturbance, Other

CLIMATE

Wind Code (enter number): ______

[0 = calm; 1 = smoke drifts; 2 = light breeze; 3 = breeze with constant motion; 4 = sm branches move, dust rises; 5 = small trees sway; 6 = lg branches moving, wind whistling]

Rain Code (enter number): _____ [0 = no rain; 1 = mist or fog; 2 = light drizzle; 3 = light rain; 4 = heavy rain; 5 = snow]

Cloud Cover (enter number): _____ Air Temperature: _____ °C _____ °C _____ °C

SITE ENVIRONMENTAL DESCRIPTION

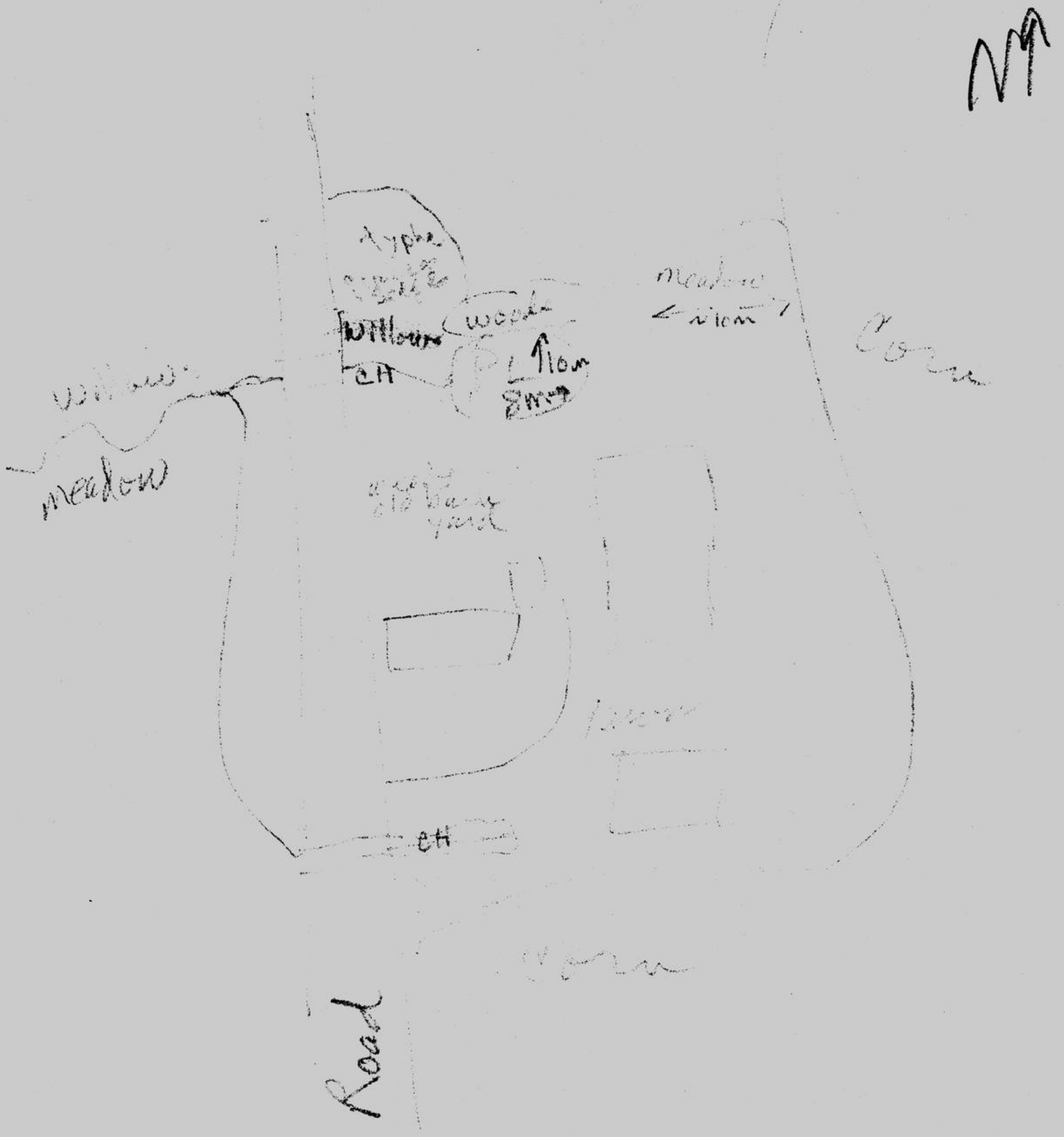
Aspect: ________ deg. Slope: ________ deg. Slope variability (check one): ☐ high ☐ medium ☒ low ☐ none

Site Area (check one) ☐ < 2 m² ☐ 2–10 m² ☐ 10-100 m² ☐ 100-1,000 m² ☐ 0.1-1 ha ☒ 1-10 ha ☐ 10-100 ha ☐ >100 ha NO 30

Landscape context | Another spring within 500 m: ☐ yes ☒ no | Other riparian vegetation within 500m: ☐ yes ☒ no

Landscape context comments:
large Dug pond to S
agricultural.

S.T.N



springs ~50m. apart.

SITE DESCRIPTION FORM

SITE CODE: SC011-- S________ SITE NAME: STN DATE: Jl 7, 2006

Landform/Geomorphic Surface Characterization

Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)	Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)
PL		5%	0						
CS	upland	10%	20:1						
CS	riparian	80%	10:1						
CH		5%	20:1						

Codes: BW= backwall; SB=sloping bedrock CS= colluvial slope; C=cave; CH=channel; HGC=hi gradient cienega; LGC= lo gradient cienega; SM=spring mound; PL=pool; TE=Terrace; TU=tunnel; MAD=madicolous flow; OTH=other

Habitats (check all that apply): ☐ cave ☐ orifice ☐ hyporheic ☐ wet wall ☐ madicolous ☐ spray zone ☒ pool ☒ stream
☐ cienega ☐ hillslope ☒ meadow ☒ riparian ☐ barren rock ☒ upland ☐ other (describe): ________________

Site Environmental Comments:
2 spring areas, ~ 50 m apart, join in one channel west of road

Solar Radiation:
Sunrise: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____
Sunset: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____

SITE CONDITION AND LAND USE

Overall site condition and disturbance (check appropriate boxes): ☐ pristine ☐ natural disturbance ☒ anthropogenic disturbance

Natural Disturbance (if box is checked above, then indicate the types of natural disturbance present on the site):
☐ recent flooding ☐ windthrow ☐ native ungulate grazing ☐ insect disturbance ☐ other (describe): ________________

Anthropogenic Disturbance (if box is checked above, then indicate the types of anthropogenic disturbance present on the site):
☒ roads/OHV trails ☐ hiking trails ☐ recreation use ☐ flow modification ☐ livestock grazing ☒ historic human occupation/use
☐ prehistoric human occupation/use ☐ other (describe): ________________

Site disturbance comments (use to describe all disturbance other than flow modification):
wetland itself not severely disturbed/modified
pool likely dug - fed by at least 2 springs

Flow Modification (if box checked above, enter 'PRE' or 'POST' in applicable fields): ☐ none ____pipe diversion ____dam diversion
____open trough/tank ____pumping ____encasement ____excavation ____sealed cracks X other (describe in comments)

Impact on flow (check appropriate box): ☐ none ☐ slowed ☐ stopped ☒ rerouted ☐ increased

Flow modification comments: - one channel routed alongside road
both thru culverts under road

SITE DESCRIPTION FORM

SITE CODE: SC011 -- S

SITE NAME: STN

DATE: Jl 7, 06

AMPHIBIAN AND OTHER WILDLIFE OBSERVATION

Amphibians Survey Conducted: ☐ yes ☒ no

Scientific Names:

Amphibian Comments:

1 Rana clamitans seen

Wildlife Observations - (check which groups were directly observed on the site):

☒ Bird ☐ Mammal ☐ Reptile

Wildlife Comments (use this field to document species observed and indirect evidence of bird, mammal and reptile presence/use):

VEGETATION SURVEY FORM

SCO11

SITE CODE: STN (all -- S 51 [illegible]) SITE NAME: ______ DATE: Jl 14 2006

Veg Strata Classes		Soil Moisture Classes (top 10 cm)		
Code	Class Name	Code	Class Name	Definition
T	tall canopy (>10 m)	6	inundated	standing water in soil
C	mid-canopy (4-10 m)	5	saturated	completely wet, no standing water
S	shrub (0-4 m)	4	wet	soil easily sticks together
H	herbaceous	3	damp	moderate moisture
M	moss/surface cover	2	moist	like after a light rain
A	Aquatic	1	dry	no moisture, soil easily separates

Prominence Scale			
Code	Class Name	Code	Class Name
6	Dominant (>95%)	2	Uncommon (1-10%)
5	Abundant (50-95%)	1	Occasional (<1%)
4	Common (25-50%)	0	Rare (<<1%, few individuals
3	< common (10-25%)		

Substrate Classes		
Code	Class Name	Definition
1	Clay	Not visible, smooth
2	Silt	Not visible, gritty
3	Sand (0.06-2 mm)	Visible, gritty, up to ladybug size
4	Fine gravel (2-15 mm)	Ladybug to marble
5	Coarse gravel (15-65 mm)	Marble to tennis ball
6	Cobble (65-250 mm)	Tennis ball to basketball
7	Boulder (>250 mm)	Basketball to car
8	Bedrock	Larger than a car
WD	Wood	Any size
LI	Litter	Dead organic matter
SL	Soil	Mineral soil
OT	Other	Use comments field

include [illegible] wood

Geomorphic Surface Type	Veg Strata Cover						Soil Moisture	Substrate Cover											
	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	Describe
CA	—	—	—		2	3	6	4		4	4	4	4						
Riparian [illegible]			4	5			5	[illegible]		4	4	4	4						
adjacent [illegible]			2	6			3	4	4		2	2							
PL										4	2	2							4 muck

SC011 5° S. Tower N across Road (channel)

	by Road		channel		North bank			
soil substrate	dry gravel		12 - 0			channel		
soil moisture	dry		6		5			
S-Acer Saccharum								
Arctium								
Carex sp	[illegible]							
Circaea lutetiana								
Cirsium sp								
Cirsium vulgare	✓							
Fragaria virginiana								
S-Fraxinus								
Galium trifolium								
Geranium sp								
Geum								
Impatiens capensis	✓				✓ ⑤			
leaf litter-DWD								
Oenothera biennis	✓							
Oxalis stricta								
Parthenocissus ~~inserta~~ ②					✓ ②			
~~Phalaris arundinaceae~~	✓ Echinochloa crusgalli				④			
Plantago major								
Polygonum sp								
S-Prunus ~~virginiana~~ serotina	✓							
S-Quercus			moist					
Ranunculus			②		Cicuta maculata ①			
Rhus typhina								
Ribes missouriense					milkweed ①		moist	
~~Rosa blanda~~ Rumex [illegible]								
Rubus allegheniensis								
Rubus idaeus	✓							
Rubus occidentalis					Caltha palustris ✓ ⓪			
Sambucus canadensis								
sedge								
Solanum dulcamara	✓				✓			
Solidago sp					✓ ②	moist		
Taraxacum officianale								
Thalictrum dioicum	③							
S-Tilia americana								
Unknown								
Urtica dioica					✓ ②	moist		
Viola sp								
Vitis riparia	✓ ①				✓ ③			
white clover	✓							
water cress	✓		✓ ③					
phleum	✓							
Vervain	✓							
Aster [illegible]	✓							
Trifolium hybrid	✓							
	verbascum				Salix ⑤			
	Erigeron							
wingseem panicum								
tufted spike					Carex scabrata			

→ Agropyron repens

2:36 Stowa R) N - SC011 - Pond N4399226 W88 25616 3D

	Pond	bank		channel		mowed w/in 3m		
soil substrate	③			Salix -	④			South [illegible]
soil moisture	⑥			interior	aqua	North	- grapes - 35-50	
S-Acer Saccharum				Typhus	N[illegible] ②			
Arctium	+5			Typhus	jap ③		Rubus Idaeus	
Carex sp								
Circaea lutetiana							Boxelder -10%	
Cirsium sp							Motherwort	
Cirsium vulgare	✓						Glechoma	
Fragaria virginiana							Phragma 4	
S-Fraxinus							Cu[illegible] 1	
Galium trifolium							Fraxinus Am ⑥	
Geranium sp								
Geum							[illegible] #-50	
Impatiens capensis	5			5			[illegible] ①	
leaf litter-DWD							Arctium ②	
Oenothera biennis								
Oxalis stricta							dry clay	
Parthenocissus ~~insedra~~ Quin	✓							
~~Phalaris arundinaceoae~~	✓	Echinochloa crusgalli		3				
Plantago major						West-channel to		
Polygonum sp - 2 -	②						roads	
S-Prunus virginiana	unspecified ⑥							
S-Quercus								
Ranunculus				Boxelder ②				
Rhus typhina								
Ribes missouriense						South		
Rosa blanda				watercress				
Rubus allegheniensis				③			chicory	
Rubus idaeus								
Rubus occidentalis							Cottonwood	
Sambucus canadensis	✓			polygonum			[illegible]	
sedge grasses				②				
Solanum dulcamara	✓ 10-20							
Solidago sp	②							
Taraxacum officianale				[illegible]				
Thalictrum dioicum				inundated				
S-Tilia americana								
Unknown				Boxelder				
Urtica dioica	✓ [illegible]							
Viola sp								
Vitis riparia	✓ ②		10-20					
Boxelder -5	②	midcanopy [illegible]						
Poa pratensis	✓							
watercress	~~3~~ ⑤							
Cornus white pith	②							
[illegible]	[illegible]							
Verbena hastata Vervain	1-10							

1 green frog

S. town Rd... Spring

Mowed a/s.. 3 m

N-grass
E-grass-yard-house
S-grass [illegible] field @ 16m

head - [illegible]
boxelder

Bar nettles
Impatiens
Phalaris
chenopod - water cress -(dry)

Motherwort $\boxed{1}$
Cirsium arvense.

~~Bank~~ Smartweeds +

~~[illegible]~~ Saturated
Lychnis ⓪
Lactuca ①
arctium ①
~~Boneset~~ (12)
E. [illegible] at
Solanum $\boxed{3}$
that unknown hollow stem not polygonum ②
Vitis ③

Moist ~~[illegible]~~ willow shrub.

South bank: Salix
Phalaris
Cirsium arvense

voucher
Epilobium angustifolium
~~poly~~ polygonum aviculare
(low growing)

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: SC013 -S **SITE NAME:** SC013 **DATE:** 8/14/06

LOCATION - GPS (Take one reading at centroid of site) **START TIME** ______ **END TIME** ______

UTM's from (check one) : ☐ Map ☐ GPS **Datum NAD 83 Zone:** ______ GPS Name and Model: ______

GPS File Name	Field UTM X	Field UTM Y	PDOP	Error +/- (m)	3D Differential Y or N
	_ _ _ _ _ _ _ mE	_ _ _ _ _ _ _ _ mN			

GPS comments:

GEOLOGIC UNIT DESCRIPTION

Geologic Unit Name		Source Geologic Unit Code		Site Geologic Unit Code
Rock Sample Taken:	1	MAYVILLE	1	
☐ yes ☒ no	2		2	
	3		3	

Geologic Unit Comments: SPRING OUTFLOW FROM BEDROCK

Rock Type and Rock Subtype for Primary Geologic Unit
(check one box for primary type and one box for primary subtype)

☒ Sedimentary	☐ Igneous	☐ Metamorphic
☐ shale	☐ granite	☐ marble
☐ mudstone	☐ granodiorite	☐ quartzite
☐ siltstone	☐ diorite	☐ slate
☐ sandstone	☐ gabbro	☐ schist
☐ conglomerate	☐ peridotite	☐ gneiss
☐ limestone	☐ rhyolite	Carbonate
☒ dolomite	☐ dacite	☐ yes ☐ no
☐ evaporites	☐ andesite	Strike ______ °
☐ coal	☐ basalt	Dip ______ °

Rock Type Characterization for Primary Geologic Unit

	Percent Grain Size (total=100%)
__	Clay (not visible, smooth)
__	Silt (not visible to eye, but gritty)
__	Sand (0.06-2mm, visible to eye)
X	Fine Gravel (2-15mm, lady bug to marble)
__	Coarse Gravel (15-65mm, marble to tennis ball)
__	Cobble (65-250mm, tennis ball to basketball)
__	Boulder (>250mm, basketball to car)

Rock Color: BUFF, GREY

Grain Shape
☐ spherical
☐ oblong
☒ other:

Grain Orientation
☐ imbrication
☒ random
☐ other

Rock type comments: TYPICAL MAYVILLE DOLOSTONE OUTCROP ALONG NIAGRA ESCARPMENT

EMERGENCE ENVIRONMENT DESCRIPTION

Emergence Environment (check one): ☐ cave ☒ sub-aerial ☐ subaqueous-lentic ☐ subaqueous-lotic ☐ other (describe in comments)

Emergence environment comments: OUTFLOW @ CONTACT BETWEEN ESCARPMENT CLIFF & MANTLING SEDIMENTS

Subaerial Emergence Setting (ck one): ☒ channel ☐ floodplain ☐ terrace ☐ canyon wall ☐ prairie ☐ mountain side [✓ other] (please describe)

Emergence Substrate Character (check one): ☐ organic ooze ☐ silt ☒ sand ☒ rock ☐ other (describe): ______

FLOW FORCING MECHANISMS

Flow Forcing Type (check one): ☒ gravity ☐ artesian ☐ geothermal ☐ natural pressure ☐ anthropogenic pressure ☐ undetermined

Flow forcing mechanism comments: 2 SPRINGS ON SITE - ONE IMPOUNDED & PIPED OFF FOR DOMESTIC SUPPLY, OTHER IMPOUNDED BUT FLOWS IMMEDIATELY INTO CHANNEL

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: SC013 -- S______ **SITE NAME:** ______________________ **DATE:** ______________

SPRING TYPE AND ORIFICE CHARACTERIZATION

Orifice Number (check one): ☐ single ☒ multiple

Orifice Geomorphic Type (check one): ☐ seepage/filtration spring ☒ fracture spring ☐ tubular spring ☒ contact spring

Spring Type (check one): ☐ cave ☐ limnocrene ☐ rheochrene ☐ mound-form ☐ heleocrene ☒ hillslope ☐ gushette ☐ hanging garden ☐ exposure ☐ hypocrene

Spring type and orifice comments:
OUTFLOW FROM FRACTURE IN DOLOSTONE @ TOP OF MANTLE SLOPE.

SPRING CHANNEL CHARACTERIZATION

Channel Present (check one): ☒ yes ☐ no

Number of Channels: 1

Meander Distance: 10:1 (m)

Flow Type (check one): ☐ perennial ☐ intermittent ☒ ephemeral

Channel Length: 1KM (m)

Channel Slope: _____ deg.

Channel Width (m)
1-2M _____ _____ _____ _____

Channel Depth (m)
.25-1.5m _____ _____ _____ _____

Channel profile comments:
CHANGING SLOPE FROM HEAD TO MOUTH. HEAD SLOPE ~ 3:1 , MOUTH SLOPE 40-50:1

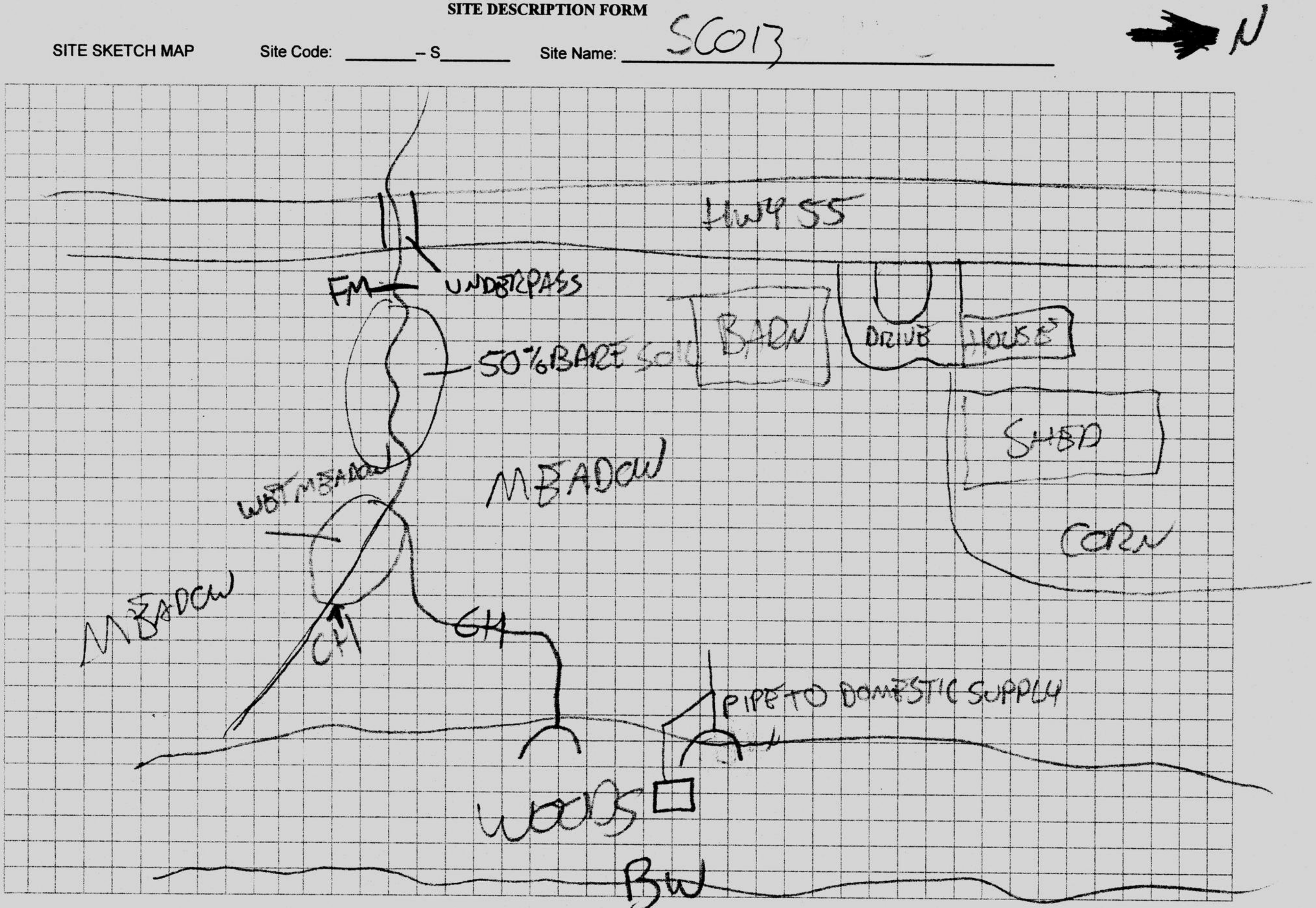
Channel substrate comments:
ROCK + GRAVEL @ HEAD, MIXTURE OF ROCK, GRAVEL, SAND SILT + CLAY @ FLOW MONITORING SITE, PRIMARILY SILT + CLAY @ MOUTH

Channel Type: ☒ spring discharge dominated ☐ run-off dominated ☐ mixed

Channel Type Comments: SHORT STREAM CHANNEL, 1ST 300M STEEP + NATURAL CUT, BOTTOM 700M CHANNELED FOR FIELD DRAINAGE

SITE DESCRIPTION FORM

SITE SKETCH MAP Site Code: ________– S________ Site Name: SC013



SKETCH MAP CODES:
WQ = water quality measurement site
DI = discharge measurement site
PP = photopoint (w/#)
GPS = GPS reading site
OR = spring orifice
PL = pool location
PO = paleo-orifice
FM = flow modification
CH = channel
SR = solar radiation reading site

SITE DESCRIPTION FORM

SITE INFORMATION /PHOTOS

Site Code: ______-- S______ Site Name: SC013 Date: Jl 7 2006

Surveyors SITEDES: ________ GEO/H2O/CLIM: ________ VEG: J Sundance INVERTS: J Sundance

Start time: ______ End Time: ______ USGS quad map: ________ State: ____ Ownership: NPS BLM USFS Private

Access Description:

Photos Taken: ☐ yes ☐ no Camera Name and Model: ________ Photo Kind (circle one): film (NCPN) digital(SCPN)

Extra Photo Log Sheet Used: ☐ yes ☐ no

Photo Pt#	Photo Type*	Roll#	Frame#	Time	Hgt (cm)	Photographer	Caption
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							

*Note: Photo Type Choices: Site; Landscape, Feature, Fieldwork, Fauna, Vegetation, Disturbance, Other

CLIMATE

Wind Code (enter number): ______

[0 = calm; 1 = smoke drifts; 2 = light breeze; 3 = breeze with constant motion; 4 = sm branches move, dust rises; 5 = small trees sway; 6 = lg branches moving, wind whistling]

Rain Code (enter number): _____ [0 = no rain; 1 = mist or fog; 2 = light drizzle; 3 = light rain; 4 = heavy rain; 5 = snow]

Cloud Cover (enter number): _____ Air Temperature: _____ °C _____ °C _____ °C

SITE ENVIRONMENTAL DESCRIPTION

Aspect: __________ deg. Slope: __________ deg. Slope variability (check one): ☐ high ☐ medium ☐ low ☐ none

[illegible]

Site Area (check one) ☐ < 2 m² ☐ 2–10 m² ☐ 10-100 m² ☐ 100-1,000 m² ☒ 0.1-1 ha ☒ 1-10 ha ☐ 10-100 ha ☐ >100 ha

Landscape context | Another spring within 500 m: ☐ yes ☒ no | Other riparian vegetation within 500m: ☐ yes ☒ no

Landscape context comments:

corn fields > 30 m from spring site. Across State Hwy

Site is within an active pasture

slope greatly increase above spring = BW

Agriculture fields, pasture, woods

SITE DESCRIPTION FORM

SITE CODE: SC013-- s________ SITE NAME: Springhill DATE: Jl 7 2006

Landform/Geomorphic Surface Characterization

includes rough

Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)	Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)
CH		2%	varies	high					
CS	Pasture	75%	4.5:1						
CS	Woods	20%	3:1						
BW	in hill	3%	1.5:1						

Codes: BW= backwall; SB=sloping bedrock CS= colluvial slope; C=cave; CH=channel; HGC=hi gradient cienega; LGC= lo gradient cienega; SM=spring mound; PL=pool; TE=Terrace; TU=tunnel; MAD=madicolous flow; OTH=other

Habitats (check all that apply): ☐ cave ☐ orifice ☐ hyporheic ☐ wet wall ☐ madicolous ☐ spray zone ☐ pool ☐ stream

☐ cienega ☒ hillslope ☒ meadow ☐ riparian ☐ barren rock ☒ upland ☐ other (describe): ____________

not bare, but > 60°

Site Environmental Comments: channel begins shallowly over a diffuse cobbly area, before coalescing into a narrow stream

zonation of vegetation -

small riparian herbaceous area around 2nd spring ~25m from main channel south & west

Solar Radiation:

Sunrise: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____

Sunset: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____

SITE CONDITION AND LAND USE

Overall site condition and disturbance (check appropriate boxes): ☐ pristine ☐ natural disturbance ☒ anthropogenic disturbance

Natural Disturbance (if box is checked above, then indicate the types of natural disturbance present on the site):

☐ recent flooding ☐ windthrow ☐ native ungulate grazing ☐ insect disturbance ☐ other (describe): ____________

Anthropogenic Disturbance (if box is checked above, then indicate the types of anthropogenic disturbance present on the site):

☒ roads/OHV trails ☐ hiking trails ☐ recreation use ☒ flow modification ☒ livestock grazing ☒ historic human occupation/use

☐ prehistoric human occupation/use ☐ other (describe): ____________

Site disturbance comments (use to describe all disturbance other than flow modification):

channel passes thru culvert under highway below study site

stream channel very muddied & trampled by cattle near road, less trampled but still disturbed near source

animal trails on hillside above spring

Flow Modification (if box checked above, enter 'PRE' or 'POST' in applicable fields): ☐ none X pipe diversion ____dam diversion

X open trough/tank ____pumping ____encasement ____excavation ____sealed cracks ____other (describe in comments)

Impact on flow (check appropriate box): ☐ none ☐ slowed ☐ stopped ☐ rerouted ☐ increased

Flow modification comments: at least 3 springs (likely some hyporheic seepage) within ~15m, one is piped/rerouted with much reduced flow, one is excavated with concrete basin, one unmodified.

SITE DESCRIPTION FORM

SITE CODE: SC013 -- S

SITE NAME: Springhill

DATE: Jl 7 2006

AMPHIBIAN AND OTHER WILDLIFE OBSERVATION

<u>Amphibians Survey Conducted</u>: ☐ yes ☒ no

Scientific Names:

Amphibian Comments:

1 Frog 8/14 in pasture by road – Rana pipiens

Wildlife Observations - (check which groups were <u>directly</u> observed on the site):

☒ Bird ☐ Mammal ☐ Reptile

Wildlife Comments (use this field to document species observed and indirect evidence of bird, mammal and reptile presence/use):

hawk too high to ID

VEGETATION SURVEY FORM

SITE CODE: SC013-- S______ SITE NAME: Springhill DATE: Jl 7 2006

Veg Strata Classes	
Code	**Class Name**
T	tall canopy (>10 m)
C	mid-canopy (4-10 m)
S	shrub (0-4 m)
H	herbaceous
M	moss/surface cover
A	Aquatic

Soil Moisture Classes (top 10 cm)		
Code	**Class Name**	**Definition**
6	inundated	standing water in soil
5	saturated	completely wet, no standing water
4	wet	soil easily sticks together
3	damp	moderate moisture
2	moist	like after a light rain
1	dry	no moisture, soil easily separates

Prominence Scale			
Code	**Class Name**	**Code**	**Class Name**
6	Dominant (>95%)	2	Uncommon (1-10%)
5	Abundant (50-95%)	1	Occasional (<1%)
4	Common (25-50%)	0	Rare (<<1%, few individuals
3	< common (10-25%)		

Substrate Classes		
Code	**Class Name**	**Definition**
1	Clay	Not visible, smooth
2	Silt	Not visible, gritty
3	Sand (0.06-2 mm)	Visible, gritty, up to ladybug size
4	Fine gravel (2-15 mm)	Ladybug to marble
5	Coarse gravel (15-65 mm)	Marble to tennis ball
6	Cobble (65-250 mm)	Tennis ball to basketball
7	Boulder (>250 mm)	Basketball to car
8	Bedrock	Larger than a car
WD	Wood	Any size
LI	Litter	Dead organic matter
SL	Soil	Mineral soil
OT	Other	Use comments field

	Veg Strata Cover						Soil Moisture	Substrate Cover											
Geomorphic Surface Type	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	Describe
BW								2	2	2	2	2	2		4				
CH head							6			3	3	3	3	3					
CH. downslop				4	2		6	3	3	2	2	2	2	2					
CS woods	2		3	4				2	2	2	2	2	2	2		1	3		
CS- Meadow		1	2	6			1	5	2	2	2	2	3	2					

VEGETATION SURVEY FORM

SITE CODE: SCOB-- S________ **SITE NAME:** Springhill **DATE:** Jl 7 2006

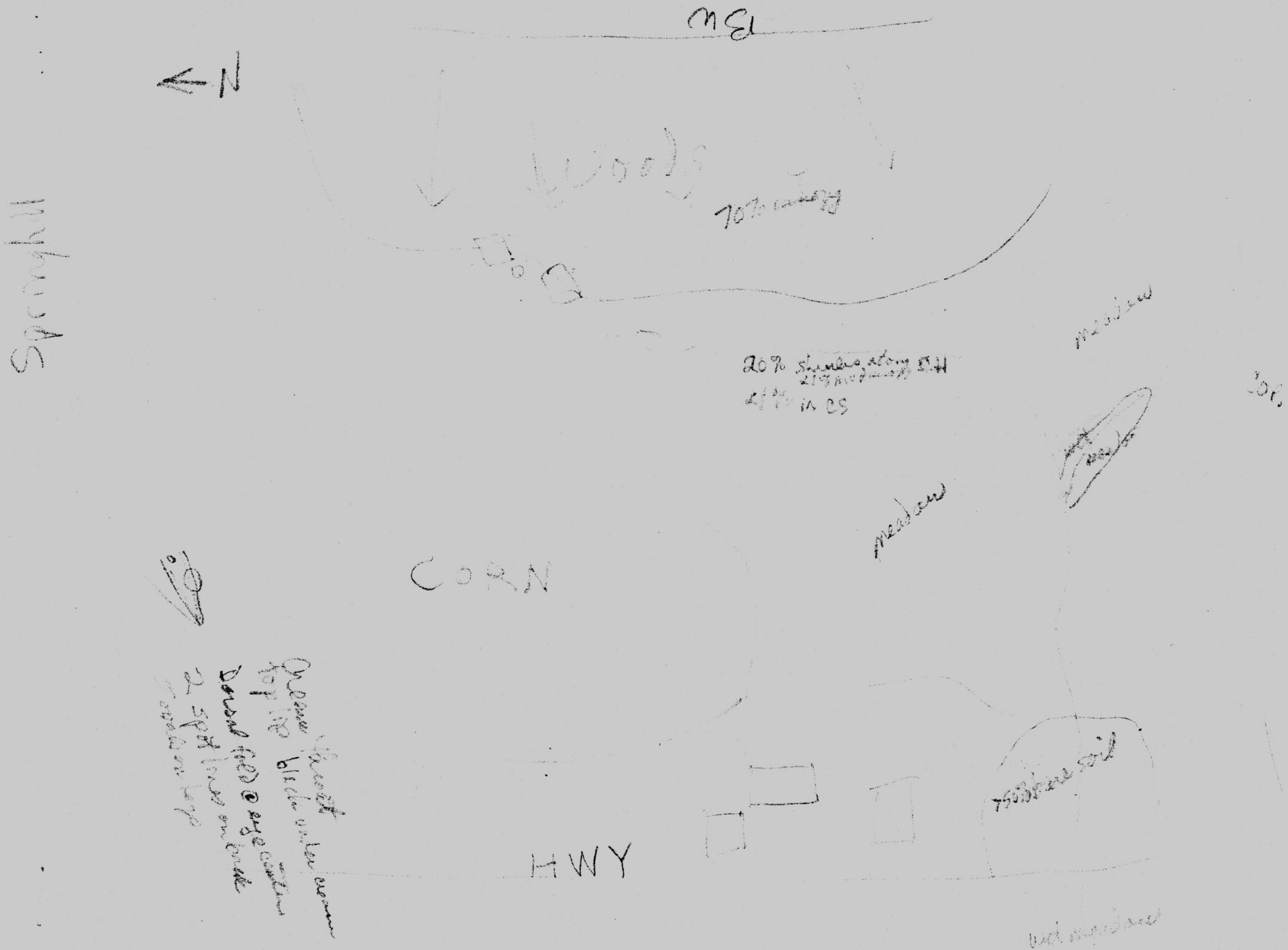
VEGETATION SPECIES FORM 2 **OF** 2 **START TIME** 1105 **END TIME** 1415

Species Cover Class: Starting with the uppermost stratum list all species with full scientific names, cover class for each species by geomorphic type. It may be helpful to group by lifeform, e.g. tree, shrub, graminoid, forbs, nonvascular. If the identification of a plant species is unknown please collect an ID sample and assign a unique unknown species code as described in the protocol. Use a check mark to indicate if ID collections or voucher collections were made.

Full Scientific Name	Unknown Species Code	Cover Class by geomorphic surface type (enter one value for each surface code)													Was Collection Made ?	
		BW	PL	CH	hill CS	upland CS	riparian-banks CS								Voucher ? ✓	ID Coll? ✓
Galium mollusca							1									
Geum canadense						1										
Impatiens capensis							3									
Oxalis stricta						1										
Parthenocissus insenta						1										
Polygonum persicaria						1										
Lychnis vulgare						1										✓
Veronica anagalis-aquatica						-	1									✓
Ribes cynosbati					1											✓
Solidago sp.						2										✓
Taraxacum officinale						1										
Toxicodendron rydbergii						1										
Daucus carota						2										
Phleum pratense						2										
Agrostis gigantea						1										✓
Trifolium						1										
Zanthoxylem						0										
Medicago lupulina						0										
Verbascum thapsus						2										
Tragopogon						1										
						2										
Ambrosia artemisiifolia						1										
Equisetum arvense						1										
grasses					3	4										

Prominence scale for estimating vegetation and substrate cover					
Number	**Class Name**	**Definition**	**Number**	**Class Name**	**Definition**
6	Dominant	>95% cover	2	Uncommon	1-10% cover
5	Abundant	50-95% cover	1	Occasional	<1% cover
4	Common	25-50% cover	0	Rare	few individuals
3	Somewhat common	10-25% cover			

Geomorphic Surface Type Code			
Code	**Name**	**Code**	**Name**
BW	Backwall	SM	Spring Mound
SB	Sloping Bedrock	PL	Pool
CS	Colluvial Slope	TE	Terrace
C	Cave	TU	Tunnel
CH	Channel	MAD	Unfocused Madicolous Flow
HGC	High Gradient Cienega	OTH	Other
LGC	Low Gradient Cienega		



Cream throat
top tip black under arm
Dorsal field @ eye contin
2 spot lines on back
[illegible] on top

-2:30 N 44.02408 SC013 W 88.30206 Spr... 5D...

	[illegible]							
soil substrate			Zonation - pool unvegetated but [illegible]					
soil moisture	1		Channel ⑤ watercress @ upper end to					
S-Acer Saccharum Populus	Balsamifera 1-5			⑥ Phalaris beyond [illegible]				
Arctium	①		Flow thru pasture					
Carex sp	✓		banks ⑤ grasses					
Circaea lutetiana	②			some shrubs & herbs, mid canopy [illegible]				
Cirsium sp arvense	③		Trees above springhead					
Cirsium vulgare	✓			Acer saccharum				
Fragaria virginiana	①							
S-Fraxinus			~25m South an intermittent spring					
Galium ~~trifolium~~	①✓		channel sedges 10%					
Geranium sp				~~[illegible]~~? 5% Scirpus				
Geum canadense	①			grass				
Impatiens capensis	✓ ③				Solanum			
leaf litter-DWD					Clearweed			
Oenothera biennis								
Oxalis stricta	✓①							
Parthenocissus inserta	✓							
~~Phalaris arundinaceae~~	✓	Echinochloa crus-galli						
Plantago major								
Polygonum sp persicaria	①							
~~S-Prunus virginiana~~								
S-Quercus								
Ranunculus								
~~Rhus typhina~~ Rosa rugosa	②							
Ribes ~~missouriense~~	② cynos ①							
Rosa ~~blanda~~ multiflora	②							
~~Rubus allegheniensis~~ Veronica								
Rubus idaeus								
Rubus occidentalis	✓①							
Sambucus canadensis								
sedge								
Solanum dulcamara	✓①							
Solidago sp	✓							
Taraxacum officianale	✓							
Thalictrum dioicum								
S-Tilia americana								
Unknown ~~trees are~~	~~some 2 trees~~	mulberry (Malg 2 tree						
Urtica dioica	✓							
~~Viola~~ sp Poison Ivy	✓							
Vitis riparia								
Daucus carota	1-5							
Phleum	5-10							
✓ Agrostis?	✓							
Trifolium red	✓							
~~Xanthoxylum~~	✓ visible buds							
Medicago black	<1							
Verbascum thapsus	✓-5							
~~Rhamnus~~ cathartica	4S							
Crataegus	✓							
Goats beard								
Ulmus pumila	✓ 2 trees							
Lonicera	1-5							
Catnip	✓-5							
Ambrosia	✓							

Pool - no veg. Equisetum arvense 1-5 Channel - Nasturtium officinale sedge 5-10 Rumex crispus

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: _______-- S______ **SITE NAME:** SC014 **DATE:** 7/14/06

LOCATION - GPS (Take one reading at centroid of site) **START TIME** 13:15 **END TIME** ________

UTM's from (check one) : ☐ Map ☐ GPS **Datum NAD 83 Zone:** ________ GPS Name and Model: ____________

GPS File Name	Field UTM X	Field UTM Y	PDOP	Error +/- (m)	3D Differential Y or N
	_ _ _ _ _ _ _ _ mE	_ _ _ _ _ _ _ _ _ mN			

GPS comments:

GEOLOGIC UNIT DESCRIPTION

Geologic Unit Name		Source Geologic Unit Code		Site Geologic Unit Code	Geologic Unit Comments:
Rock Sample Taken: ☐ yes ☒ no	1	MAYVILLE ?	1		NO BEDROCK EXPOSURES WITHIN 1 MILE. NEAR CONTACT W/ MAQUOKETA
	2		2		
	3		3		

Rock Type and Rock Subtype for Primary Geologic Unit
(check one box for primary type and one box for primary subtype)

☒ Sedimentary	☐ Igneous	☐ Metamorphic
☒ shale ?	☐ granite	☐ marble
☐ mudstone	☐ granodiorite	☐ quartzite
☐ siltstone	☐ diorite	☐ slate
☐ sandstone	☐ gabbro	☐ schist
☐ conglomerate	☐ peridotite	☐ gneiss
☐ limestone	☐ rhyolite	Carbonate
☒ dolomite ?	☐ dacite	☐ yes ☐ no
☐ evaporites	☐ andesite	Strike ______ °
☐ coal	☐ basalt	Dip ______ °

Rock Type Characterization for Primary Geologic Unit

Percent Grain Size (total=100%)		Grain Shape
___	Clay (not visible, smooth)	☐ spherical
___	Silt (not visible to eye, but gritty)	☐ oblong
___	Sand (0.06-2mm, visible to eye)	☐ other:
___	Fine Gravel (2-15mm, lady bug to marble)	
___	Coarse Gravel (15-65mm, marble to tennis ball)	Grain Orientation
___	Cobble (65-250mm, tennis ball to basketball)	☐ imbrication
___	Boulder (>250mm, basketball to car)	☐ random
Rock Color	_ _ _ _ _ / _	☐ other

Rock type comments:

EMERGENCE ENVIRONMENT DESCRIPTION

Emergence Environment (check one): ☐ cave ☒ sub-aerial ☐ subaqueous-lentic ☐ subaqueous-lotic ☐ other (describe in comments)

Emergence environment comments: SPRING CAPTURED IN CULVERT - PREVIOUSLY USED AS DOMESTIC SUPPLY. CULVERT OVERFLOWS INTO DITCH WHEN Q IS HIGH ENOUGH.

Subaerial Emergence Setting (ck one): ☐ channel ☐ floodplain ☐ terrace ☐ canyon wall ☐ prairie ☐ mountain side [✓ other] (please describe)

Emergence Substrate Character (check one): ☐ organic ooze ☐ silt ☒ sand ☐ rock ☐ other (describe): ____________

CAPTURED SPRING W/ SMALL POND OVERFLOWING TO DITCH

FLOW FORCING MECHANISMS

Flow Forcing Type (check one): ☒ gravity ☐ artesian ☐ geothermal ☐ natural pressure ☐ anthropogenic pressure ☐ undetermined

Flow forcing mechanism comments: SAND BOILS @ SPRING SUBSTRATE

GPS AND GEOMORPHOLOGY DATASHEET

SITE CODE: SC018_S______ **SITE NAME:** ______________________ **DATE:** ______________

SPRING TYPE AND ORIFICE CHARACTERIZATION

Orifice Number (check one): ☐ single ☒ multiple SAND BOILS

Orifice Geomorphic Type (check one): ☒ seepage/filtration spring ☐ fracture spring ☐ tubular spring ☐ contact spring

?

Spring Type (check one): ☐ cave ☐ limnocrene ☐ rheochrene ☐ mound-form ☐ heleocrene ☐ hillslope ☐ gushette ☐ hanging garden ☐ exposure ☐ hypocrene

Spring type and orifice comments:
MULTIPLE SAND BOILS, OTHERWISE MUCH COVERING SAND + GRAVEL

SPRING CHANNEL CHARACTERIZATION

Channel Present (check one) : ☐ yes ☒ no

Number of Channels: 0

Meander Distance: ______ (m)

Flow Type (check one): ☐ perennial ☐ intermittent ☒ ephemeral

Channel Length: _____(m)

Channel Slope: _____deg.

Channel Width (m)
______ ______ ______ ______ ______

Channel Depth (m)
______ ______ ______ ______ ______

Channel profile comments:
SPRING CAPTURED + USED DOMESTICALLY FOR 100+ YRS AREA LEVELED + IS NOW GRASS/YARD/BUILDINGS

Channel substrate comments: SEE ABOVE

Channel Type: ☐ spring discharge dominated ☐ run-off dominated ☐ mixed N/A

Channel Type Comments: SEE ABOVE

SITE DESCRIPTION FORM

SITE INFORMATION /PHOTOS

Site Code: ______-- S______ Site Name: SC018 Date: Jl 7 2006

Surveyors SITEDES: ________________ GEO/H2O/CLIM: ________________ VEG: JSundance INVERTS: JSundance, Carolin Bacel

Start time: ______ End Time: ______ USGS quad map: ________________ State: ____ Ownership: NPS BLM USFS [✓ Private]

Access Description:

Photos Taken: ☐ yes ☐ no Camera Name and Model: ________________ Photo Kind (circle one): film (NCPN) digital(SCPN)

Extra Photo Log Sheet Used: ☐ yes ☐ no

Photo Pt#	Photo Type*	Roll#	Frame#	Time	Hgt (cm)	Photographer	Caption
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							
Photo Relocation Comments:							

*Note: Photo Type Choices: Site; Landscape, Feature, Fieldwork, Fauna, Vegetation, Disturbance, Other

CLIMATE

Wind Code (enter number): ______

[0 = calm; 1 = smoke drifts; 2 = light breeze; 3 = breeze with constant motion; 4 = sm branches move, dust rises; 5 = small trees sway; 6 = lg branches moving, wind whistling]

Rain Code (enter number): _____ [0 = no rain; 1 = mist or fog; 2 = light drizzle; 3 = light rain; 4 = heavy rain; 5 = snow]

Cloud Cover (enter number): _____

Air Temperature: _____ °C _____ °C _____ °C

SITE ENVIRONMENTAL DESCRIPTION

Aspect: ___________ deg. Slope: _____________deg. Slope variability (check one): ☐ high ☐ medium ☐ low ☐ none

Site Area (check one) ☐ < 2 m² ☐ 2–10 m² ☐ 10-100 m² ☒ 100-1,000 m² ☐ 0.1-1 ha ☐ 1-10 ha ☐ 10-100 ha ☐ >100 ha

Landscape context

Another spring within 500 m: ☐ yes ☒ no

Other riparian vegetation within 500m: ☐ yes ☒ no

Landscape context comments:

agriculture/residence

[illegible] [illegible] under road

2005: APR 14

SITE DESCRIPTION FORM

SITE CODE: SC018-- s______ SITE NAME: S-T5 DATE: JL 7, 2006

Landform/Geomorphic Surface Characterization

Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)	Surface Type Code	Subtype #	Proportion (total=100%)	Slope (deg.)	Slope Variability (high, med, low)
PL	MAIN POOL	50%							
CH	PITCH	5%	20:1	LOW					
CS	UPLAND	45%	20:1	LOW					

Codes: BW= backwall; SB=sloping bedrock CS= colluvial slope; C=cave; CH=channel; HGC=hi gradient cienega; LGC= lo gradient cienega; SM=spring mound; PL=pool; TE=Terrace; TU=tunnel; MAD=madicolous flow; OTH=other

Habitats (check all that apply): ☐ cave ☐ orifice ☐ hyporheic ☐ wet wall ☐ madicolous ☐ spray zone ☒ pool ☐ stream
☐ cienega ☐ hillslope ☒ meadow ☐ riparian ☐ barren rock ☒ upland ☐ other (describe): ________________

Site Environmental Comments:
ANTHROPOGENIC DISTURBANCE IN ENTIRE SITE.

Solar Radiation:
Sunrise: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____
Sunset: J____ F____ M____ A____ M____ J____ J____ A____ S____ O____ N____ D____

SITE CONDITION AND LAND USE

Overall site condition and disturbance (check appropriate boxes): ☐ pristine ☐ natural disturbance ☒ anthropogenic disturbance

Natural Disturbance (if box is checked above, then indicate the types of natural disturbance present on the site):
☐ recent flooding ☐ windthrow ☐ native ungulate grazing ☐ insect disturbance ☐ other (describe): ________________

Anthropogenic Disturbance (if box is checked above, then indicate the types of anthropogenic disturbance present on the site):
☒ roads/OHV trails ☐ hiking trails ☐ recreation use ☒ flow modification ☐ livestock grazing ☒ historic human occupation/use
☐ prehistoric human occupation/use ☒ other (describe): DUG POOL

Site disturbance comments (use to describe all disturbance other than flow modification):
Ag field within 8m above spring pool. road crossing over channel.
Channel captured by piping.
Tree (Salix sp) cut down by pool → bare soil east of pool just beginning to be covered by adventive species

Flow Modification (if box checked above, enter 'PRE' or 'POST' in applicable fields): ☐ none X pipe diversion ____dam diversion
X open trough/tank ____pumping ____encasement ____excavation ____sealed cracks ____other (describe in comments)

Impact on flow (check appropriate box): ☐ none ☐ slowed ☐ stopped ☒ rerouted ☐ increased

Flow modification comments: underground pipe to stream channel. Formerly piped to barn & house (west) below barn (beyond site)

SITE DESCRIPTION FORM

SITE CODE: SC018 ~~STS~~ -- S________ SITE NAME: STS DATE: 11 7 2006

AMPHIBIAN AND OTHER WILDLIFE OBSERVATION

Amphibians Survey Conducted: ☐ yes ☒ no

Scientific Names:

Amphibian Comments: 3 Rana clamitans observed. more unidentified frogs present

Wildlife Observations - (check which groups were directly observed on the site):

☒ Bird ☐ Mammal ☐ Reptile

Wildlife Comments (use this field to document species observed and indirect evidence of bird, mammal and reptile presence/use):

VEGETATION SURVEY FORM

SITE CODE: SC018 S_____ SITE NAME: STS DATE: JL 7, 2006

Veg Strata Classes	
Code	**Class Name**
T	tall canopy (>10 m)
C	mid-canopy (4-10 m)
S	shrub (0-4 m)
H	herbaceous
M	moss/surface cover
A	Aquatic

Soil Moisture Classes (top 10 cm)		
Code	**Class Name**	**Definition**
6	inundated	standing water in soil
5	saturated	completely wet, no standing water
4	wet	soil easily sticks together
3	damp	moderate moisture
2	moist	like after a light rain
1	dry	no moisture, soil easily separates

Prominence Scale			
Code	**Class Name**	**Code**	**Class Name**
6	Dominant (>95%)	2	Uncommon (1-10%)
5	Abundant (50-95%)	1	Occasional (<1%)
4	Common (25-50%)	0	Rare (<<1%, few individuals
3	< common (10-25%)		

Substrate Classes		
Code	**Class Name**	**Definition**
1	Clay	Not visible, smooth
2	Silt	Not visible, gritty
3	Sand (0.06-2 mm)	Visible, gritty, up to ladybug size
4	Fine gravel (2-15 mm)	Ladybug to marble
5	Coarse gravel (15-65 mm)	Marble to tennis ball
6	Cobble (65-250 mm)	Tennis ball to basketball
7	Boulder (>250 mm)	Basketball to car
8	Bedrock	Larger than a car
WD	Wood	Any size
LI	Litter	Dead organic matter
SL	Soil	Mineral soil
OT	Other	Use comments field

	Veg Strata Cover						Soil Moisture	Substrate Cover											
Geomorphic Surface Type	T	C	S	H	M	A		1	2	3	4	5	6	7	8	WD	LI	SL	Describe
PL				0	5		6	3	3	3	3	3							
CH				6			5-6	3	3	3	3	3	3						
CS			2	5			1	3	5										

5:20 to 5:40 STS- SC018 N 49.97786 W 88.28632 July 7 '06 Green Frogs

	Pool		Channel				banks	
soil substrate								
soil moisture								
S-Acer Saccharum								
Arctium							✓	
Carex sp								
Circaea lutetiana								
Cirsium sp							✓	
Cirsium vulgare							✓	
Fragaria virginiana							✓	
S-Fraxinus							✓	
Galium trifolium								
Geranium sp								
Geum							✓	
Impatiens capensis								
leaf litter-DWD								
Oenothera biennis								
Oxalis stricta							✓	
Parthenocissus inserta								
~~Phalaris arundinaceae~~	Echinochloa crusgalli ✓						✓	
Plantago major								
Polygonum sp								
S-Prunus virginiana								
S-Quercus								
Ranunculus								
Rhus typhina								
Ribes missouriense							✓	
Rosa blanda							✓ 30%	
Rubus allegheniensis								
Rubus idaeus								
Rubus occidentalis								
Sambucus canadensis							bladder campion Lychnis vulgaris ①	
sedge								
Solanum dulcamara							Verbascum	
Solidago sp							✓	
Taraxacum officianale							✓	
Thalictrum dioicum							Capsella bursa-pastoris	
S-Tilia americana							Velvetleaf ≤1 ②	
Unknown							ambrosia ①	
Urtica dioica								
Viola sp							Timothy	
Vitis riparia							grasses – long peduncle	
	moss ~ ≤50%						Hordeum jubatum	
							~~[illegible]~~ – ✓	
							Sonchus oleraceus	
						both	✗ Sonchus asper	
							black medic N1	
							pigweed) Amaranthus retroflexus N1	
	3 green frogs						milkweed ≤1	
							~~[illegible]~~ Thlaspi N Liver	
							~~[illegible]~~ ≤1	
							Chenopodium sp.	