DISCOVERY FARMS MINNESOTA

2011 WATER YEAR MONITORING RESULTS

October 1, 2010 – September 30, 2011

MINNESOTA DEPARTMENT OF AGRICULTURE

May 2012

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Acronyms and Abbreviations

BE1-F	Blue Earth County 1 overland flume monitoring station
BE1-T	Blue Earth County 1 subsurface tile monitoring station
BE2-F	Blue Earth County 2 overland flume monitoring station
BE2-T	Blue Earth County 2 subsurface tile monitoring station
cfs	Cubic feet per second (ft^3/sec)
CH1	Chisago County overland flume monitoring station
CoC	Chain of custody
CSG	Crest stage gage
CST	Central standard time
degF	Degrees Fahrenheit
DFM	Discovery Farms Minnesota
DOP	Dissolved (soluble) orthophosphorus
FTS	Forest Technology Systems
GO1	Goodhue County overland flume monitoring station
MAWRC	Minnesota Agricultural Water Resources Center
MDA	Minnesota Department of Agriculture
MS	Measured stage
MVTL	Minnesota Valley Testing Laboratory
NOAA	National Oceanic and Atmospheric Administration
NO_2+NO_3-N	Nitrate + nitrite nitrogen
NOHRSC	National Operational Hydrologic Remote Sensing Center
RE1	Renville County Discovery Farm
RP	Reference point
SOP	Standard operating procedure
ST1-F	Stearns County overland flume monitoring station
ST1-T	Stearns County subsurface tile monitoring station
SWCD	Soil and Water Conservation District
TKN	Total kjeldahl nitrogen
TN	Total nitrogen (NO_2+NO_3-N + TKN)
TP	Total phosphorus
TSS	Total suspended solids
t-tube	Transparency tube
USDA	United States Department of Agriculture
WR1	Wright County Discovery Farm
WY	Water year (October to September of following year)

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SECTION 1: INTRODUCTION

1.1 Program Overview and History

In July of 2008, the University of Minnesota Water Resources Center and University of Minnesota Extension completed a feasibility study of an on-farm water quality program in Minnesota funded by the Minnesota Department of Agriculture's (MDA) Clean Water Legacy Act appropriation. The feasibility study addressed several key areas including: an extensive review of Midwestern water quality demonstrations; an assessment of existing field and watershed scale projects in Minnesota; stakeholder input; network structure and mission; education and outreach; research; funding opportunities; and design recommendations and cost analysis. As part of the study, the concept was shared with stakeholders across the state and there was generally strong support for an on-farm water quality monitoring network.

In the fall of 2009, the Minnesota Agricultural Water Resources Center (MAWRC, formerly Minnesota Agricultural Water Resources Coalition) launched the Discovery Farms Minnesota (DFM) program with support and assistance from the 15 farm organizations that comprise the MAWRC, MDA, and University of Minnesota Extension. The program is largely based on the Wisconsin Discovery Farms model.

In order for the DFM program to be successful, financial and technical support is contributed by a number of different entities including farmers, farm organizations, and various government agencies.

1.1.1 Goals and Objectives

Discovery Farms Minnesota is a producer led effort, organized and established for the purpose of gathering field-scale information to accurately quantify the impact of a variety of farming enterprises across Minnesota on water quality. The mission of the program is to collect water quality information under real-world conditions and to organize practical, credible, and site-specific information which will stimulate farm management decisions supported by a better understanding of the relationships between land management and water quality.

The goals of the Discovery Farms Minnesota program include:

- Increase understanding of agricultural impacts on soil and water quality, and work toward reducing adverse impacts;
- Protect water quality by engaging the farm community in learning about and evaluating the water quality benefits in a wide range of agricultural practices on actual operating farms;
- Integrate outreach and research programs with environmental management and regulatory efforts;
- Provide research-based information on agricultural production and natural resource management;
- Promote the economic viability of Minnesota agriculture across the state's diverse livestock and cropping systems.

1.2 Partnerships

Steering Committee

The DFM program is conducted through a partnership of the MAWRC, MDA, farm cooperators and local monitoring partners. DFM emphasizes farmer input and direction and program activities are guided by a Steering Committee which provides oversight, direction, and assistance as requested or needed. The Steering Committee consists of representatives of: 1) farm or commodity organizations, 2) public agencies and institutions, and 3) conservation organizations. Personnel from public agencies and institutions are considered to be non-voting advisors. The Steering Committee is responsible for:

- Providing overall direction to DFM
- Ensuring that DFM remains a producer led program
- Assisting in identification of issues and overseeing program planning to ensure that DFM continues to focus on challenges that face Minnesota producers
- Review and selection of new farms into the program

The DFM Steering Committee currently has fifteen members. Additional members will be added as needed. Organizations currently represented on the DFM Steering Committee are included in Table 1.0.

Table 1.0: Voting and non-voting member organizations for the DFM Steering Committee.

DISCOVERY FARM MINNESOTA Steering Committee Members
Voting Members
Minnesota Soybean Growers Association
Minnesota Corn Growers Association
Minnesota Farm Bureau
Minnesota Farmers Union
Minnesota Turkey Growers Association
Minnesota Pork Producers
Broiler and Egg Association of Minnesota
Minnesota Milk Producers Association
Irrigators Association of Minnesota
Minnesota State Cattlemen's Association
The Nature Conservancy
Non-Voting Advisors
Minnesota Department of Agriculture
Natural Resources Conservation Service (USDA)
Stearns County Soil and Water Conservation District
University of Minnesota - Extension

Farm Cooperators

Farm cooperators provide the critical link in the DFM research and outreach program. Knowledge and understanding of their farming system and local landscape is essential in connecting the collected water quality data to farm management practices. Farmers participating in the DFM program work closely with a number of partners to examine their existing farming system. From there, they explore and implement changes, if needed, designed to reduce or eliminate adverse environmental impacts. Participating farmers provide access to the site and keep and provide detailed records on practices that occur in the monitored area. Visits, tours, and field days are often held at participating farms throughout the duration of their involvement in the DFM program.

Cooperating farmers are not expected to assist with sample collection or troubleshooting of the monitoring equipment. Asking them to be involved in sample collection compromises the appearance of unbiased data collection. The extent of involvement of the participating producers is in providing the farm management information, anecdotal information (unusual occurrences), and assistance in the overall management and operation of the program.

Partners

There are multiple partners involved in the operation of the DFM program including research, data collection, outreach, and educational activities. The roles and responsibilities of the key partners will continue to evolve as the DFM program grows. The current roles and responsibilities of the key partners are summarized below.

Minnesota Agricultural Water Resources Center (MAWRC)

The primary responsibility of MAWRC for the DFM program is to coordinate overall program operations to ensure program goals are met. The MAWRC also identifies potential cooperators through an application process and identifies priorities for agricultural systems and/or area of the state to be assessed. More specifically MAWRC is responsible for the following activities:

- Organize the data collection, educational, and outreach activities of DFM
- Coordinate contracts and agreements with local partners and farmer cooperation
- Collect and store farm management and site specific data
- Organize and secure funding for the DFM program

Minnesota Department of Agriculture (MDA)

The primary responsibility of MDA for the DFM program is to assist with the establishment and operation of monitoring systems that will provide high-quality, water-quantity and water-quality data from agricultural systems and operations identified by the MAWRC. More specifically, MDA will be responsible for the following activities:

- The selection of the appropriate monitoring equipment and associated platforms such as data storage, communication, power supply, and sample collection;

- Identification of appropriate locations for monitoring equipment within a selected farm;
- Installation of monitoring equipment;
- Development of procedures for site maintenance, sample collection, processing, and analysis;
- Quantification of annual and event specific runoff volumes, sediment, nutrient and other selected constituent loads, flow-weighted mean concentrations, and other meaningful water quality statistics and associated information;
- Ensure data integrity, accuracy and transparency;
- Ensure that all data are captured and archived in MDA databases and published annually;
- Aid in the scientific interpretation of the results;
- Train local partners on sampling procedures.

Local Partners: Chisago Soil and Water Conservation District (SWCD), Goodhue SWCD, Hawk Creek Watershed Project, Stearns County SWCD, Sauk River Watershed District, and Wright SWCD

- Provide routine sample collection as needed and maintenance at Core Farms
- Assist with local meetings (field days etc.) and other outreach activities

1.3 Discovery Farms

Five core farm monitoring sites and one special project farm (Figure 1) were monitored during all or part of the 2011 Water Year (WY), October 1, 2010 through September 30, 2011. The special project site, KA1, is located in Kandiyohi County and is monitored by the University of Minnesota. MDA is not responsible for this site and information regarding this farm is not included in this report. For more information regarding KA1, refer to staff at MAWRC (www.mawrc.org).

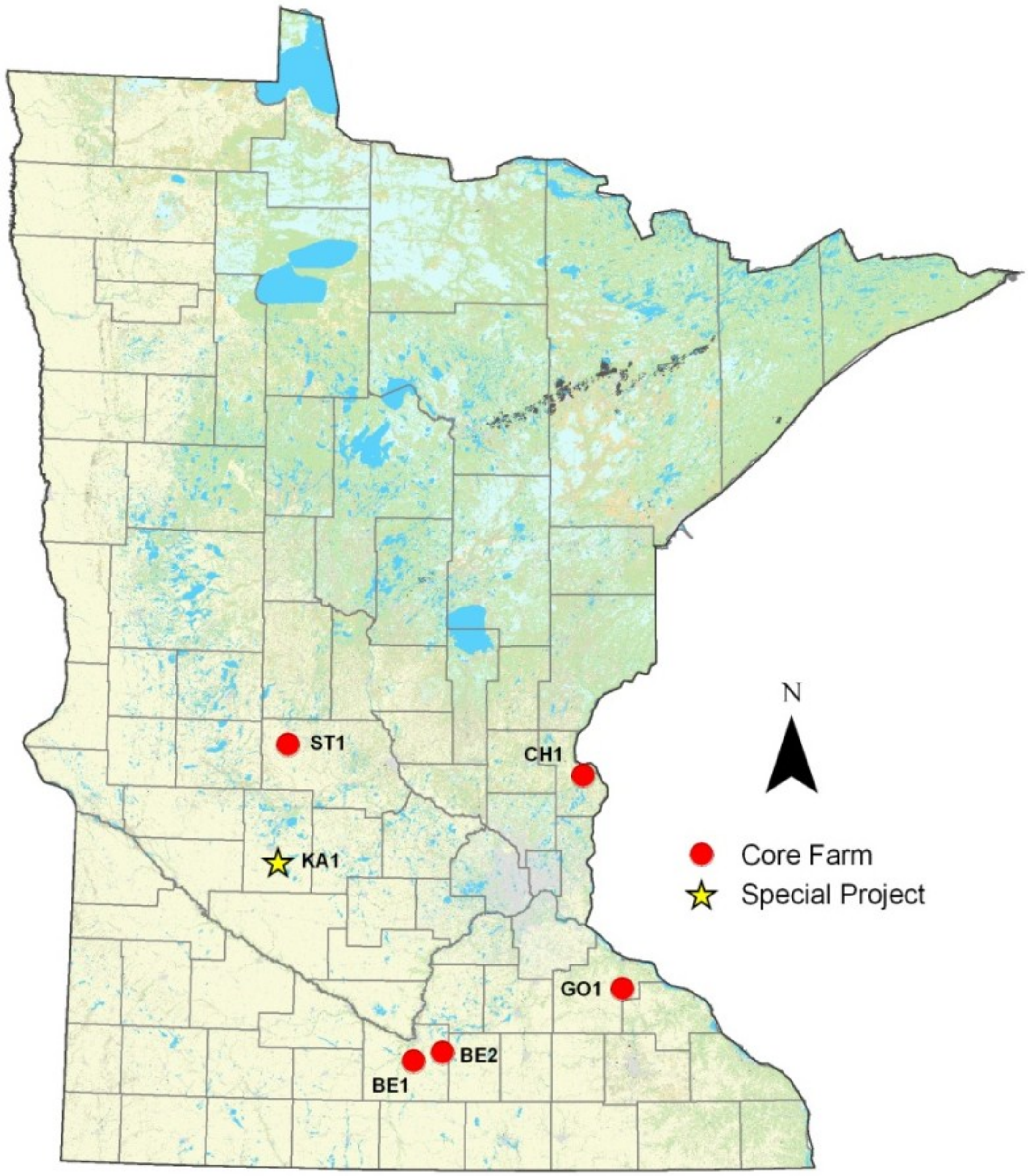

Figure 1: Distribution of Discovery Farms across the state of Minnesota for the 2011 water year (10-01-10 through 09-30-11). **Note:** KA1 is a special project site administered through a research grant with the University of Minnesota. MDA does not manage data at this site.

Table 2.0: Operational Discovery Farms installed during the 2011 water year (October 2010 - September 2011).

Discovery Farm ID	County	Farm Type	Minor Watershed	Major Basin	Nearest Town	Drainage Area (acres)	Dominant Soil Type	Station Type	Crop Rotation
BE1	Blue Earth	Swine	Le Sueur	Minnesota	Mankato	14.3 OL* 26.2 ST**	Poorly drained silty clay loam	Edge-of-Field & Subsurface Tile	Corn-Soybean
BE2	Blue Earth	Cash Crop	Le Sueur	Minnesota	St. Clair	14.2 OL* 14.2 ST**	Very poorly drained muck/clay loam	Edge-of-Field & Subsurface Tile	Corn-Soybean
CH1	Chisago	Cash Crop	Sunrise	St. Croix	North Branch	6.1 OL*	Well drained loam soils	Edge-of-Field	Corn-Soybean
GO1	Goodhue	Beef-Swine	Wells Creek	Lower Mississippi	Goodhue	6.3 OL*	Well drained silty loam	Edge-of-Field	Corn-Alfalfa
ST1	Stearns	Dairy	Sauk River	Upper Mississippi	Sauk Centre	28.2 OL* 24.2 ST**	Poorly drained loam soils	Edge-of-Field & Subsurface Tile	Corn-Alfalfa

*OL = Overland surface watershed | **ST = Subsurface tile watershed

SECTION 2: OVERVIEW OF REPORT

The data presented in this report are generated from edge-of-field monitoring sites across several different agricultural areas of Minnesota, representing diverse landscapes, soil and land management techniques typical for the region. Previous research, including that of Wisconsin Discovery Farms program has shown that runoff losses and climatic conditions can vary greatly from year to year (Stuntebeck et al., 2011; http://pubs.usgs.gov/sir/2011/5008/). The results presented in this report represent up to one year of data and do not allow for comparisons across years.

Section 3 of this report provides an overview of the each Discovery Farm in operation for the 2011 water year. A description of the monitoring setup and results of precipitation, runoff and water quality monitoring are included. Water quality results have been combined with flow data to calculate constituent loads, yields and flow-weighted mean concentrations (FWMC). All data analysis for load calculation follows the standard operating procedures outlined in MDA's Loading Guidelines document (available upon request). Summary data provided in the remainder of this report includes:

Runoff

Runoff is defined as the total volume of water that leaves an area divided by the total watershed area. Runoff in this report is presented in inches and is reported to the nearest hundredth of an inch. Conceptually, one inch of runoff, would equate to one inch of water spread across the surface of the watershed. Runoff is often compared to precipitation as a percentage. Runoff is useful when comparing sites with different watershed areas as it normalizes the total volume for area. Runoff as used in this report also describes the water movement from subsurface tile systems.

Frozen versus Non-frozen Runoff

Frozen and Non-Frozen runoff terms are used to describe the percentage of flow that occurred over frozen ground versus the percentage of flow that occurred over non-frozen ground. Frozen ground is defined as when snow is present on the surface of the field or when the soil temperature is consistently below the freezing temperature. Frozen ground conditions will typically occur from December to March but can persist in November and early April as well.

Load

Load is defined as the total mass of the constituent (sediment, phosphorus, nitrogen) over a predetermined period of time. In this report, load is presented in pounds (lbs) and is reported to the nearest tenth of a pound.

Yield

Yield is defined as the total load (mass over a predetermined period of time) divided by the area of the watershed. Yield is useful when comparing different size watersheds, as it normalizes based on area. In this report, yield is presented as pounds per acre (lbs/acre) and is reported to the nearest tenth. In following the significant digits, results less than 0.05 lbs/acre will be reported as 0.0 lbs/acre.

FWMC

Flow-weighted mean concentration (FWMC) is defined as the total load divided by the total water volume. FWMC is useful as it represents the average constituent concentration of all the water that drained from the watershed during the monitoring period. In this report, FWMC is presented as milligrams per liter (mg/L) and values are reported with significant digits that are consistent with results received by the laboratory. Total suspended solid results are displayed to the nearest whole number. Ammonia and total kjeldahl nitrogen are displayed to the nearest tenth. Total nitrogen, nitrate+nitrite nitrogen, and ammonia are displayed to the nearest hundredths. Total phosphorus and dissolved orthophosphorus are displayed to the nearest thousandths.

Runoff, yield and FWMC must all be considered when interpreting the data collected by DFM. A high FWMC, but low runoff, may equate to a low yield. Conversely, a low FWMC, but high runoff value, can result in high yields. Yield is important for understanding how sediment and nutrient losses compare across different landscapes and farm operations. FWMC is useful in providing context with sediment and nutrients levels found in rivers and lakes. It must be noted, however, that the sediment and nutrient losses calculated for edge-of-field sites are often not the same as what is delivered to surface waters. Delivery will be different for each site and is dependent on proximity to surface water and landscape characteristics. Sites that drain directly to a stream, ditch or lake will have the highest potential for delivery.

All data (water quality, flow, precipitation) collected by MDA from Discovery Farms monitoring stations is public data, and is available upon request. Farm management data collected by MAWRC is private but can be requested from http://www.mawrc.org.

For more detail regarding methodology in sample collection, load calculations and analysis of the data; please refer to the DFM Standard Operating Procedures Manual available from http://www.discoveryfarmsmn.org.

SECTION 3: RESULTS

3.1 BE1

3.1.1 Farm Overview

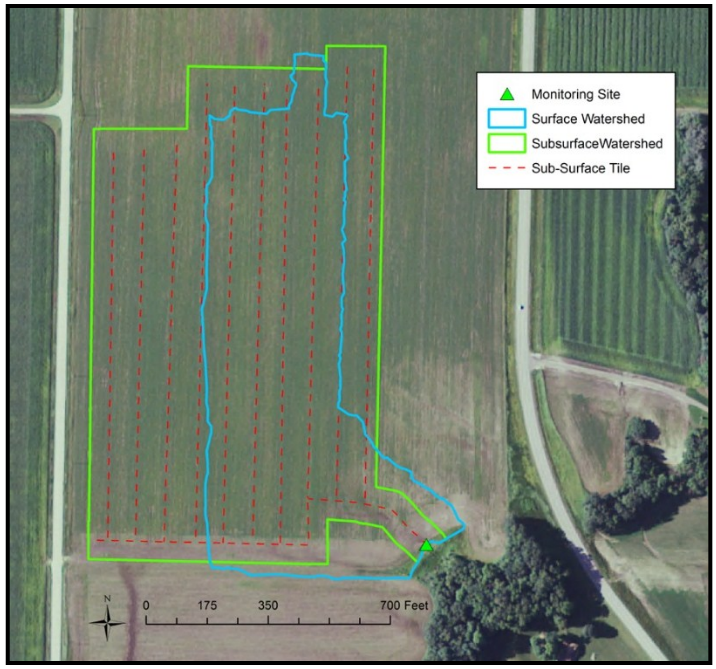

Figure 3.00: BE1 map of monitored subsurface and overland surface runoff watersheds.

BE1 is a swine finishing operation located in Blue Earth County south of Mankato, Minnesota. The producer operates a swine finishing and grain operation. Located in the Western Corn Belt eco-region, the landscape is relatively flat in the upland with steeper slopes near the rivers that drain into the Minnesota River valley. The farm is located in the Big Cobb River Watershed, a tributary to the Le Sueur River Watershed.

The site selected for monitoring (Figure 3.00) provides an edge-of-field surface and subsurface runoff evaluation in a corn-soybean crop rotation, conventional tillage, with liquid swine manure application. The monitored area for the surface and subsurface tile drainage is 14.3 and 26.2 acres, respectively. The monitored field has poorly drained silty clay loam soils and an average slope of approximately 1.5 percent. Swine manure was injected in fall 2010, tillage occurred just prior to planting corn in May 2011, and corn was harvested in October 2011.

BE1 was adopted by DFM in spring 2011 following the conclusion of a tile drainage study (2008-2010) conducted by the Water Resources Center at Minnesota State University, Mankato. Results from the Water Resources Center tile drainage study can be found online at: http://mrbdc.mnsu.edu/sites/mrbdc.mnsu.edu/files/public/org/tile/index.html. Equipment from the previous drainage study was retained and used to monitor the tile and surface drainage. Equipment included two each: ISCO model 6712 automated samplers, ISCO model 450 area velocity module and probes, marine batteries, solar panels and shelters.

The subsurface tile was monitored from March 1 through September 30, 2011. A 13 foot grade stabilization drop structure was located at the field edge. The structure was installed as part of a ravine stabilization project several years prior. The tile outlet entered the drop structure approximately five feet below the field surface, as presented in Figure 3.01. An ISCO area velocity probe, attached to a spring clamp, was inserted into the tile outlet where it entered the drop structure and used to measure tile flow.

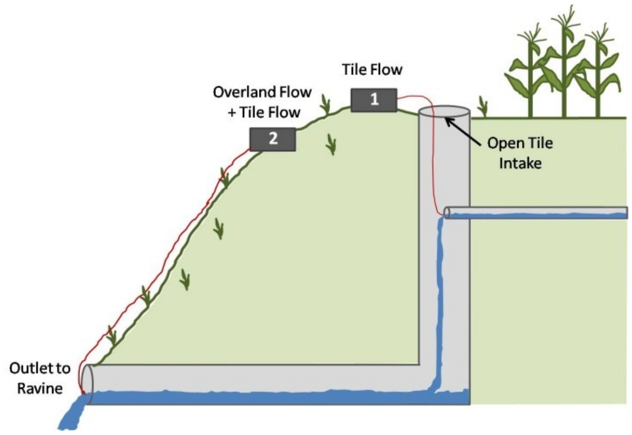

Figure 3.01: Instrument configuration at BE1 from snowmelt through mid-May 2011.

Surface flow was monitored at the outlet of the culvert drop pipe structure where it entered the ravine. The culvert would provide the combined flow from both the overland and tile watersheds. Overland flow was calculated by subtracting the tile flow from the combined culvert flow. However, conditions at the culvert location were not ideal and it was not possible to accurately measure flow. To better gage the flow from the overland area, a 1.5 foot H-flume and wingwall (Figures 3.02 and 3.03) were installed in late May 2011. Only data collected after the flume was installed, from June 1 through September 30, 2011, were used to calculate flows and constituent loads.

Figure 3.02: BE1 monitoring location showing 1.5 foot H flume, wingwall and open drop structure, May 2011.

Figure 3.03: BE1 monitoring location, June 2011.

An ISCO rain gage was also installed in the spring, but only operated intermittently during the season. Rainfall data from the nearby stream gaging station on the Big Cobb River (0.5 miles south east of BE1) were utilized for this report. Soil temperature, soil moisture, air humidity and air temperature were not monitored at the site during WY2011. The site has since been instrumented with this equipment (as well as a FTS datalogger and rain gage) for the WY2012 season.

3.1.2 Precipitation and Runoff

The National Oceanic and Atmospheric Administration (NOAA) 30-year (1981-2010) normal precipitation for this region is 32.30 inches annually, based on the long term network gage at Mankato, Minnesota (NOAA Station # 215073), located approximately eight miles north of BE1.

Snow water equivalent data was taken from the National Operational Hydrologic Remote Sensing Center (NOHRSC), which is operated by NOAA. NOHRSC reported approximately 6.0 inches of water in the snow pack in New Ulm, MN (22 miles west) on March 13 and 2.6 inches in Waseca (24 mile east) on March 14. A value of 4.0 inches was estimated for BE1, based on the NOHRSC SNOw Data Assimilation System model.

Precipitation data was obtained from the Big Cobb River gaging station, located 0.5 miles southeast of BE1. The precipitation total (Figure 3.04) for March through September was 21.12 inches, which was 4.15 inches below the 30-year normal (1981-2010) of 25.27 inches (NOAA station #215073, Mankato, MN). Precipitation during the March through July period matched closely with the 30-year normal of 17.88 inches. However, August and September were very dry, with only 1.45 inches of precipitation, compared to the 7.39 inch 30-year normal (Figure 3.05).

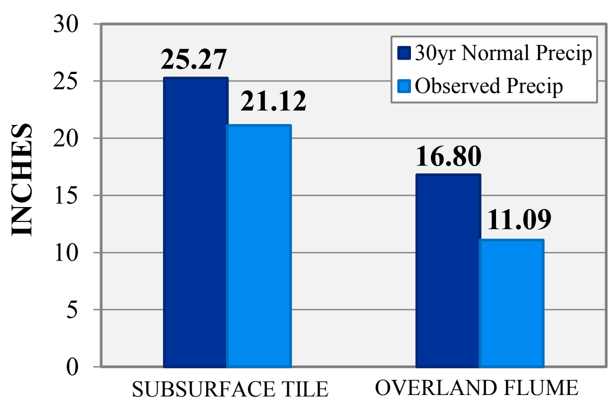

Figure 3.04: Big Cobb River station observed total rainfall versus the 30-year normal precipitation total for the same period. Tile (Mar-Sep) | Flume (Jun-Sep).

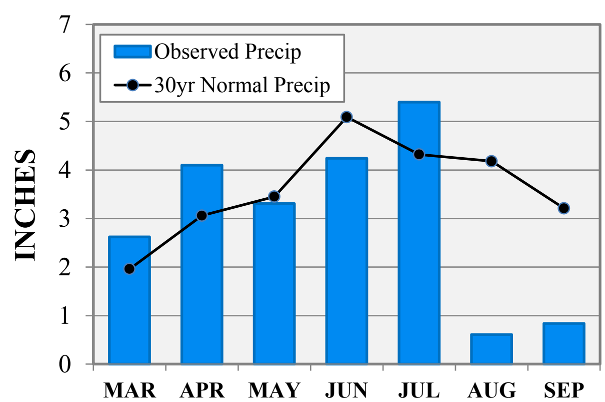

Figure 3.05: Big Cobb River station observed monthly rainfall (March - September 2011) versus the 30-year normal precipitation total for the same period.

The monitoring season for the subsurface tile was from March 1 through September 30, 2011. The total subsurface runoff was 11.08 inches (Figure 3.06), of which 3.69 inches or 33 percent occurred during the snowmelt period (March 17 through March 24). Storm flow accounted for 3.27 inches or 30 percent of the total runoff. The remaining 4.13 inches or 37 percent of the flow occurred during base flow conditions.

The overland flow was monitored for a partial season from June 1 through September 30, 2011. The rainfall total for the four month period was 11.09 inches, which subsequently produced 0.46 inches of surface runoff. Approximately 0.19 inches (42 percent) of the runoff occurred during three storm events in June. The remaining 0.26 inches (58 percent) of runoff occurred in July during three storm events. No overland runoff occurred in August or September. The largest runoff event took place on July 15, when 2.31 inches of precipitation resulted in a multiple peak event with 0.26 inches of runoff.

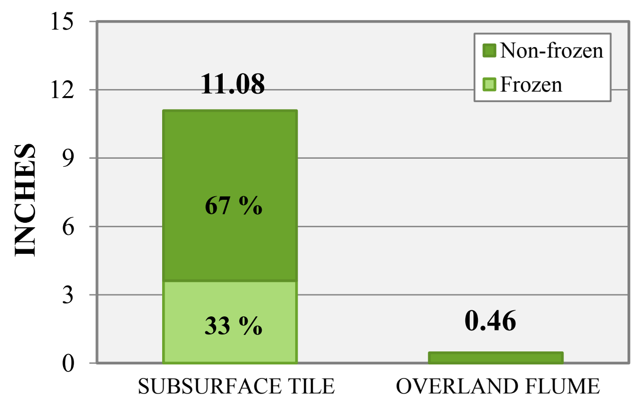

Figure 3.06: BE1 total runoff for monitored period.
Tile (Mar-Sep) | Flume (Jun-Sep).

Hydrographs for BE1-T (subsurface tile) and BE1-F (overland flume) are presented in Figures 3.07 and 3.08, respectively. BE1-T flowed for a combined total of 140.7 days, or 66 percent of the time spanning the 214 day monitoring period (March – September 2011). The overland flume flowed much less frequently for a combined total of 2.6 days, or 2 percent of the 122 monitored days (June – September 2011).

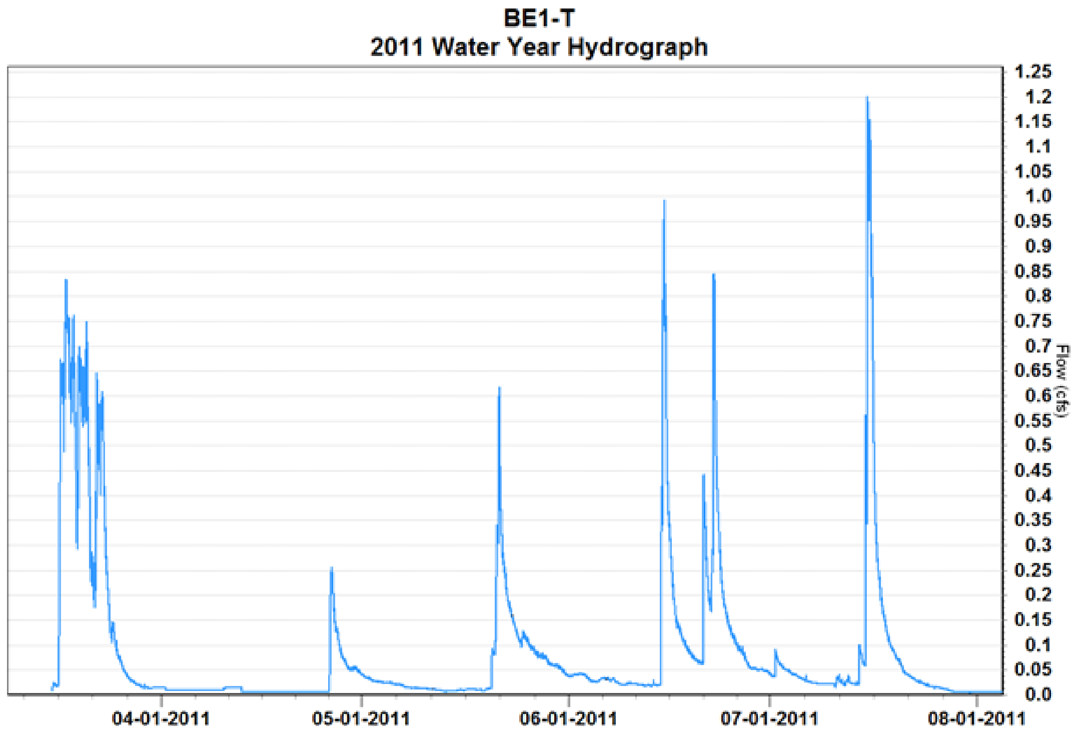

Figure 3.07: BE1-T (subsurface tile) hydrograph for available flow data. No flow was observed outside of the dates presented in the figure.

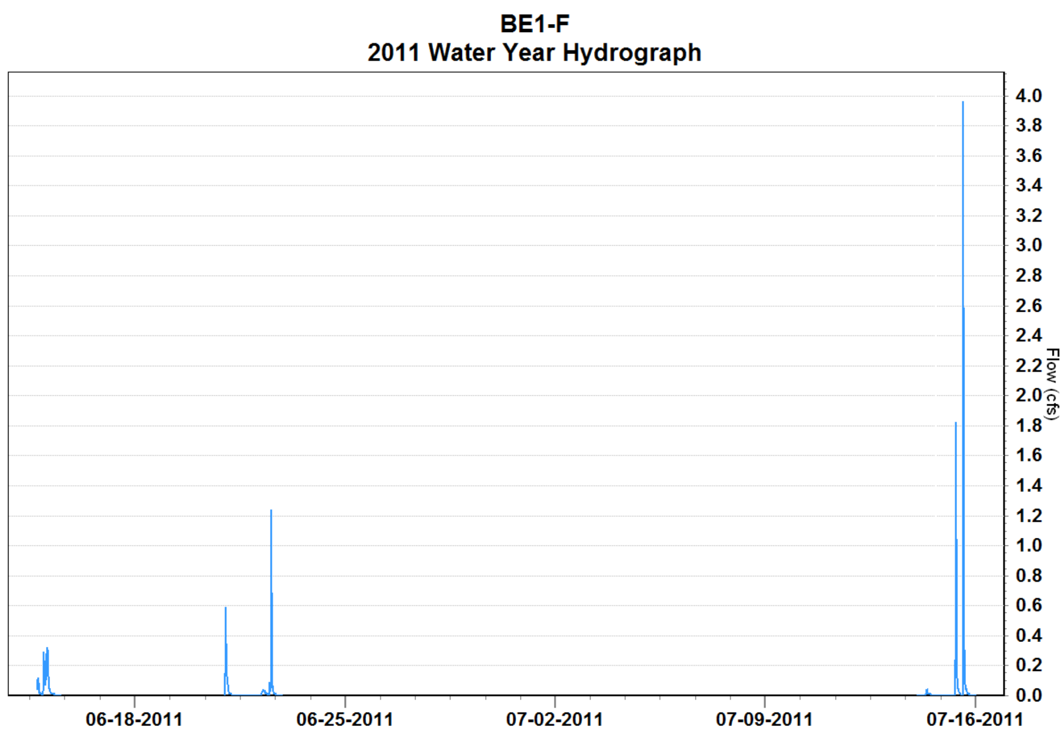

Figure 3.08: BE1-F (overland flume) hydrograph for available flow data. No flow was observed outside of the dates presented in the figure.

3.1.3 Loads, Yields, Flow-weighted Mean Concentrations

A total of 34 subsurface tile and 13 overland water samples were collected during the WY2011 monitoring periods at BE1. The figures presented in this section provide yield and FWMC for constituents monitored at BE1. However, it must be noted that the monitored periods for the subsurface tile and overland flume were different. Subsurface tile data represents losses from March 1 – September 30, 2011 (seven months) while the overland flume data only represents data from June 1 – September 30, 2011 (four months). Because overland monitoring data is not available until June 1, frozen vs. non-frozen runoff percentages are not presented in the yield graphs.

The drainage system contains no surface inlets. The highest Total Suspended Solids (TSS) sample concentration was 11 mg/L and several of the samples had less than detectable levels of TSS (< 2 mg/L). For the monitoring period, only 5.3 lbs/acre of TSS moved through the tile, with a FWMC of 2 mg/L.

The TSS losses from the overland watershed were 91.0 lbs/acre. The majority (69 percent) of the TSS loss occurred on July 15, 2011 during storm runoff. The FWMC for the monitoring period was 882 mg/L. TSS yield and FWMC data for the subsurface tile and overland flume are provided in Figures 3.09 and 3.10.

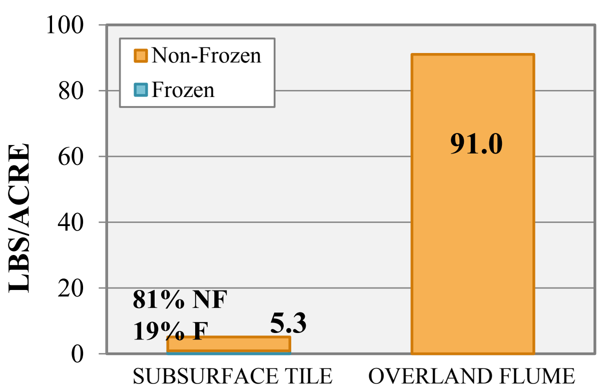

Figure 3.09: BE1 total suspended solids yield. NF = Non-Frozen | F = Frozen Tile (Mar-Sep) | Flume (Jun-Sep).

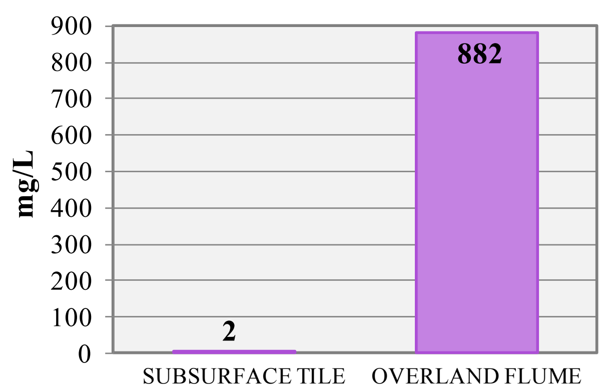

Figure 3.10: BE1 total suspended solids flow-weighted mean concentration.

Total phosphorus (TP) and dissolved orthophosphorus (DOP) losses were 0.1 lbs/acre and 0.1 lbs/acre respectively from the subsurface tile. The largest loss occurred during the snowmelt period in late March. During that period, 33 percent of the total runoff occurred, with 50 percent of the TP load and 55 percent of the DOP load. The TP and DOP sample concentrations during this period were higher than during storm runoff events. TP and DOP were lowest during base flow conditions, resulting in 37 percent of the runoff but only 18 percent of the TP and 15 percent of the DOP loads. Overall, TP and DOP concentrations were relatively low for the subsurface tile, with FWMC's of 0.056 mg/L and 0.035 mg/L, respectively for the monitoring period.

From the overland watershed, the TP losses were 0.1 lbs/acre and 0.0 lbs/acre for DOP for the four month period. Similar to TSS, a large quantity of the TP (55 percent) and DOP (60 percent) load occurred during storm runoff on July 15, 2011. The FWMC for TP and DOP from the watershed were 1.389 and 0.430 mg/L, respectively. Figures 3.11 through 3.15 present the yield and FWMC for TP and DOP at the subsurface tile and overland flume watersheds.

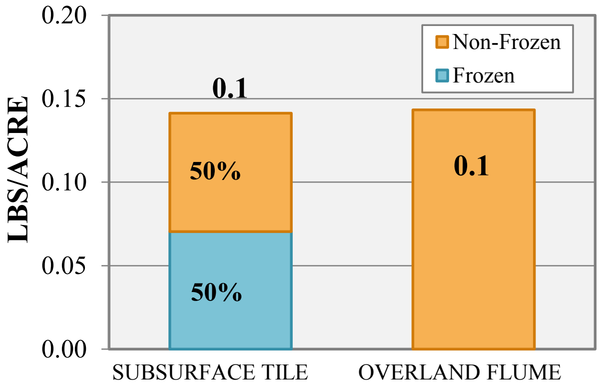

Figure 3.11: BE1 total phosphorus yield Tile (Mar-Sep) | Flume (Jun-Sep).

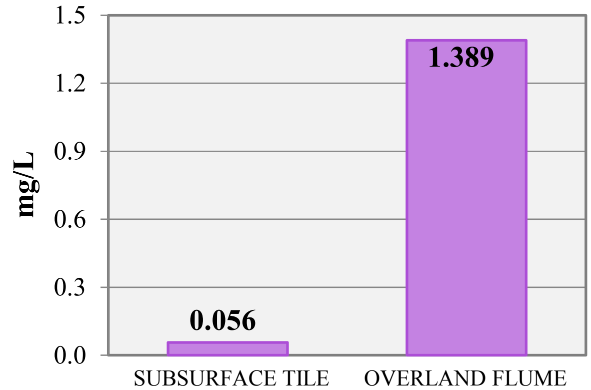

Figure 3.12: BE1 total phosphorus flow-weighted mean concentration.

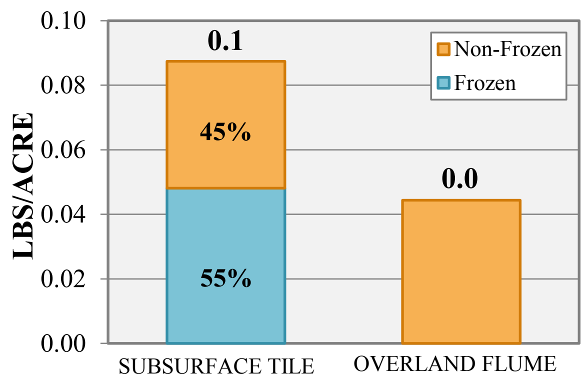

Figure 3.13: BE1 dissolved orthophosphorus yield. NF = Non-Frozen | F = Frozen Tile (Mar-Sep) | Flume (Jun-Sep).

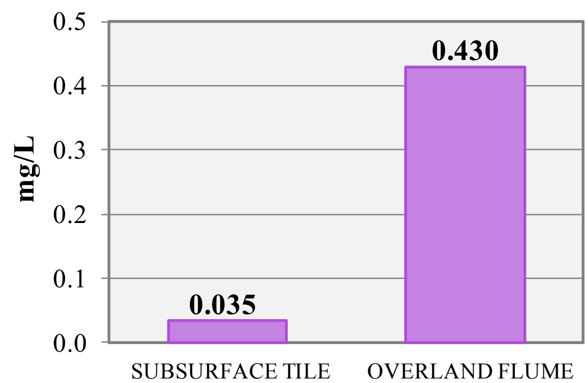

Figure 3.14: BE1 dissolved orthophosphorus flow-weighted mean concentration.

Comparison of TP and DOP (Figure 3.15) from the tile drainage shows that approximately 62 percent of the TP load was dissolved, compared with 38 percent that was particulate. Conversely, 69 percent of TP for the overland surface runoff was in the particulate form and only 31 percent dissolved.

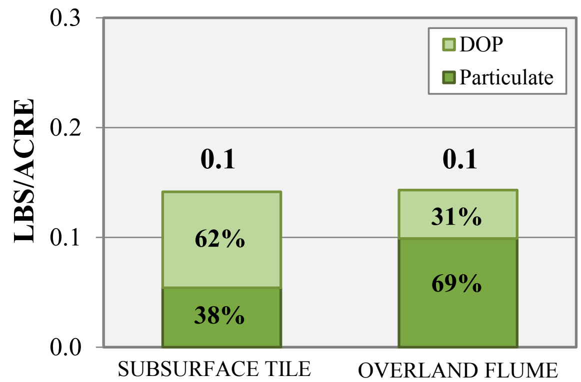

Figure 3.15: BE1 particulate versus dissolved phosphorus yield.

The total nitrogen (TN) yield (Figure 3.16) for the subsurface tile drainage was 42.9 lbs/acre, while the overland surface watershed yield was 0.9 lbs/acre. Figure 3.17 presents the FWMC for NO_2+NO_3-N, TKN, ammonia and total nitrogen. The majority (95 percent) of the TN that moved through the subsurface tile was in the NO_2+NO_3-N form.

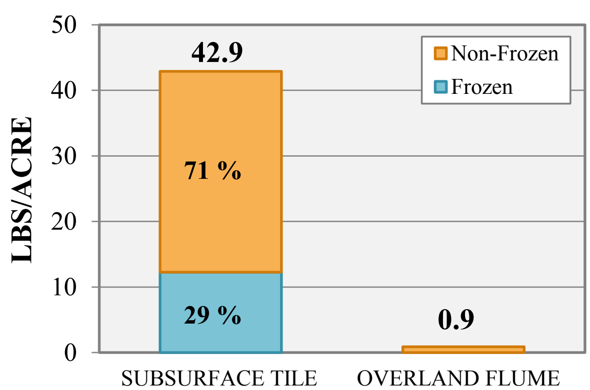

Figure 3.16: BE1 total nitrogen yield Tile (Mar-Sep) | Flume (Jun-Sep).

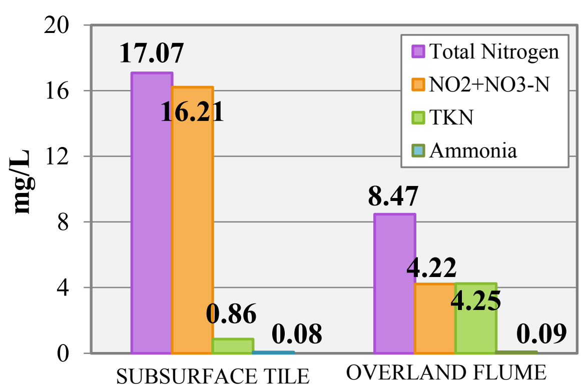

Figure 3.17: BE1 nitrogen flow-weighted mean concentrations.

Little ammonia (NH_3) was found in the subsurface tile or overland surface runoff (Figure 3.18), with most samples having less than detectable concentration levels (< 0.16 mg/L). Figure 3.19 presents a comparison of the NO_2+NO_3-N and TKN, which combined equals the TN.

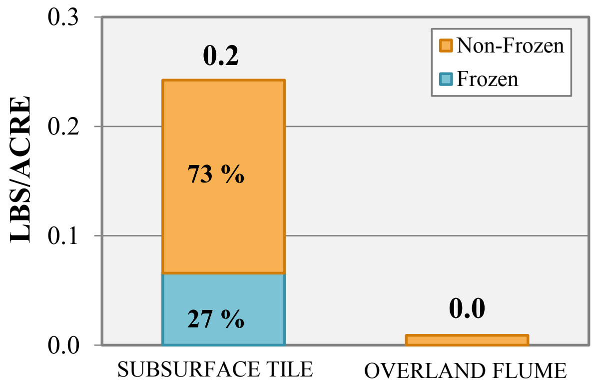

Figure 3.18: BE1 ammonia yield
NF = Non-Frozen | F=Frozen
Tile (Mar-Sep) | Flume (Jun-Sep).

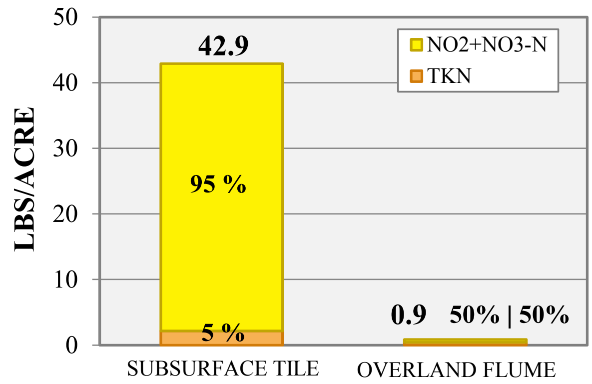

Figure 3.19: BE1 nitrate+nitrite nitrogen and total kjeldahl nitrogen yield percentages of total nitrogen.

Figures 3.20 and 3.21 present the yield and FWMC for chloride at the subsurface tile and overland flume watersheds.

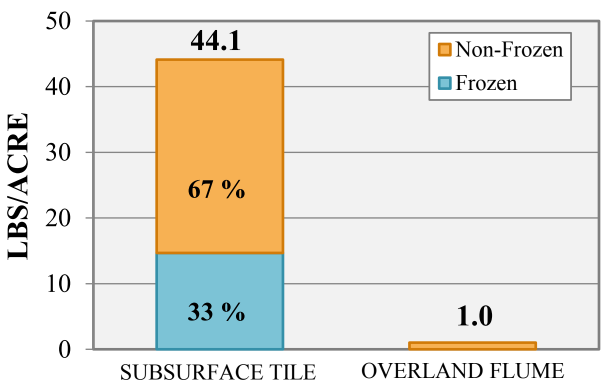

Figure 3.20: BE1 chloride yield
Tile (Mar-Sep) | Flume (Jun-Sep).

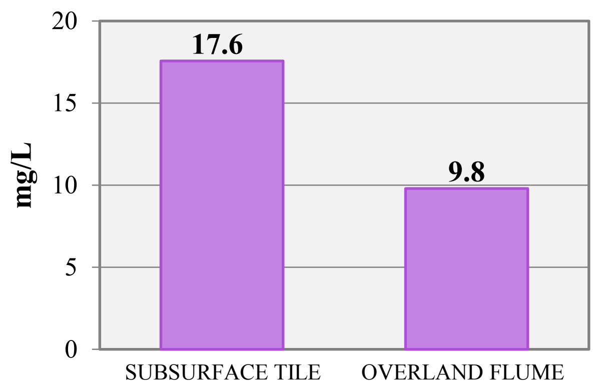

Figure 3.21: BE1 chloride flow-weighted mean concentration.

3.2 BE2

3.2.1 Farm Overview

BE2 is a grain operation located in Blue Earth County, near St. Clair, Minnesota. Located in the western corn-belt plains eco-region, the farm is surrounded by a flat to rolling landscape. Runoff from BE2 drains directly to an adjacent county ditch. The farm is located in the Le Sueur River Watershed.

Figure 3.22: BE2 monitored area showing overland surface and subsurface tile contributing areas.

The site selected for monitoring (Figure 3.22) provides an edge-of-field surface and subsurface runoff evaluation of a 14.2 acre field in a corn-soybean crop rotation with conventional tillage. The monitored field has poorly drained muck and clay loam soils and an average slope of approximately six percent. The field was disked in fall of 2010, field cultivation occurred shortly prior to planting soybeans in May 2011, and soybeans were harvested in October 2011.

BE2 was initially part of a study on the effectiveness of vegetative filter strips in reducing acetochlor, nutrient, and sediment in cropland runoff at side-inlet drains. This project was initiated by the Acetochlor Registration Partnership (ARP) and conducted by Stone Environmental, Inc., in collaboration with MDA. The study site was established in 2009, along with three edge-of-field sites in a separate field operated by the same cooperator. Flow, acetochlor, nutrient and sediment losses were monitored from the four sites during the 2009 and 2010 growing seasons. The initial two-year monitoring period was to determine if the four plots functioned hydraulically similar so that sites could be statistically compared. After the calibration period, in 2011, two of the plots were to receive a grass buffer treatment near the flume to assess reductions in acetochlor, nutrient and sediment as compared with the non-treated plots. The watershed at BE2 was dropped from the study after it was discovered that the field contained denser subsurface tile than previously known. The watershed did not function in a hydraulically similar manner to the other three watersheds, and so could not be statistically paired with them.

While not suitable for the ARP study, the watershed was still valuable in that it represented a typical agricultural field (tile drainage, corn/soybean rotation, fertilizer application rates, etc) for the region, and that equipment was already in place. In spring 2010 the ARP gifted the existing monitoring equipment from the site to the MAWRC. The equipment included a 2.0 foot flume, Rubbermaid shelter, ISCO 6712 sampler, ISCO 2105 network interface module, ISCO 4230 bubbler and Texas Instruments rain gage (Figure 3.24).

The monitoring instruments (which for the previous study were put into storage each fall) were installed immediately following the snowmelt period in late March 2011. The overland surface watershed was monitored from April 1, 2011 through September 30, 2011.

The tile drainage system at BE2 was not monitored prior to WY2011. In order to make the site suitable for monitoring, several modifications were made to the drainage system (Figure 3.23), which included:

1.) An eight inch concrete county main carried subsurface tile drainage water from a neighboring field, located across the township road to the east. The county main ran under the township road into and across the BE2 watershed. The tile outlet into the drainage ditch on the northwest corner of the field, near where the surface flume was located. Existing subsurface tile from BE2 also outlet into the county main before it outlet into the ditch. To separate the neighboring field tile drainage from the BE2 watershed, a new eight inch non-perforated dual wall plastic county main was connected to the concrete tile that drained the neighboring field. This new county main was installed across the BE2 watershed, and outlet into the drainage ditch. This enabled the tile drainage from the neighboring field to be separated from the drainage in the BE2 tile watershed.

2.) A road culvert delivered surface runoff to the BE2 watershed from the neighboring field to the east. To avoid possible contamination of surface water, the neighboring field needed to be diverted. An open intake was installed below the culvert outlet and routed with non-perforated tile to the new county main. This diverted the surface water from spilling across the BE2 watershed.

3.) The producer added several laterals of subsurface tile to the existing drainage system.

4.) An eight foot Agri Drain structure (Figure 3.25) was installed near the drainage ditch, on the field edge, in late May 2011. This served as the monitoring location for the BE2 subsurface tile watershed.

Figure 3.23: Modifications made to the BE2 watershed for monitoring the subsurface tile. Yellow dot indicates monitoring station location.

Tile monitoring equipment was installed at the site in early July 2011. Tile drainage was measured from July 8, 2011 through September 30, 2011. An ISCO 6712 sampler with 450 Area Velocity Flow Module and probe were installed to measure flow. In late August, a Texas Instruments rain gage, Campbell Scientific soil reflectometer and MDX soil temperature probe were instrumented at the site. These sensors were logged to a Campbell Scientific CR10X datalogger.

Figure 3.24: BE2 monitoring setup for overland surface runoff. Set up and equipment gifted from the Acetochlor Registration Partnership study.

Figure 3.25: Installation of Agri Drain control structure at BE2, June 2011. Agri Drain provides access point for subsurface tile monitoring.

3.2.2 Precipitation and Runoff

The BE2 WY2011 monitoring season was from April 1 through September 30. The rain gage at the site functioned intermittently, so 15 minute and daily rainfall data were obtained from the Le Sueur River monitoring station located in St. Clair, MN on County State Aid Highway 28 (2 miles south west of BE2). Monthly precipitation totals are presented in Figure 3.26. Rainfall for the monitoring season was 17.72 inches, which was 5.59 inches below the 30-year normal (1981-2010) of 23.31 inches (NOAA station #215073, Mankato, MN) for the same period. April through July was near the 30-year normal, but August and September were very dry with only 1.41 inches combined. This was 5.98 inches below the normal of 7.39 inches for August and September.

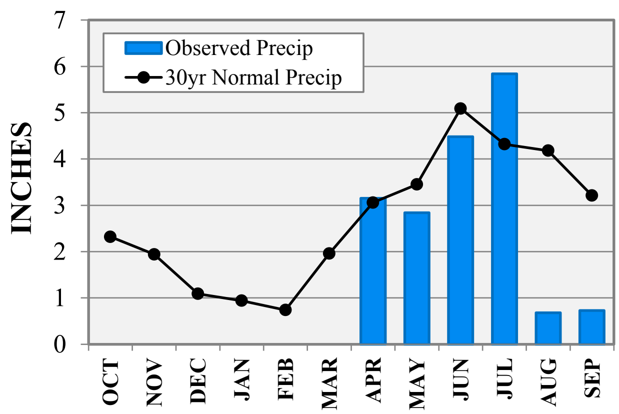

Figure 3.26: Observed monthly rainfall totals for station near BE2 compared with 30-year normal precipitation from station #215073 at Mankato, MN.

The highest intensity and greatest quantity rainfall event of the WY2011 monitoring period occurred during the morning and afternoon of July 15. This was the only event that produced overland surface runoff. On that morning, 1.03 inches of rain fell in 30 minutes. A small quantity of runoff occurred during this period and one sample bottle was collected. The rain stopped for five hours before another front moved in that dropped an additional 1.40 inches in 1 hour 15 minutes (1.03 inches occurred during a 15 minute period). The rain fell on already saturated soils, resulting in rapid overland runoff from the field. Within 15 minutes of the start of the second event, the 2.0 foot flume was flooded (Figure 3.27). On the afternoon of July 15, a site visit was conducted by MDA field staff. Two problems were immediately evident, the flooded condition of the bottom of the field where the flume was located, and the contamination of surface flow from outside the BE2 watershed. The culvert at the township road was running at full capacity (water was nearly running over the township road) and the open intake on the field edge was not able to contain the flow volume. Excess water spilled across the surface of the field towards the flume. Due to these two issues, it was not possible to calculate a load for BE2 in WY2011. The July 15 event was the only overland surface runoff generated during the April through September monitoring season as the result of a dry fall.

Figure 3.27: BE2, flooded monitoring station, July 15, 2011.

The DFM Steering Committee met in fall 2011 to discuss the problems outlined above. It was decided to continue with the overland monitoring to assess if the event on July 15 was unique. Under normal runoff conditions, surface runoff from the adjacent road ditch should be handled by the open intake. To address the flooding of the flume area, an ISCO area velocity probe was installed April 2012 at the culvert immediately downstream the flume. If the flume area becomes flooded, discharge can be accurately calculated by measuring the flow through the culvert.

The monitoring season for the subsurface tile was July 8 through September 30, 2011. During that time, 2.25 inches of total runoff was calculated. The majority of runoff (66 percent) occurred during the only storm event of the period (July 15). Due to the dry conditions observed from late July through the fall, the tile went completely dry by July 28.

Figure 3.28 presents the hydrograph for BE2-T (subsurface tile). BE2-T flowed for a combined total of 27.9 days, or 33 percent of the 85 day monitoring period (July 7 – September 30, 2011).

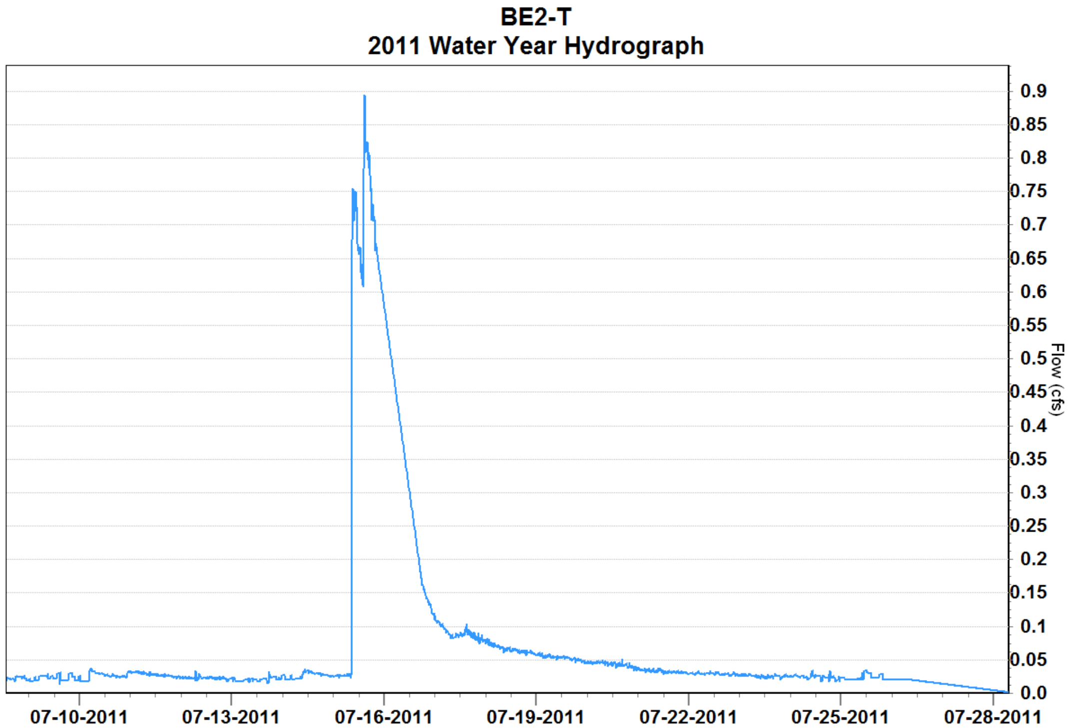

Figure 3.28: BE2-T (subsurface tile) hydrograph for available flow data. No flow was observed outside of the dates presented in the figure.

3.2.3 Loads, Yields, Flow-weighted Mean Concentrations

Five overland runoff samples were collected during the storm event that occurred on July 15, 2011. However, four of the samples were contaminated with runoff water from the neighboring field. As discussed previously, loads were not calculated in WY2011 for the overland surface runoff. Load data for BE2-T (subsurface tile) was only available for a two and a half month period and is based on one base flow sample and four storm flow samples. Partial season results for BE2-T are presented in Table 3.0.

Table 3.0: BE2 subsurface tile loading results, July 7 - September 30, 2011.

TOTAL RESULTS		2011 BE2-Tile | July 7 - September 30, 2011							
		TSS	TP	DOP	TN	NO_2+NO_3	Ammonia	TKN	Chloride
Load	lbs	318.3	1.6	0.5	142.5	121.9	0.6	20.5	54.1
FWMC	mg/L	44	0.214	0.064	19.69	16.85	0.08	2.8	7.5
Yield	lbs/acre	22.4	0.1	0.0	10.0	8.6	0.0	1.4	3.8
Norm.Yield	lbs/ac/in	10.0	0.1	0.1	4.5	3.8	0.0	0.6	1.7
Rainfall	inches	6.75							
Runoff	inches	2.25							
	%	33.3%							
Volume	liters	3,281,452.6							
	ft^3	115,870.5							
Watershed Size	acres	14.2							
	ft^2	618,552.0							

3.3 CH1

3.3.1 Farm Overview

CH1 is located in Chisago County east of North Branch, Minnesota and is a cash-crop grain operation producing mostly corn and soybeans with a small amount of vegetables that are sold locally. The farm has been operated by the same family since the mid-1970s. Approximately 700 acres of corn and 700 acres of soybeans are grown each season utilizing a reduced-till planting system. Located in the north central hardwoods forest eco-region, the landscape is dominated by rolling plains with a mix of woodlands, row crops and pastures. The farm is situated within the Sunrise River Watershed which is located within the St. Croix River Basin.

Figure 3.29: CH1 overland surface watershed boundary.

Figure 3.30: CH1 monitoring station following corn harvest, fall 2011.

Figure 3.31: CH1 monitoring location during spring snowmelt runoff, March 2011.

The 6.1 acre watershed selected for monitoring has a corn-soybean rotation and a modified no-till management system (Figure 3.29). Subsurface tile drainage does not exist within this field; therefore, only overland runoff is being monitored. The flume and equipment are installed on the downstream edge of a grassed waterway. Soil within the monitored watershed is classified as a well-drained Cushing loam. Soil phosphorus samples collected in November of 2010 indicated that the soil P (Bray) was very high (39 ppm), and soil Potassium was in the middle range (119 ppm). Corn was planted for the 2011 monitoring season. Banded applications of phosphorus and potassium occurred prior to planting and split applications of nitrogen and sulfur occurred after planting.

CH1 was adopted into the DFM program in 2010. During that fall, the 2.0 foot H flume, wingwalls and berms were installed (Figures 3.30 and 3.31). In February of 2011, the shelter was put in place and the site was equipped with a Forest Technology Systems (FTS) H2 axiom datalogger, FTS tipping bucket rain gage, FTS air temperature and humidity sensor, OTT CBS high accuracy bubbler, APG ultrasonic transducer and ISCO 6712 portable automated sampler. A Campbell Scientific CS650 soil moisture probe was installed in fall 2011. At the same time, installation of a depth integrated soil temperature probe was attempted but abandoned due to a prominent gravel and cobble horizon approximately 12-18 inches beneath the soil surface which could not be penetrated by a hand auger.

3.3.2 Precipitation and Runoff

The NOAA 30-year (1981-2010) normal precipitation for this region is 32.05 inches annually, based on the long term network gage at Forest Lake, Minnesota (NOAA Station #212881), located approximately 18 miles from CH1. From March through September 2011, the observed precipitation at the monitoring station measured 18.72 inches, versus 24.50 inches normally over the same period (a deficit of 5.78 inches) (Figure 3.32). The March monthly rainfall total was taken from the nearest network rain gage at Wild River State Park (NOAA station #218986) which is 4.75 miles from CH1. This value was substituted for March because the rain gage at the site was not capable of accurately measuring frozen precipitation. By comparison, the Wild River State Park gage measured 17.4 inches over the same March through September period.

Rainfall totals exceeded 30-year normal values in March, April and May of 2011 by 1.46 inches for the three months (Figure 3.33). Conditions became drier by mid-summer and then very dry by September. Monthly totals for June, July, August and September were all below normal with a cumulative deficit of 7.24 inches. Drought-like conditions were observed by September with only 0.42 inches of precipitation which was down 3.14 inches from the 30-year normal of 3.56 inches. Of the 18.72 inches of rain that fell during the seven month monitored period, 4.20 inches of rain ran off the 6.1 acre watershed (22 percent) (Figure 3.34).

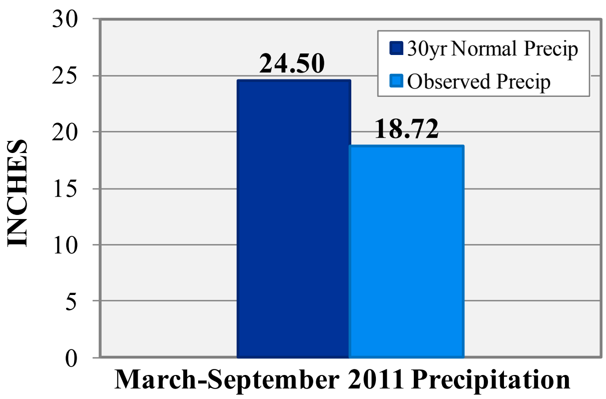

Figure 3.32: CH1 observed total rainfall (March - September 2011) versus the 30-year normal precipitation total for the same period.

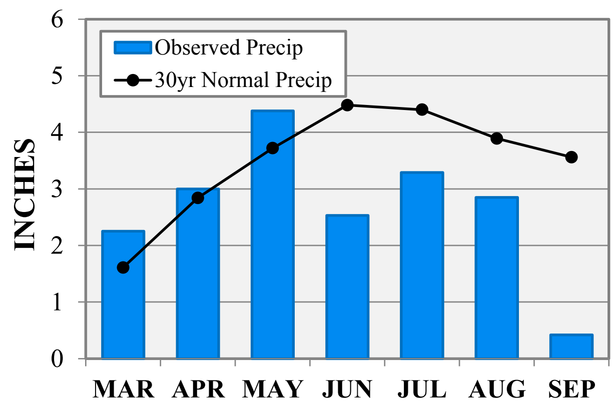

Figure 3.33: CH1 observed monthly precipitation vs. 30-year normal, March – September 2011.

According to the National Operational Hydrologic Remote Sensing Center (NOHRSC), there was approximately 2.29 inches of water in the snow pack near the Chisago County station (NOAA #1689R_MADIS) on March 14. Snowmelt began on March 15 and lasted through March 23. This initial flush accounted for 64.1 percent of all runoff for the monitored period. A majority of the snow was melted off the field during this time; however, temperatures fell back below freezing followed by a late March snowfall. It was again reported that there was 1.05 inches of snow-water equivalent from the Chisago County station on March 28, and 1.20 inches at the St. Croix Falls (#SCFW3) station on March 29. A second snowmelt runoff occurred from April 1 through April 4 and totaled 24.5 percent of the cumulative runoff. By the afternoon of April 4, it was noted that all snow had been melted from the field. Collectively, snowmelt accounted for 88.5 percent (3.71 inches) of the runoff for the entire March through September 2011 monitoring period.

Seventeen separate runoff events took place from March through September, a few of which can be combined together (snowmelt, May 21-23 and June 21-23). Numerous small runoff events occurred between April 10 and May 12; each accounting for less than one percent of the total flow volume for the monitored period. Four separate events also occurred May 21-23 that accounted for 6.4 percent (0.27 inches of runoff) of the total flow volume for the period. The remainder of the flow volume is made up of multiple small events from June 21-22 and two events in August (2 and 6). No runoff occurred in the month of July or September 2011. In total, 92,912.96 ft^3 (2,631,294.95 liters) of water flowed through the monitoring station from March 1 through September 30. Figure 3.35 presents the hydrograph for CH1. CH1 flowed for a combined total of 11.4 days, or just over 5 percent of the 214 day monitoring period (March – September 30).

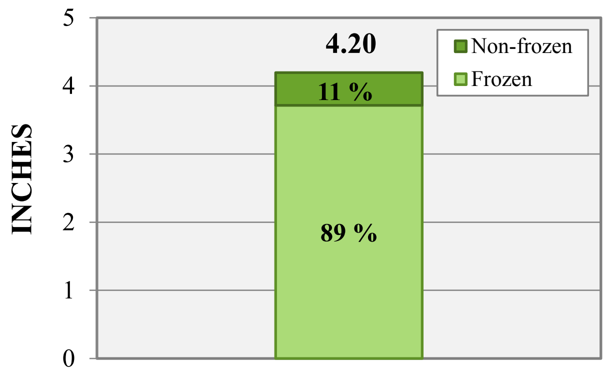

Figure 3.34: CH1 frozen vs. non-frozen total runoff, March - September 2011.

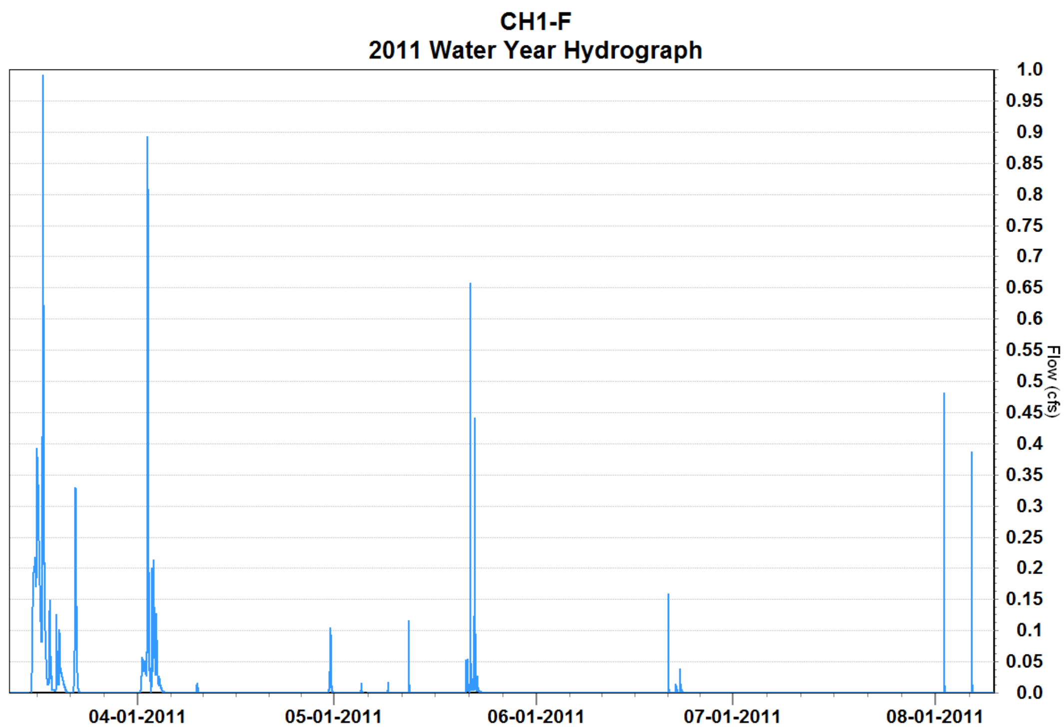

Figure 3.35: CH1-F (overland flume) hydrograph for available flow data. No flow was observed outside of the dates presented in the figure.

3.3.3 Loads, Yields, Flow-weighted Mean Concentrations

Fourteen flow-incremented composite samples were collected over the monitored period from March 1 through September 30, 2011. Of the fourteen samples, ten were collected from snowmelt runoff and four were collected during late May through early August storm events. The following graphs show the constituent yield (pounds/acre) based on the 6.1 acre watershed with the associated FWMC (mg/L).

TSS losses at CH1 yielded 82.0 lbs/acre, with a FWMC of 86 mg/L (Figures 3.36 and 3.37). Only 24 percent of the TSS yield occurred during the frozen period, though 88.5 percent of the runoff occurred during the same period. Seventy-two percent of TSS losses were observed during a three day multiple peak storm event from May 21-23, although only 6.4 percent of the runoff occurred over the same period.

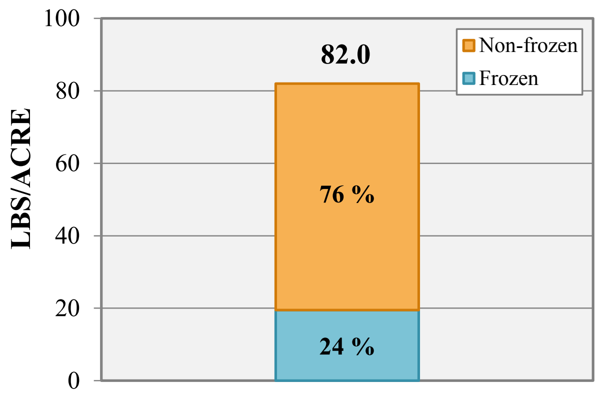

Figure 3.36: CH1 TSS yield, March – September 2011.

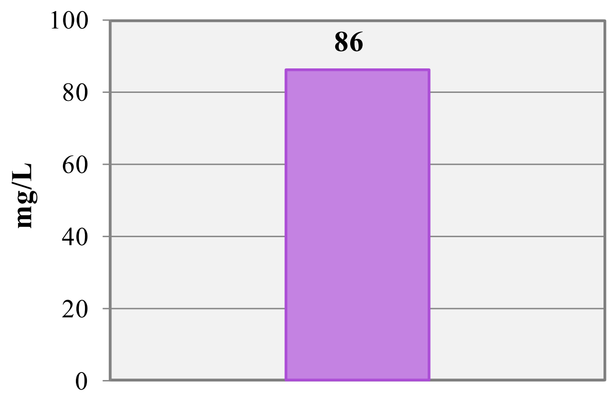

Figure 3.37: CH1 TSS flow-weighted-mean concentration (FWMC), March – September 2011.

The two snowmelt runoff events in March and early April produced 73 percent of TP load (Figure 3.38) and 74 percent of the DOP load (Figure 3.40). Nearly 22 percent of the TP load occurred during a multiple peak event from May 21-23. The same event produced 20 percent of the DOP load. FWMC concentrations were 1.314 mg/L for TP (Figure 3.39) and 0.684 mg/L for DOP (Figure 3.41). Approximately 48 percent of the TP was in the particulate form, while 52 percent was dissolved (Figure 3.42).

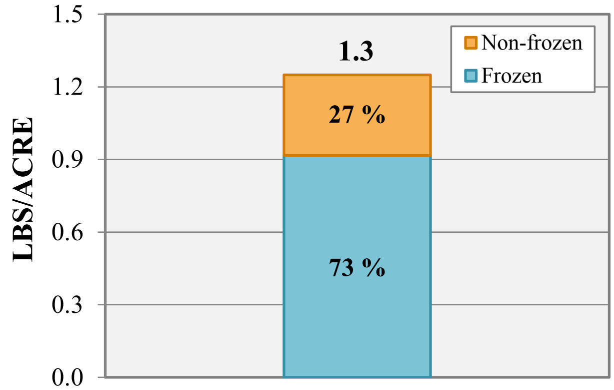

Figure 3.38: CH1 TP yield, March – September 2011.

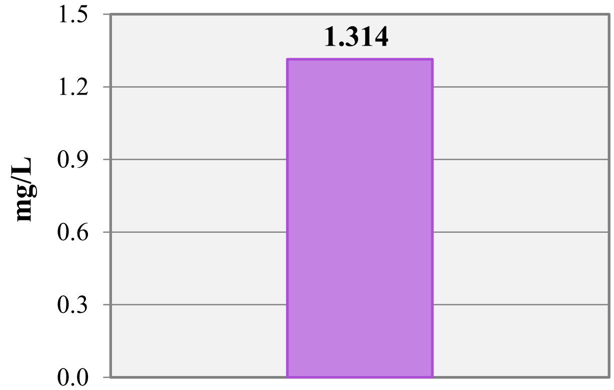

Figure 3.39: CH1 TP flow-weighted-mean concentration, March – September 2011.

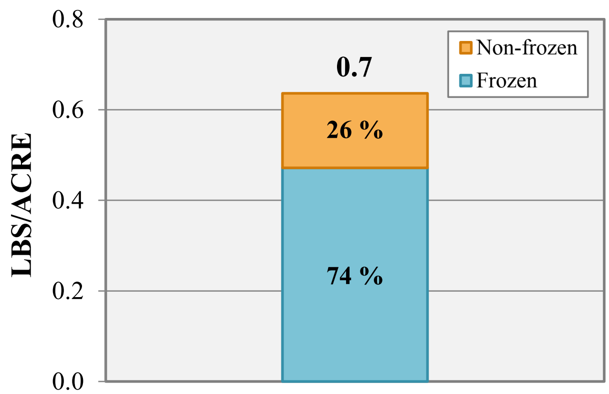

Figure 3.40: CH1 DOP yield, March – September 2011.

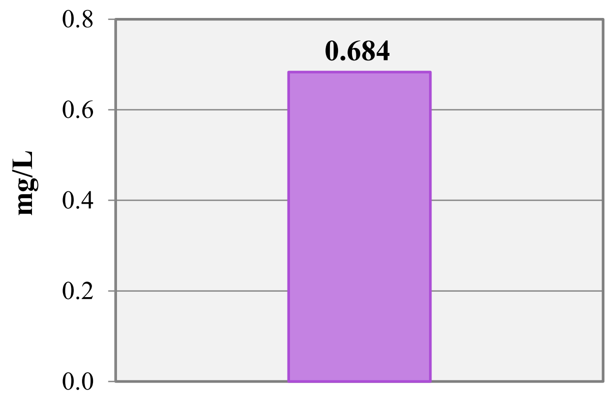

Figure 3.41: CH1 DOP flow-weighted-mean concentration, March – September 2011.

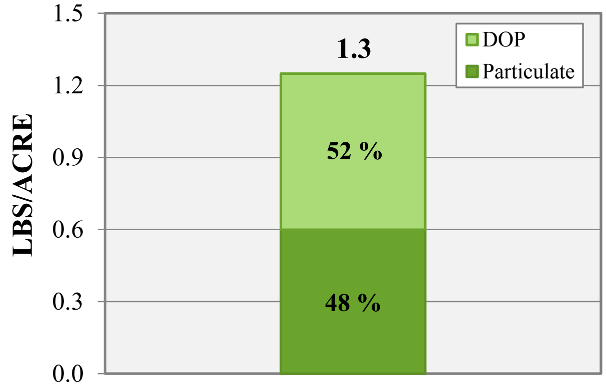

Figure 3.42: CH1 particulate versus dissolved phosphorus yield, March – September 2011.

Snowmelt (frozen) runoff accounted for 77 percent of the total nitrogen loss at CH1 from March through September 2011 (Figure 3.43). The multiple peak events from May 21-23 made of 17 percent of the load for the monitored period. The FWMC for TN was 4.12 mg/L. TKN, ammonia and NO_2+NO_3-N FWMC are presented in Figure 3.44. Ammonia losses were 0.5 lbs/acre (Figure 3.45). TKN made up the majority (86 percent) of TN (Figure 3.46).

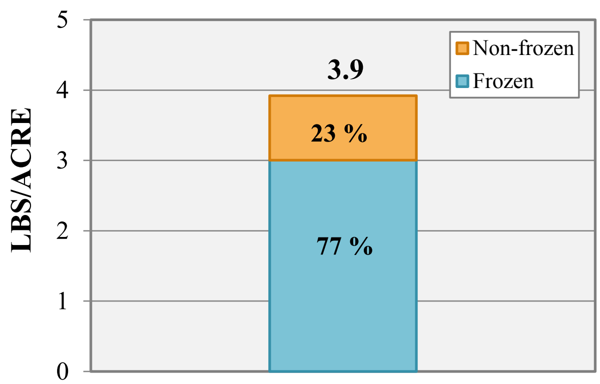

Figure 3.43: CH1 total nitrogen yield, March – September 2011.

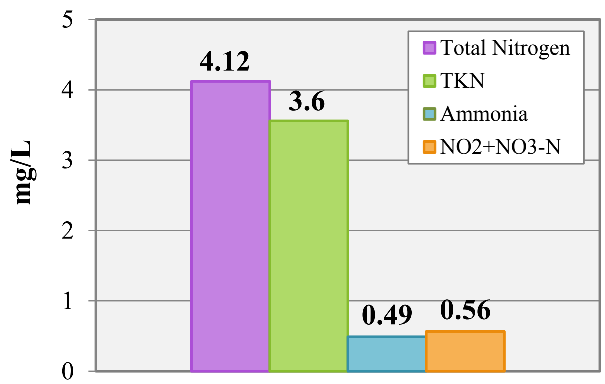

Figure 3.44: CH1 nitrogen flow-weighted-mean concentrations, March – September 2011.

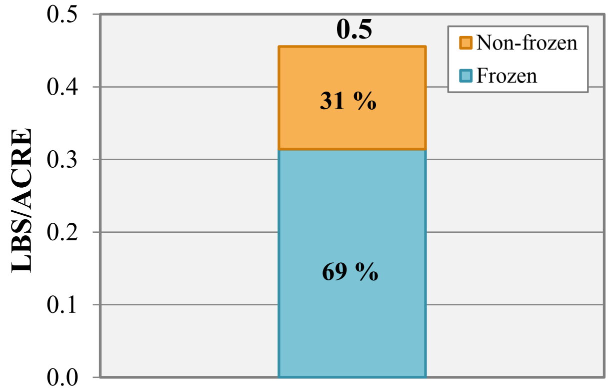

Figure 3.45: CH1 ammonia yield, March – September 2011.

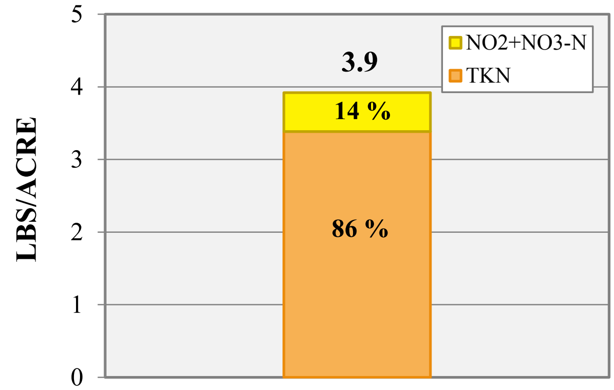

Figure 3.46: CH1 NO_2+NO_3-N vs. TKN, March – September 2011.

In contrast to other constituent loads, frozen ground runoff only accounted for 31 percent of the chloride losses at CH1 with a total of 4.0 lbs/acre (Figure 3.47). The majority (63.5 percent) of chloride loss was during the multiple event May runoff (May 21-23). The chloride FWMC was 4.2 mg/L (Figure 3.48).

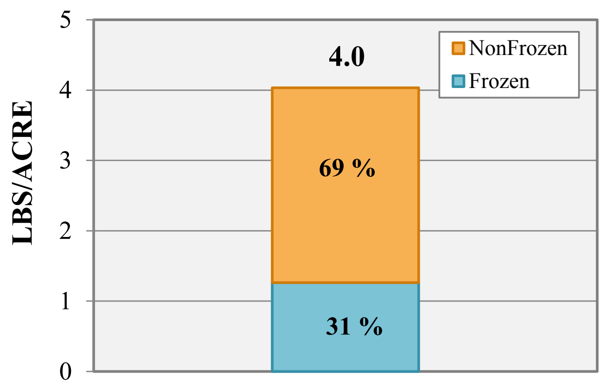

Figure 3.47: CH1 chloride yield, March – September 2011.

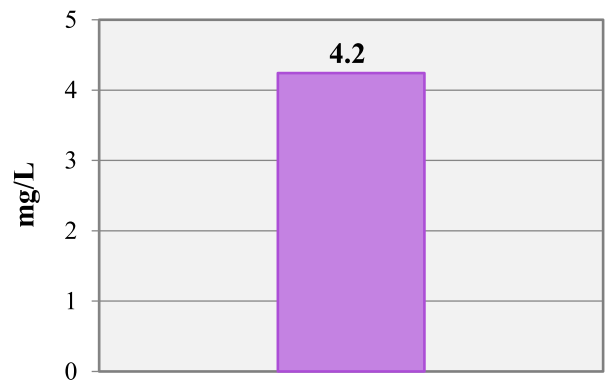

Figure 3.48: CH1 chloride flow-weighted-mean concentration, March – September 2011.

3.4 GO1

3.4.1 Farm Overview

GO1 is a beef cow-calf and swine farrow-to-wean livestock operation located in Goodhue County, near Goodhue, Minnesota. The farm manages approximately 190 acres of crops with the typical crop rotation consisting of three years of alfalfa followed by two years of corn.

The farm is located in the southeastern non-glaciated region of Minnesota. The region is characterized by broad, rolling ridges and narrow valleys cut by one of the regions numerous rivers and streams. The farm is located on the upper portion of the Wells Creek Watershed, approximately 12 miles from Lake Pepin and the Mississippi River.

The site selected for monitoring (Figures 3.49, 3.50 and 3.51) provides edge-of-field surface runoff evaluation of a 6.3 acre watershed with an alfalfa-corn rotation and swine manure application. The monitored field has well-drained silt loam soils and an average slope of approximately six percent. In WY2011, the cropping rotation in the monitored field was in the second year of alfalfa. There were no manure or fertilizer applications in WY2011 and three cuttings of hay were harvested throughout the summer.

Figure 3.49: GO1 6.3 acre overland surface watershed.

Figure 3.50: GO1 monitoring location during snowmelt runoff, March 2011.

Figure 3.51: GO1 watershed in alfalfa, September 2011. Photo is taken from top of watershed looking towards the monitoring station.

GO1 was instrumented in the fall of 2010. A 2.5 foot flume was installed at the field edge to monitor the overland runoff. The site was equipped with a Forest Technology Systems (FTS) H2 axiom datalogger, FTS tipping bucket rain gage, FTS air temperature and humidity sensor, OTT CBS high accuracy bubbler and ISCO 6712 portable automated sampler. An APG Ultrasonic transducer was installed in the summer of 2011 as a backup stage measuring device. A Campbell Scientific CS650 soil moisture probe and depth integrated soil temperature probe were installed in August 2011. GO1 is the only site to have a full water year of data available (October 1, 2010 – September 30, 2011).

During a storm event on July 15, 2011, GO1 experienced a lightning strike which damaged several instruments in the shelter. The cellular modem, datalogger, refrigerated sampler, ISCO interface cable and rain gage were all affected. The flow for the event was recorded by the datalogger, but no samples were collected.

3.4.2 Precipitation and Runoff

According to the NOHRSC, there was approximately 3.80 inches of water in the snow pack near the Red Wing Dam 3 on March 14, just one day prior to the beginning of the March snowmelt runoff. Red Wing Dam 3 is approximately 12 miles to the north of GO1.

The total measured precipitation at GO1 for October 2010 through September 2011 was 27.23 inches, which was 6.20 inches below the 30-year normal (1981-2010) of 33.43 inches (NOAA station #216817, Red Wing, MN) (Figure 3.52). Due to issues with the rain gage on site for a majority of the year, observed monthly precipitation totals were taken from the Claybank, MN (NOAA station #211560) network gage (approximately 3.6 miles from GO1), except for May, June and September of 2011 (Figure 3.53).

From March through July 2011, there was a surplus of 1.06 inches over normal, however, conditions became very dry in late summer and only 2.03 inches of rain fell in August and September which was a shortage of 6.46 inches from normal.

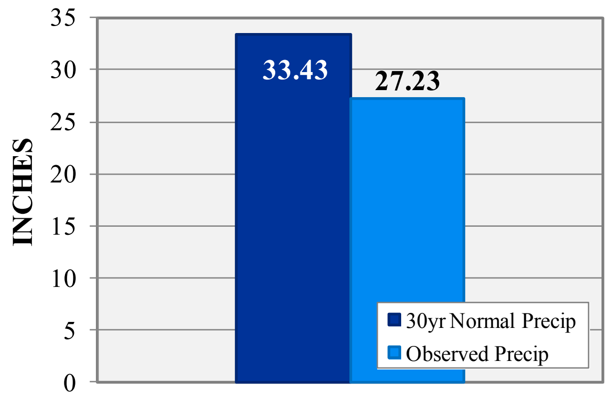

Figure 3.52: GO1 annual precipitation (October 2010 - September 2011) versus the 30-year normal from Red Wing, MN (station #216817).

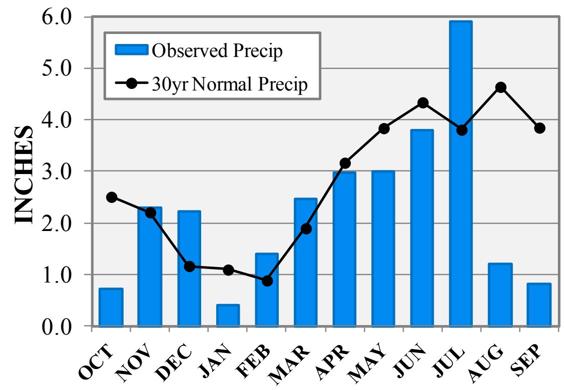

Figure 3.53: GO1 observed monthly precipitation versus the 30-year normal from Red Wing, MN (station #216817).

The overland runoff for WY2011 was 4.31 inches from the 6.3 acre overland watershed. Of the 4.31 inches that ran off, approximately 92 percent (3.98 inches) occurred off of "frozen" ground (Figure 3.54). Three snowmelt runoff events occurred; December 29, February 14, and March 15. Snow was completely melted from the field by April 2-3. In addition, just over 2 percent of the runoff occurred during a multiple peak event from June 21-22, and 3.60 percent of runoff occurred during an August 1 event.

Figure 3.55 presents the hydrograph for GO1. GO1 flowed for a combined total of 13.1 days, or just under 4 percent of the 365 day monitoring period (October 1, 2010 – September 30, 2011).

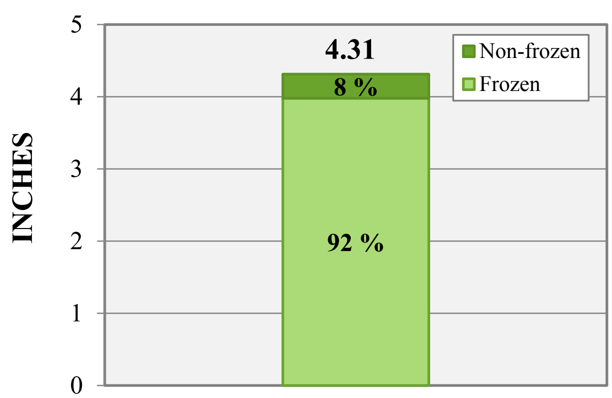

Figure 3.54: GO1 frozen vs. non-frozen annual runoff (inches), October 2010 - September 2011.

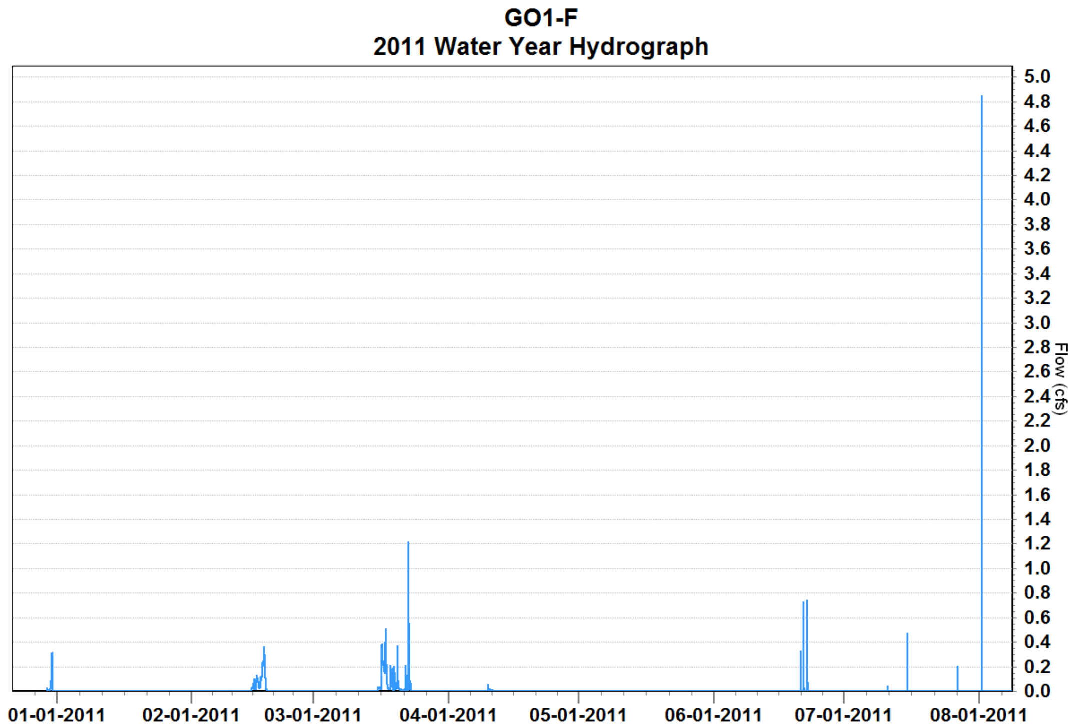

Figure 3.55: GO1-F (overland flume) hydrograph for available flow data. No flow was observed outside dates presented in the figure.

3.4.3 Loads, Yields, Flow-weighted Mean Concentrations

A total of 22 samples were collected during WY2011. The 2011 crop in the monitored watershed was alfalfa which is known for its deep roots and water retention. Because of this, it was not unexpected that the majority of runoff occurred over frozen ground. Between 82 percent (TSS) and 95 percent (TN) of the load for each constituent was transported during three snowmelt events occurring on December 29, February 14 or March 15 snowmelt runoff events. Between 5 percent (TP) and 12 percent (TSS) of the load was delivered during a multiple peak event that occurred on June 21-22.

TSS yield and FWMC for WY2011 were 47.2 lbs/acre and 48 mg/L, respectively (Figures 3.56 and 3.57).

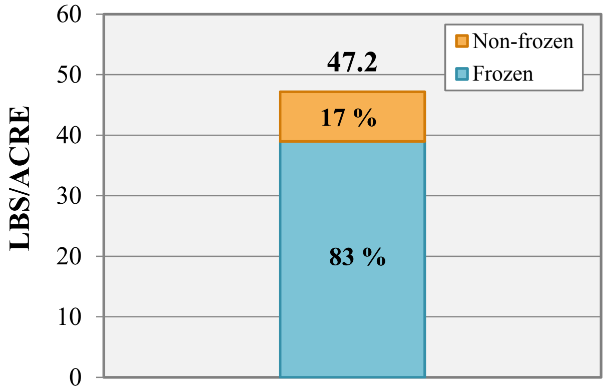

Figure 3.56: GO1 annual total suspended solids yield, October 2010 - September 2011.

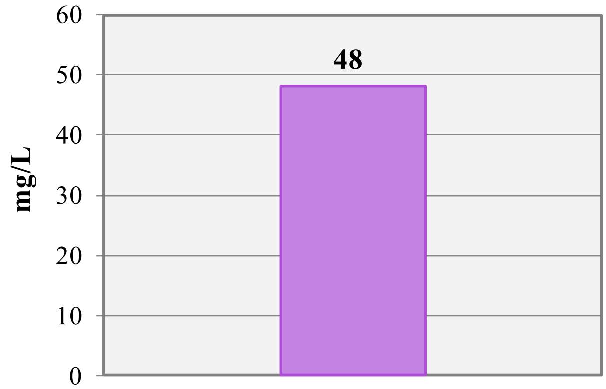

Figure 3.57: GO1 annual total suspended solids flow-weighted mean concentration, October 2010 - September 2011.

Total phosphorus yield for the WY2011 was 0.6 lbs/acre, of which 89 percent occurred during the frozen period (Figure 3.58). TP FWMC for the runoff was 0.646 mg/L (Figure 3.59). DOP yield and FWMC were 0.2 lbs/acre and 0.203 mg/L, respectively (Figures 3.60 and 3.61). The majority, (69 percent) of the TP was in the particulate form, with 31 percent dissolved (Figure 3.62).

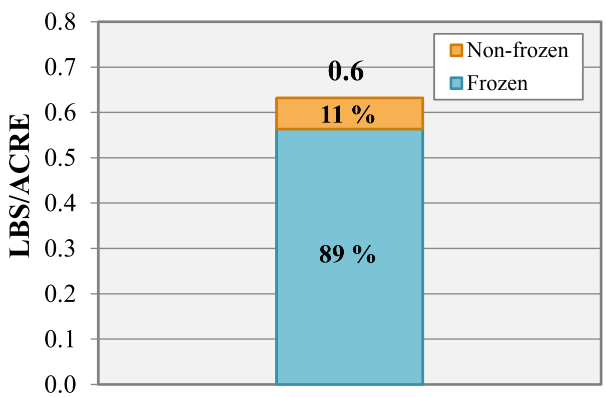

Figure 3.58: GO1 total phosphorus annual yield, October 2010 – September 2011.

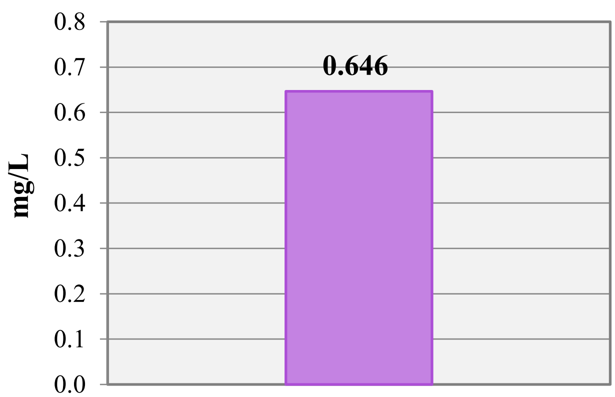

Figure 3.59: GO1 total phosphorus annual flow-weighted mean concentration, October 2010 - September 2011.

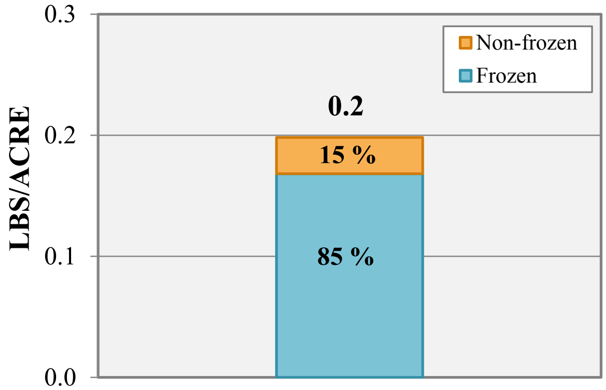

Figure 3.60: GO1 dissolved orthophosphorus yield, October 2010 - September 2011.

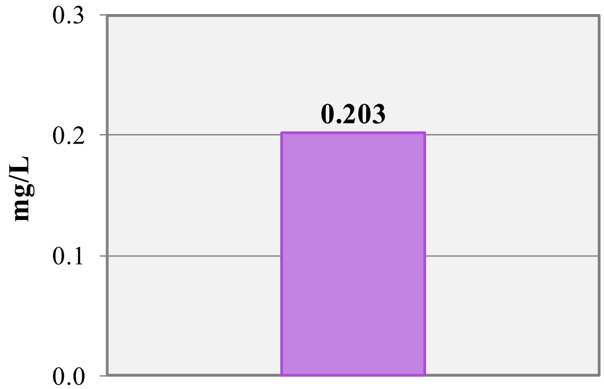

Figure 3.61: GO1 dissolved orthophosphorus flow-weighted mean concentration, October 2010 - September 2011.

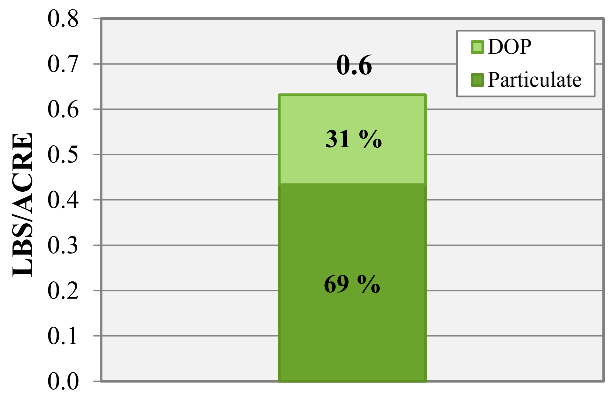

Figure 3.62: GO1 particulate versus dissolved phosphorus yield, October 2010 - September 2011.

Total nitrogen yield for the GO1 watershed was 8.7 lbs/acre, of which 95 percent was delivered during the frozen period (Figure 3.63). Total nitrogen FWMC was 8.88 mg/L. Most of the TN was found to be in the form of TKN (94 percent), with only 6 percent as NO_2+NO_3-N (Figure 3.66). Ammonia yield was 3.7 lbs/acre and FWMC 3.78 mg/L (Figure 3.64 and 3.65). Almost all (95 percent) ammonia loss occurred during the frozen period.

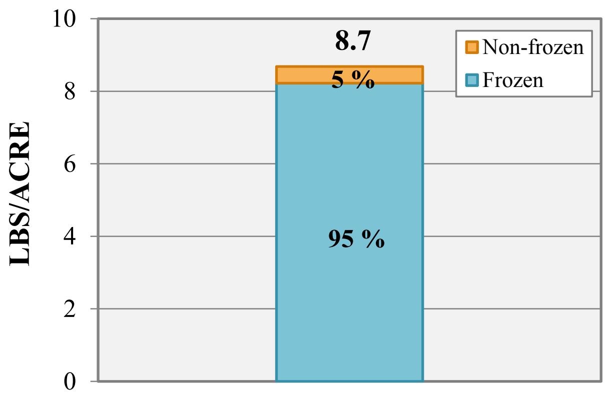

Figure 3.63: GO1 total nitrogen yield, October 2010 - September 2011.

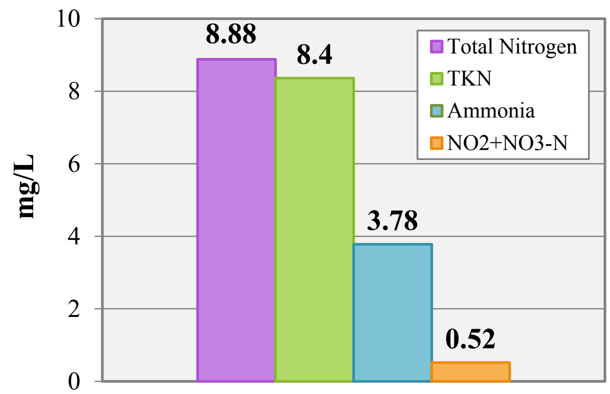

Figure 3.64: GO1 nitrogen flow-weighted mean concentrations, October 2010 - September 2011.

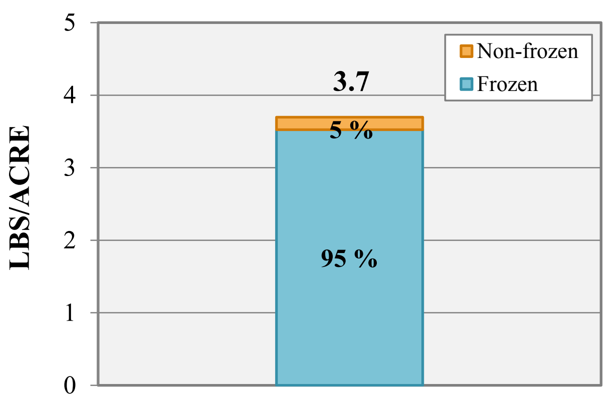

Figure 3.65: GO1 ammonia yield, October 2010 - September 2011.

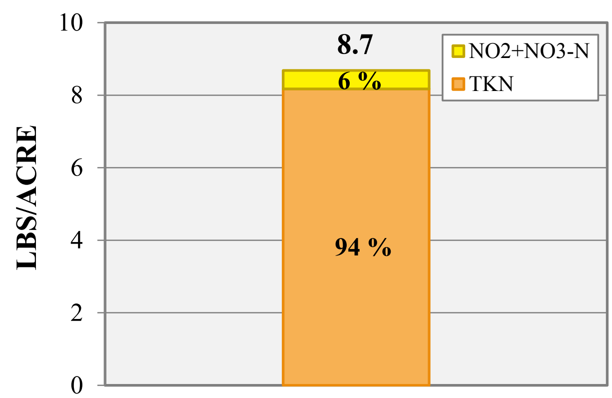

Figure 3.66: GO1 total nitrogen yield showing percentages of nitrate+nitrite nitrogen and total kjeldahl nitrogen, October 2010 - September 2011.

Chloride yield for the GO1 watershed was 4.9 lbs/acre, of which 94 percent was delivered during the frozen period (Figure 3.67). The chloride FWMC was 5.0 mg/L (Figure 3.68).

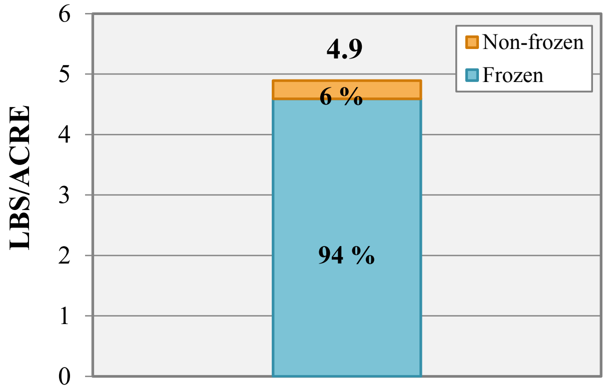

Figure 3.67: GO1 chloride yield, October 2010 - September 2011.

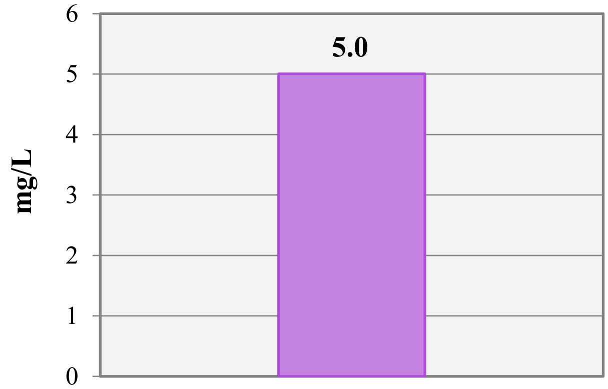

Figure 3.68: GO1 chloride flow-weighted mean concentration, October 2010 - September 2011.

3.5 ST1

3.5.1 Farm Overview

ST1 is a 175 cow dairy located in Stearns County, near Sauk Centre, Minnesota. Feed for the dairy cattle are grown on 360 acres. Typical cropping rotation at the farm is four years of alfalfa followed by four years of corn. Approximately 60 percent of the tillable acres are tile drained to improve crop productivity. Liquid manure from a manure storage basin is injected in the fall or spring to the cropped acres that will be planted to corn. Pen pack manure from the barn and calf area is surface applied where needed and incorporated into the soil profile within 24 hours.

The farm is located in the north central hardwood forest region of Minnesota. The region is characterized by rolling plains with a mix of woodlands, row crops and pasture. ST1 is located in the Upper Sauk River Watershed, approximately four miles from the Sauk River.

The site selected for monitoring provides an edge-of-field surface and subsurface runoff evaluation of a field with an alfalfa-corn rotation and dairy manure application. Overland surface water runoff is monitored from a 28.2 acre watershed with a subsurface tile watershed of 24.2 acres (Figure 3.69). The monitored field has poorly drained loam soils and average slope of approximately three percent. In WY2011, the cropping rotation in the monitored field was in the second year of corn. The field was tilled with a chisel plow in October 2010 and manure was injected in April 2011 prior to planting of corn. The corn was harvested as silage in September.

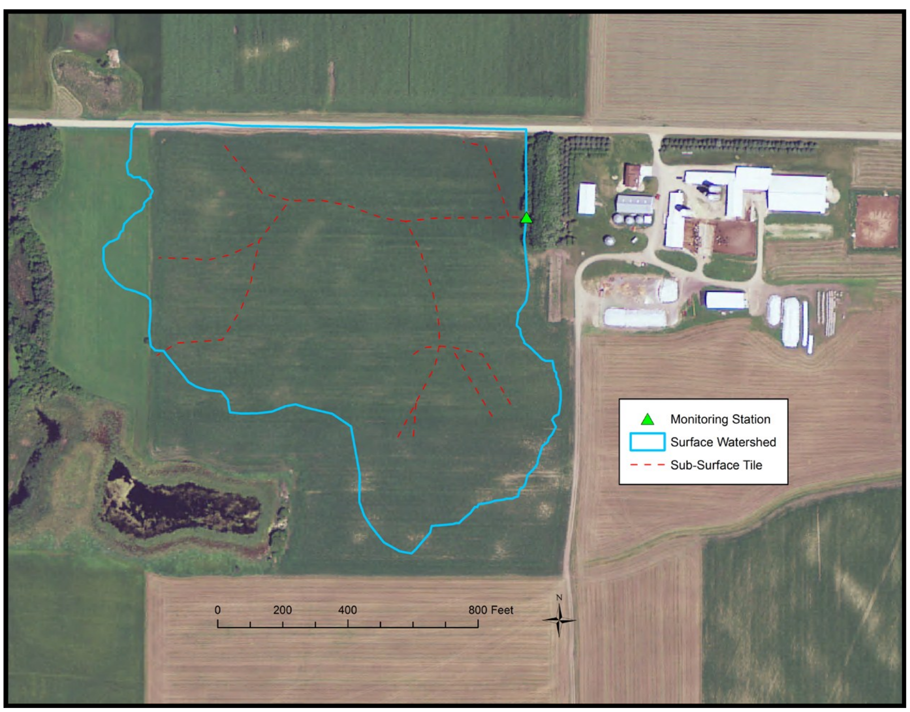

Figure 3.69: ST1 monitored watershed extent with subsurface tile.

Equipment installation for monitoring the subsurface drainage and surface runoff was completed in February 2011. A 2.5 foot flume was installed at the field edge to monitor the surface runoff. A shelter was installed and the site was equipped with a Forest Technology Systems (FTS) H2 axiom datalogger, FTS tipping bucket rain gage, FTS air temperature and humidity sensor, OTT CBS high accuracy bubbler, APG ultrasonic transducer and ISCO 6712 portable automated sampler. A Campbell Scientific CS650 soil moisture probe and depth integrated soil temperature probe were installed in fall 2011.

To monitor the subsurface tile runoff, a six foot Agri Drain structure was installed in November 2010 and instrumented with a FTS pressure transducer and ISCO 6712 portable automated sampler in February 2011. Initially, tile runoff was calculated by using a weir equation that had been developed for the Agri Drain structure. The rating equation can be used for free flow conditions, but is invalid when surcharge and backwater occurs. During the snowmelt and moderate to large storm events the site experienced surcharge due to the gradient of the tile in the field and the limited capacity of the eight inch tile. In order to calculate flows during these periods, a Greyline area velocity flow meter was installed in the Agri Drain structure in June 2011. Flow was calculated by taking the area of the full pipe multiplied by the velocity of the water.

Figure 3.70: ST1 monitoring station, summer 2011.

Figure 3.71: ST1 monitoring station and watershed from township road, facing south east, March 2011.

3.5.2 Precipitation and Runoff

Average annual precipitation is about 27 inches, most of which occurs during the growing season. On average 23.5 inches are in the form of rain and 3.5 inches are in the form of snowfall. According to the NOHRSC, there was approximately 4.1 inches of water in the snow pack near ST1 on March 11, just prior to snowmelt. The precipitation at ST1 for March through September was 24.76 inches, which was 2.51 inches above the 30-year normal (1981-2010) of 22.25 inches for the same time period. July received the most precipitation with 8.99 inches. The largest storm event occurred over July 14 and 15, with the site receiving 5.06 inches over a two day period. Monitoring season and monthly precipitation, along with the 30-year normal values are provided in Figures 3.72 and 3.73.

The 2011 monitoring season for the overland surface flume was from March 1 to September 30. Estimates for runoff are based on an overland watershed of 28.2 acres. The overland runoff during that period was 4.09 inches, of which approximately 35 percent occurred during frozen ground period of March and early April. 2.04 inches or 50 percent of the runoff occurred during the July 15 event. During this event, field staff noted surface flow from an adjacent field entering the ST1 watershed. It was not possible to quantify the additional flow from the neighboring field. In order to alleviate this problem in the future, the Stearns County SWCD installed a berm along the field edge to divert this water from the ST1 watershed into an open intake. Figure 3.74 presents the monitoring season and runoff for the surface watershed.

The subsurface tile drainage watershed was initially calculated as being similar to the surface watershed. However, using this area resulted in a much higher than anticipated runoff value (more runoff than rainfall). At that time a closer examination of the location of the tile drainage in the field was conducted. The review indicated that several of the tile lines, which had been installed decades ago, were draining an area outside of the monitored overland surface watershed. Since an accurate drainage area could not be determined, 2011 data will be omitted from this report. To address this issue, tile draining land outside of the overland watershed was rerouted from the ST1 subsurface tile study watershed in late fall of 2011.

Figure 3.75 presents the hydrograph for ST1-F (overland flume). ST1-F flowed for a combined total of 13.6 days, or just over 6 percent of the 214 day monitoring period (March – September 2011).

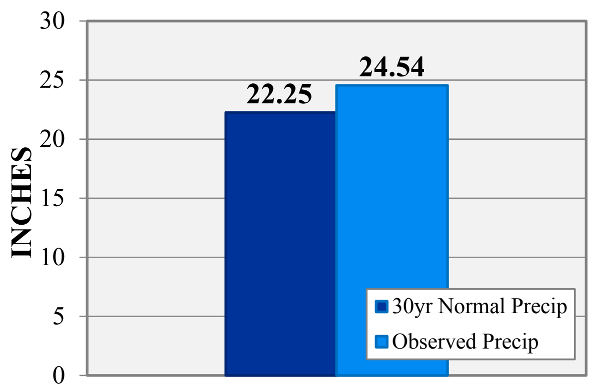

Figure 3.72: ST1 observed versus normal precipitation, March – September 2011.

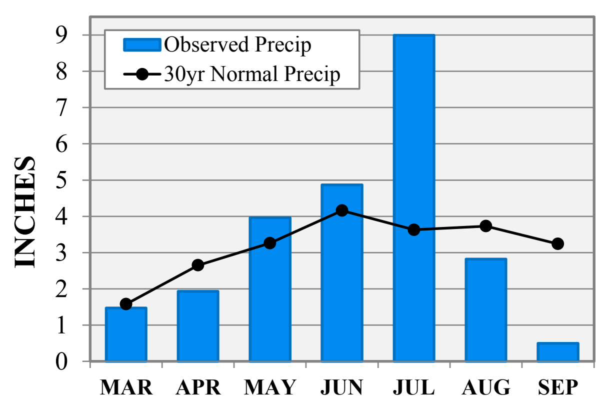

Figure 3.73: ST1 observed month rainfall totals versus monthly normals, March - September 2011.

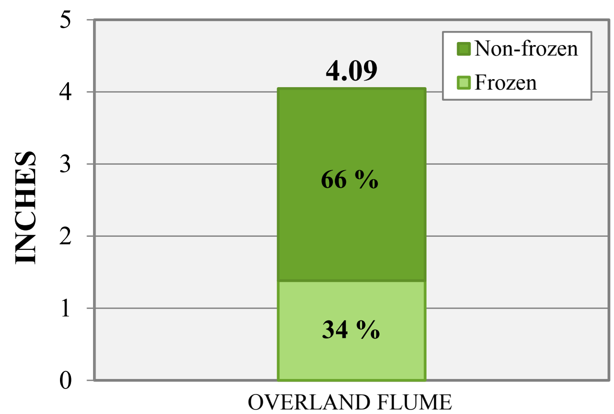

Figure 3.74: ST1 total overland runoff (inches) through the flume from March - September 2011.

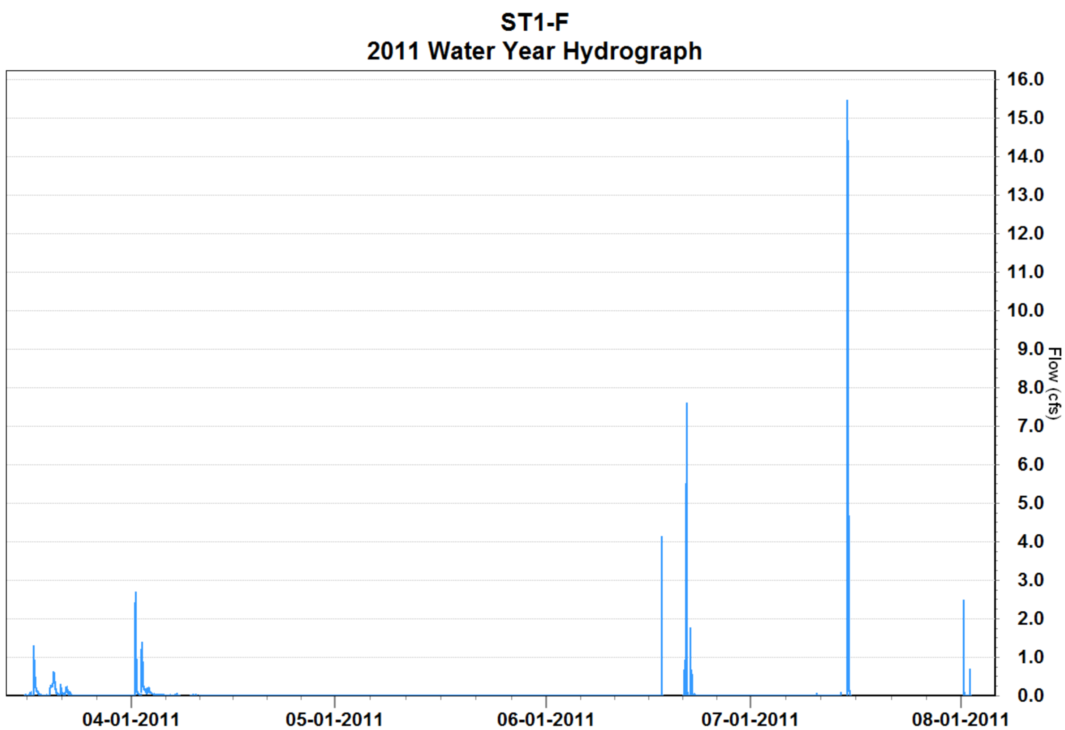

Figure 3.75: ST1-F (overland flume) hydrograph for available data. No flow was observed outside of the dates presented in the figure.

3.5.3 Loads, Yields, Flow-weighted Mean Concentrations

A total of 26 overland surface water samples were collected from March to September 2011. The figures presented in this section provide results for only the overland surface runoff through the flume. Subsurface data will not be available for the 2011 water year as the subsurface watershed was not known.

The TSS yield loss from the overland watershed was 395.6 lbs/acre, of which 88 percent occurred during the non-frozen ground period. The majority (75 percent) of the TSS load occurred during a large storm event on July 15, 2011. The FWMC for the monitoring period was 427 mg/L. TSS yield and FWMC data for the overland flume are provided in Figures 3.76 and 3.77.

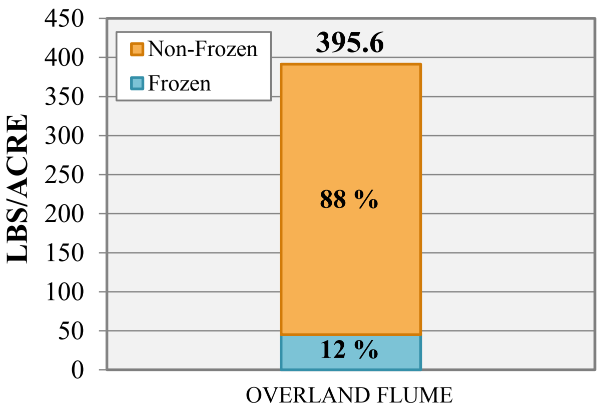

Figure 3.76: ST1 overland total suspended solids yield, March - September 2011.

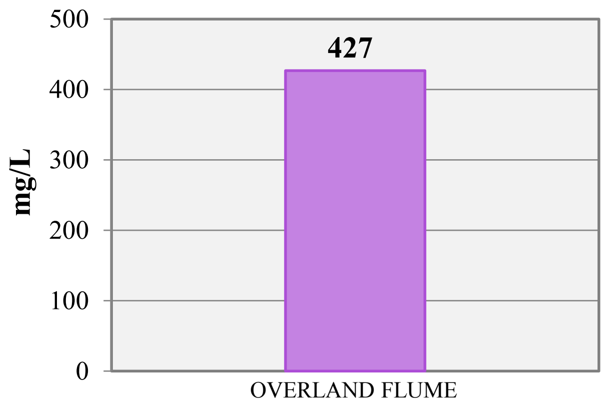

Figure 3.77: ST1 total suspended solids flow-weighted mean concentration, March - September 2011.

The TP and DOP losses from the overland surface watershed were 0.9 and 0.4 lbs/acre respectively (Figures 3.78 and 3.80). Nearly two-thirds (62 percent) of the TP loss and 41 percent of the DOP loss occurred during the non-frozen ground period. Approximately 48 percent of the TP load was in the dissolved form and 52 percent particulate (Figure 3.82). The FWMC for TP was 0.929 mg/L and DOP was 0.448 mg/L. Figures 3.79 and 3.81 present the TP and DOP FWMC for the overland surface flume.

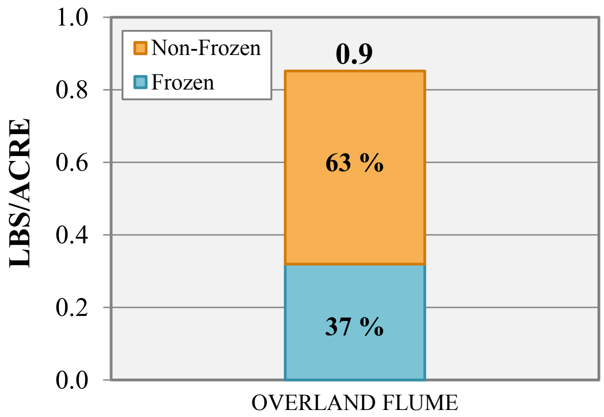

Figure 3.78: ST1 overland total phosphorus yield, March - September 2011.

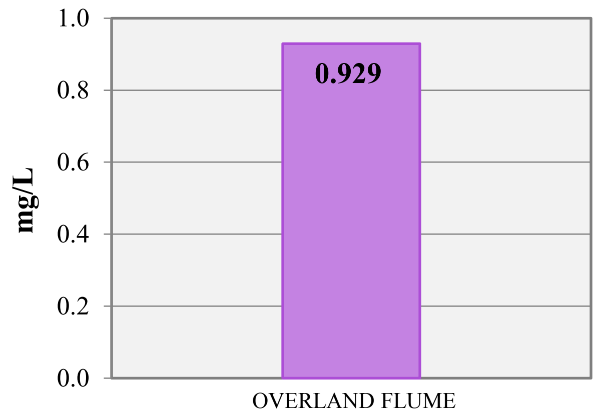

Figure 3.79: ST1 total phosphorus flow-weighted mean concentration, March - September 2011.

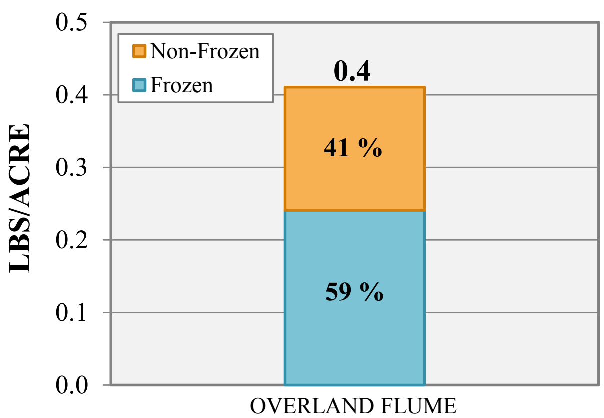

Figure 3.80: ST1 overland dissolved orthophosphorus yield, March - September 2011.

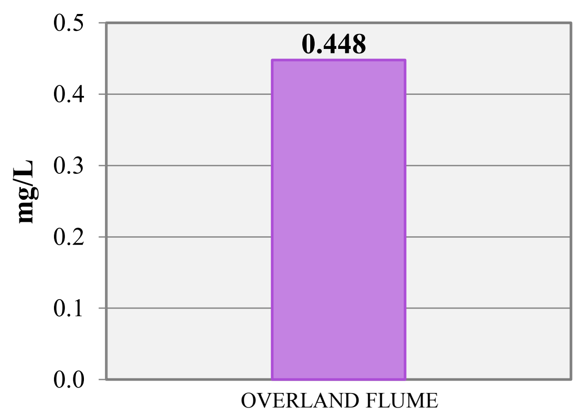

Figure 3.81: ST1 dissolved orthophosphorus flow-weighted mean concentration, March - September 2011.

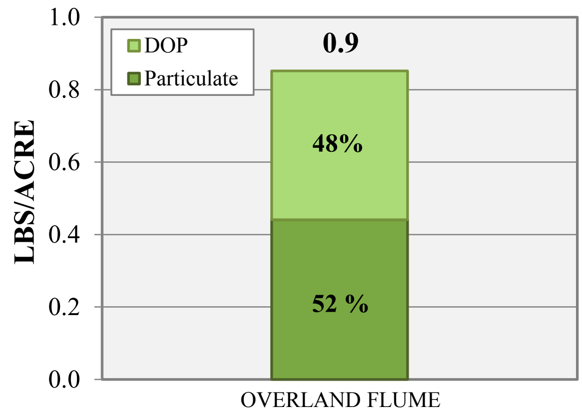

Figure 3.82: ST1 particulate versus dissolved phosphorus yield, March - September 2011.

The yield loss for total nitrogen from the overland surface watershed was 5.9 lbs/acre, of which 59 percent occurred during the non-frozen period (Figure 3.83). The total nitrogen FWMC for the monitoring period was 6.36 mg/L. Figure 3.84 presents the FWMC for NO_2+NO_3-N, TKN, ammonia and TN for the overland surface runoff.

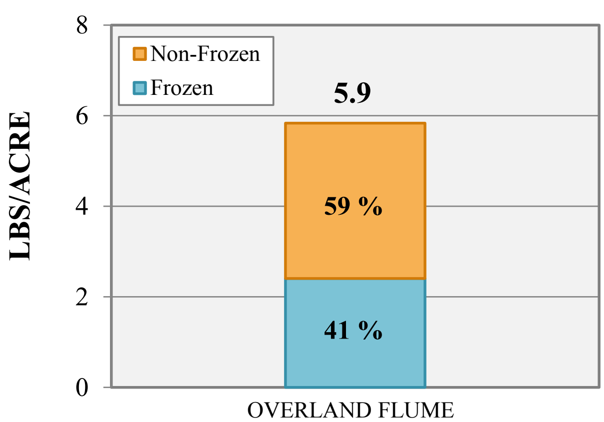

Figure 3.83: ST1 overland total nitrogen yield, March - September 2011.

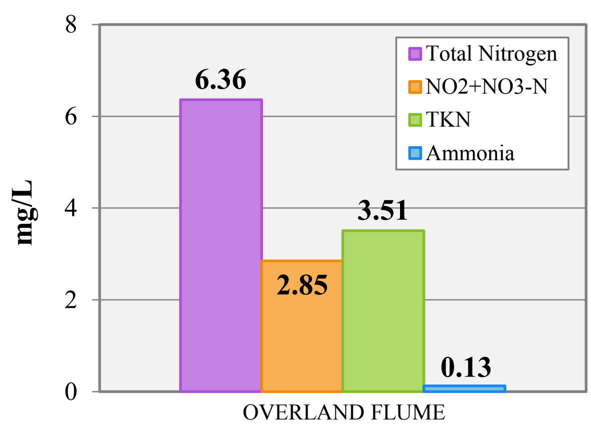

Figure 3.84: ST1 nitrogen flow-weighted mean concentrations, March - September 2011.

Detectable levels of ammonia were only found at low concentrations in three surface runoff samples, thus the 0.1 lbs/acre yield was low (Figure 3.85). Figure 3.86 illustrates the breakdown of the NO_2+NO_3-N and TKN, which combined equals the TN.

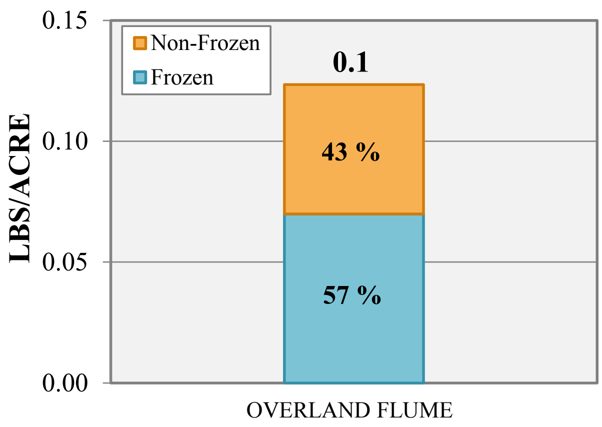

Figure 3.85: ST1 overland ammonia yield, March - September 2011.

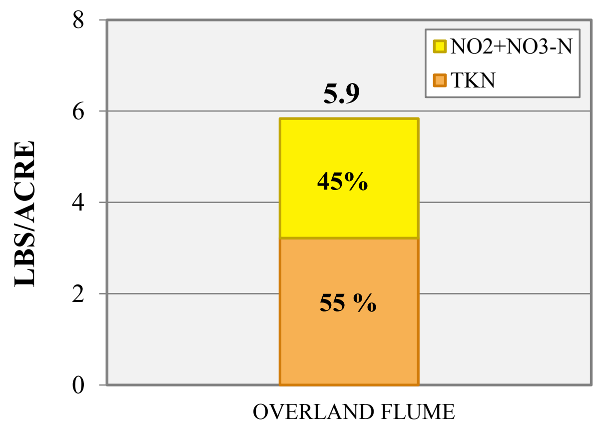

Figure 3.86: ST1 total nitrogen yield showing percentages of nitrate+nitrite nitrogen and total kjeldahl nitrogen, March – September 2011.

Figures 3.87 and 3.88 display the chloride yield and FWMC for the overland surface runoff. The chloride loss from March through September 2011 was 4.9 lbs/acre. The FWMC for the same time period was 5.2 mg/L.

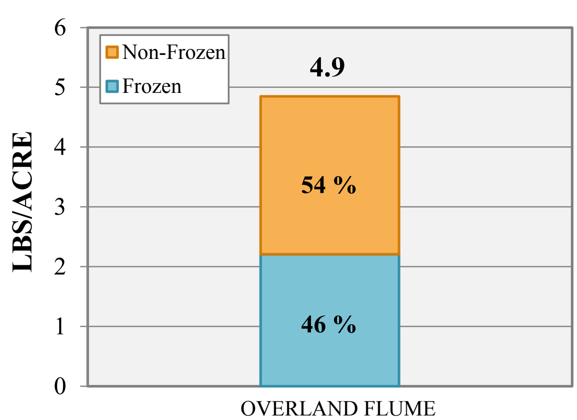

Figure 3.87: ST1 overland chloride yield, March - September 2011.

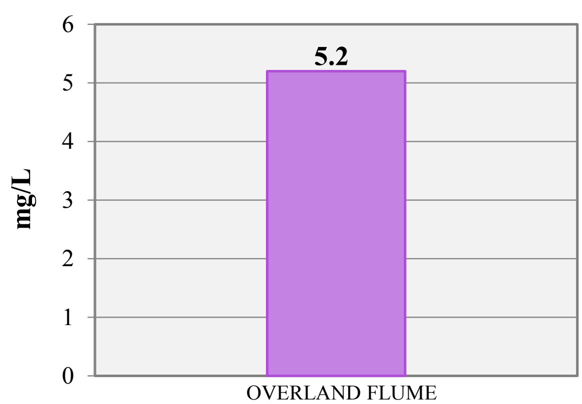

Figure 3.88: ST1 chloride flow-weighted mean concentration, March - September 2011.

SECTION 4: SUMMARY

4.1 Summary of Results

2011 was the first year of monitoring for the DFM program. It is important keep the following in mind when reviewing the results presented in this report:

- Most sites only present a partial year of data (7 months or less), with the exception of GO1, which has a full water year.
- Timing, intensity and duration of precipitation events is highly variable by year, indicating that constituent loading can also be highly variable.
- Caution must be exercised when comparing data between specific farms in this report as they differ by regions, soils, management and climactic variables. After a few consecutive years of data collection, ranges of constituent losses will be available for each site and regionally.

An overview of available results at each site for load, runoff, rainfall, yield and FWMC is presented in Table 4.

Table 4: Summary of available DFM data, October 2010 - September 2011.
NOTE: monitoring period durations are variable among sites.

Site ID	County	Watershed acres	Monitoring Period	Samples #	Volume ft^3	Runoff inches	Rainfall inches
BE1-F	Blue Earth	14.3	6/1/11-9/30/11	13	23,640	0.46	11.09
BE1-T		26.2	3/1/11-9/30/11	34	1,053,976	11.08	21.12
BE2-F	Blue Earth	14.2	4/1/11-9/30/11	5	-	-	17.72
BE2-T		14.2	7/8/11-9/30/11	4	115,871	2.25	6.75
CH1-F	Chisago	6.1	3/1/11-9/30/11	14	92,913	4.20	18.72
GO1-F	Goodhue	6.3	10/1/10-9/30/11	22	98,637	4.31	27.23
ST1-F	Stearns	28.2	3/1/11-9/30/11	27	418,492	4.09	24.76
ST1-T		24.2	2/17/11-9/30/11	34	-	-	25.50

LOAD (lbs)

Site ID	TSS	TP	DOP	TN	NO_2+NO_3-N	Ammonia	TKN	Chloride
BE1-F	1,301.7	2.1	0.6	12.5	6.2	0.1	6.3	14.5
BE1-T	139.0	3.7	2.3	1,123.7	1,066.9	6.4	56.9	1,155.9
BE2-F	-	-	-	-	-	-	-	-
BE2-T	318.3	1.6	0.5	142.5	121.9	0.6	20.5	54.1
CH1-F	500.0	7.6	4.0	23.9	3.3	2.8	20.6	24.6
GO1-F	297.2	4.0	1.3	54.7	3.2	23.3	51.5	30.8
ST1-F	11,154.7	24.3	11.7	166.3	74.6	3.5	91.7	136.7
ST1-T	-	-	-	-	-	-	-	-

YIELD (lbs/acre)

Site ID	TSS	TP	DOP	TN	NO_2+NO_3-N	Ammonia	TKN	Chloride
BE1-F	91.0	0.1	0.0	0.9	0.4	0.0	0.4	1.0
BE1-T	5.3	0.1	0.1	42.9	40.7	0.2	2.2	44.1
BE2-F	-	-	-	-	-	-	-	-
BE2-T	22.4	0.1	0.0	10.0	8.6	0.0	1.5	3.8
CH1-F	82.0	1.3	0.7	3.9	0.5	0.5	3.4	4.0
GO1-F	47.2	0.6	0.2	8.7	0.5	3.7	8.2	4.9
ST1-F	395.6	0.9	0.4	5.9	2.7	0.1	3.3	4.9
ST1-T	-	-	-	-	-	-	-	-

FWMC (mg/L)

Site ID	TSS	TP	DOP	TN	NO_2+NO_3-N	Ammonia	TKN	Chloride
BE1-F	882	1.389	0.430	8.47	4.22	0.09	4.3	9.8
BE1-T	2	0.056	0.035	17.07	16.21	0.10	0.9	17.6
BE2-F	-	-	-	-	-	-	-	-
BE2-T	44	0.214	0.064	19.69	16.85	0.08	2.8	7.5
CH1-F	86	1.314	0.684	4.12	0.56	0.49	3.6	4.2
GO1-F	48	0.646	0.203	8.88	0.52	3.78	8.4	5.0
ST1-F	427	0.929	0.448	6.36	2.85	0.13	3.5	5.2
ST1-T	-	-	-	-	-	-	-	-

BE2-F data were not calculated for 2011 due to incomplete data and equipment problems.
ST1-T data were not calculated or presented due to an unknown contributing subsurface watershed acreage.
T = tile | F = flume

4.2 Plans for the 2012 Water Year

New Discovery Farms

After an application process was completed in summer of 2011, the potential farms were visited in August by MDA and MAWRC staff. An overview of the applicant farms was presented to the DFM Steering Committee on August 30, 2011. The steering committee voted to add two new farms to the program; located in Renville and Wright counties. Equipment was ordered and the sites were installed in November and December 2011. The two new farms will bring the total core farms monitored by the DFM program to seven for the 2012 water year monitoring season. Both farms will be monitored following the same standard operating procedures as the existing sites. Relevant information for both farms is included in Table 7.

Table 5: Renville (RE1) and Wright (WR1) county farms for 2012.

Discovery Farm ID	County	Major Watershed	Major Basin	Drainage Area (acres)	Dominant Soil Texture and Drainage	Nearest Town	Station Type
RE1	Renville	Middle Minnesota	Minnesota	81.0*** ST** w/open intakes	Poorly drained clay loam	Fairfax	Subsurface Tile w/open intakes
WR1	Wright	Crow River (Upper Fork)	Upper Mississippi	23.9 OL* TBD ST**	Poorly drained clay loam to well drained loam	Howard Lake	Edge of Field & Subsurface Tile

***OL** = Overland watershed | ****ST** = subsurface tile

***Watershed size could change upon further investigation of subsurface tile configuration.

RE1 is a cash-crop operation, with a corn and soybean rotation. The monitored field has an 81.0 acre watershed which includes an old cement “turkey foot” subsurface tile configuration with numerous open intakes (surface inlets). The field is relatively flat and no overland surface runoff has been observed by the landowner; therefore, a flume was not installed. An eight foot Agri Drain structure was put in place to capture water leaving the field from both the subsurface component and overland surface runoff via the open intakes. Approximately half of the watershed will be in either corn or soybeans as the field is split into two crops.

WR1 is a conventional dairy operation with a corn (silage) and alfalfa rotation. The field selected for monitoring provides both overland surface and subsurface tile monitoring. The overland surface watershed is 23.9 acres. Subsurface tile configuration maps were not available; the field will need to be mapped prior to data compilation in the fall of 2012. Overland surface flow will be monitored via a 2.5 foot H flume.

A new round of funding for the DFM program through Clean Water Fund dollars granted to MDA will be available beginning July 1, 2012. At that time, additional funds will be available for equipment and supplies. A third application process for new farms was completed at the end of March 2012. Sites will be visited, assessed, reported to the DFM Steering Committee and selected during a summer 2012 meeting. New farms will be installed in fall 2012, including at least one farm in the Red River Valley of northwest Minnesota.

APPENDICES

Appendix 1: Runoff, load, yield and FWMC results by month and events.

Table 6: BE1 overland flume monthly runoff, water volume, and precipitation values associated with the TSS, TP, DOP and chloride monthly loads, yields and flow-weighted mean concentrations, June - September 2011.

BE1 - OVERLAND FLUME					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
JUN	0.19	42.4%	10,020	4.24	372.7	28.6%	26.1	596	0.9	44.2%	0.1	1.448	0.3	38.7%	0.0	0.393	5.6	38.6%	0.4	8.9
JUL	0.26	57.6%	13,620	5.40	929.0	71.4%	65.0	1,092	1.1	55.8%	0.1	1.346	0.4	61.3%	0.0	0.457	8.9	61.4%	0.6	10.4
AUG	0.00	0.0%	0	0.61	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA
SEP	0.00	0.0%	0	0.84	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA
TOTAL	**0.46**		**23,640**	**11.09**	**1,301.7**		**91.0**		**2.1**		**0.1**		**0.6**		**0.0**		**14.5**		**1.0**	

Table 7: BE1 overland flume monthly runoff, water volume and precipitation values associated with TN, NO_2+NO_3-N, TKN and ammonia monthly loads, yields and flow-weighted mean concentrations, June - September 2011.

BE1 - OVERLAND FLUME					TOTAL NITROGEN				NITRATE + NITRITE - N				TOTAL KJELDAHL NITROGEN				AMMONIA			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
JUN	0.19	42.4%	10,020	4.24	8.5	67.7%	0.6	13.53	5.2	84.0%	0.4	8.37	3.2	51.4%	0.2	5.2	0.1	46.8%	0.0	0.10
JUL	0.26	57.6%	13,620	5.40	4.1	32.3%	0.3	4.76	1.0	16.0%	0.1	1.17	3.1	48.6%	0.2	3.6	0.1	53.2%	0.0	0.08
AUG	0.00	0.0%	0	0.61	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA
SEP	0.00	0.0%	0	0.84	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA	0.0	0.0%	0.0	NA
TOTAL	**0.46**		**23,640**	**11.09**	**12.5**		**0.9**		**6.2**		**0.4**		**6.3**		**0.4**		**0.1**		**0.0**	

Table 8: BE1 overland flume event runoff and water volume values associated with the TSS, TP, DOP and chloride event loads, yields and flow-weighted mean concentrations, June - September 2011.

BE1 - OVERLAND FLUME				TOTAL SUSP. SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
EVENT	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
JUN 14-15	0.08	17.3%	4,081	48.3	3.7%	3.4	190	0.3	12.2%	0.0	0.983	0.1	20.4%	0.0	0.508	2.0	13.9%	0.1	7.9
JUN 21	0.04	8.3%	1,953	162.0	12.4%	11.3	1,328	0.3	15.1%	0.0	2.531	0.0	6.1%	0.0	0.315	1.6	11.1%	0.1	13.1
JUN 21-22	0.08	16.9%	3,986	162.4	12.5%	11.4	652	0.4	16.9%	0.0	1.393	0.1	12.3%	0.0	0.312	2.0	13.6%	0.1	7.9
JUL 14-15	0.01	1.4%	340	29.7	2.3%	2.1	1,400	0.0	1.0%	0.0	0.924	0.0	0.9%	0.0	0.268	0.3	2.3%	0.0	15.9
JUL 15 #1	0.08	16.6%	3,931	258.6	19.9%	18.1	1,053	0.3	12.9%	0.0	1.073	0.1	10.0%	0.0	0.257	3.9	27.1%	0.3	16.0
JUL 15 #2	0.18	39.5%	9,349	640.8	49.2%	44.8	1,098	0.9	42.0%	0.1	1.475	0.3	50.4%	0.0	0.548	4.6	31.9%	0.3	7.9
TOTAL	**0.46**		**23,640**	**1,301.7**		**91.0**		**2.1**		**0.1**		**0.6**		**0.0**		**14.5**		**1.0**	

Table 9: BE1 overland flume event runoff and water volume values associated with TN, NO_2+NO_3-N, TKN and ammonia event loads, yields and flow-weighted mean concentrations, June - September 2011.

BE1 - OVERLAND FLUME				TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
EVENT	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
JUN 14-15	0.08	17.3%	4,081	5.4	42.9%	0.4	21.04	4.3	68.7%	0.3	16.81	1.1	17.2%	0.1	4.2	0.0	23.6%	0.0	0.12
JUN 21	0.04	8.3%	1,953	1.6	12.7%	0.1	13.05	0.6	9.5%	0.0	4.86	1.0	15.9%	0.1	8.2	0.0	7.6%	0.0	0.08
JUN 21-22	0.08	16.9%	3,986	1.5	12.1%	0.1	6.07	0.4	5.8%	0.0	1.46	1.2	18.3%	0.1	4.6	0.0	15.6%	0.0	0.08
JUL 14-15	0.01	1.4%	340	0.2	1.5%	0.0	8.69	0.0	0.3%	0.0	0.99	0.2	2.6%	0.0	7.7	0.0	1.3%	0.0	0.08
JUL 15 #1	0.08	16.6%	3,931	1.2	9.9%	0.1	5.04	0.2	2.6%	0.0	0.65	1.1	17.2%	0.1	4.4	0.0	15.4%	0.0	0.08
JUL 15 #2	0.18	39.5%	9,349	2.6	21.0%	0.2	4.50	0.8	13.1%	0.1	1.39	1.8	28.9%	0.1	3.1	0.1	36.5%	0.0	0.08
TOTAL		**0.46**	**23,640**	**12.5**		**0.9**		**6.2**		**0.4**		**6.3**		**0.4**		**0.1**		**0.0**	

Table 10: BE1 subsurface tile monthly runoff, water volume, and precipitation values associated with the TSS, TP, DOP and chloride monthly loads, yields and flow-weighted mean concentrations, March - September 2011.

BE1 – SUBSURFACE TILE					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
MAR	3.81	34.4%	362,630	2.62	28.1	20.2%	1.1	1	1.9	50.5%	0.1	0.083	1.3	55.7%	0.1	0.056	402.4	34.8%	15.4	17.8
APR	0.59	5.3%	55,674	4.10	12.4	8.9%	0.5	4	0.1	3.1%	0.0	0.033	0.1	4.3%	0.0	0.028	69.7	6.0%	2.7	20.0
MAY	1.44	13.0%	137,044	3.31	17.9	12.9%	0.7	2	0.3	7.7%	0.0	0.033	0.1	5.8%	0.0	0.016	140.2	12.1%	5.4	16.4
JUN	3.05	27.5%	290,182	4.24	49.6	35.7%	1.9	3	0.8	21.6%	0.0	0.044	0.5	20.9%	0.0	0.026	334.1	28.9%	12.8	18.4
JUL	2.17	19.6%	206,539	5.40	30.9	22.2%	1.2	2	0.6	17.2%	0.0	0.049	0.3	13.2%	0.0	0.023	207.7	18.0%	7.9	16.1
AUG	0.02	0.2%	1,908	0.61	0.1	0.1%	0.0	1	0.0	0.1%	0.0	0.020	0.0	0.1%	0.0	0.010	1.8	0.2%	0.1	15.2
SEP	0.00	0.0%	0	0.84	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
TOTAL	**11.08**		**1,053,976**	**21.12**	**139.0**		**5.3**		**3.7**		**0.1**		**2.3**		**0.1**		**1,155.9**		**44.1**	

Table 11: BE1 subsurface tile monthly runoff, water volume and precipitation values associated with TN, NO_2+NO_3-N, TKN and ammonia monthly loads, yields and flow-weighted mean concentrations, March - September 2011.

BE1 – SUBSURFACE TILE					TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
MAR	3.81	34.4%	362,630	2.62	338.1	30.1%	12.9	14.93	323.0	30.3%	12.3	14.26	15.1	26.6%	0.6	0.7	1.8	28.5%	0.1	0.08
APR	0.59	5.3%	55,674	4.10	60.7	5.4%	2.3	17.45	56.6	5.3%	2.2	16.27	4.1	7.2%	0.2	1.2	0.3	4.4%	0.0	0.08
MAY	1.44	13.0%	137,044	3.31	135.6	12.1%	5.2	15.84	130.2	12.2%	5.0	15.21	5.4	9.5%	0.2	0.6	0.7	10.8%	0.0	0.08
JUN	3.05	27.5%	290,182	4.24	362.6	32.3%	13.8	20.01	339.8	31.8%	13.0	18.75	22.8	40.1%	0.9	1.3	2.5	39.9%	0.1	0.14
JUL	2.17	19.6%	206,539	5.40	225.1	20.0%	8.6	17.46	215.7	20.2%	8.2	16.73	9.4	16.5%	0.4	0.7	1.0	16.3%	0.0	0.08
AUG	0.02	0.2%	1,908	0.61	1.7	0.2%	0.1	14.50	1.7	0.2%	0.1	14.10	0.1	0.1%	0.0	0.4	0.0	0.2%	0.0	0.08
SEP	0.00	0.0%	0	0.84	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.00
TOTAL	**11.08**		**1,053,976**	**21.12**	**1,123.7**		**42.9**		**1,066.9**		**40.7**		**56.9**		**2.2**		**6.4**		**0.2**	

Table 12: BE1 subsurface tile event runoff and water volume values associated with the TSS, TP, DOP and chloride event loads, yields and flow-weighted mean concentrations, March - September 2011.

BE1 – SUBSURFACE TILE					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
EVENT #	EVENT DATE	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
1	MAR 15-25	3.69	33.3%	350,507	26.4	19.0%	1.0	1	1.9	50.0%	0.1	0.085	1.3	55.2%	0.1	0.058	389.9	33.7%	14.9	17.8
2	APR 26	0.15	1.4%	14,252	7.0	5.0%	0.3	8	0.1	1.6%	0.0	0.067	0.0	1.9%	0.0	0.048	17.6	1.5%	0.7	19.7
3	MAY 20	0.40	3.6%	37,819	7.5	5.4%	0.3	3	0.1	3.6%	0.0	0.057	0.1	2.4%	0.0	0.023	40.4	3.5%	1.5	17.1
4	JUN 14	0.70	6.3%	66,145	17.0	12.2%	0.7	4	0.3	7.7%	0.0	0.069	0.2	8.5%	0.0	0.047	78.2	6.8%	3.0	18.9
5	JUN 21	0.29	2.6%	27,561	13.1	9.4%	0.5	8	0.1	2.2%	0.0	0.047	0.1	2.0%	0.0	0.027	33.2	2.9%	1.3	19.3
6	JUN 22	0.66	5.9%	62,565	5.1	3.7%	0.2	1	0.2	4.3%	0.0	0.041	0.1	5.4%	0.0	0.032	75.0	6.5%	2.9	19.2
7	JUL 15	1.08	9.8%	102,810	21.6	15.5%	0.8	3	0.5	12.6%	0.0	0.072	0.2	10.0%	0.0	0.036	103.3	8.9%	3.9	16.1
BF*	BASE FLOW	4.13	37.2%	392,318	41.4	29.8%	1.6	2	0.7	18.1%	0.0	0.027	0.3	14.6%	0.0	0.014	418.0	36.2%	16.0	17.1
TOTAL		**11.08**		**1,053,976**	**139.0**		**5.3**		**3.7**		**0.1**		**2.3**		**0.1**		**1,155.7**		**44.1**	

*BF = Base flow

Table 13: BE1 subsurface tile event runoff and water volume values associated with TN, NO_2+NO_3-N, TKN and ammonia event loads, yields and flow-weighted mean concentrations, March - September 2011.

BE1 – SUBSURFACE TILE					TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
EVENT #	EVENT DATE	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
1	MAR 15-25	3.69	33.3%	350,507	326.8	29.1%	12.5	14.93	312.2	29.3%	11.9	14.26	14.7	25.8%	0.6	0.7	1.8	27.6%	0.1	0.08
2	APR 26	0.15	1.4%	14,252	17.0	1.5%	0.7	19.08	15.6	1.5%	0.6	17.52	1.4	2.4%	0.1	1.6	0.1	1.1%	0.0	0.08
3	MAY 20	0.40	3.6%	37,819	41.0	3.7%	1.6	17.38	39.0	3.7%	1.5	16.52	2.0	3.6%	0.1	0.9	0.2	3.0%	0.0	0.08
4	JUN 14	0.70	6.3%	66,145	96.6	8.6%	3.7	23.39	86.8	8.1%	3.3	21.02	9.8	17.2%	0.4	2.4	0.3	5.2%	0.0	0.08
5	JUN 21	0.29	2.6%	27,561	36.1	3.2%	1.4	20.95	31.8	3.0%	1.2	18.47	4.3	7.5%	0.2	2.5	0.6	9.9%	0.0	0.36
6	JUN 22	0.66	5.9%	62,565	79.9	7.1%	3.1	20.45	77.2	7.2%	3.0	19.76	2.7	4.7%	0.1	0.7	0.9	14.2%	0.0	0.23
7	JUL 15	1.08	9.8%	102,810	120.5	10.7%	4.6	18.76	114.7	10.7%	4.4	17.86	5.8	10.2%	0.2	0.9	0.5	8.1%	0.0	0.08
BF*	BASE FLOW	4.13	37.2%	392,318	405.8	36.1%	15.5	16.57	389.6	36.5%	14.9	15.90	16.2	28.6%	0.6	0.7	2.0	30.9%	0.1	0.08
TOTAL		**11.08**		**1,053,976**	**1,123.7**		**42.9**		**1,066.9**		**40.7**		**56.9**		**2.2**		**6.4**		**0.2**	

*BF = Base flow

Table 14: CH1 overland flume monthly runoff, water volume, and precipitation values associated with the TSS, TP, DOP and chloride monthly loads, yields and flow-weighted mean concentrations, March - September 2011.

CH1 – OVERLAND FLUME					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
MAR	2.69	64.1%	59,516	2.25	84.6	16.9%	13.9	23	5.0	64.9%	0.8	1.332	2.5	63.6%	0.4	0.679	5.6	22.7%	0.9	1.5
APR	1.10	26.1%	24,268	3.00	42.9	8.6%	7.0	28	0.8	9.9%	0.1	0.500	0.5	12.1%	0.1	0.316	2.5	10.2%	0.4	1.7
MAY	0.29	7.0%	6,471	4.38	362.9	72.6%	59.5	898	1.7	22.3%	0.3	4.212	0.8	20.7%	0.1	2.035	15.8	64.0%	2.6	39.0
JUN	0.04	1.0%	924	2.53	5.4	1.1%	0.9	93	0.1	1.0%	0.0	1.353	0.0	1.0%	0.0	0.708	0.3	1.1%	0.0	4.5
JUL	0.00	0.0%	0	3.29	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
AUG	0.08	1.9%	1,734	2.85	4.3	0.9%	0.7	40	0.1	1.8%	0.0	1.241	0.1	2.5%	0.0	0.930	0.5	2.0%	0.1	4.6
SEP	0.00	0.0%	0	0.42	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
TOTAL	**4.20**		**92,913**	**18.72**	**500.0**		**82.0**		**7.6**		**1.3**		**4.0**		**0.7**		**24.6**		**4.0**	

Table 15: CH1 overland flume monthly runoff, water volume and precipitation values associated with TN, NO_2+NO_3-N, TKN and ammonia monthly loads, yields and flow-weighted mean concentrations, March - September 2011.

CH1 – OVERLAND FLUME					TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
MAR	2.69	64.1%	59,516	2.25	14.6	61.2%	2.4	3.94	0.8	25.6%	0.1	0.23	13.8	66.8%	2.3	3.7	1.6	57.4%	0.3	0.44
APR	1.10	26.1%	24,268	3.00	4.1	17.1%	0.7	2.71	0.7	22.3%	0.1	0.48	3.4	16.3%	0.6	2.2	0.4	13.3%	0.1	0.25
MAY	0.29	7.0%	6,471	4.38	4.3	17.9%	0.7	10.58	1.4	41.9%	0.2	3.39	2.9	14.1%	0.5	7.2	0.8	26.4%	0.1	1.86
JUN	0.04	1.0%	924	2.53	0.2	1.0%	0.0	4.23	0.0	1.1%	0.0	0.61	0.2	1.0%	0.0	3.6	0.0	1.1%	0.0	0.54
JUL	0.00	0.0%	0	3.29	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.00
AUG	0.08	1.9%	1,734	2.85	0.7	2.8%	0.1	6.14	0.3	9.1%	0.1	2.75	0.4	1.8%	0.1	3.4	0.1	1.8%	0.0	0.47
SEP	0.00	0.0%	0	0.42	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.00
TOTAL	**4.20**		**92,913**	**18.72**	**23.9**		**3.9**		**3.3**		**0.5**		**20.6**		**3.4**		**2.8**		**0.5**	

Table 16: CH1 overland flume event runoff and water volume values associated with the TSS, TP, DOP and chloride event loads, yields and flow-weighted mean concentrations, March - September 2011.

CH1 – OVERLAND FLUME					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
Event #	Event Date	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
1	MAR 15-23	2.69	64.1%	59,516	84.6	16.9%	13.9	23	5.0	64.9%	0.8	1.332	2.5	63.6%	0.4	0.679	5.6	22.7%	0.9	1.5
2	APR 1-4	1.03	24.5%	22,737	35.1	7.0%	5.8	25	0.6	8.4%	0.1	0.450	0.4	10.5%	0.1	0.293	2.1	8.7%	0.4	1.5
3	APR 10	0.01	0.2%	203	0.1	0.0%	0.0	11	0.0	0.1%	0.0	0.526	0.0	0.1%	0.0	0.376	0.0	0.1%	0.0	1.5
4	APR 30	0.06	1.4%	1,327	7.7	1.5%	1.3	93	0.1	1.5%	0.0	1.353	0.1	1.5%	0.0	0.708	0.4	1.5%	0.1	4.5
5	MAY 5	0.00	0.1%	52	0.3	0.1%	0.1	93	0.0	0.1%	0.0	1.353	0.0	0.1%	0.0	0.708	0.0	0.1%	0.0	4.5
6	MAY 9	0.00	0.1%	59	0.3	0.1%	0.1	93	0.0	0.1%	0.0	1.353	0.0	0.1%	0.0	0.708	0.0	0.1%	0.0	4.5
7	MAY 12	0.02	0.4%	405	2.4	0.5%	0.4	93	0.0	0.4%	0.0	1.353	0.0	0.5%	0.0	0.708	0.1	0.5%	0.0	4.5
8	MAY 21 #1	0.01	0.3%	237	14.3	2.9%	2.4	968	0.1	0.9%	0.0	4.460	0.0	0.8%	0.0	2.150	0.6	2.5%	0.1	42.0
9	MAY 21 #2	0.01	0.3%	311	18.8	3.8%	3.1	968	0.1	1.1%	0.0	4.460	0.0	1.1%	0.0	2.150	0.8	3.3%	0.1	42.0
10	MAY 21-22	0.10	2.3%	2,131	128.8	25.8%	21.1	968	0.6	7.8%	0.1	4.460	0.3	7.2%	0.1	2.150	5.6	22.7%	0.9	42.0
11	MAY 22 #1	0.14	3.3%	3,046	184.1	36.8%	30.2	968	0.9	11.1%	0.1	4.460	0.4	10.3%	0.1	2.150	8.0	32.5%	1.3	42.0
12	MAY 22-23	0.01	0.2%	228	13.8	2.8%	2.3	968	0.1	0.8%	0.0	4.460	0.0	0.8%	0.0	2.150	0.6	2.4%	0.1	42.0
13	JUN 21	0.02	0.5%	435	2.5	0.5%	0.4	93	0.0	0.5%	0.0	1.353	0.0	0.5%	0.0	0.708	0.1	0.5%	0.0	4.5
14	JUN 22	0.01	0.1%	128	0.7	0.1%	0.1	93	0.0	0.1%	0.0	1.353	0.0	0.1%	0.0	0.708	0.0	0.1%	0.0	4.5
15	JUN 22-23	0.02	0.4%	361	2.1	0.4%	0.3	93	0.0	0.4%	0.0	1.353	0.0	0.4%	0.0	0.708	0.1	0.4%	0.0	4.5
16	AUG 2	0.05	1.2%	1,093	2.3	0.5%	0.4	34	0.1	1.0%	0.0	1.160	0.1	1.2%	0.0	0.707	0.3	1.1%	0.0	3.9
17	AUG 6	0.03	0.7%	641	2.0	0.4%	0.3	49	0.1	0.7%	0.0	1.380	0.1	1.3%	0.0	1.310	0.2	0.9%	0.0	5.7
TOTAL		**4.20**		**92,913**	**500.0**		**82.0**		**7.6**		**1.3**		**4.0**		**0.7**		**24.6**		**4.0**	

Table 17: CH1 overland flume event runoff and water volume values associated with TN, NO_2+NO_3-N, TKN and ammonia monthly loads, yields and flow-weighted mean concentrations, March - September 2011.

CH1 – OVERLAND FLUME					TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
Event #	Event Date	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
1	MAR 15-23	2.69	64.1%	59,516	14.6	61.2%	2.4	3.94	0.8	25.63%	0.1	0.23	13.8	66.8%	2.3	3.7	1.6	57.4%	0.3	0.44
2	APR 1-4	1.03	24.5%	22,737	3.7	15.5%	0.6	2.61	0.7	20.42%	0.1	0.47	3.0	14.7%	0.5	2.1	0.3	11.6%	0.1	0.23
3	APR 10	0.01	0.2%	203	0.1	0.2%	0.0	3.57	0.0	0.34%	0.0	0.87	0.0	0.2%	0.0	2.7	0.0	0.1%	0.0	0.23
4	APR 30	0.06	1.4%	1,327	0.4	1.5%	0.1	4.23	0.1	1.55%	0.0	0.61	0.3	1.5%	0.1	3.6	0.0	1.6%	0.0	0.54
5	MAY 5	0.00	0.1%	52	0.0	0.1%	0.0	4.23	0.0	0.06%	0.0	0.61	0.0	0.1%	0.0	3.6	0.0	0.1%	0.0	0.54
6	MAY 9	0.00	0.1%	59	0.0	0.1%	0.0	4.23	0.0	0.07%	0.0	0.61	0.0	0.1%	0.0	3.6	0.0	0.1%	0.0	0.54
7	MAY 12	0.02	0.4%	405	0.1	0.4%	0.0	4.23	0.0	0.47%	0.0	0.61	0.1	0.4%	0.0	3.6	0.0	0.5%	0.0	0.54
8	MAY 21 #1	0.01	0.3%	237	0.2	0.7%	0.0	11.13	0.1	1.64%	0.0	3.63	0.1	0.5%	0.0	7.5	0.0	1.0%	0.0	1.97
9	MAY 21 #2	0.01	0.3%	311	0.2	0.9%	0.0	11.13	0.1	2.16%	0.0	3.63	0.2	0.7%	0.0	7.5	0.0	1.3%	0.0	1.97
10	MAY 21-22	0.10	2.3%	2,131	1.5	6.2%	0.2	11.13	0.5	14.78%	0.1	3.63	1.0	4.8%	0.2	7.5	0.3	9.2%	0.0	1.97
11	MAY 22 #1	0.14	3.3%	3,046	2.1	8.9%	0.4	11.13	0.7	21.12%	0.1	3.63	1.4	6.9%	0.2	7.5	0.4	13.2%	0.1	1.97
12	MAY 22-23	0.01	0.2%	228	0.2	0.7%	0.0	11.13	0.1	1.58%	0.0	3.63	0.1	0.5%	0.0	7.5	0.0	1.0%	0.0	1.97
13	JUN 21	0.02	0.5%	435	0.1	0.5%	0.0	4.23	0.0	0.51%	0.0	0.61	0.1	0.5%	0.0	3.6	0.0	0.5%	0.0	0.54
14	JUN 22	0.01	0.1%	128	0.0	0.1%	0.0	4.23	0.0	0.15%	0.0	0.61	0.0	0.1%	0.0	3.6	0.0	0.2%	0.0	0.54
15	JUN 22-23	0.02	0.4%	361	0.1	0.4%	0.0	4.23	0.0	0.42%	0.0	0.61	0.1	0.4%	0.0	3.6	0.0	0.4%	0.0	0.54
16	AUG 2	0.05	1.2%	1,093	0.4	1.8%	0.1	6.32	0.2	5.89%	0.0	2.82	0.2	1.2%	0.0	3.5	0.0	0.9%	0.0	0.37
17	AUG 6	0.03	0.7%	641	0.2	1.0%	0.0	5.84	0.1	3.23%	0.0	2.64	0.1	0.6%	0.0	3.2	0.0	0.9%	0.0	0.65
TOTAL		**4.20**		**92,913**	**23.9**		**3.9**		**3.3**		**0.5**		**20.6**		**3.4**		**2.8**		**0.5**	

Table 18: GO1 overland flume monthly runoff, water volume, and precipitation values associated with the TSS, TP, DOP and chloride monthly loads, yields and flow-weighted mean concentrations, October 2010 - September 2011.

GO1 – OVERLAND FLUME						TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
YEAR	MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	Cl- LOAD		YIELD	FWMC
		inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
2010	OCT	0.00	0.0%	0.00	0.73	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
	NOV	0.00	0.0%	0.00	2.30	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
	DEC	0.28	6.4%	6,305	2.23	9.6	3.2%	1.5	24	0.2	5.1%	0.0	0.519	NA	NA	NA	NA	NA	NA	NA	NA
2011	JAN	0.00	0.0%	0.00	0.41	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
	FEB	1.24	28.7%	28,346	1.41	20.1	6.8%	3.2	11	0.9	23.1%	0.2	0.519	0.2	11.9%	0.0	0.084	17.7	57.5%	2.8	10.0
	MAR	2.47	57.2%	56,376	2.46	215.9	72.6%	34.3	61	2.4	61.0%	0.4	0.690	0.9	73.0%	0.1	0.259	11.2	36.3%	1.8	3.2
	APR	0.04	1.0%	1,004	2.97	2.9	1.0%	0.5	47	0.0	1.0%	0.0	0.615	0.0	1.0%	0.0	0.194	0.3	1.0%	0.1	4.8
	MAY	0.00	0.0%	0.00	3.00	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
	JUN	0.09	2.1%	2,056	3.79	34.1	11.5%	5.4	266	0.2	4.6%	0.0	1.414	0.1	6.5%	0.0	0.628	0.4	1.3%	0.1	3.1
	JUL	0.04	1.0%	1,001	5.90	4.3	1.4%	0.7	68	0.1	1.9%	0.0	1.196	0.1	4.2%	0.0	0.846	0.2	0.5%	0.0	2.4
	AUG	0.16	3.6%	3,548	1.20	10.4	3.5%	1.6	47	0.1	3.4%	0.0	0.615	0.0	3.4%	0.0	0.194	1.1	3.4%	0.2	4.8
	SEP	0.00	0.0%	0.00	0.83	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
TOTAL		**4.31**		**98,637**	**27.23**	**297.2**		**47.2**		**4.0**		**0.6**		**1.3**		**0.2**		**30.8**		**4.9**	

Table 19: GO1 overland flume monthly runoff, water volume and precipitation values associated with TN, NO_2+NO_3-N, TKN and ammonia monthly loads, yields and flow-weighted mean concentrations, October 2010 - September 2011.

GO1 – OVERLAND FLUME						TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
YEAR	MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
2010	OCT	0.00	0.0%	0	0.73	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.0
	NOV	0.00	0.0%	0	2.30	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.0
	DEC	0.28	6.4%	6,305	2.23	1.5	2.7%	0.2	3.70	0.5	15.8%	0.1	1.28	1.0	1.8%	0.2	2.4	0.3	1.4%	0.1	0.8
2011	JAN	0.00	0.0%	0	0.41	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.0
	FEB	1.24	28.7%	28,346	1.41	21.8	39.9%	3.5	12.33	1.2	37.8%	0.2	0.68	20.6	40.0%	3.3	11.7	9.4	40.4%	1.5	5.3
	MAR	2.47	57.2%	56,376	2.46	28.5	52.2%	4.5	8.10	1.3	39.1%	0.2	0.36	27.3	53.0%	4.3	7.8	12.5	53.5%	2.0	3.5
	APR	0.04	1.0%	1,004	2.97	0.5	1.0%	0.1	8.43	0.0	1.0%	0.0	0.50	0.5	1.0%	0.1	7.9	0.2	1.0%	0.0	3.6
	MAY	0.00	0.0%	0	3.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.0
	JUN	0.09	2.1%	2,056	3.79	0.2	0.4%	0.0	1.56	0.1	2.1%	0.0	0.53	0.1	0.3%	0.0	1.0	0.0	0.1%	0.0	0.1
	JUL	0.04	1.0%	1,001	5.90	0.3	0.5%	0.1	4.60	0.0	0.7%	0.0	0.37	0.3	0.5%	0.0	4.2	0.1	0.3%	0.0	1.0
	AUG	0.16	3.6%	3,548	1.20	1.9	3.4%	0.3	8.43	0.1	3.5%	0.0	0.50	1.8	3.4%	0.3	7.9	0.8	3.4%	0.1	3.6
	SEP	0.00	0.0%	0	0.83	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.0
TOTAL		**4.31**		**98,637**	**27.23**	**54.7**		**8.7**		**3.2**		**0.5**		**51.5**		**8.2**		**23.3**		**3.7**	

Table 20: GO1 overland flume event runoff and water volume values associated with the TSS, TP, DOP and chloride event loads, yields and flow-weighted mean concentrations, October 2010 - September 2011.

GO1 – OVERLAND FLUME					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
YEAR	DATE	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
2010	DEC 29-30	0.28	6.4%	6,305	9.6	3.2%	1.5	24	0.2	5.1%	0.0	0.519	NA	NA	NA	NA	NA	NA	NA	NA
2011	FEB 14-17	1.24	28.7%	28,346	20.1	6.7%	3.2	11	0.9	23.1%	0.2	0.519	0.2	11.9%	0.0	0.084	17.7	57.5%	2.8	10.0
	MAR 15-23	2.47	57.2%	56,376	215.9	72.4%	34.3	61	2.4	61.0%	0.4	0.690	0.9	73.0%	0.1	0.259	11.2	36.3%	1.8	3.2
	APR 10-11	0.04	1.0%	1,004	2.9	1.0%	0.5	47	0.0	1.0%	0.0	0.615	0.0	1.0%	0.0	0.194	0.3	1.0%	0.1	4.8
	JUN 21 #1	0.01	0.2%	167	2.8	0.9%	0.4	265	0.0	0.4%	0.0	1.410	0.0	0.5%	0.0	0.636	0.0	0.1%	0.0	3.1
	JUN 21 #2	0.03	0.7%	685	11.3	3.8%	1.8	265	0.1	1.5%	0.0	1.410	0.0	2.2%	0.0	0.636	0.1	0.4%	0.0	3.1
	JUN 21 #3	0.00	0.0%	14	0.2	0.1%	0.0	265	0.0	0.0%	0.0	1.410	0.0	0.0%	0.0	0.636	0.0	0.0%	0.0	3.1
	JUN 22	0.05	1.2%	1,190	19.8	7.0%	3.1	281	0.1	2.6%	0.0	1.417	0.1	3.7%	0.0	0.621	0.2	0.8%	0.0	3.2
	JUL 10	0.00	0.0%	21	0.3	0.1%	0.1	235	0.0	0.2%	0.0	5.360	0.0	0.2%	0.0	1.920	0.0	0.1%	0.0	20.4
	JUL 15 #1	0.02	0.4%	364	1.6	0.5%	0.3	68	0.0	0.7%	0.0	1.200	0.0	1.7%	0.0	0.941	0.0	0.1%	0.0	1.5
	JUL 15 #2	0.02	0.5%	461	2.0	0.7%	0.3	68	0.0	0.9%	0.0	1.200	0.0	2.2%	0.0	0.941	0.0	0.1%	0.0	1.5
	JUL 27	0.01	0.2%	155	0.5	0.2%	0.1	47	0.0	0.1%	0.0	0.615	0.0	0.2%	0.0	0.194	0.1	0.1%	0.0	4.8
	AUG 1	0.16	3.6%	3,548	10.4	3.5%	1.6	47	0.1	3.4%	0.0	0.615	0.0	3.4%	0.0	0.194	1.1	3.4%	0.2	4.8
TOTAL		**4.31**		**98,637**	**297.2**		**47.2**		**4.0**		**0.6**		**1.3**		**0.2**		**30.8**		**4.9**	

Table 21: GO1 overland flume event runoff and water volume values associated with TN, NO_2+NO_3-N, TKN and ammonia monthly loads, yields and flow-weighted mean concentrations, October 2010 - September 2011.

GO1 – OVERLAND FLUME					TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
YEAR	DATE	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
2010	DEC 29-30	0.28	6.4%	6,305	1.5	2.7%	0.2	3.70	0.5	15.8%	0.1	1.28	1.0	1.8%	0.2	2.4	0.3	1.4%	0.1	0.82
2011	FEB 14-17	1.24	28.7%	28,346	21.8	39.9%	3.5	12.33	1.2	37.8%	0.2	0.68	20.6	40.0%	3.3	11.7	9.4	40.4%	1.5	5.32
	MAR 15-23	2.47	57.2%	56,376	28.5	52.2%	4.5	8.10	1.3	39.1%	0.2	0.36	27.3	53.0%	4.3	7.8	12.5	53.5%	2.0	3.54
	APR 10-11	0.04	1.0%	1,004	0.5	1.0%	0.1	8.43	0.0	1.0%	0.0	0.50	0.5	1.0%	0.1	7.9	0.2	1.0%	0.0	3.58
	JUN 21 #1	0.01	0.2%	167	0.0	0.0%	0.0	1.27	0.0	0.2%	0.0	0.57	0.0	0.0%	0.0	0.7	0.0	0.0%	0.0	0.08
	JUN 21 #2	0.03	0.7%	685	0.1	0.1%	0.0	1.27	0.0	0.8%	0.0	0.57	0.0	0.1%	0.0	0.7	0.0	0.0%	0.0	0.08
	JUN 21 #3	0.00	0.0%	14	0.0	0.0%	0.0	1.27	0.0	0.0%	0.0	0.57	0.0	0.0%	0.0	0.7	0.0	0.0%	0.0	0.08
	JUN 22	0.05	1.2%	1,190	0.1	0.2%	0.0	1.77	0.0	1.2%	0.0	0.50	0.1	0.2%	0.0	1.3	0.0	0.0%	0.0	0.10
	JUL 10	0.00	0.0%	21	0.0	0.0%	0.0	18.70	0.0	0.0%	0.0	0.80	0.0	0.0%	0.0	17.9	0.0	0.0%	0.0	0.08
	JUL 15 #1	0.02	0.4%	364	0.1	0.1%	0.0	3.53	0.0	0.2%	0.0	0.33	0.1	0.1%	0.0	3.2	0.0	0.0%	0.0	0.51
	JUL 15 #2	0.02	0.5%	461	0.1	0.2%	0.0	3.53	0.0	0.3%	0.0	0.33	0.1	0.2%	0.0	3.2	0.0	0.1%	0.0	0.51
	JUL 27	0.01	0.2%	155	0.1	0.1%	0.0	8.43	0.0	0.2%	0.0	0.50	0.1	0.1%	0.0	7.9	0.0	0.1%	0.0	3.58
	AUG 1	0.16	3.6%	3,548	1.9	3.4%	0.3	8.43	0.1	3.5%	0.0	0.50	1.8	3.4%	0.3	7.9	0.8	3.4%	0.1	3.58
TOTAL		**4.31**		**98,637**	**54.7**		**8.7**		**3.2**		**0.5**		**51.5**		**8.2**		**23.3**		**3.7**	

Table 22: ST1 overland flume monthly runoff, water volume, and precipitation values associated with the TSS, TP, DOP and chloride monthly loads, yields and flow-weighted mean concentrations, March - September 2011.

ST1 – OVERLAND FLUME					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS				CHLORIDE			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
MAR	0.64	15.7%	65,776	1.69	846.2	7.6%	30.0	206	3.9	16.0%	0.1	0.946	2.8	23.8%	0.1	0.678	16.6	12.1%	0.6	4.0
APR	0.78	19.1%	79,940	1.93	442.4	4.0%	15.7	89	5.3	22.0%	0.2	1.069	4.2	35.7%	0.2	0.837	48.8	35.7%	1.7	9.8
MAY	0.00	0.0%	155	3.96	4.4	0.0%	0.2	457	0.0	0.0%	0.0	1.005	0.0	0.0%	0.0	0.510	0.1	0.0%	0.0	5.6
JUN	0.57	13.8%	57,961	4.87	1,352.7	12.1%	48.0	374	4.4	18.2%	0.2	1.218	1.7	14.7%	0.1	0.476	24.9	18.2%	0.9	6.9
JUL	2.04	49.9%	208,879	8.99	8,330.7	74.7%	295.4	639	10.3	42.2%	0.4	0.786	2.9	24.4%	0.1	0.219	45.3	33.1%	1.6	3.5
AUG	0.06	1.4%	5,782	2.82	178.4	1.6%	6.3	494	0.4	1.6%	0.0	1.070	0.2	1.3%	0.0	0.409	1.1	0.8%	0.0	3.0
SEP	0.00	0.0%	0	0.50	0.0	0.0%	0.0	0	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.000	0.0	0.0%	0.0	0.0
TOTAL	**4.09**		**418,492**	**24.76**	**11,154.7**		**395.6**		**24.3**		**0.9**		**11.7**		**0.4**		**136.7**		**4.9**	

Table 23: ST1 overland flume monthly runoff, water volume and precipitation values associated with TN, NO_2+NO_3-N, TKN and ammonia monthly loads, yields and flow-weighted mean concentrations, March - September 2011.

ST1 – OVERLAND FLUME					TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
MONTH	RUNOFF		VOLUME	PRECIP	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
	inches	%	ft^3	inches	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
MAR	0.64	15.7%	65,776	1.69	31.8	19.1%	1.1	7.75	22.1	29.6%	0.8	5.38	9.7	10.6%	0.4	2.4	0.3	9.3%	0.0	0.08
APR	0.78	19.1%	79,940	1.93	37.7	22.7%	1.3	7.55	20.7	27.7%	0.7	4.14	17.0	18.5%	0.6	3.4	1.7	47.7%	0.1	0.34
MAY	0.00	0.0%	155	3.96	0.1	0.0%	0.0	7.08	0.0	0.0%	0.0	3.29	0.0	0.0%	0.0	3.8	0.0	0.0%	0.0	0.15
JUN	0.57	13.8%	57,961	4.87	41.3	24.9%	1.5	11.42	23.9	32.1%	0.9	6.61	17.4	19.0%	0.6	4.8	0.3	9.6%	0.0	0.09
JUL	2.04	49.9%	208,879	8.99	53.7	32.3%	1.9	4.12	7.8	10.4%	0.3	0.60	46.0	50.1%	1.6	3.5	1.1	32.5%	0.0	0.09
AUG	0.06	1.4%	5,782	2.82	1.7	1.0%	0.1	4.58	0.1	0.1%	0.0	0.28	1.6	1.7%	0.1	4.3	0.0	0.8%	0.0	0.08
SEP	0.00	0.0%	0	0.50	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.00	0.0	0.0%	0.0	0.0	0.0	0.0%	0.0	0.00
TOTAL	**4.09**		**418,492**	**24.76**	**166.3**		**5.9**		**74.6**		**2.7**		**91.7**		**3.3**		**3.5**		**0.1**	

Table 24: ST1 overland flume event runoff and water volume values associated with the TSS, TP, DOP and chloride event loads, yields and flow-weighted mean concentrations, March - September 2011.

ST1 – OVERLAND FLUME					TOTAL SUSPENDED SOLIDS				TOTAL PHOSPHORUS				DISSOLVED ORTHOPHOS.				CHLORIDE			
EVENT #	MONTH	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
1	3/16/11 Snowmelt	0.02	0.5%	1,998	115.4	1.0%	4.1	925	0.1	0.6%	0.0	1.080	0.1	0.5%	0.0	0.476	0.6	0.4%	0.0	4.4
2	3/17/11 Snowmelt	0.24	5.9%	24,841	690.2	6.2%	24.5	445	1.4	5.8%	0.1	0.912	0.8	6.7%	0.0	0.505	5.7	4.1%	0.2	3.7
3	3/19/11 Snowmelt	0.26	6.3%	26,439	17.9	0.2%	0.6	11	1.5	6.3%	0.1	0.921	1.2	10.6%	0.0	0.749	6.0	4.4%	0.2	3.6
4	3/21/11 Snowmelt	0.05	1.1%	4,666	8.2	0.1%	0.3	28	0.3	1.2%	0.0	1.000	0.3	2.2%	0.0	0.889	1.5	1.1%	0.1	5.3
5	3/22/11 Snowmelt	0.08	1.9%	7,833	14.5	0.1%	0.5	30	0.5	2.2%	0.0	1.073	0.5	3.8%	0.0	0.911	2.9	2.1%	0.1	5.8
6	4/1/11 Snowmelt	0.33	8.2%	34,195	209.3	1.9%	7.4	98	2.4	9.9%	0.1	1.120	1.9	16.0%	0.1	0.875	18.6	13.6%	0.7	8.7
7	4/2/11 Snowmelt	0.45	10.9%	45,745	233.2	2.1%	8.3	82	3.0	12.1%	0.1	1.031	2.3	19.8%	0.1	0.809	30.2	22.1%	1.1	10.6
8	5/9/2011	0.00	0.0%	155	4.4	0.0%	0.2	457	0.0	0.0%	0.0	1.005	0.0	0.0%	0.0	0.510	0.1	0.0%	0.0	5.6
9	6/17/2011	0.10	2.5%	10,328	294.5	2.6%	10.4	457	0.7	2.7%	0.0	1.005	0.3	2.8%	0.0	0.510	3.6	2.7%	0.1	5.6
10	6/21/11 #1	0.02	0.6%	2,456	7.7	0.1%	0.3	50	0.2	0.8%	0.0	1.300	0.1	0.9%	0.0	0.681	2.3	1.7%	0.1	15.0
11	6/21/11 #2	0.36	8.8%	36,877	948.2	8.5%	33.6	412	2.8	11.5%	0.1	1.217	0.8	7.1%	0.0	0.361	13.6	9.9%	0.5	5.9
12	6/22/11 #1	0.05	1.2%	5,075	89.6	0.8%	3.2	283	0.5	1.8%	0.0	1.410	0.2	1.9%	0.0	0.697	2.5	1.8%	0.1	7.9
13	6/22/11 #2	0.03	0.8%	3,225	12.7	0.1%	0.5	63	0.3	1.3%	0.0	1.550	0.2	2.0%	0.0	1.190	2.9	2.1%	0.1	14.4
14	7/10/2011	0.00	0.0%	54	1.6	0.0%	0.1	457	0.0	0.0%	0.0	1.004	0.0	0.0%	0.0	0.512	0.0	0.0%	0.0	5.6
15	7/14/2011	0.00	0.1%	289	8.2	0.1%	0.3	457	0.0	0.1%	0.0	1.005	0.0	0.1%	0.0	0.510	0.1	0.1%	0.0	5.6
16	7/15/2011	2.04	49.8%	208,536	8,320.9	74.6%	295.1	639	10.2	42.1%	0.4	0.785	2.9	24.4%	0.1	0.219	45.2	33.1%	1.6	3.5
17	8/1/2011	0.06	1.4%	5,782	178.4	1.6%	6.3	494	0.4	1.6%	0.0	1.070	0.2	1.3%	0.0	0.409	1.1	0.8%	0.0	3.0
TOTAL		**4.09**		**418,492**	**11,154.7**		**395.6**		**24.3**		**0.9**		**11.7**		**0.4**		**136.7**		**4.9**	

Table 25: ST1 overland flume event runoff and water volume values associated with TN, NO_2+NO_3-N, TKN and ammonia event loads, yields and flow-weighted mean concentrations, March - September 2011.

ST1 – OVERLAND FLUME					TOTAL NITROGEN				NITRATE + NITRITE - N				TOT. KJELDAHL NITROGEN				AMMONIA			
EVENT #	MONTH	RUNOFF		VOLUME	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC	LOAD		YIELD	FWMC
		inches	%	ft^3	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L	lbs	%	lbs/acre	mg/L
1	3/16/11 Snowmelt	0.02	0.5%	1,998	1.0	0.6%	0.0	8.14	0.4	0.6%	0.0	3.54	0.6	0.6%	0.0	4.6	0.0	0.3%	0.0	0.08
2	3/17/11 Snowmelt	0.24	5.9%	24,841	10.1	6.1%	0.4	6.49	5.8	7.8%	0.2	3.73	4.3	4.7%	0.2	2.8	0.1	3.5%	0.0	0.08
3	3/19/11 Snowmelt	0.26	6.3%	26,439	12.2	7.3%	0.4	7.39	9.1	12.2%	0.3	5.50	3.1	3.4%	0.1	1.9	0.1	3.8%	0.0	0.08
4	3/21/11 Snowmelt	0.05	1.1%	4,666	3.2	1.9%	0.1	10.80	2.5	3.4%	0.1	8.70	0.6	0.7%	0.0	2.1	0.0	0.7%	0.0	0.08
5	3/22/11 Snowmelt	0.08	1.9%	7,833	5.4	3.2%	0.2	11.01	4.3	5.7%	0.2	8.70	1.1	1.2%	0.0	2.3	0.0	1.1%	0.0	0.08
6	4/1/11 Snowmelt	0.33	8.2%	34,195	16.9	10.1%	0.6	7.90	9.2	12.3%	0.3	4.30	7.7	8.4%	0.3	3.6	0.8	23.1%	0.0	0.38
7	4/2/11 Snowmelt	0.45	10.9%	45,745	20.8	12.5%	0.7	7.28	11.5	15.4%	0.4	4.02	9.3	10.2%	0.3	3.3	0.9	24.6%	0.0	0.30
8	5/9/2011	0.00	0.0%	155	0.1	0.0%	0.0	7.08	0.0	0.0%	0.0	3.29	0.0	0.0%	0.0	3.8	0.0	0.0%	0.0	0.15
9	6/17/2011	0.10	2.5%	10,328	4.6	2.7%	0.2	7.08	2.1	2.8%	0.1	3.29	2.5	2.7%	0.1	3.8	0.1	2.8%	0.0	0.15
10	6/21/11 #1	0.02	0.6%	2,456	5.7	3.4%	0.2	36.89	5.1	6.8%	0.2	32.99	0.6	0.7%	0.0	3.9	0.0	0.3%	0.0	0.08
11	6/21/11 #2	0.36	8.8%	36,877	23.4	14.0%	0.8	10.14	11.1	14.9%	0.4	4.83	12.2	13.3%	0.4	5.3	0.2	5.2%	0.0	0.08
12	6/22/11 #1	0.05	1.2%	5,075	4.0	2.4%	0.1	12.64	2.7	3.6%	0.1	8.54	1.3	1.4%	0.1	4.1	0.0	0.7%	0.0	0.08
13	6/22/11 #2	0.03	0.8%	3,225	3.8	2.3%	0.1	18.70	2.9	3.9%	0.1	14.50	0.9	0.9%	0.0	4.2	0.0	0.5%	0.0	0.08
14	7/10/2011	0.00	0.0%	54	0.0	0.0%	0.0	7.08	0.0	0.0%	0.0	3.29	0.0	0.0%	0.0	3.8	0.0	0.0%	0.0	0.16
15	7/14/2011	0.00	0.1%	289	0.1	0.1%	0.0	7.08	0.1	0.1%	0.0	3.29	0.1	0.1%	0.0	3.8	0.0	0.1%	0.0	0.15
16	7/15/2011	2.04	49.8%	208,536	53.6	32.2%	1.9	4.12	7.7	10.3%	0.3	0.59	45.9	50.0%	1.6	3.5	1.1	32.4%	0.0	0.09
17	8/1/2011	0.06	1.4%	5,782	1.7	1.0%	0.1	4.58	0.1	0.1%	0.0	0.28	1.6	1.7%	0.1	4.3	0.0	0.8%	0.0	0.08
TOTAL		**4.09**		**418,492**	**166.3**		**5.9**		**74.6**		**2.7**		**91.7**		**3.3**		**3.5**		**0.1**	

Appendix 2: Water quality results

Table 26: Water quality sample concentrations, October 2010 – September 2011.

SITE ID	SAMPLE START	SAMPLE END	SAMPLE TYPE	TSS	NO_2+NO_3	TP	DOP	TKN	NH_3	Cl
	Date/Time	Date/Time		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
BE1-F	6/14/11 17:32	6/14/11 17:32	EFI	395	15.1	1.33	0.497	4.7	<0.16	12.1
BE1-F	6/15/11 12:15		G	23	18.3	0.734	0.525	4	0.23	4.5
BE1-F	6/15/11 12:15		G	21	18.1	0.674	0.509	3.7	<0.16	4.4
BE1-F	6/21/11 0:06	6/21/11 5:36	EFI	1,350	4.88	2.56	0.320	8.3	<0.16	13.3
BE1-F	6/21/11 8:56	6/22/11 9:13	EFI	110	3.46	0.928	0.049	2.1	<0.16	4.4
BE1-F	6/22/11 11:42	6/22/11 13:01	EFI	780	1	2.23	0.253	9.8	<0.16	11.2
BE1-F	6/22/11 13:03	6/22/11 17:46	EFI	690	1.32	1.08	0.388	2.6	<0.16	7
BE1-F	7/14/11 7:58	7/15/11 8:30	EFI	1,400	0.99	0.924	0.268	7.7	<0.16	15.9
BE1-F	7/15/11 8:31	7/15/11 10:15	EFI	1,020	0.63	1.08	0.257	4.2	<0.16	16
BE1-F	7/15/11 13:48	7/15/11 14:16	EFI	3,640	0.45	1.53	0.174	2.8	<0.16	13.2
BE1-F	7/15/11 14:17	7/15/11 14:41	EFI	660	1.44	1.41	0.571	2.8	<0.16	7.5
BE1-F	7/15/11 14:42	7/15/11 15:06	EFI	1,590	1.54	1.61	0.619	4	<0.16	6.5
BE1-F	7/15/11 15:07	7/15/11 15:30	EFI	685	1.7	1.6	0.613	3.7	<0.16	8.2
BE1-T	3/16/11 14:16		G	2	10.6	0.049	0.041	0.7	<0.16	15.9
BE1-T	3/16/11 18:16		G	4	14.8	0.089	0.066	0.4	<0.16	18.3
BE1-T	3/16/11 22:16		G	2	15.2	0.085	0.050	0.7	<0.16	19.2
BE1-T	3/17/11 2:16		G	<2	14.8	0.085	0.061	0.4	<0.16	19.2
BE1-T	3/17/11 6:16		G	<2	14.7	0.078	0.059	0.7	<0.16	19.6
BE1-T	3/17/11 10:16		G	<2	14.7	0.069	0.050	0.6	<0.16	20.1
BE1-T	3/17/11 12:06		G	<2	14.2	0.084	0.063	0.8	<0.16	19.3
BE1-T	3/17/11 16:06		G	3	14.5	0.174	0.138	0.8	<0.16	17.4
BE1-T	3/17/11 18:06		G	2	14.4	0.255	0.204	1.3	<0.16	17
BE1-T	3/17/11 20:06		G	2	14.6	0.267	0.222	1.4	<0.16	16.7
BE1-T	3/18/11 2:06		G	<2	14.7	0.208	0.166	1.3	<0.16	17.8
BE1-T	3/18/11 10:06		G	2	14.8	0.133	0.100	0.8	<0.16	19.5
BE1-T	3/18/11 16:07		G	<2	14.1	0.14	0.078	1.1	<0.16	19.3
BE1-T	3/18/11 22:07		G	<2	14.2	0.126	0.082	0.8	<0.16	19.8
BE1-T	3/29/11 10:40		G	9	14.9	0.052	0.044	1	<0.16	20.9
BE1-T	4/18/11 13:30		G	2	14.9	0.017	0.026	1	<0.16	20.4
BE1-T	4/26/11 7:01		G	11	18.2	0.102	0.064	2	<0.16	19.6
BE1-T	4/26/11 13:01		G	6	17.6	0.07	0.052	1.4	<0.16	19.5
BE1-T	4/26/11 17:01		G	10	17.5	0.057	0.041	1.4	<0.16	19.8
BE1-T	4/27/11 1:01		G	3	16.6	0.03	0.028	1.5	<0.16	20.1
BE1-T	4/27/11 9:01		G	2	16.7	0.022	0.018	1.1	<0.16	20.3
BE1-T	6/14/11 17:20	6/15/11 4:26	EFI	9	21.5	0.101	0.070	2.5	<0.16	18.6
BE1-T	6/15/11 4:45	6/15/11 11:58	EFI	<2	21.9	0.065	0.047	3.3	<0.16	18.5
BE1-T	6/15/11 12:38	6/16/11 4:58	EFI	2	19.5	0.036	0.021	1.2	<0.16	19.8
BE1-T	6/16/11 5:58	6/16/11 11:18	EFI	3	19.5	0.025	0.015	1.2	<0.16	19.8
BE1-T	6/17/11 14:46	6/19/11 17:41	EFI	3	19.3	0.022	0.014	1.4	<0.16	20.3
BE1-T	6/21/11 0:36	6/21/11 22:27	EFI	8	18.5	0.047	0.026	2.2	<0.16	19.3
BE1-T	6/21/11 23:55	6/22/11 9:39	EFI	5	18.3	0.044	0.031	4.2	2.1	19.4
BE1-T	6/22/11 11:28	6/23/11 16:52	EFI	<2	19.9	0.041	0.032	0.4	<0.16	19.2
BE1-T	7/14/11 8:54	7/15/11 12:15	EFI	8	18.4	0.071	0.023	0.9	<0.16	17.5
BE1-T	7/15/11 16:28	7/15/11 22:30	EFI	5	17.8	0.108	0.058	0.7	<0.16	14.4
BE1-T	7/15/11 22:47	7/16/11 5:05	EFI	3	17.6	0.075	0.038	0.7	<0.16	15.6
BE1-T	7/16/11 5:24	7/16/11 14:20	EFI	<2	17.9	0.046	0.023	1.4	<0.16	17.1
BE1-T	7/16/11 14:53	7/17/11 11:17	EFI	<2	18	0.035	0.013	0.8	<0.16	18

SITE ID	SAMPLE START Date/Time	SAMPLE END Date/Time	SAMPLE TYPE	TSS mg/L	NO_2+NO_3 mg/L	TP mg/L	DOP mg/L	TKN mg/L	NH_3 mg/L	Cl mg/L
BE2-F	7/15/11 9:59	7/15/11 11:07	EFI	3,870	1.31	0.878	0.078	8.4	0.37	17.5
BE2-T	6/30/11 12:50		G	<2	11	0.108	0.083	1.2	<0.16	10
BE2-T	7/15/11 11:30		G	48	24.5	0.348	0.086	3.9	<0.16	6.6
BE2-T	7/15/11 11:30	7/15/11 20:30	EFI	98	20.7	0.379	0.086	3.3	<0.16	6
BE2-T	7/16/11 11:40	7/17/11 11:44	EFI	16	14.6	0.106	0.041	2.8	<0.16	8
CH1-F	3/15/11 22:23	3/16/11 10:41	EFI	29	0.56	1.41	0.679	4.2	0.82	<3
CH1-F	3/16/11 11:05	3/16/11 17:59	EFI	23	0.39	1.72	0.969	4.5	0.82	<3
CH1-F	3/16/11 18:09	3/16/11 23:55	EFI	18	0.23	1.72	1.070	4.5	0.52	<3
CH1-F	3/17/11 0:16	3/17/11 7:55	EFI	8	0.2	1.58	0.934	3.6	0.67	<3
CH1-F	3/17/11 10:53	3/17/11 14:08	EFI	32	<.2	1.25	0.495	3.5	0.38	<3
CH1-F	3/17/11 14:13	3/17/11 17:24	EFI	27	<.2	1.18	0.482	3.4	<.16	<3
CH1-F	3/17/11 17:37	3/18/11 7:46	EFI	20	<.2	1.02	0.502	3.1	0.17	<3
CH1-F	4/1/11 3:13	4/2/11 14:03	EFI	51	0.24	0.392	0.228	2.1	<.16	<3
CH1-F	4/2/11 14:09	4/2/11 17:52	EFI	16	0.21	0.414	0.254	1.5	0.38	<3
CH1-F	4/2/11 18:25	4/3/11 22:46	EFI	11	0.87	0.526	0.376	2.7	0.23	<3
CH1-F	5/21/11 13:10	5/22/11 16:59	EFI	968	3.63	4.46	2.150	7.5	1.97	42
CH1-F	6/22/11 4:19	6/22/11 4:19	EFI			2.2				
CH1-F	6/22/11 22:59	6/22/11 22:59	EFI	80						
CH1-F	8/2/11 8:08	8/2/11 8:53	EFI	34	2.82	1.16	0.707	3.5	0.37	3.9
CH1-F	8/6/11 13:39	8/6/11 14:30	EFI	49	2.64	1.38	1.310	3.2	0.65	5.6
GO1-F	12/29/10 18:44	12/30/10 17:55	EFI	68	1.5	0.712		2.7	0.52	
GO1-F	12/30/10 17:56	12/30/10 20:16	EFI	7	1.37	0.479		2.7	1.1	
GO1-F	12/30/10 20:17	12/30/10 21:43	EFI	8	1.17	0.43		2	0.95	
GO1-F	12/30/10 21:44	12/30/10 23:04	EFI	3	1.04	0.404		2.2	0.81	
GO1-F	2/14/11 20:57	2/15/11 23:20	EFI	21	1.39	0.871	0.328	12.4	5.42	20.5
GO1-F	2/16/11 10:29	2/17/11 3:36	EFI	21	0.69	0.57	0.013	15.1	5.57	12
GO1-F	2/17/11 4:05	2/17/11 11:17	EFI	7	0.52	0.392	0.008	13.1	6.72	7.5
GO1-F	2/17/11 11:38	2/17/11 16:57	EFI	<2	0.4	0.366	<.005	9.7	4.56	5.2
GO1-F	2/17/11 17:13	2/17/11 20:17	EFI	6	0.32	0.352	0.045	7.4	4.13	3.4
GO1-F	3/16/11 7:32	3/16/11 15:14	EFI	58	0.68	0.738	0.329	9.3	3.79	6.5
GO1-F	3/16/11 16:13	3/16/11 21:36	EFI	28	0.3	0.93	0.229	13.8	6.7	5.9
GO1-F	3/16/11 21:56	3/17/11 6:08	EFI	14	0.23	0.647	0.219	10.1	5.1	3.5
GO1-F	3/17/11 6:32	3/17/11 14:08	EFI	15	<.2	0.539	0.256	6.6	3.35	<3
GO1-F	3/17/11 14:19	3/17/11 15:15	EFI	22	<.2	0.612	0.257	5.8	2.77	<3
GO1-F	3/18/11 13:52	3/18/11 14:37	EFI	9	<.2	0.604	0.333	5.5	2.7	<3
GO1-F	3/22/11 4:22	3/22/11 21:26	EFI	256	0.72	0.862	0.356	4.3	0.96	<3
GO1-F	3/22/11 21:34	3/23/11 5:43	EFI	99	0.65	0.667	0.412	3.4	0.96	<3
GO1-F	3/30/11 14:12	3/31/11 13:09	EFI		0.27					
GO1-F	6/21/11 14:00	6/22/11 13:30	EFI	265	0.57	1.41	0.636	0.7	<0.16	3.1
GO1-F	6/22/11 14:31	6/23/11 6:39	EFI	273	<.2	1.46	0.538	4.5	0.23	3.5
GO1-F	7/11/11 0:06	7/11/11 14:00	EFI	235	0.8	5.36	1.920	17.9	<0.16	20.4
GO1-F	7/14/11 10:02	7/16/11 8:09	EFI	68	0.33	1.2	0.941	3.2	0.51	<3
ST1-F	3/16/11 16:23	3/17/11 18:21	EFI	925	3.54	1.08	0.476	4.6	<0.16	4.4
ST1-F	3/17/11 18:33	3/18/11 6:22	EFI	213	3.63	0.807	0.498	1.8	<0.16	3.2
ST1-F	3/18/11 7:16	3/18/11 16:05	EFI	62	5.12	0.93	0.669	na	na	3.7
ST1-F	3/20/11 1:39	3/20/11 10:59	EFI	13	5.77	0.902	0.738	2	<0.16	3.5
ST1-F	3/20/11 11:37	3/20/11 21:15	EFI	6	4.66	0.914	0.724	1.8	<0.16	3.3
ST1-F	3/20/11 22:00	3/21/11 16:33	EFI	28	8.7	1	0.889	2.1	<0.16	5.3
ST1-F	3/23/11 2:04	3/28/11 7:00	EFI	34	8.7	1.28	0.975	2.9	<0.16	7.3
ST1-F	4/1/11 16:00	4/3/11 10:38	EFI	98	4.3	1.12	0.875	3.6	0.38	8.7
ST1-F	4/3/11 15:31	4/5/11 1:47	EFI	54	3.3	0.805	0.635	2.4	<0.16	14.5
ST1-F	4/5/11 1:51	4/5/11 9:11	EFI	2	3.05	0.718	0.589	2.1	<0.16	18.5

SITE ID	SAMPLE START	SAMPLE END	SAMPLE TYPE	TSS	NO_2+NO_3	TP	DOP	TKN	NH_3	Cl
	Date/Time	Date/Time		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ST1-F	6/21/11 9:16	6/21/11 9:35	EFI		33	1.3	0.681	3.9	<0.16	15
ST1-F	6/21/11 15:04	6/21/11 15:38	EFI	390	7.17	1.39	0.427	7.1	<0.16	6.4
ST1-F	6/21/11 15:39	6/21/11 16:03	EFI	440	2.35	1.14	0.194	5.7	<0.16	4.6
ST1-F	6/21/11 16:03	6/21/11 16:32	EFI	505	2.52	0.997	0.222	4.2	<0.16	5.3
ST1-F	6/21/11 16:34	6/22/11 4:59	EFI	283	8.53	1.41	0.697	4.1	<0.16	7.9
ST1-F	6/21/11 16:34	6/22/11 4:59	EFI	275	8.5	1.47	0.722	4.4	<0.16	7.7
ST1-F	6/22/11 9:53	6/22/11 19:32	EFI	63	14.5	1.55	1.190	4.2	<0.16	14.4
ST1-F	7/15/11 6:00	7/15/11 6:32	EFI	2,370	0.62	1.47	0.218	10.1	<0.16	5.2
ST1-F	7/15/11 6:33	7/15/11 6:56	EFI	2,010	0.52	0.988	0.223	4.8	0.23	4
ST1-F	7/15/11 6:57	7/15/11 7:27	EFI	665	0.59	0.956	0.223	4.3	<0.16	3.7
ST1-F	7/15/11 7:28	7/15/11 7:51	EFI	735	0.56	0.923	0.229	3.9	0.23	3.4
ST1-F	7/15/11 7:28	7/15/11 7:51	EFI	707	0.56	0.919	0.227	4.2	<0.16	3.5
ST1-F	7/15/11 11:02	7/15/11 11:35	EFI	156	0.56	0.476	0.189	1.6	<0.16	3
ST1-F	7/15/11 11:37	7/15/11 12:30	EFI	192	0.75	0.535	0.254	1.9	<0.16	3.5
ST1-F	7/15/11 12:33	7/15/11 14:04	EFI	280	1.06	0.707	0.308	2.2	<0.16	3.6
ST1-F	8/1/11 9:53	8/2/11 8:14	EFI	494	0.28	1.07	0.409	4.3	<0.16	3

G = grab sample | **EFI** = equal flow incremented (composite) sample