Evaluation of Drain and Tributary Pollutant Sources to C.J. Strike–Swan Falls Reach, Snake River, Idaho

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1. INTRODUCTION

Swan Falls Reservoir is a small run-of-river reservoir with water residence time generally less than one day. Over the years, Idaho Power Company (IPC) has collected Snake River water quality information to support the relicensing processes for both the Swan Falls project and also the upstream C.J. Strike project. IPC has also participated in the development of the Mid-Snake River/Succor Creek Subbasin Assessment and Total Maximum Daily Load. With a recent relicensing application for the Swan Falls project, IPC recognized a need to increase understanding of Snake River water quality inflowing to Swan Falls reservoir and changes that occur in the approximately 20-mile reach from C.J. Strike Dam to the Swan Falls inflow. Specifically, IPC utilized a limited dataset from the United States Environmental Protection Agency (USEPA) (1974) and the Idaho Department of Environmental Quality (IDEQ) (J. Achabal, IDEQ, unpubl. data) to assess possible tributary and drain inputs directly to Swan Falls Reservoir (IPC 2008). These data were sparse or historical in nature, and a more contemporary assessment was needed. As a result, IPC initiated a water quality study of drains and tributaries to the Snake River, between the C.J. Strike and Swan Falls reservoirs, in May of 2007 to provide additional information on water quality inputs in this reach.

This was a reconnaissance-level study designed to document the location and water quality of tributaries and agricultural drains flowing into the Snake River between Swan Falls Dam and C.J. Strike Dam. Specific objectives include assessment of sediment and nutrient loads, primarily phosphorus, and their contribution to the total load of the mainstem Snake River as it flows into Swan Falls Reservoir. In addition, information relative to tributaries and drains flowing directly into Swan Falls Reservoir was collected.

2. STUDY AREA

Swan Falls Reservoir is located in southwest Idaho, approximately 25 miles southwest of Boise, on the Snake River (Figure 1). The C.J. Strike Dam is located approximately 36 river miles upstream of Swan Falls Dam. The study area was bounded by the tailrace outflows from C.J. Strike Dam, downstream to the Swan Falls Dam tailrace. The town of Grand View, Idaho, is located adjacent to and south of the Snake River, near river mile (RM) 483-485. Major tributaries to the study reach include Shoofly, Birch, and Castle Creeks. These tributaries drain water from the south, north to the river.

The portion of the Snake River located within the study reach is used intensively to meet agriculture and ranching demands. Irrigated lands adjacent to the river rely on water drawn from the river. As consumptive needs are met, surplus and post-use water returns to the river via return drains. The inflow contributors within the study reach are comprised of drains, canals, and natural tributaries. For purposes of this study, these three types of returns are defined collectively as drains. All of the large natural tributary inflows (> 5cfs mean discharge) within this reach are used for irrigation and ranching needs before entering the river. Smaller tributaries and springs account for a small portion of the inflow to the reach. Water losses and gains within the river channel are not well understood and were not accounted for in this study.

Snake River flows within the study reach are regulated by the operation of the C.J. Strike Hydroelectric Project. The Grand View Canal is diverted at C.J. Strike Dam and provides much of the water for agriculture along the south side of the river, down to river mile 476.3. The High Line and Low Line Canals are diverted at the C.J. Strike Dam and deliver water along the north side of the river.

3. METHODS

3.1. Field Collection

Field data collection was performed over a two-day period each month (excluding September) from May through October 2007. A total of five sample events, defined as each two-day period that was required to perform sampling of all survey sites, occurred during the May through October sample period (i.e., entire sample period).

3.1.1. Site Selection

Drain sample sites were initially identified with assistance from a USEPA (1974) inventory of return flows to the Snake River. Following review of this inventory, aerial photo maps and visual observation during site visits was used to develop the list of drain sample sites. All field data collection was performed at the same point location at individual sample sites for each sample event. Drain sample sites were located as close to the point of inflow to the river as was reasonable to ensure there was no river influence on the data collected. Channelized sections of stream with homogenous substrate and good depth were selected for sites when available.

Snake River sample sites were selected to correspond with previous Swan Falls and C.J. Strike relicensing studies. Snake River sites included upper (C.J Strike outflow, RM 493.6), middle (Swan Falls inflow, RM 474.8) and lower (Swan Falls outflow, RM 457.7) locations within the study reach to assess inflow, midpoint and outflow conditions. A comprehensive list of survey sites is shown in Appendix 1.

3.1.2. Field Parameters

Instantaneous water quality data that included temperature, dissolved oxygen, pH, and conductivity were collected at each sample site using a Hach Hydrolab MS4a™. Sensors were calibrated according to manufacturer specifications before each sampling event. Water quality data were recorded on datasheets and values were stored electronically using a Hach surveyor for later data transfer. Higher river flows during some sample events affected access to select sites, limiting some water quality data collection.

In addition to instantaneous temperature data collected at each site, a continuous temperature logger (Onset, StowAway Tidbit Temp Logger™) was deployed at the river inflow to Swan Falls reservoir at river mile 474.8. The logger was attached to the right bank and cast to the right channel position. Data were recorded in 10-minute intervals and downloaded monthly.

A National Institute of Standards and Technology (NIST)-certified thermometer was used for data quality assurance by checking temperatures each time the logger was downloaded. NIST temperatures were compared to logger temperatures, and a difference of 0.5^{o} C was used as criteria to validate or invalidate the logger data.

3.1.3. Nutrients and Suspended Solids

Water samples were collected for nutrient analysis. Surface samples were collected in one-liter volumes, in containers that were triple-rinsed with native water. Samples were labeled with river mile, date, time, river position, and depth of sample. Samples were placed on ice, in a cooler, and delivered to the analyzing laboratory within 48 hours of collection.

Nutrient samples were analyzed by Alchem Laboratories in Boise, Idaho. Water sample analyses were performed for ammonia, nitrate, dissolved orthophosphate, total phosphorus, total and volatile suspended solids, total and total dissolved organic carbon, and total Kjeldahl nitrogen. Concentrations for all analytes were reported in mg/L.

3.1.4. Stream Flow

Stream flow measurements were collected at all drain sample sites, when possible. Water velocity was collected using a Marsh-McBirney™ model 2000 flow meter in conjunction with a top-setting rod in 1/10 foot increments. Accuracy of +/–2% of reading was achieved according to product specifications. An adaptive approach depending on drain size was developed from other sources (USGS 2005, IDEQ 2004, Hauer, Lamberti 1996) and used for this study. Depending on drain size, depth and velocity measurements were made at 1–7 locations across a transect. Depending on the drain depth, velocity measurements were made at 60%, *or* 20 and 80% of the depth at each location on the transect. Increased river flows during some sample events impeded access to select sites, limiting some data collection.

3.1.5. Site Documentation

Upon navigating to a site, the best sampling location was determined and the coordinate points collected using a Trimble Geo XT™ GPS unit. Notes were made of culverts, spring influences, private land postings, and other features or observations at each site.

3.2. Data Analysis

3.2.1. Field Parameters

Instantaneous drain temperature, dissolved oxygen and pH data were summarized for each individual drain by calculating the mean, minimum, maximum, and standard deviation for all data collected during the entire sample period (May–October). Similarly, these calculations were made for all drains, collectively, for the entire sample period.

Snake River instantaneous temperature, dissolved oxygen, pH and conductivity were summarized for each river site by calculating the mean, minimum, maximum and standard deviation of each parameter for the entire sample period (May–October).

Consideration of diel temperature fluctuation in both drains and the river led us to believe that the temperature dataset for the sample period was not sufficient to warrant further analysis of the data. Continuous logger data between the dates of 5/24 and 6/20 was deemed invalid due to lower river flows that resulted in dewatering of the logger device.

3.2.2. Nutrients and Suspended Solids

Nutrient concentrations reported as below detection limit were incorporated into analyses by using one-half of the detection limit value. Drain nutrient concentrations were summarized for each individual drain by calculating the mean, minimum, maximum and standard deviation of each nutrient parameter for all data collected during the entire sample period (May–October). Similarly, these calculations were made for all drains, collectively, for the entire sample period.

Snake River nutrient concentrations were summarized for each site, individually, by calculating the mean, minimum, maximum and standard deviation of each nutrient parameter for all data collected during the entire sample period (May–October).

Daily nutrient loads (kg/day) were calculated using discharge (cfs) and nutrient concentration (mg/L) values and converting to report in kg/day. Through this analysis we assumed that the instantaneous measured flow and nutrient concentrations were constant for the entire 24-hour period on the date which the sampling occurred. Nutrient loads for each individual drain sampled were combined (i.e., summed) and then added to the load from Snake River mile 493.6 (C.J. Strike outflow) to generate the total load to the study reach, from which the relative contributions for both combined drains and the Snake River at River Mile 493.6 could be determined.

A linear regression analysis between total phosphorus and inorganic suspended solids was performed to determine the primary source of the total phosphorus loads carried by drains. In order to perform the regression analysis, both phosphorus and solids data were $\log_{10}$ transformed, plus one added, to accommodate differences in scale. Values for inorganic suspended solids were generated by subtracting the volatile suspended solids values from the total suspended solids values.

3.3.3. Stream Flow

Drain water velocity (feet per second), depths and widths were used to calculate drain discharges (cubic feet per second). Drain discharges were summarized by calculating the mean, minimum, maximum, and standard deviation for each drain for the entire sample period.

Snake River flow data was accessed through Joint Water Resources (JWR), an IPC internal-use data resource. Daily mean discharges from the C.J. Strike and Murphy gauges were used for this study. For Snake River load calculations, the daily mean discharge on the first day of the two-day sample event was used.

3.3.4. Assumptions

In order to perform the load analyses, some data assumptions were required; specifically, we assumed that drain and river conditions (i.e., nutrients, flow, etc.) were stable for 24 hours within the day that sampling occurred, and that drain and river conditions were stable during the two-day sample event.

4. RESULTS AND DISCUSSION

4.1. Field Parameters

Mean temperature, dissolved oxygen and pH for combined drains were 20.0 °C, 7.8 mg/L and 8.1 (Table 1), respectively, for the entire sample period. Instantaneous temperature between drains ranged from 10.6 to 31.8 °C. Dissolved oxygen and pH ranges were 1.31 to 20.0mg/L and 7.1 to 10.2, respectively (Table 1).

Mean instantaneous temperature for Snake River sites (Table 2) at river miles 493.6, 474.8, and 457.7 were 19.8, 18.5, and 19.2 °C, respectively. Mean values for dissolved oxygen at these sites were 8.5, 9.7, and 9.1mg/L (Table 2).

Continuous temperature logger data from the river at river mile 474.8 indicates that mean daily temperatures exceeded the coldwater biota target of 19 ° C, as defined by the IDEQ, beginning sometime in June and extending through mid-September. Peak mean daily temperature for the study period was 24.6 °C, occurring on July 14.

4.2. Nutrients and Suspended Solids

A total of 101 nutrient samples were collected from 33 drain sites (Table 3). The number of samples collected at any specific site ranged from 1 to 5. Additionally, a total of 16 nutrient samples were collected at the three Snake River sites (Table 4), with a range of five to six samples per individual site.

4.2.1. Phosphorus

4.2.1.1. Drains

The mean total phosphorus concentration for all drains for the entire sample period was 0.68 mg/L, with a range of 0.037 to 6.7 mg/L (Table 3, Figure 2). This mean concentration is approximately 10 times the IDEQ target of 0.07 mg/L for the Snake River (IDEQ 2003). The mean orthophosphate concentration for all drains for the entire sample period was 0.14 mg/L, with a range of 0.006 to 0.74 mg/L (Table 3). Concentration values for both total phosphorus and orthophosphate were highly variable both in and among drains but are supported by similar findings in a study conducted in 1995 (Hoelscher and Myers 1998) on drains between the Swan Falls and Brownlee dam projects.

A regression analysis of total phosphorus and inorganic suspended solids (Figure 3) resulted in $p < 0.001$ and $R^2 = 0.554$, indicating that inorganic suspended solids (i.e., sediment) and total phosphorus were strongly correlated. This suggests that most of the total phosphorus carried by drains is associated with sediments.

4.2.1.2. Snake River

Mean total phosphorus concentrations for individual Snake River sites for the entire sample period (Table 4) were 0.064, 0.066, and 0.059 mg/L at river miles 493.6, 474.8, and 457.7, respectively. Exceedance of the 0.07 mg/L target occurred at least once at each of the river sample sites, with a maximum concentration of 0.091 mg/L measured at river mile 474.8 (Table 4). Mean orthophosphate concentrations for individual Snake River sites for the entire sample period (Table 4) were 0.022, 0.016, and 0.019 mg/L by site, in order listed above.

4.2.2. Total Suspended Solids

4.2.2.1. Drains

The mean total suspended solids concentration for all drains for the entire sample period was 646 mg/L, with minimum and maximum values of 2 and 16,800 mg/L (Table 3). The maximum concentration of 16,800 mg/L occurred in the drain located at river mile 477.5 and was twice that of any other drain. Additionally, this drain had a minimum concentration of 142 mg/L, providing evidence that conditions within drains are highly variable. The standard deviation for combined drains mean nutrient concentrations was 2,072 mg/L, illustrating the high degree of variability between drains (Table 3).

4.2.2.2. Snake River

Mean total suspended solids concentrations for individual Snake River sites for the entire sample period (Table 4) were 9.3, 10.4, and 10.4 mg/L at river miles 493.6, 474.8, and 457.7, respectively. Concentrations ranged from 2 to 20 mg/L among sites. The maximum concentration of 20 mg/L occurred at river mile 474.8. Concentrations were highest in June at each site (Table 4).

4.2.3. Nitrogen

4.2.3.1. Drains

The mean ammonia concentration for combined drains was 0.11 mg/L for the entire sample period. A maximum ammonia concentration of 2.41 mg/L occurred at river mile 487.7. Two sites, located at river miles 487.7 and 487.5, had mean ammonia concentrations of 0.68 and 1.04 mg/L for the entire sample period (Table 3). These concentrations were substantially higher than those found in any other drains. The mean concentration for combined drains was not substantially higher than concentrations observed at some Snake River sites.

The mean nitrate and Kjeldahl nitrogen concentrations for combined drains were 2.02 and 1.15 mg/L, respectively (Table 3), for the entire sample period. The maximum nitrate concentration was 8.61 mg/L, occurring at river mile 481.1. The maximum Kjeldahl nitrogen concentration was 8.5 mg/L, occurring at river mile 487.7 (Table 3).

4.2.3.2. Snake River

Snake River sites at river miles 493.6, 474.8, and 457.7 had mean ammonia concentrations of 0.12, 0.05, and 0.03 mg/L, respectively (Table 4), for the entire sample period. Trends indicate that ammonia concentrations decrease as water travels downstream through the study reach. Mean nitrate concentrations at river miles 493.6, 474.8, and 457.7 were 0.65, 0.80, and 0.75, respectively (Table 4), for the entire sample period. Kjeldahl nitrogen mean concentrations for the entire sample period at river miles 493.6, 474.8, and 457.7 were 0.69, 0.54, and 0.50 mg/L, respectively (Table 4).

4.3. Nutrient Loads

4.3.1. Phosphorus

Combined drains contributed a minimum of 50 (October) to a maximum of 253 (June) kg of total phosphorus per day to the study reach among sample events. These phosphorus loads accounted for 4–23% of the total phosphorus load to the study reach (Table 5, Figure 4). The most substantial load contributors among drains were at river miles 477.5 and 478.9 (Figure 5). Appendix 2 illustrates the phosphorus loads for combined drains and individual river sites by sample event.

Orthophosphate load contributions for combined drains accounted for 4–39% of the total orthophosphate load to the study reach (Table 5) between sample events. There were no discernable trends among river sites for total phosphorus or orthophosphate in regard to increased loads as water traveled downstream (Figure 6). With substantial phosphorus and orthophosphate loads contributed by combined drains, it is probable that these load contributions are not apparent in downstream river sites due to phosphorus processing that occurs in the river and settling out of sediment associated phosphorus before reaching downstream river sample locations.

Despite the lack of a strong trend, evaluation of total phosphorus load tracking (Figure 6) indicates that a portion of the total phosphorus contributed to the study reach is being stored within the river before reaching the inflow to Swan Falls Reservoir (June, July and Oct.) in addition to phosphorus storage that occurs in the reservoir (May, June and July). Additionally, we observed an export of total phosphorus from the reservoir in the months of August and October. These results indicate that short term phosphorus storage is occurring, at certain times, in both Swan Falls Reservoir and the river located upstream of the reservoir.

4.3.2. Total Suspended Solids

Combined drains contributed a minimum of 6,444 (October) to a maximum of 233,400 (June) kg of total suspended solids per day to the study reach among sample events (Table 5). Total suspended solid contributions for combined drains accounted for 5–63% of the total load to the study reach (Table 5, Figure 7). During the height of irrigation (June–July) combined drains accounted for more than 50% of the total load to the reach. Similar to phosphorus loads, the drains located at river miles 477.5 and 478.9 were the largest contributors of total suspended solids among drains (Figure 5).

Consistent trends for total suspended solid loads were not observed between river sites (Appendix 2). In October, near the end of the irrigation season, river mile 493.6 accounted for 95% of the total load to the reach (Figure 7), illustrating the high level of seasonal variability associated with drain inflows and corresponding loads.

Load contributions for combined drains volatile suspended solids were relatively much lower than that of total suspended solids (Table 5). These results, in conjunction with visual observations made during sampling, suggest that much of the total suspended solids load carried by the drains is sediment load. High correlation between phosphorus and total suspended solids loads indicates phosphorus associated with sediment is a large proportion of the load from most drains; however, many drains showed relatively low sediment and high phosphorus load (i.e., RM 484.6). In addition, the settling of the heavier sediment particles may occur between river sample sites, making a clear assessment of loads between these sites difficult.

Evaluation of load tracking for total suspended solids (Figure 8) indicates that substantial storage of drain solids contributions is occurring (June-August) in the river before reaching the inflow to Swan Falls Reservoir. Roughly half of the suspended solids that make up the total load to the study reach are stored upstream of the Swan Falls Reservoir inflow. Additionally, an export of suspended solids from Swan Falls Reservoir was observed in the months of May and October, indicating that short term storage of suspended solids occurs within the study reach.

4.3.3. Nitrogen

Combined drains contributed a minimum of 8 (October) to a maximum of 39 (August) kg of ammonia per day to the study reach among sample events (Table 5). This range accounted for 0.3–4.5% of the total load to the study reach (Figure 6).

Drain contributions for nitrate load to the study reach had a minimum of 371 (July) to a maximum of 746 (October) kg of nitrate per day among sample events (Table 5). Minimum and maximum percent of total load contribution to the reach ranged from 3 (October) to 6.6% (June) for combined drains (Figure 7).

Combined drains contributed a minimum of 160 (June) to a maximum of 265 (May) kg of total Kjeldahl nitrogen per day to the study reach among sample events (Table 5). The percent contribution of drains to the total reach load ranged from 1.5 (October) to 3.6% (May) (Figure 8).

Among sample events, combined drains accounted for a maximum of 6.6% of the total load to the reach for all nitrogen parameters. In addition, the load spikes observed for phosphorus and total suspended solids during peak irrigation months do not occur for nitrogen. Rather, nitrogen load contributions for combined drains remained relatively consistent between sample events throughout the sample period (Table 5).

Results for ammonia and Kjeldahl nitrogen loads at river sample sites show no distinct trends between sites (Appendix 2). Alternately, the nitrate load at river mile 474.8 appears to be balanced with the sum of the loads from the upstream river site (493.6) and combined drain sites.

4.4. Stream Flow

Snake River flows were stable throughout the sample period with the exception of the October sample event, during which stream flows were approximately 2,000 cubic feet per second greater than that for any previous sampling event (Tables 2 and 4). Hydroelectric operations and timing of sampling did not allow calculation of water balance between river sites.

Stream flow discharges in and among drains were highly variable between sample events (Tables 1 and 3). For instance, discharges for the drain site located at river mile 485.5 ranged from a minimum of 0.3 to a maximum of 13.3 cubic feet per second between sample events. The dynamic nature of the drains prohibited the extrapolation of discharge data for periods in between sample events.

5. SUMMARY AND CONCLUSIONS

Daily loads for combined drains as reported in this study are conservative estimates considering the several drain inflows that were not sampled due to factors such as accessibility or low discharge.

The nutrient loads carried by drains increase markedly during the growing season and the associated irrigation activity. This is primarily the result of increased discharges.

The high variability of drain discharges coupled with survey timing did not allow interpolation of data for periods in between sample events.

The mean phosphorus concentration for combined drains was approximately ten times that of concentrations at Snake River sites. Drain phosphorus concentrations exceeded the Snake River phosphorus target criteria by approximately 10 times.

The phosphorus load for combined drains contributed up to 23% of the total phosphorus load to the study reach. These results suggest that the phosphorus loads from drain sources can be a substantial contributor to river phosphorus loads within the study reach.

Total phosphorus and sediment values within drains showed a strong correlation through regression analysis, suggesting that much of the total phosphorus in drains is associated with the sediment load.

Periods of total phosphorus storage as well periods of phosphorus export from the study reach were observed, indicating some amount of short term storage of drain contributed phosphorus.

Nitrogen load contributions for combined drains accounted for less than 7% of the total load to reach for all nitrogen nutrient types. Study results suggest that evaluating the differences in nitrate nitrogen loads between Snake River sites at river miles 493.6 and 474.8 could potentially be used to generally assess the drain contributions between these river sites. Total suspended solids loads contributed by combined drains accounted for more than 50% of the total load to the study reach for two sample events (June–July). Total suspended solids mean concentration for combined drains was approximately 64 times the mean concentrations at Snake River sites.

Comparison of drain load contributions for total suspended solids and volatile suspended solids indicates that much of the total suspended solid load carried by drains is sediment. Study results show that short term storage of drain contributed solids occurs in Swan Falls Reservoir as well as in the river located upstream of the reservoir inflow.

Maximum temperatures among individual drains exceeded river site maximum temperatures by approximately 8 °C. Analysis of temperature data for drain and river sites was limited, considering diel temperature fluctuation and timing of instantaneous temperature measurements.

6. ACKNOWLEDGMENTS

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Table 1
Individual drains water quality parameters and combined drains statistical summary for entire sample period (May–October).

Measure Date	River Mile*	Stream	Flow (cfs)	pH	Temperature (^oC)	DO (mg/L)
7/31/2007	461.20	Drain	0.5	7.9	23.1	3.3
10/8/2007	461.20	Drain	0.3	8.3	12.3	7.0
5/14/2007	462.00	Sinker Creek	0.1	7.4	12.7	2.9
6/19/2007	462.00	Sinker Creek	0.0	7.5	13.4	1.3
5/14/2007	468.70	Drain	not collected	8.8	16.7	9.3
5/14/2007	470.80	Castle Creek	1.3	8.6	22.7	10.9
6/19/2007	470.80	Castle Creek	1.7	8.5	18.9	9.7
7/31/2007	470.80	Castle Creek	0.4	8.3	29.3	11.6
8/29/2007	470.80	Castle Creek	0.2	8.0	25.7	9.9
10/8/2007	470.80	Castle Creek	1.3	8.1	14.8	6.8
5/14/2007	476.30	Grand View Canal	6.2	8.6	20.4	7.4
6/19/2007	476.30	Grand View Canal	16.4	8.8	20.7	7.7
7/31/2007	476.30	Grand View Canal	4.1	8.5	23.9	6.1
8/29/2007	476.30	Grand View Canal	7.6	8.4	21.8	7.4
10/8/2007	476.30	Grand View Canal	30.7	8.7	13.5	9.5
5/14/2007	476.80	Drain	1.4	8.0	22.2	6.9
6/19/2007	476.80	Drain	0.5	7.5	13.3	7.9
10/8/2007	476.80	Drain	2.5	7.4	14.5	7.3
5/14/2007	477.00	Drain	1.7	7.7	14.2	9.8
6/19/2007	477.00	Drain	1.3	8.1	24.0	6.4
7/31/2007	477.00	Drain	0.2	8.1	23.6	7.4
8/29/2007	477.00	Drain	1.4	7.8	20.1	6.2
10/8/2007	477.00	Drain	0.3	7.5	13.1	7.3
5/14/2007	477.50	Drain	1.4	8.3	23.6	6.9
6/19/2007	477.50	Drain	1.4	8.6	26.4	6.9
7/31/2007	477.50	Drain	5.0	8.4	25.5	7.6
8/29/2007	477.50	Drain	2.1	7.9	23.6	5.4
5/14/2007	477.60	Drain	1.3	8.3	25.0	6.8
6/19/2007	477.60	Drain	1.5	8.4	26.6	6.2
7/31/2007	477.60	Drain	1.4	8.2	24.7	6.3
5/14/2007	477.70	Drain	0.5	8.5	25.1	6.3
5/14/2007	478.00	Drain	2.0	8.5	21.5	7.6
6/19/2007	478.00	Drain	2.4	8.8	21.0	7.6
8/29/2007	478.00	Drain	1.4	8.3	24.0	6.8
6/19/2007	478.10	Drain	7.6	8.1	23.1	5.8
8/29/2007	478.10	Drain	5.2	7.7	19.2	5.3
5/17/2007	478.90	Birch Creek	15.4	8.4	18.3	8.6
6/19/2007	478.90	Birch Creek	15.3	8.1	21.4	6.2
7/31/2007	478.90	Birch Creek	18.8	8.0	23.0	7.3

Measure Date	River Mile*	Stream	Flow (cfs)	pH	Temperature (°C)	DO (mg/L)
8/29/2007	478.90	Birch Creek	16.2	7.9	19.4	7.4
10/8/2007	478.90	Birch Creek	32.3	7.9	12.4	8.4
5/17/2007	479.70	Drain	1.2	8.0	24.1	8.4
5/17/2007	479.70	Drain	1.2	8.5	28.7	7.3
5/17/2007	479.71	Drain	0.3	7.4	13.7	5.7
7/31/2007	479.71	Drain	1.1	8.0	26.9	7.2
10/8/2007	479.71	Drain	2.3	7.6	10.6	9.0
6/19/2007	479.90	Drain	1.7	8.5	26.7	6.2
7/31/2007	479.90	Drain	1.1	8.2	25.1	7.0
8/29/2007	479.90	Drain	4.5	8.2	21.4	7.5
5/17/2007	480.10	Drain	0.4	7.6	20.2	6.6
7/31/2007	480.10	Drain	1.4	7.6	22.1	6.1
8/29/2007	480.10	Drain	0.2	7.7	19.1	7.3
10/8/2007	480.10	Drain	2.6	7.5	11.5	8.0
5/17/2007	480.30	Drain	0.3	7.5	25.3	8.9
7/31/2007	480.30	Drain	0.3	7.4	20.6	10.1
8/29/2007	480.30	Drain	0.5	7.5	18.6	7.4
10/8/2007	480.30	Drain	0.7	7.1	14.2	6.3
5/17/2007	481.10	Drain	16.8	8.4	22.5	8.4
6/19/2007	481.10	Drain	14.5	8.7	22.4	10.8
7/31/2007	481.10	Drain	2.7	8.3	19.6	10.9
8/29/2007	481.10	Drain	3.5	8.3	17.7	11.1
10/8/2007	481.10	Drain	34.5	7.9	11.8	8.8
5/17/2007	482.00	Drain	0.9	8.9	29.3	9.7
6/19/2007	482.00	Drain	1.2	9.0	29.2	7.2
7/31/2007	482.00	Drain	1.4	8.1	22.8	8.0
8/29/2007	482.00	Drain	0.8	7.8	17.0	7.4
5/17/2007	483.90	Drain	1.8	8.0	18.0	11.8
6/20/2007	483.90	Drain	2.8	7.6	14.3	8.4
7/31/2007	483.90	Drain	4.4	7.5	14.7	7.0
8/29/2007	483.90	Drain	4.4	7.4	14.9	6.2
10/9/2007	483.90	Drain	3.7	7.5	13.5	6.1
5/17/2007	484.60	Drain	5.0	8.0	25.0	7.8
6/20/2007	484.60	Drain	3.0	8.3	21.1	9.6
7/31/2007	484.60	Drain	2.3	8.0	19.4	7.7
8/29/2007	484.60	Drain	5.7	7.8	15.6	6.5
10/9/2007	484.60	Drain	7.5	7.8	10.9	7.9
5/17/2007	485.70	Drain	2.9	7.8	15.1	9.5
6/20/2007	485.70	Drain	0.1	8.0	16.8	8.4
7/31/2007	485.70	Drain	0.6	7.9	19.8	7.4
8/29/2007	485.70	Drain	6.8	7.6	16.9	7.0
10/9/2007	485.70	Drain	4.3	7.5	16.4	7.4
5/17/2007	485.80	Drain	3.7	8.7	23.0	9.3

Measure Date	River Mile*	Stream	Flow (cfs)	pH	Temperature (^oC)	DO (mg/L)
6/20/2007	485.80	Drain	0.3	8.6	24.9	6.2
7/31/2007	485.80	Drain	9.2	8.1	22.5	8.2
8/29/2007	485.80	Drain	13.3	7.9	19.2	6.5
10/9/2007	485.80	Drain	8.2	8.3	12.0	8.2
5/17/2007	486.20	Drain	3.9	7.6	22.3	7.0
6/20/2007	486.20	Drain	6.6	7.8	22.1	6.8
7/31/2007	486.20	Drain	1.3	7.6	17.6	8.0
8/29/2007	486.20	Drain	not collected	7.5	15.8	5.7
10/9/2007	486.20	Drain	not collected	7.5	12.9	7.8
5/17/2007	486.40	Drain	2.8	7.5	20.0	7.2
6/20/2007	486.40	Drain	2.0	7.5	19.2	6.4
7/31/2007	486.40	Drain	2.1	7.4	17.9	7.4
5/17/2007	486.50	Drain	2.4	7.8	16.9	7.9
6/20/2007	486.50	Drain	2.6	7.7	17.9	5.5
7/31/2007	486.50	Drain	3.4	7.5	16.7	5.6
8/29/2007	486.50	Drain	3.9	7.5	16.2	5.7
10/9/2007	486.50	Drain	3.3	7.8	16.5	5.6
6/20/2007	487.10	Drain	0.9	8.4	31.7	4.2
8/1/2007	487.10	Drain	0.7	8.4	24.9	7.6
8/30/2007	487.10	Drain	2.8	8.3	21.5	7.5
6/20/2007	487.50	Drain	1.2	8.2	31.8	3.7
8/30/2007	487.50	Drain	0.7	8.1	19.4	6.4
5/17/2007	487.70	Drain	1.7	9.9	27.5	20.0
6/20/2007	487.70	Drain	3.8	10.2	31.4	19.3
8/1/2007	487.70	Drain	3.9	9.5	25.8	17.8
8/30/2007	487.70	Drain	3.8	9.7	23.3	20.0
10/9/2007	487.70	Drain	1.8	9.2	12.7	10.7
5/17/2007	489.60	Drain	12.7	8.3	20.5	8.6
6/20/2007	489.60	Drain	0.9	7.8	19.4	6.9
8/1/2007	489.60	Drain	1.6	7.6	16.5	6.7
8/30/2007	489.60	Drain	4.2	7.8	19.3	6.4
10/9/2007	489.60	Drain	13.1	7.9	14.0	9.1
5/17/2007	490.40	Shoofly Creek	13.0	7.8	19.6	7.7
6/20/2007	490.40	Shoofly Creek	10.7	7.8	22.2	6.7
8/1/2007	490.40	Shoofly Creek	10.4	7.7	18.1	7.5
8/30/2007	490.40	Shoofly Creek	16.3	7.7	17.2	7.2
10/9/2007	490.40	Shoofly Creek	16.2	7.7	14.5	7.4
Mean				8.1	20.0	7.8
Maximum				10.2	31.8	20.0
Minimum				7.1	10.6	1.3
SD				0.5	5.0	2.7

*Location of inflow to river as described in Snake River miles

Table 2
Water quality parameters and statistical summary for Snake River sites.

Measure Date	River Mile	River Position	Flow[b] (cfs)	Conductivity (mS)	pH	Temperature (°C)	DO (mg/L)
5/14/2007	457.7	RB	5712	0.4190	8.62	15.88	8.57
6/19/2007	457.7	RB	5466	0.4094	8.92	20.83	11.81
7/31/2007	457.7	RB	6097	0.4418	8.47	23.48	7.14
8/29/2007	457.7	RB	5754	0.4888	8.54	21.76	8.46
10/8/2007	457.7	RB	7230	0.4818	8.51	13.93	9.37
Mean			6052	0.4482	8.61	19.18	9.07
Maximum			7230	0.4888	8.92	23.48	11.81
Minimum			5466	0.4094	8.47	13.93	7.14
SD			696	0.04	0.18	4.07	1.73

Measure Date	River Mile	River Position	Flow[a](cfs)	Conductivity (mS)	pH	Temperature (°C)	DO (mg/L)
5/14/2007	474.8	MC	5913	0.4123	8.68	15.67	10.63
6/19/2007	474.8	MC	5184	0.4249	8.51	18.64	8.24
7/31/2007	474.8	MC	6017	0.4431	8.58	23.90	10.77
8/29/2007	474.8	MC	5595	0.4950	8.50	21.21	9.35
10/8/2007	474.8	RC	7416	0.4849	8.38	13.03	9.42
Mean			6025	0.4520	8.53	18.49	9.68
Maximum			7416	0.495	8.68	23.9	10.77
Minimum			5184	0.4123	8.38	13.03	8.24
SD			843	0.04	0.11	4.31	1.04

Measure Date	River Mile	River Position	Flow[a](cfs)	Conductivity (mS)	pH	Temperature (°C)	DO (mg/L)
5/17/2007	493.6	LB	5809	0.3578	8.75	18.09	9.05
6/20/2007	493.6	LB	4970	0.4115	8.68	20.28	8.46
8/1/2007	493.6	LB	6164	0.4381	8.37	23.60	6.79
8/1/2007	493.6	MC	6164	0.4490	8.28	22.93	7.77
8/30/2007	493.6	MC	5619	0.4602	8.64	21.28	10.10
10/9/2007	493.6	MC	7791	0.4789	8.49	12.83	8.71
Mean			6086	0.4326	8.54	19.84	8.48
Maximum			7791	0.4789	8.75	23.6	10.1
Minimum			4970	0.3578	8.28	12.83	6.79
SD			944	0.04	0.19	3.95	1.13

[a] Daily mean flow at C.J. Strike gauge
[b] Daily mean flow at Murphy gauge

Table 3
Individual drains nutrient data and combined drains statistical summary for entire sample period (May–October).

				Nitrogen			Organic Carbon		Phosphorus		Suspended Solids	
Measure Date	**River Mile***	**River**	**Flow (cfs)**	**Ammonia[a]**	**Nitrate[b]**	**Kjeldahl[c]**	**Total**	**Dissolved**	**Ortho**	**Total**	**Total**	**Volatile**
7/31/2007	461.20	Drain	0.5	0.08	0.05	0.64	4.14	3.67	0.028	0.166	138	23
10/8/2007	461.20	Drain	0.3	0.005	1.12	0.73	3.15	2.63	0.03	0.059	9	3
5/14/2007	462.00	Sinker Creek	0.1	0.04	0.05	0.5	3.23	3.05	0.088	0.125	4	2
6/19/2007	462.00	Sinker Creek	0.0	0.005	0.05	0.41	3.95	3.89	0.102	0.177	11	9
5/14/2007	468.70	Drain	not collected	0.01	0.67	0.58	3.29	2.15	0.007	0.043	5	2
5/14/2007	470.80	Castle Creek	1.3	0.01	0.05	0.44	5.89	4.94	0.058	0.125	6	4
6/19/2007	470.80	Castle Creek	1.7	0.005	0.05	0.41	6.27	5.8	0.068	0.118	6	4
7/31/2007	470.80	Castle Creek	0.4	0.05	0.05	0.9	6.7	5.9	0.02	0.19	133	15
8/29/2007	470.80	Castle Creek	0.2	0.01	0.4	0.82	6.73	6.15	0.013	0.052	13	4
10/8/2007	470.80	Castle Creek	1.3	0.005	0.05	0.88	7.09	6.67	0.054	0.066	2	2
5/14/2007	476.30	Grand View Canal	6.2	0.1	0.66	0.73	3.54	2.32	0.006	0.072	18	6
6/19/2007	476.30	Grand View Canal	16.4	0.005	0.38	0.33	3.6	2.58	0.01	0.11	67	14
7/31/2007	476.30	Grand View Canal	4.1	0.05	0.45	0.35	2.61	2.49	0.023	0.056	5	2
8/29/2007	476.30	Grand View Canal	7.6	0.02	0.73	0.23	2.87	2.42	0.032	0.061	6	2
10/8/2007	476.30	Grand View Canal	30.7	0.005	1.03	0.43	2.8	2.31	0.011	0.037	6	4
5/14/2007	476.80	Drain	1.4	0.04	1.66	0.92	3.68	2.37	0.012	0.386	280	31
6/19/2007	476.80	Drain	0.5	0.005	5.82	0.24	3.75	3.5	0.048	0.094	4	1
10/8/2007	476.80	Drain	2.5	0.005	1.91	1	4.79	4.29	0.107	0.432	277	21
5/14/2007	477.00	Drain	1.7	0.005	4.91	0.16	3.61	2.9	0.042	0.093	25	11
6/19/2007	477.00	Drain	1.3	0.24	2.81	0.96	6.4	2.96	0.156	1.34	6510	410
7/31/2007	477.00	Drain	0.2	0.09	1.88	1.49	3.82	2.85	0.075	2.24	1590	98
8/29/2007	477.00	Drain	1.4	0.005	2.96	1.48	5.62	3.32	0.095	1.21	2312	124
10/8/2007	477.00	Drain	0.3	0.005	1.71	0.25	2.99	2.84	0.056	0.097	29	4
5/14/2007	477.50	Drain	1.4	0.12	1.08	3.46	6.18	3.72	0.176	2.65	1770	138
6/19/2007	477.50	Drain	1.4	0.32	0.66	0.93	6.41	3.03	0.06	1.28	16800	1290
7/31/2007	477.50	Drain	5.0	0.1	0.81	2.19	4.78	2.51	0.067	6.7	8890	390
8/29/2007	477.50	Drain	2.1	0.005	0.56	0.72	4.9	4.67	0.039	0.136	142	11
5/14/2007	477.60	Drain	1.3	0.14	0.84	2.17	5.09	2.54	0.165	1.78	922	138

				Nitrogen			Organic Carbon		Phosphorus		Suspended Solids	
Measure Date	River Mile*	River	Flow (cfs)	Ammonia[a]	Nitrate[b]	Kjeldahl[c]	Total	Dissolved	Ortho	Total	Total	Volatile
6/19/2007	477.60	Drain	1.5	0.04	0.54	0.51	4.78	3.09	0.035	0.86	3890	230
7/31/2007	477.60	Drain	1.4	0.08	0.66	0.77	3.13	3.04	0.045	0.299	122	10
5/14/2007	477.70	Drain	0.5	0.1	0.84	2.57	4.93	2.48	0.055	1.68	1160	68
5/14/2007	478.00	Drain	2.0	0.1	0.87	1.73	3.67	2.15	0.02	0.78	556	106
6/19/2007	478.00	Drain	2.4	0.005	0.43	0.47	3.51	2.49	0.008	0.112	59	9
8/29/2007	478.00	Drain	1.4	0.03	1.8	0.59	4.22	3.93	0.067	0.182	57	7
6/19/2007	478.10	Drain	7.6	0.14	0.84	0.75	3.98	3.39	0.05	1.35	874	61
8/29/2007	478.10	Drain	5.2	0.03	1.37	0.74	5.13	4.85	0.104	0.177	38	4
5/14/2007	478.60	Drain	not collected	0.13	0.81	1.29	3.43	2.19	0.009	0.077	40	12
5/17/2007	478.90	Birch Creek	15.4	0.23	1.1	1.5	3.48	2.75	0.01	0.28	217	18
6/19/2007	478.90	Birch Creek	15.3	0.1	1.02	0.56	4.04	2.78	0.05	4.15	2720	155
7/31/2007	478.90	Birch Creek	18.8	0.1	1.21	1.39	2.96	2.35	0.032	1.14	742	56
8/29/2007	478.90	Birch Creek	16.2	0.12	1.67	0.67	2.99	2.47	0.049	0.52	531	38
10/8/2007	478.90	Birch Creek	32.3	0.005	1.47	0.26	2.51	2.18	0.018	0.044	10	3
5/17/2007	479.70	Drain	1.2	0.03	0.05	1.15	9.46	8.02	0.246	0.68	551	33
5/17/2007	479.70	Drain	1.2	0.03	0.66	4.75	6.66	2.67	0.037	6.25	4050	2120
5/17/2007	479.71	Drain	0.3	0.01	0.46	0.4	5.58	5.42	0.16	0.175	28	12
6/19/2007	479.90	Drain	1.7	0.005	0.44	0.4	3.69	2.66	0.025	3.05	2430	155
7/31/2007	479.90	Drain	1.1	0.08	0.96	2.57	3.69	2.52	0.046	2.5	2030	145
8/29/2007	479.90	Drain	4.5	0.1	1.04	1.48	3.85	2.88	0.062	0.65	1272	72
5/17/2007	480.10	Drain	0.4	0.04	0.94	0.99	7.25	6.19	0.284	0.5	65	12
5/17/2007	480.30	Drain	0.3	0.005	0.38	0.46	4.99	4.52	0.047	0.09	12	4
5/17/2007	481.10	Drain	16.8	0.04	0.89	1.01	4.88	3.74	0.043	0.224	69	12
6/19/2007	481.10	Drain	14.5	0.005	2.68	0.35	3.5	3.14	0.025	0.119	13	4
7/31/2007	481.10	Drain	2.7	0.03	8.61	0.52	4.26	3.76	0.037	0.091	71	4
8/29/2007	481.10	Drain	3.5	0.04	5.85	0.15	3.17	2.8	0.054	0.082	3	3
10/8/2007	481.10	Drain	34.5	0.06	1.77	0.67	3.53	3.17	0.038	0.072	10	9
5/17/2007	482.00	Drain	0.9	0.04	0.69	1.84	21.3	17.9	0.07	1.09	65	6
6/19/2007	482.00	Drain	1.2	0.02	0.4	1.43	18.8	17.7	0.53	0.68	31	10
7/31/2007	482.00	Drain	1.4	0.16	1.75	1.7	10	9.6	0.52	0.77	32	6
8/29/2007	482.00	Drain	0.8	0.09	2.13	1.66	16.3	11.9	0.57	0.61	3	4

Measure Date	River Mile*	River	Flow (cfs)	Nitrogen			Organic Carbon		Phosphorus		Suspended Solids	
				Ammonia[a]	Nitrate[b]	Kjeldahl[c]	Total	Dissolved	Ortho	Total	Total	Volatile
5/17/2007	483.90	Drain	1.8	0.005	4.66	0.35	3.34	3.31	0.029	0.071	4	1
5/17/2007	484.60	Drain	5.0	0.06	3.22	1.23	6.7	6.02	0.472	0.64	93	12
6/20/2007	484.60	Drain	3.0	0.08	1.38	0.86	8.16	7.16	0.59	0.66	27	9
7/31/2007	484.60	Drain	2.3	0.07	0.87	0.71	4.63	3.61	0.416	0.54	7	2
8/29/2007	484.60	Drain	5.7	0.05	0.54	0.62	7.97	5.6	0.65	0.67	5	4
10/9/2007	484.60	Drain	7.5	0.03	1.97	0.84	4.93	4.82	0.388	1.06	51	10
5/17/2007	485.70	Drain	2.9	0.005	6.54	0.05	3.28	3.01	0.064	0.08	5	2
8/29/2007	485.70	Drain	6.8	0.03	2.71	0.24	4.07	3.01	0.074	0.091	16	3
5/17/2007	485.80	Drain	3.7	0.06	1.69	0.79	6.3	5.42	0.063	0.101	8	3
6/20/2007	485.80	Drain	0.3	0.33	0.17	1.15	6.9	5.67	0.01	0.126	25	10
7/31/2007	485.80	Drain	9.2	0.13	2.68	1.07	6.04	4.17	0.059	0.15	11	5
8/29/2007	485.80	Drain	13.3	0.16	3.54	0.7	5.28	4.01	0.094	0.134	7	2
10/9/2007	485.80	Drain	8.2	0.04	3.81	0.64	5.32	4.72	0.088	0.156	7	5
5/17/2007	486.20	Drain	3.9	0.005	2.3	2.15	19.4	17.4	0.62	0.84	52	10
6/20/2007	486.20	Drain	6.6	0.05	2.47	0.87	7.8	7.13	0.166	0.256	22	8
7/31/2007	486.20	Drain	1.3	0.06	3.64	1.22	11.8	11.2	0.323	0.423	2	1
8/29/2007	486.20	Drain	not collected	0.05	5.11	0.8	7.34	5.74	0.171	0.215	12	2
10/9/2007	486.20	Drain	not collected	0.02	4.07	0.77	6.62	6.41	0.243	0.3	3	3
5/17/2007	486.40	Drain	2.8	0.005	3.61	0.83	6.87	6.69	0.189	0.226	12	3
6/20/2007	486.40	Drain	2.0	0.05	3.99	0.76	6.24	5.49	0.169	0.202	12	10
7/31/2007	486.40	Drain	2.1	0.09	5.87	1.3	6.21	4.41	0.19	0.325	44	9
5/17/2007	486.50	Drain	2.4	0.005	3.93	0.34	3.37	3.33	0.061	0.075	6	3
6/20/2007	487.10	Drain	0.9	0.74	1.54	1.44	6.63	5.53	0.56	2.38	842	118
8/1/2007	487.10	Drain	0.7	0.15	2.87	1.24	7.55	7.16	0.318	0.467	20	4
8/30/2007	487.10	Drain	2.8	0.1	3.86	1.64	13.6	8.66	0.74	0.9	151	14
6/20/2007	487.50	Drain	1.2	1.86	0.8	2.93	8.13	6.67	0.72	3.23	940	124
8/30/2007	487.50	Drain	0.7	0.19	3.58	1.44	10.2	6.27	0.64	0.74	289	32
5/17/2007	487.70	Drain	1.7	0.005	3.89	3.93	9.1	6.85	0.013	0.3	52	30
6/20/2007	487.70	Drain	3.8	0.78	1.57	3	18.2	7.03	0.012	0.67	122	76
8/1/2007	487.70	Drain	3.9	0.16	1.32	8.5	18.7	8.9	0.02	1.05	65	57

Measure Date	River Mile*	River	Flow (cfs)	Nitrogen Ammonia[a]	Nitrogen Nitrate[b]	Nitrogen Kjeldahl[c]	Organic Carbon Total	Organic Carbon Dissolved	Phosphorus Ortho	Phosphorus Total	Suspended Solids Total	Suspended Solids Volatile
8/30/2007	487.70	Drain	3.8	2.41	0.05	4.53	21.2	6.4	0.017	0.34	81	62
10/9/2007	487.70	Drain	1.8	0.04	4.13	4.44	15.7	9.35	0.56	1.18	73	37
5/17/2007	489.60	Drain	12.7	0.005	0.92	0.4	3.87	2.78	0.013	0.072	64	13
6/20/2007	489.60	Drain	0.9	0.02	3.33	0.41	5.06	2.68	0.021	0.051	13	8
8/1/2007	489.60	Drain	1.6	0.05	5.8	0.29	3.32	2.81	0.049	0.091	26	4
8/30/2007	489.60	Drain	4.2	0.04	1.98	0.68	3.99	2.06	0.029	0.046	5	1
10/9/2007	489.60	Drain	13.1	0.01	1.86	0.34	2.71	1.96	0.039	0.068	19	6
5/17/2007	490.40	Shoofly Creek	13.0	0.005	5.05	0.47	4.5	4.02	0.045	0.14	84	25
6/20/2007	490.40	Shoofly Creek	10.7	0.05	3.37	0.58	5.89	4.3	0.043	0.19	82	15
8/1/2007	490.40	Shoofly Creek	10.4	0.05	3.32	0.7	4.65	4.04	0.082	0.212	88	7
8/30/2007	490.40	Shoofly Creek	16.3	0.03	3.61	0.48	4.31	3.25	0.068	0.178	97	10
10/9/2007	490.40	Shoofly Creek	16.2	0.005	4.99	0.68	4.75	4.36	0.076	0.108	15	5
Mean				0.114	2.023	1.149	6.259	4.759	0.140	0.683	646	68
Maximum				2.410	8.610	8.500	21.300	17.900	0.740	6.700	16800	2120
Minimum				0.005	0.050	0.050	2.510	1.960	0.006	0.037	2	1
SD				0.3	1.8	1.2	4.2	3.1	0.2	1.1	2073	250

* Location of inflow to river as described in Snake River miles

[a] Represents a detection limit correction of 1/2 the detection limit value for Ammonia for all values equal to .005

[b] Represents a detection limit correction of 1/2 the detection limit value for Nitrate for all values equal to .05

[c] Represents a detection limit correction of 1/2 the detection limit value for TKN for all values equal to .05

Table 4
Snake River nutrient data and statistical summary for entire sample period (May–October).

				Nitrogen			Organic Carbon		Phosphorus		Suspended Solids	
Measure Date	**River Mile**	**River Position**	**Flow[b] (cfs)**	**Ammonia[c]**	**Nitrate**	**Kjeldahl**	**Total**	**Dissolved**	**Ortho**	**Total**	**Total**	**Volatile**
5/14/2007	457.7	RB	5712	0.01	0.7	0.52	3.22	2.03	0.005	0.051	16	9
6/19/2007	457.7	RB	5466	0.005	0.32	0.5	4.01	3.06	0.005	0.039	17	9
7/31/2007	457.7	RB	6097	0.09	0.6	0.81	4.27	3.59	0.024	0.068	7	4
8/29/2007	457.7	RB	5754	0.05	0.92	0.24	2.69	2.12	0.038	0.06	2	2
10/8/2007	457.7	RB	7230	0.02	1.23	0.44	2.59	2.23	0.025	0.079	10	6
Mean			6052	0.04	0.75	0.50	3.36	2.61	0.02	0.06	10.4	6
Maximum			7230	0.09	1.23	0.81	4.27	3.59	0.038	0.079	17	9
Minimum			5466	0.005	0.32	0.24	2.59	2.03	0.005	0.039	2	2
SD			696	0.04	0.34	0.20	0.76	0.69	0.01	0.02	6.27	3.08

				Nitrogen			Organic Carbon		Phosphorus		Suspended Solids	
Measure Date	**River Mile**	**River Position**	**Flow[a](cfs)**	**Ammonia[c]**	**Nitrate**	**Kjeldahl**	**Total**	**Dissolved**	**Ortho**	**Total**	**Total**	**Volatile**
5/14/2007	474.8	MC	5913	0.02	0.72	0.63	3.17	2.07	0.006	0.055	12	6
6/19/2007	474.8	MC	5184	0.09	0.51	0.85	5.68	5.14	0.005	0.066	20	7
7/31/2007	474.8	MC	6017	0.08	0.65	0.45	3	2.39	0.021	0.091	8	4
8/29/2007	474.8	MC	5595	0.01	0.84	0.35	3	1.52	0.029	0.056	5	4
10/8/2007	474.8	MC	7416	0.07	1.3	0.42	2.87	2.29	0.022	0.062	7	4
Mean			6025	0.05	0.80	0.54	3.54	2.68	0.02	0.07	10.4	5
Maximum			7416	0.09	1.3	0.85	5.68	5.14	0.029	0.091	20	7
Minimum			5184	0.01	0.51	0.35	2.87	1.52	0.005	0.055	5	4
SD			843	0.04	0.30	0.20	1.20	1.41	0.01	0.01	5.94	1.41

Measure Date	River Mile	River Position	Flow[a](cfs)	Nitrogen			Organic Carbon		Phosphorus		Suspended Solids	
				Ammonia[c]	Nitrate	Kjeldahl	Total	Dissolved	Ortho[d]	Total	Total	Volatile
5/17/2007	493.6	LB	5809	0.04	0.55	0.5	3.54	2.87	0.038	0.04	9	5
6/20/2007	493.6	LB	4970	0.15	0.44	0.71	5.01	2.88	0.0025	0.071	18	13
8/1/2007	493.6	LB	6164	0.13	0.56	0.8	3.43	2.42	0.022	0.083	7	4
8/1/2007	493.6	MC	6164	0.18	0.49	0.83	3.29	2.24	0.029	0.082	6	4
8/30/2007	493.6	MC	5619	0.06	0.67	0.54	3.13	1.79	0.011	0.042	9	5
10/9/2007	493.6	MC	7791	0.16	1.2	0.73	2.77	2.41	0.03	0.065	7	2
Mean			6086	0.12	0.65	0.69	3.53	2.44	0.02	0.06	9.33	5.5
Maximum			7791	0.18	1.2	0.83	5.01	2.88	0.038	0.083	18	13
Minimum			4970	0.04	0.44	0.5	2.77	1.79	0.0025	0.04	6	2
SD			944	0.06	0.28	0.14	0.77	0.41	0.01	0.02	4.41	3.83

[a] Daily mean flow at C.J. Strike gauge
[b] Daily mean flow at Murphy gauge
[c] Represents a detection limit correction of 1/2 the detection limit value for Ammonia for all values equal to .005
[d] Represents a detection limit correction of 1/2 the detection limit value for Orthophosphate for all values equal to .0025

Table 5
Snake River at C.J. Strike and combined drains daily nutrient loads, total load to reach, and percent of load contribution by sample event.

		Daily Load Reported in kg/Day								
		Nitrogen			Organic Carbon		Phosphorus		Suspended Solids	
Sample Event		Ammonia	Nitrate	Kjeldahl	Total	Total Dissolved	Ortho	Total	Total	Volatile
May	Cumulative Drains	16	528	265	1337	1083	22	95	46318	11152
	RM 493.6	569	7818	7107	50319	40795	540	569	127930	71072
	Total Load	584	8346	7372	51656	41879	562	664	174247	82224
	% Drains	3%	6%	4%	3%	3%	4%	14%	27%	14%
	% Snake River-C.J. Strike	97%	94%	96%	97%	97%	96%	86%	73%	86%
June	Cumulative Drains	26	375	160	1269	932	19	253	233400	16981
	RM 493.6	1824	5350	8634	60922	35021	30	863	218881	158081
	Total Load	1850	5726	8793	62191	35953	50	1116	452282	175062
	% Drains	1%	7%	2%	2%	3%	39%	23%	52%	10%
	% Snake River-C.J. Strike	99%	93%	98%	98%	97%	61%	77%	48%	90%
July	Cumulative Drains	15	371	255	869	632	14	174	154657	8864
	RM 493.6	2715	7390	12518	49620	33784	437	1237	90492	60328
	Total Load	2730	7761	12773	50489	34416	451	1410	245149	69191
	% Drains	1%	5%	2%	2%	2%	3%	12%	63%	13%
	% Snake River-C.J. Strike	99%	95%	98%	98%	98%	97%	88%	37%	87%
August	Cumulative Drains	39	546	189	1267	871	29	72	51082	4219
	RM 493.6	825	9212	7425	43036	24612	151	577	123747	68748
	Total Load	864	9758	7614	44303	25483	181	649	174829	72967
	% Drains	4%	6%	2%	3%	3%	16%	11%	29%	6%
	% Snake River-C.J. Strike	96%	94%	98%	97%	97%	84%	89%	71%	94%
October	Cumulative Drains	8	746	205	1306	1125	22	50	6444	2279
	RM 493.6	3050	22877	13917	52807	45944	572	1239	133448	38128
	Total Load	3058	23622	14122	54113	47070	594	1289	139891	40407
	% Drains	0%	3%	1%	2%	2%	4%	4%	5%	6%
	% Snake River-C.J. Strike	100%	97%	99%	98%	98%	96%	96%	95%	94%

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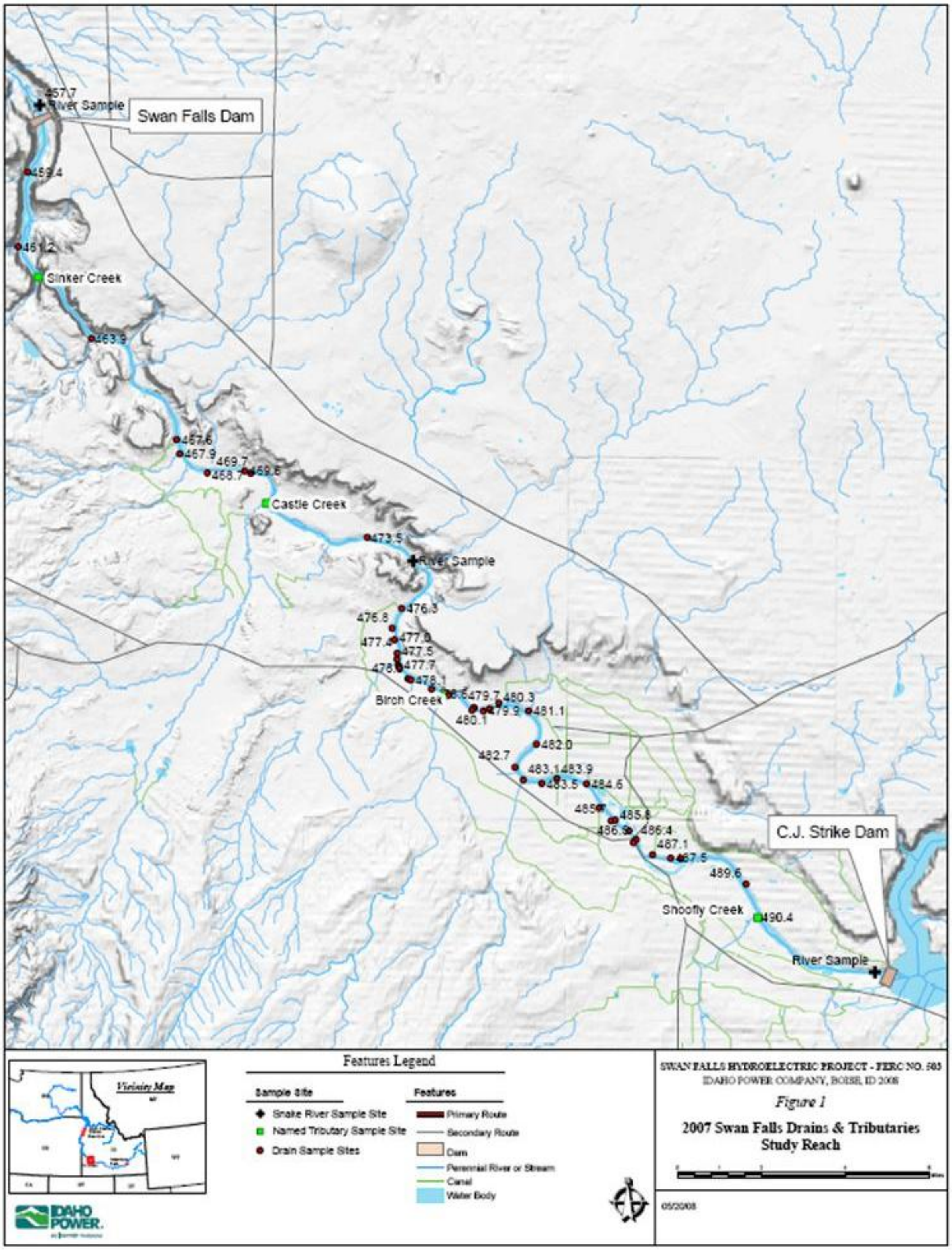

Figure 1
Map of study area, drain and Snake River sampling sites.

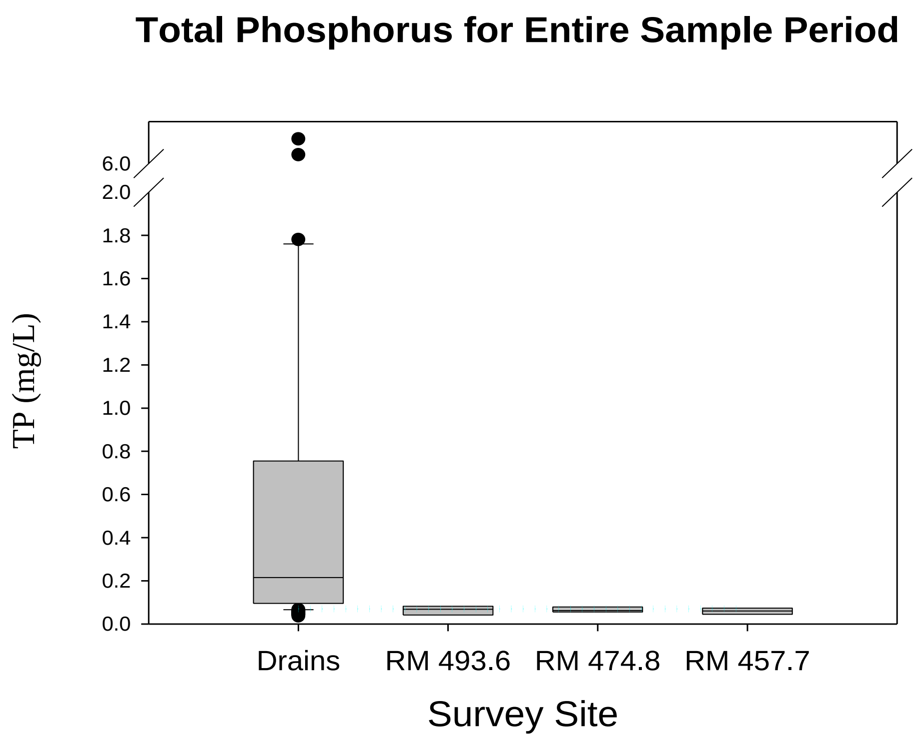

Figure 2
Total phosphorus concentration distributions for combined drains and individual Snake River sites for the entire sample period (May–October). The dotted line represents the 0.07 mg/L river TMDL target for total phosphorus. Data gapped between 2 and 6 mg/L for scaling purposes, with some data points falling within that range.

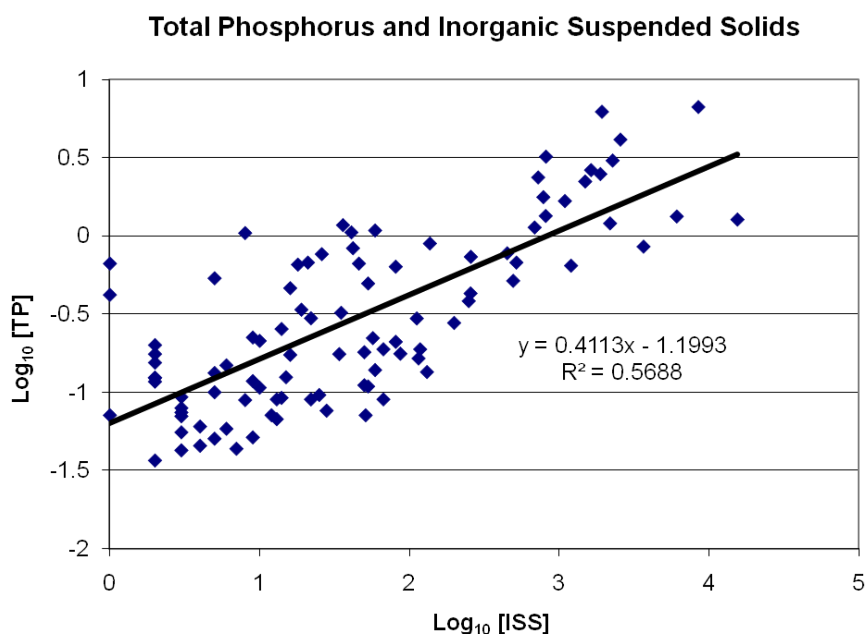

Figure 3
Log transformed regression plot of total phosphorus and inorganic suspended solids for combined drains for the entire sample period (May–October).

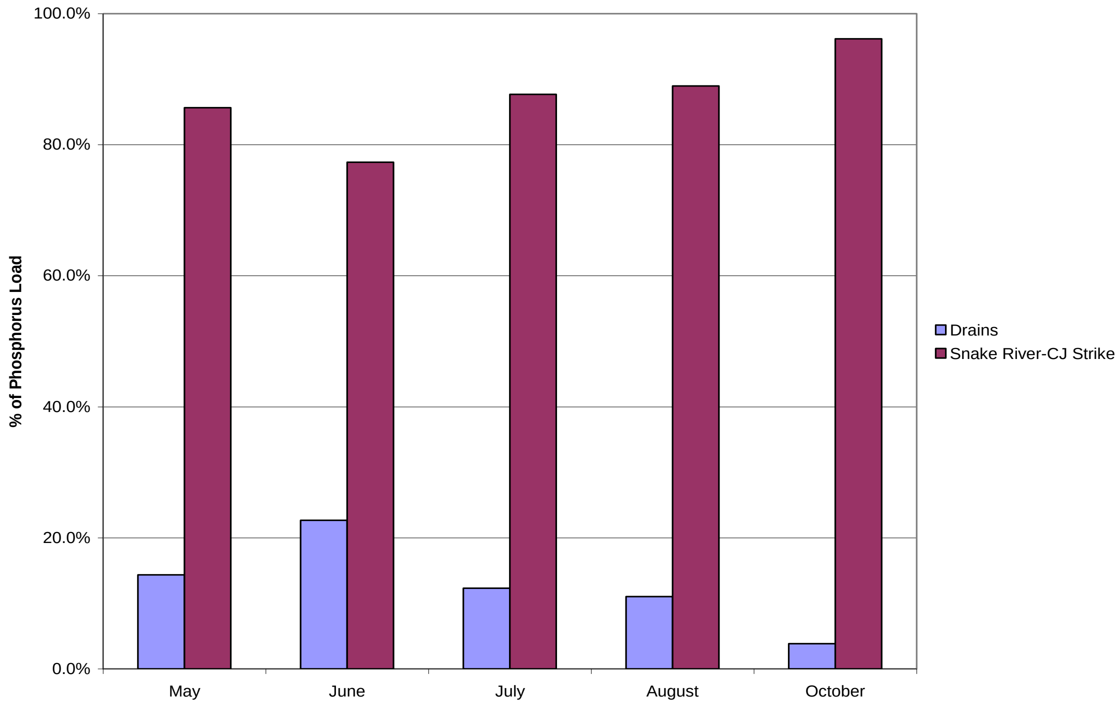

Figure 4
Percent contribution of total phosphorus load to reach for combined drains and Snake River site at river mile 493.6, by sample event.

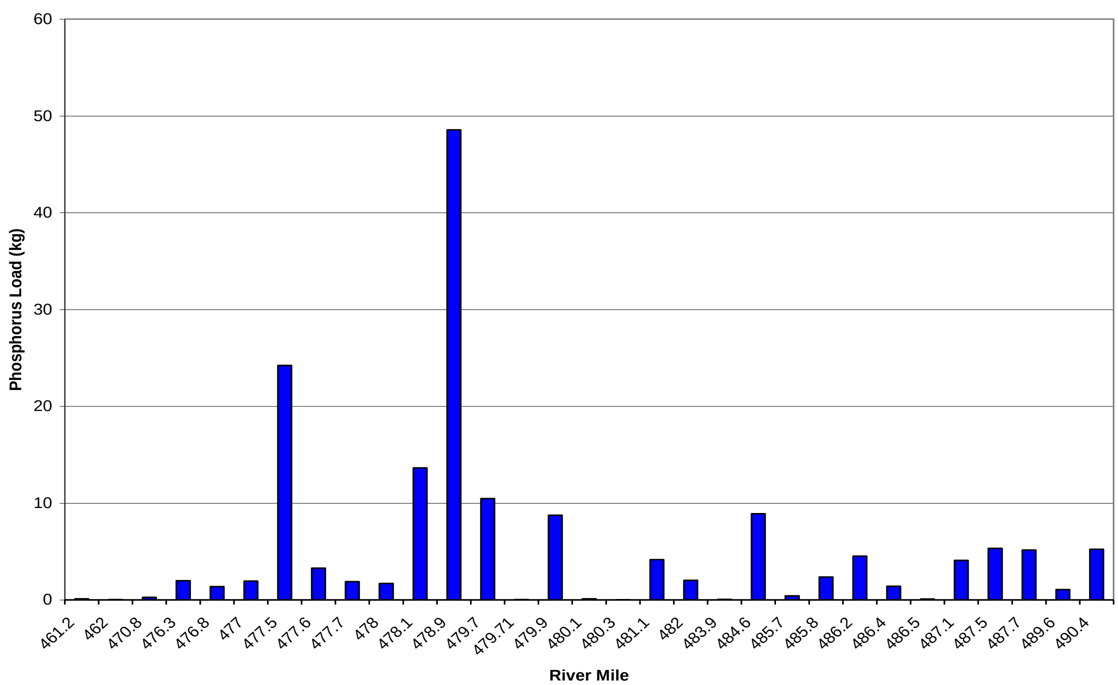

Figure 5
Individual drains average daily total phosphorus loads for entire sample period (May–October).

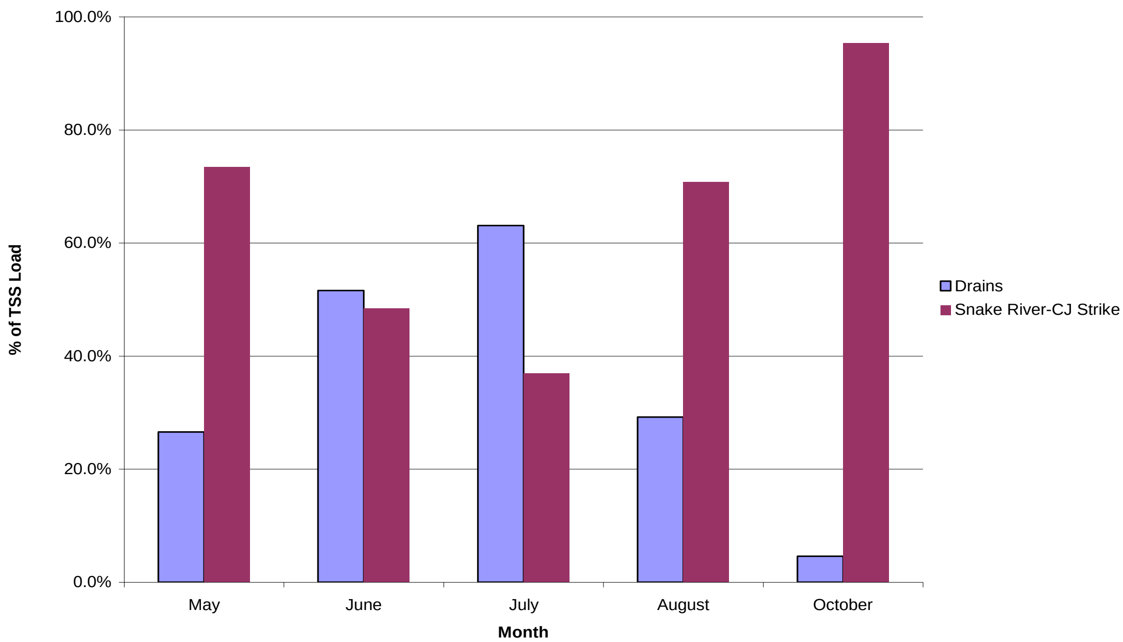

Figure 6
Percent contribution of total suspended solids load to reach for combined drains and Snake River site at river mile 493.6, by sample event.

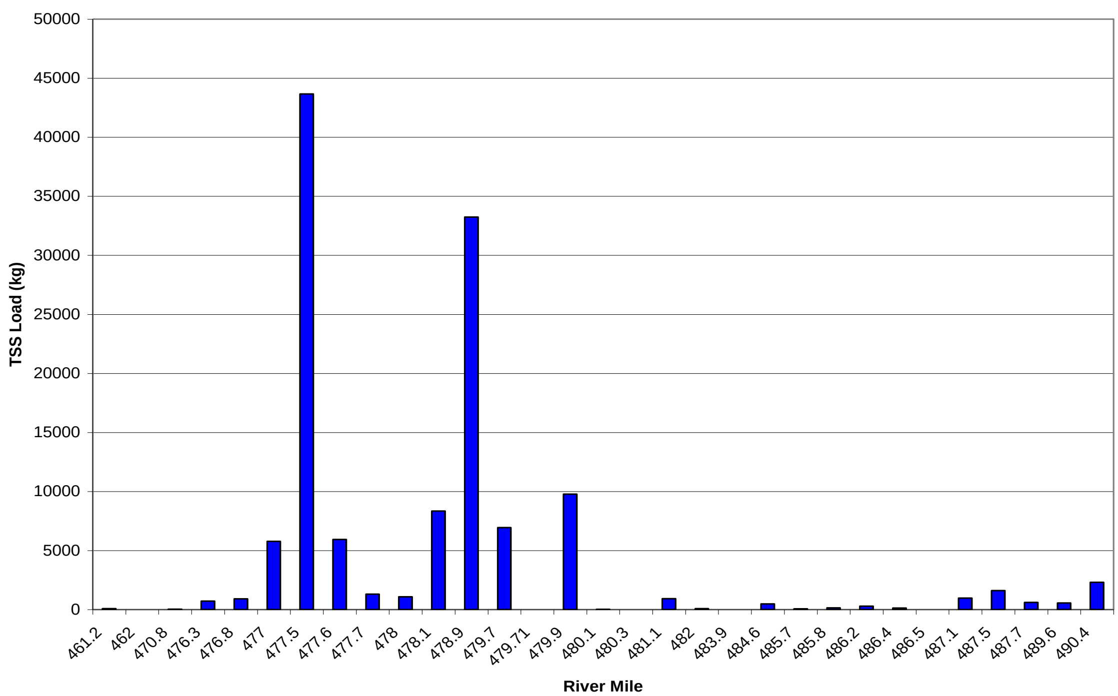

Figure 7
Individual drains average daily total suspended solids loads for entire sample period (May–October).

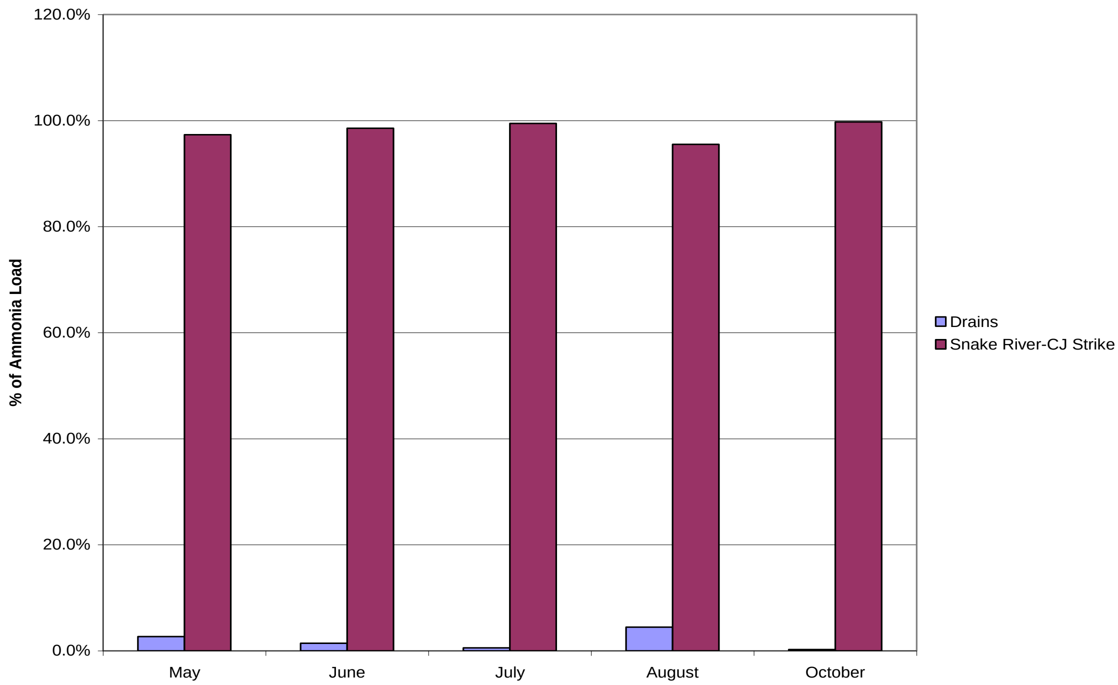

Figure 8
Percent contribution of ammonia load to reach for combined drains and Snake River site at river mile 493.6, by sample event.

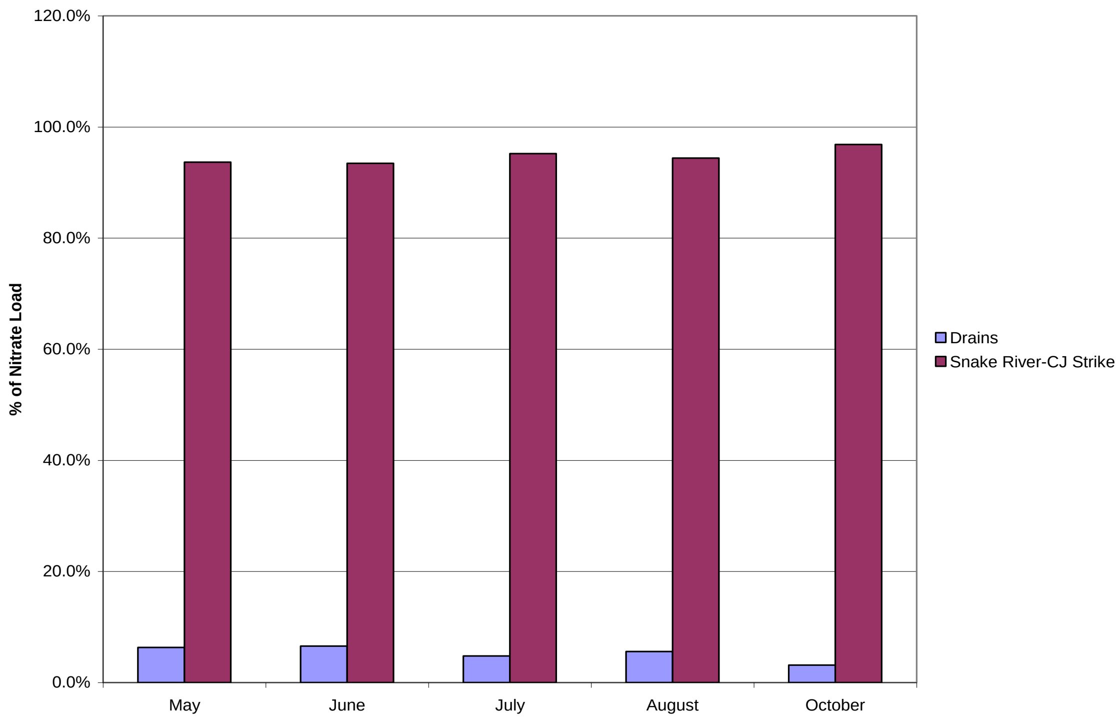

Figure 9
Percent contribution of nitrate load to reach for combined drains and Snake River site at river mile 493.6, by sample event.

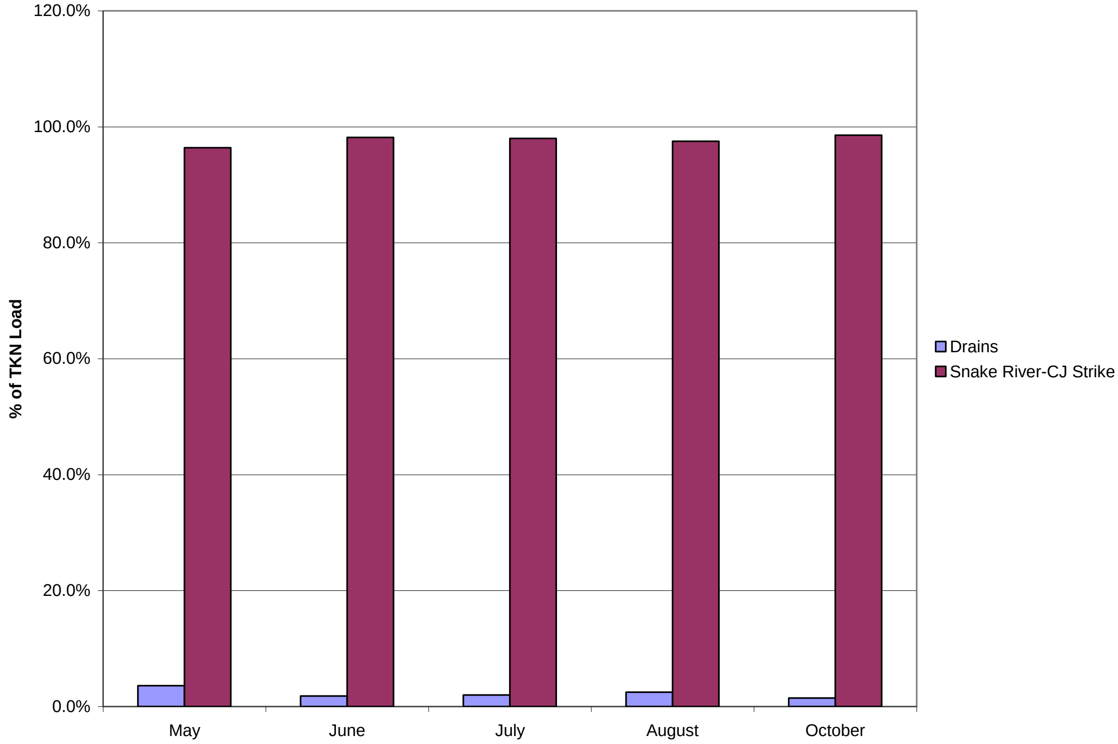

Figure 10
Percent contribution of total Kjeldahl nitrogen load to reach for combined drains and Snake River site at river mile 493.6, by sample event.

Appendix 1
Snake River and drain survey site location descriptions.

			NAD 83 Projection	
River Mile*	River Position	Site Description	UTM E	UTM N
457.70	RB	Snake River-Swan Falls Outflow	1406421.55	782717.99
459.40	LB	Drain	1404968.56	774248.44
461.20	LB	Drain	1403768.33	764880.25
462.00	LB	Sinker Creek	1406250.35	761122.40
463.90	LB	Drain	1413026.88	753368.17
468.70	LB	Drain	1427600.24	736508.67
469.60	LB	Drain	1432298.64	736732.24
470.80	LB	Castle Creek	1434970.49	732713.01
473.50	RB	Drain	1447757.10	728427.77
474.80	MC	Snake River-Swan Falls Inflow	1453442.60	725547.40
476.30	LB	Grandview Canal	1452087.92	719490.75
476.80	LB	Drain	1450891.11	717034.72
477.00	LB	Drain	1451187.06	715569.77
477.40	LB	Drain	1451519.52	713880.22
477.50	LB	Drain	1451481.51	713134.04
477.60	LB	Drain	1451626.09	712371.34
477.70	LB	Drain	1451790.76	712025.55
478.00	LB	Drain	1452885.55	710696.30
478.10	LB	Drain	1453225.45	710554.37
478.60	LB	Drain	1455827.20	709420.44
478.90	LB	Birch Creek	1457401.88	708689.16
479.00	LB	Drain	1457998.28	708614.64
479.70	LB	Drain	1460957.06	706724.21
479.70	RB	Drain	1461162.77	707043.97
479.71	RB	Drain	1461214.68	707035.27
479.90	LB	Drain	1462380.18	706617.07
480.10	LB	Drain	1463158.59	706916.08
480.30	RB	Drain	1464280.56	707669.18
481.10	RB	Drain	1468074.36	706637.06
482.00	RB	Drain	1469063.21	702497.95
482.70	LB	Drain	1466349.10	699571.83
483.10	LB	Drain	1467410.24	697984.61
483.90	LB	Drain	1471609.90	698160.36
484.60	RB	Drain	1475382.04	697529.27
485.30	LB	Drain	1476933.22	694504.14
485.70	LB	Drain	1478460.13	692870.14
485.80	RB	Drain	1478967.44	692964.26
486.20	RB	Drain	1480723.90	691603.88
486.40	RB	Drain	1481619.62	690500.69
486.50	LB	Drain	1481265.52	690145.27
487.10	RB	Drain	1483694.26	688635.82
487.50	RB	Drain	1485955.05	688184.22
487.70	RB	Drain	1487228.97	688125.43
489.60	RB	Drain	1495461.94	684927.10
490.40	LB	Shoofly Creek	1496902.67	680786.09
493.60	LB,MC	Snake River–C.J. Strike Outflow	1511642.56	673520.39

*Site location described in Snake River miles

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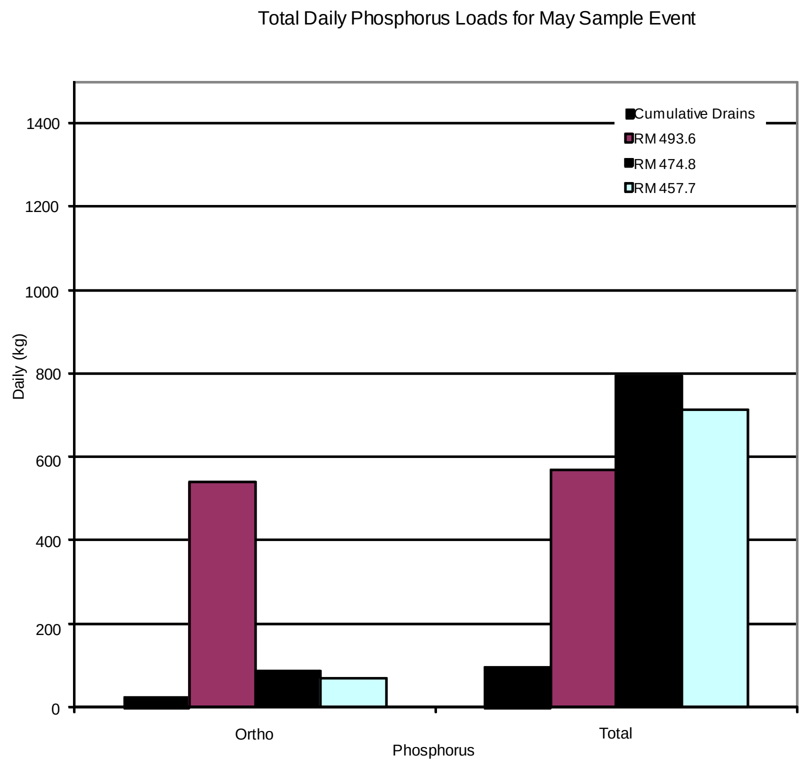
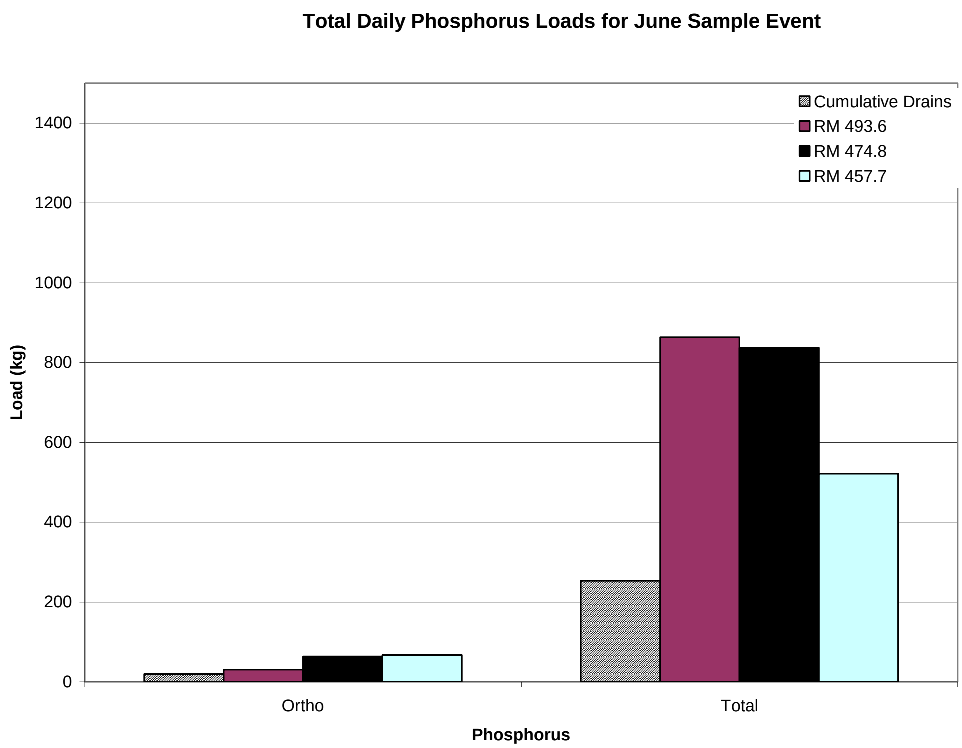
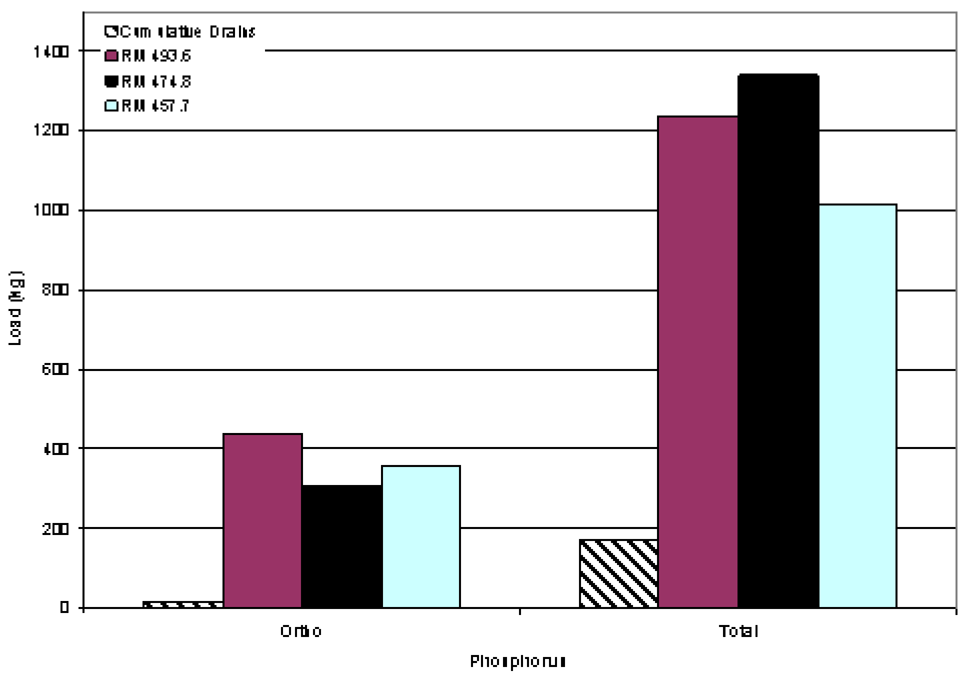
Appendix 2

Daily phosphorus, total suspended solids and nitrogen loads (kg) for combined drains and individual river sites by sample event.

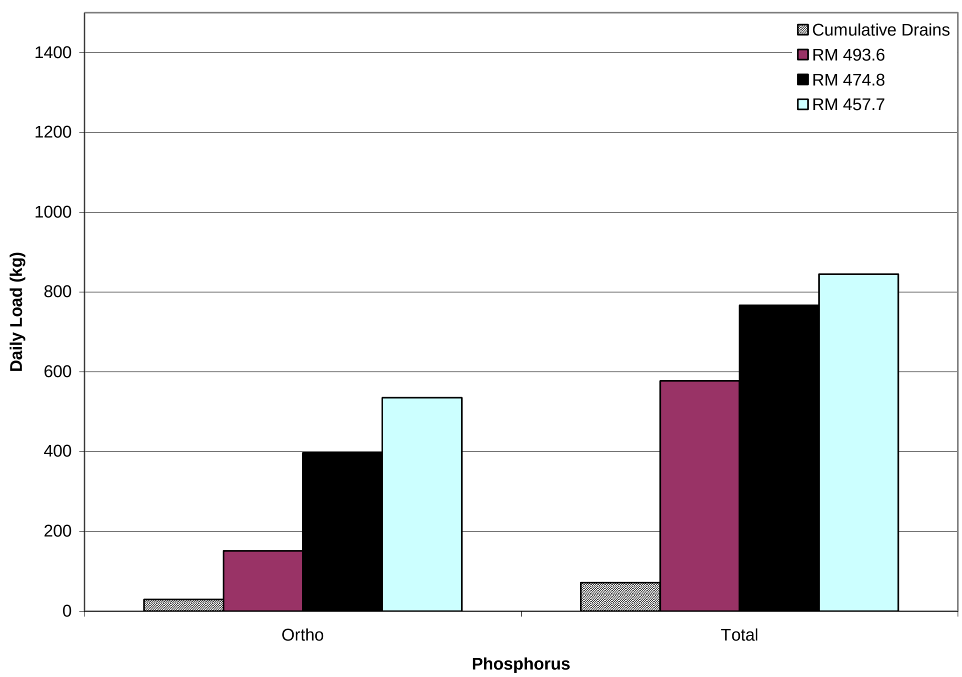


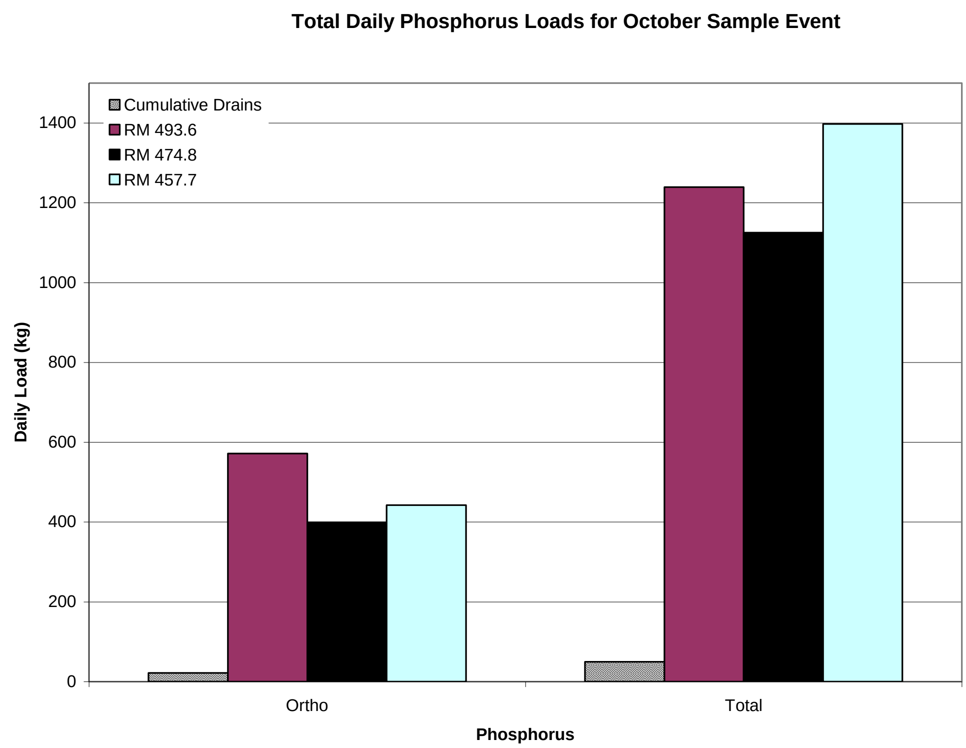


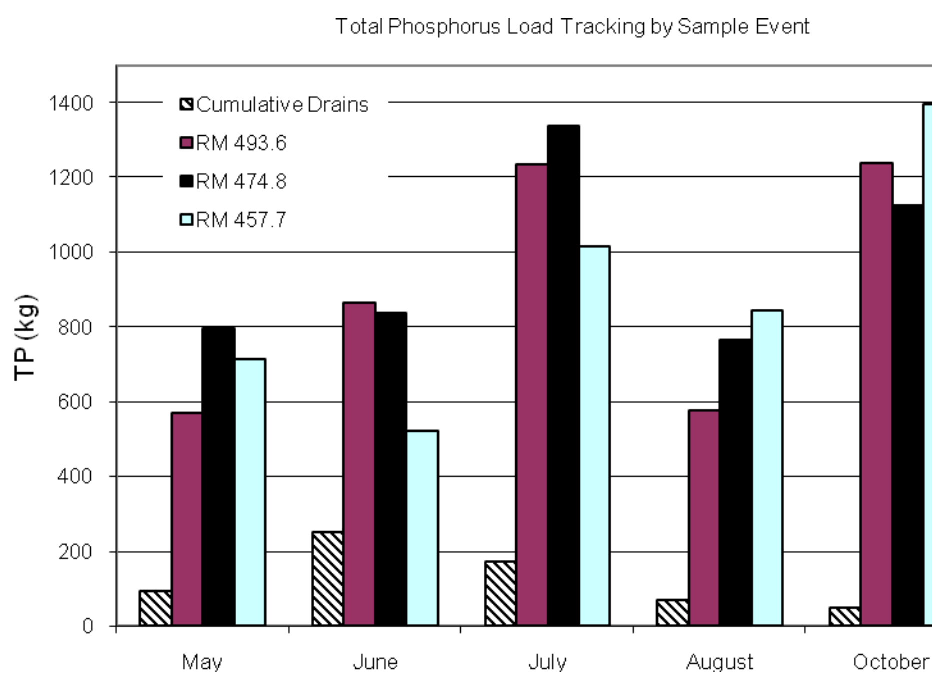
Total Daily Phosphorus Loads for July Sample Event



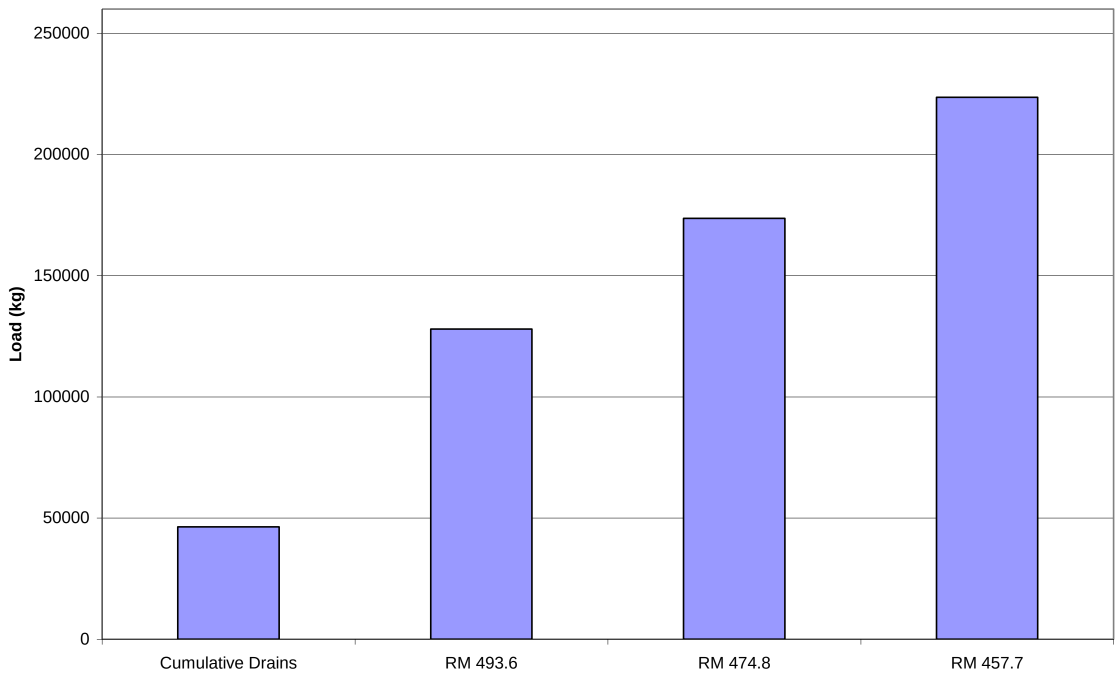
Total Daily Phosphorus Loads for August Sample Event



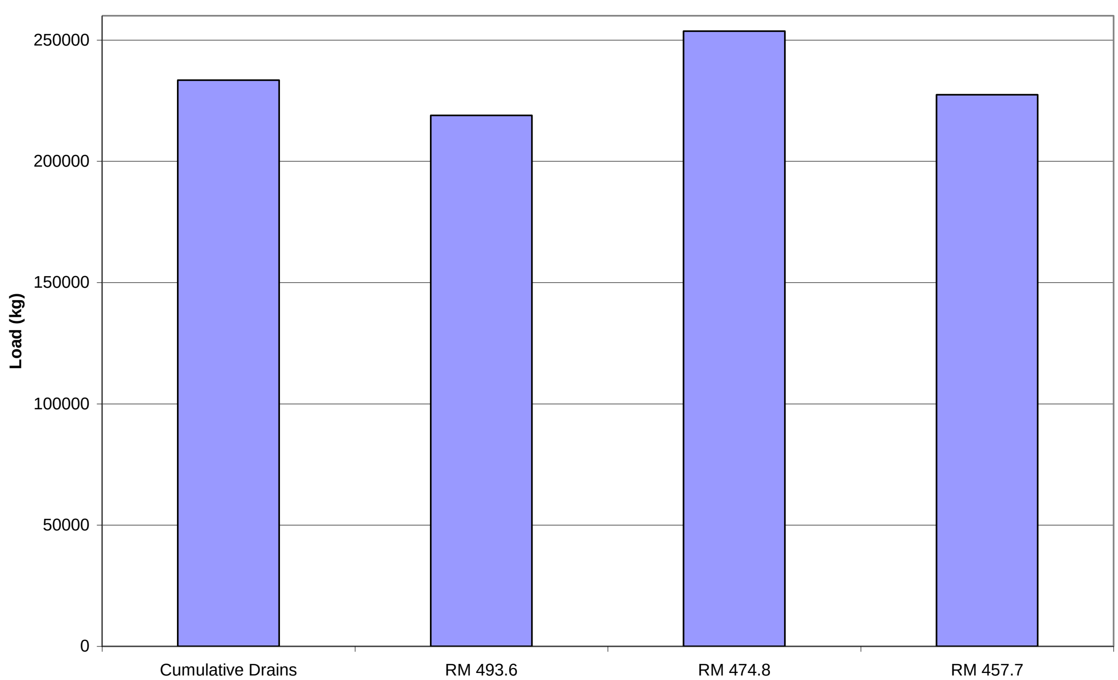

Total Daily Phosphorus Loads for October Sample Event
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7
Daily Load (kg)
0
200
400
600
800
1000
1200
1400
Ortho
Total
Phosphorus

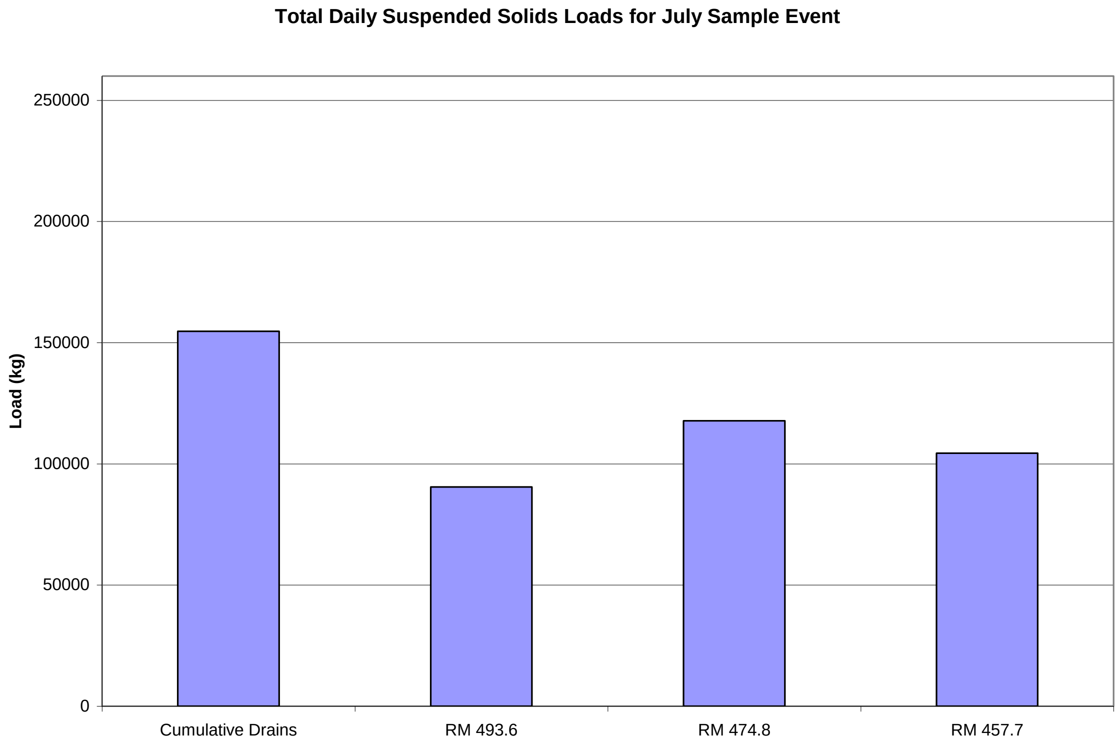

Total Phosphorus Load Tracking by Sample Event
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7
TP (kg)
0
200
400
600
800
1000
1200
1400
May
June
July
August
October

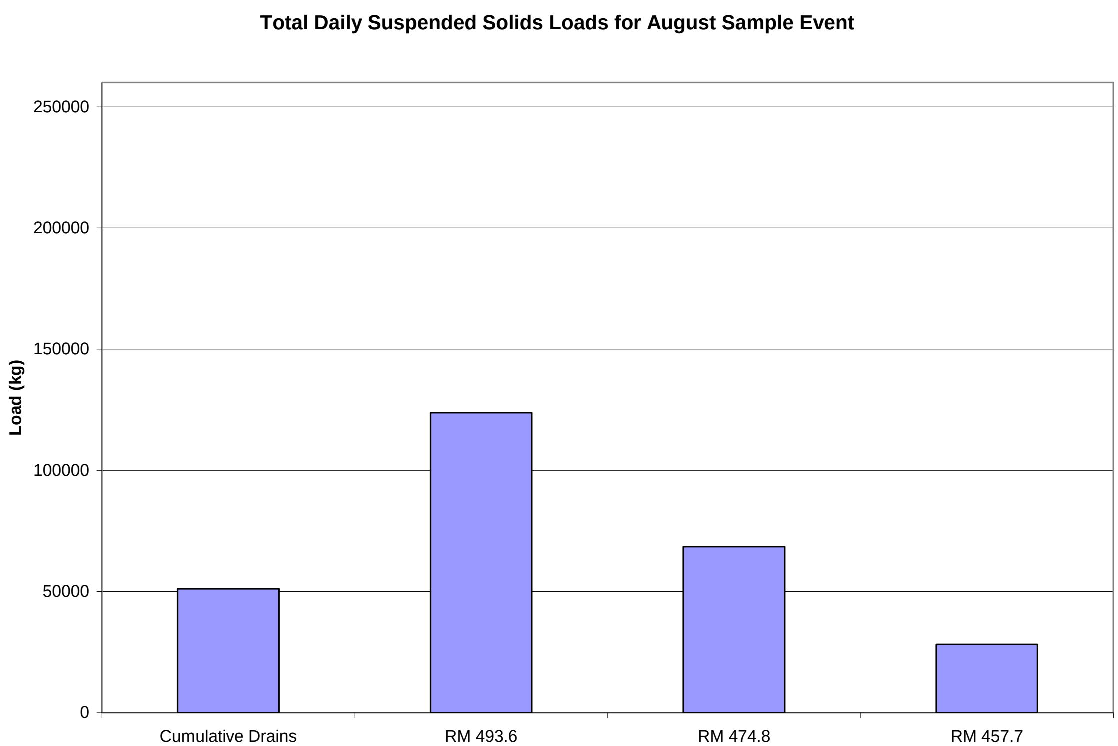
Total Daily Suspended Solids Loads for May Sample Event



Total Daily Suspended Solids Loads for June Sample Event




Total Daily Suspended Solids Loads for July Sample Event
Load (kg)
250000
200000
150000
100000
50000
0
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7


Total Daily Suspended Solids Loads for August Sample Event
Load (kg)
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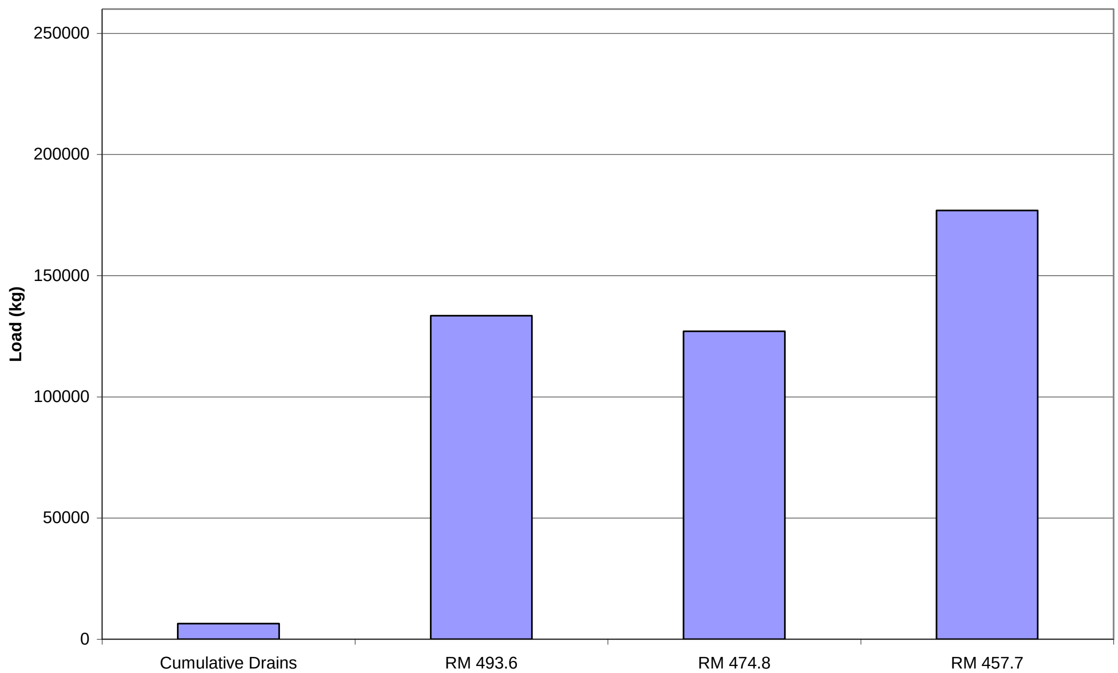
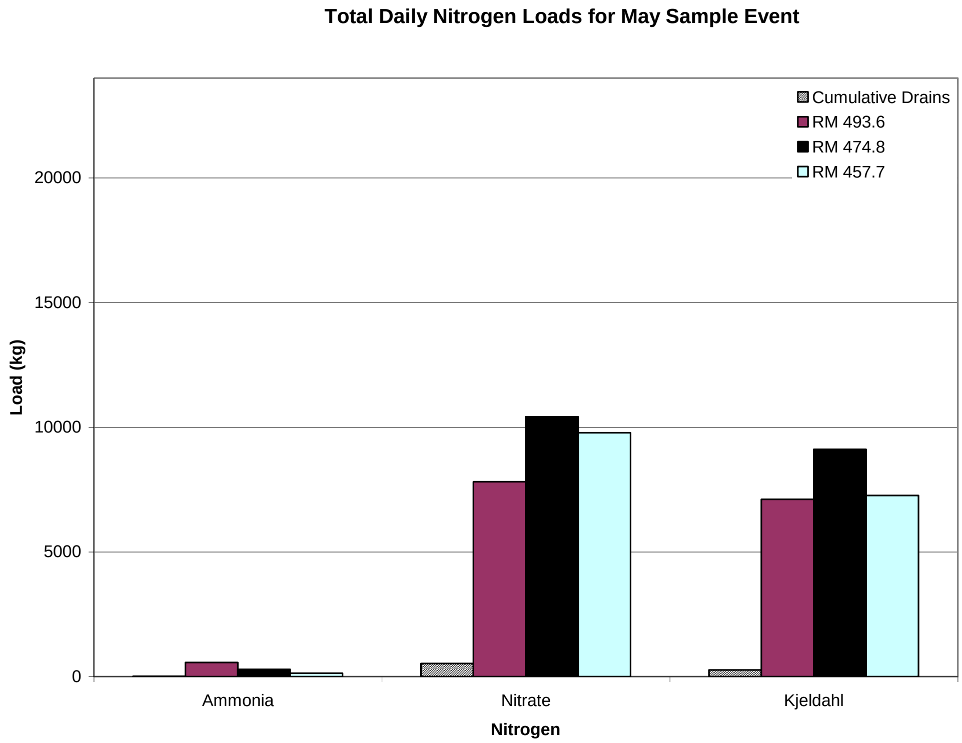
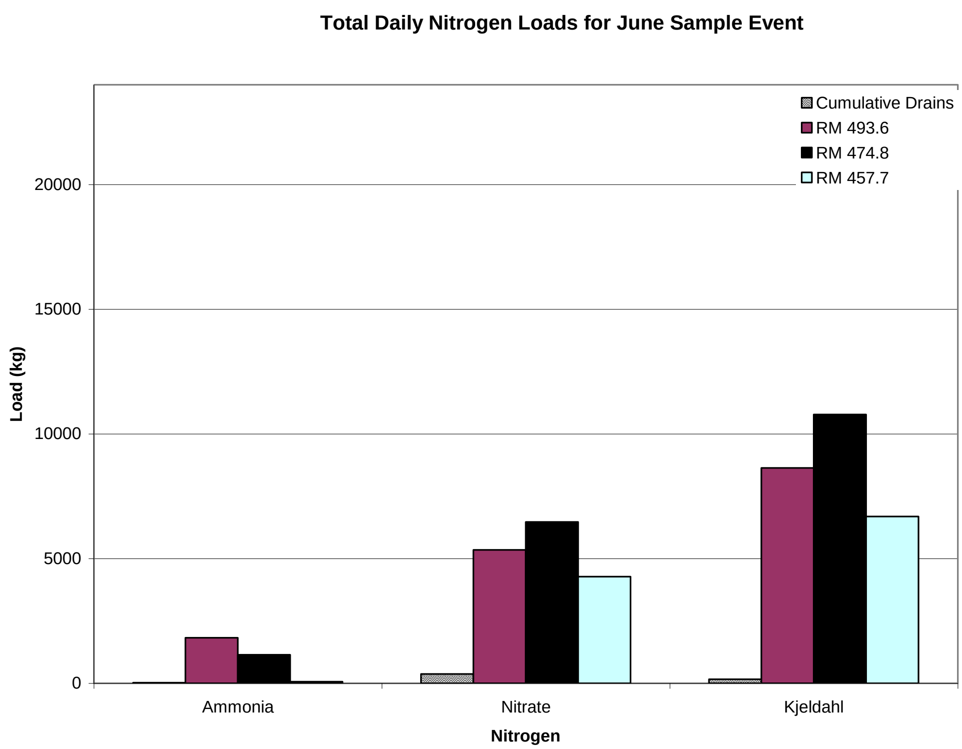
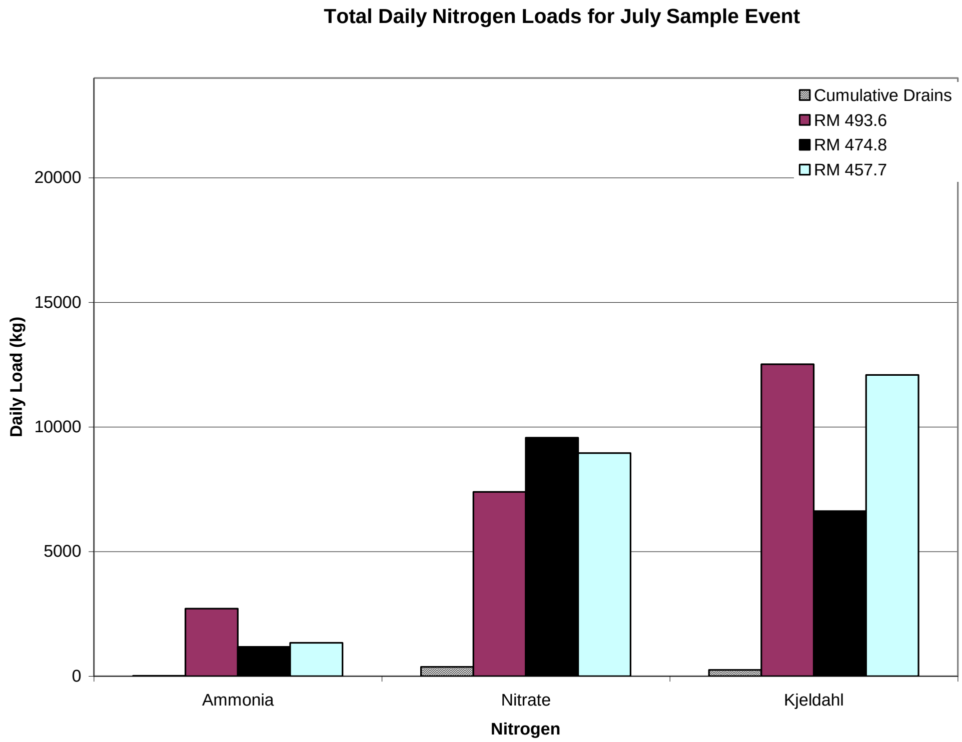
200000
150000
100000
50000
0
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7

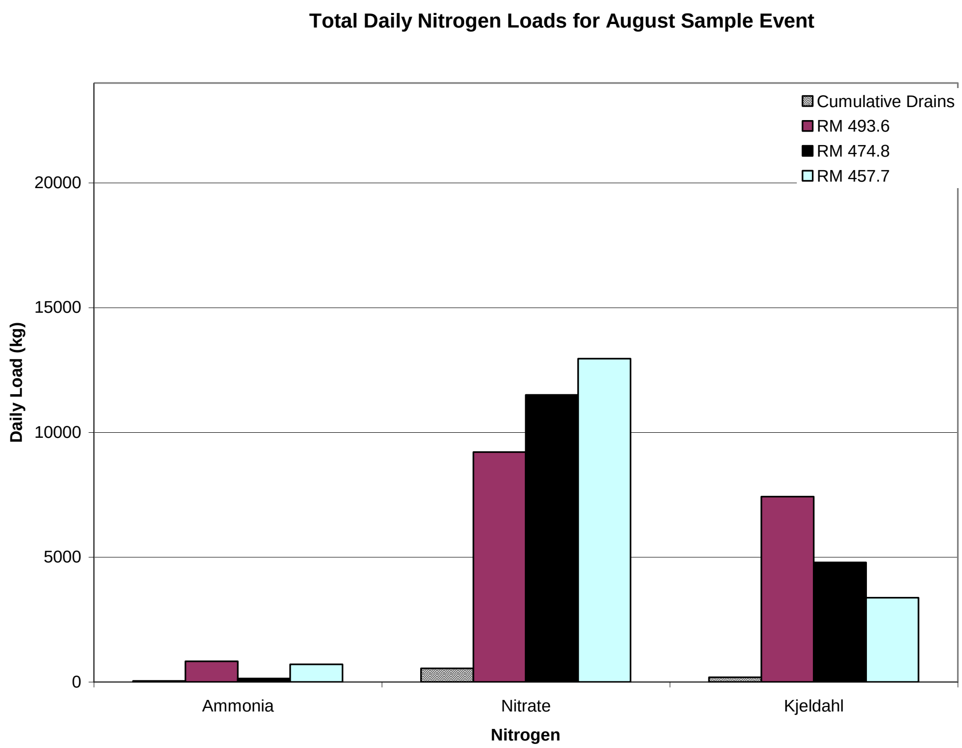
Total Daily Suspended Solids Loads for October Sample Event




Total Daily Nitrogen Loads for May Sample Event
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7
Load (kg)
20000
15000
10000
5000
0
Ammonia
Nitrate
Kjeldahl
Nitrogen


Total Daily Nitrogen Loads for June Sample Event
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7
Load (kg)
20000
15000
10000
5000
0
Ammonia
Nitrate
Kjeldahl
Nitrogen


Total Daily Nitrogen Loads for July Sample Event
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7
Daily Load (kg)
0
5000
10000
15000
20000
Ammonia
Nitrate
Kjeldahl
Nitrogen


Total Daily Nitrogen Loads for August Sample Event
Cumulative Drains
RM 493.6
RM 474.8
RM 457.7
Daily Load (kg)
0
5000
10000
15000
20000
Ammonia
Nitrate
Kjeldahl
Nitrogen

Total Daily Nitrogen Loads for October Sample Event