2015 Ashley Creek Nutrient and Discharge Sampling Results

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Prepared by:
Water Quality Planning Bureau, Watershed Management Section
Montana Department of Environmental Quality
Water Quality Planning Bureau
1520 E. Sixth Avenue
P.O. Box 200901
Helena, MT 59620-0901

Contributors:
Watershed Management Section
Paul Kusnierz

Water Quality Standards Section
Erik Makus
Eric Regensburger

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1.0 INTRODUCTION AND BACKGROUND INFORMATION

This project was implemented to support nutrient total maximum daily load (TMDL) and water quality model refinement in the Flathead-Stillwater TMDL Planning Area (TPA) of Montana. Nutrient TMDLs and associated source assessment modeling for the TPA were completed in 2014 with the TMDLs being approved by the U.S. Environmental Protection Agency in December 2014 (DEQ and EPA 2014). The focus of this project was to refine the model used for nutrient TMDL source assessment by collecting nutrient samples at multiple locations along upper and middle Ashley Creek and on several tributaries of Ashley Creek, and monitoring discharge at the Ashley Lake outlet.

Ashley Creek is located in Flathead County, Montana. It is in the *Flathead Lake* (*17010208)* 4th level Hydrologic Unit Code, and is located within the Northern Rockies Level III Ecoregion (**Figure 1-1**). The Ashley Creek watershed is 325 mi^2 (841 km^2) in size, and Ashley Creek is 43 miles (69 kilometers) in length. The stream is divided into three water quality assessment units. From Ashley Lake to Smith Lake is defined as Montana water quality assessment unit MT76O002_010 (upper Ashley Creek), from Smith Lake to the Kalispell Airport Road as MT76O002_020 (middle Ashley Creek), and from the Kalispell Airport Road to the mouth as MT76O002_030 (lower Ashley Creek). The nutrient listings on the 2014 303(d) list were total nitrogen for upper Ashley Creek and total nitrogen and total phosphorus for middle Ashley Creek. TMDLs for each of these pollutants were written in 2014 (DEQ and EPA 2014). Although TMDLs were written for total nitrogen and total phosphorus for lower Ashley Creek, the segment was not sampled for this project.

Existing water quality data for upper Ashley Creek show what appears to be a large nutrient load entering somewhere between Ashley Lake and just downstream of Smith Lake (see DEQ and EPA 2014). Within this area, there are very few existing data points. In addition, this area includes a large wetland complex, several smaller lakes, moderate agriculture use, septic systems, and three major tributaries. In the TMDL document (DEQ and EPA 2014), this unexplained load is referred to as the “wetland complex” load, and is theorized to be from the large wetland complex around Smith Lake and the unique soils present. This project involved gathering data to help refine the nutrient source assessment for the area between Ashley and Smith lakes. Nutrient samples were collected from Ashley Creek at the outlet of Ashley Lake; above and below Lone Lake, at the Highway 2 crossing, and above and below Smith Lake; samples were also collected from Idaho and Truman creeks (**Figure 1-2**). The nutrient and flow data collected will be used to gain insight into what mechanisms are at work within the area, ultimately refining the source assessment for Ashley Creek and improving restoration planning. The sampling methods used were consistent with those outlined in Montana Department of Environmental Quality (DEQ) protocols (DEQ 2005, 2012a) and the sampling and analysis plan developed for this project (DEQ 2015).

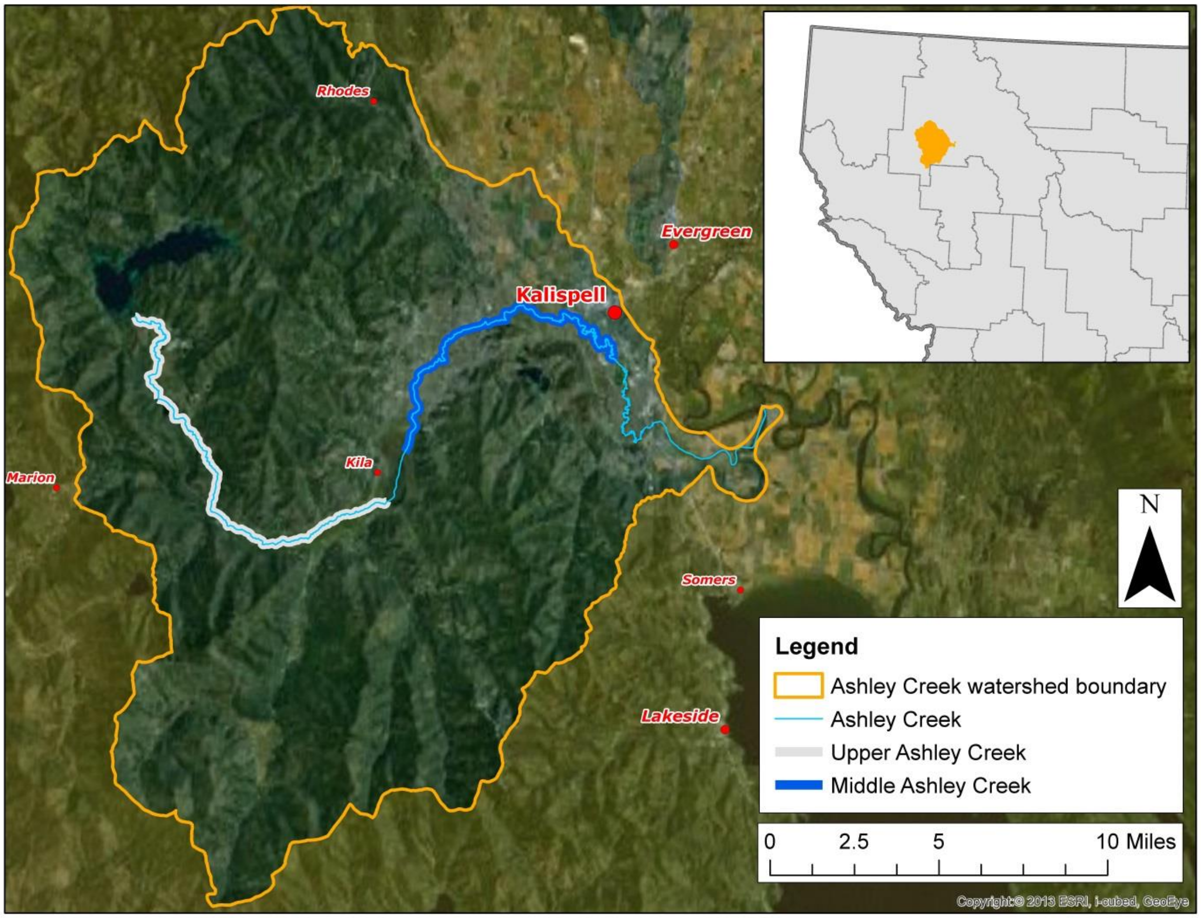

Figure 1-1. Location map of Ashley Creek

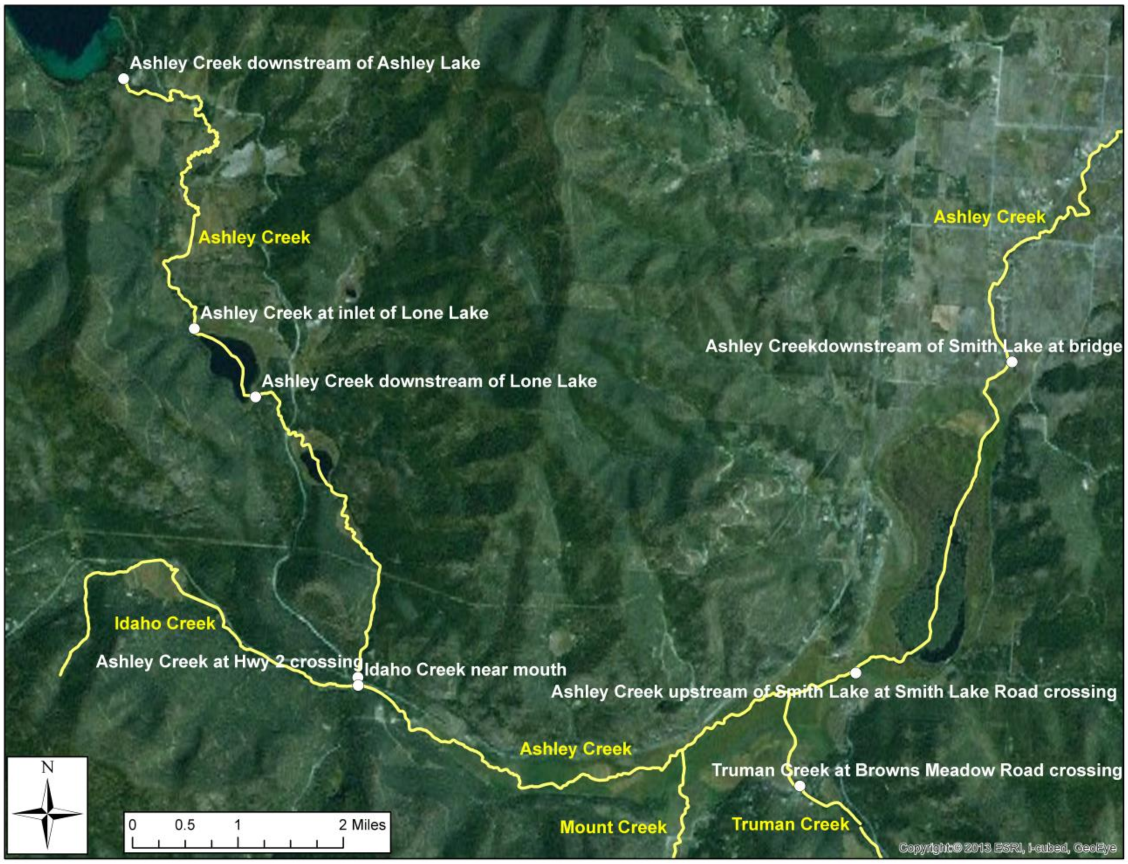

Figure 1-2. Location of 2015 sampling sites on Ashley Creek

2.0 PROJECT SAMPLING

Sampling for this project occurred between June 15 and November 13, 2015. On June 15th, flow was measured at the site just downstream of the Ashley Lake outlet. At this time a camera (**Figure 2-1**) was installed that took a photograph of the existing staff gage at the site every hour (**Figure 2-2**). Additional flow measurements were collected at the site on: 6/29, 7/16, 7/27, 8/10, 8/17, 8/27, 9/18, 9/22, 10/6, 10/30, and 11/13. The camera was removed on 11/13. A representative photograph from each day (typically 8:00 to 11:00 AM) was used to determine the stage used in discharge estimation. When peaks were observed during a day, the photographed peak gage height and photographed gage height from each side of the peak were included in the flow dataset.

Figure 2-1. Camera used to photograph the staff gage on Ashley Creek downstream of Ashley Lake

Figure 2-2. The staff gage on Ashley Creek downstream of Ashley Lake on August 17, 2015

Nutrient samples were collected from Ashley Creek and tributaries on 7/16, 8/17, and 9/22. During the July and September trips, all sites shown in **Figure 1-2** were sampled. During the trip on 8/17, the two sites adjacent to Lone Lake and the site on Idaho Creek were not sampled because access had not been procured. Although sampling was planned for Mount Creek, the creek was dry at the Browns Meadow Road crossing on all three visits and therefore nutrient samples were not collected. Idaho, Mount, and Truman creeks enter Ashley Creek between the Highway 2 crossing site and the site upstream of Smith Lake (**Figure 1-2**). During each trip, water samples were collected for total nitrogen, total phosphorus, nitrate + nitrite, ammonia, and total suspended solids analyses. In addition, discharge was measured at all sites except for the site on Ashley Creek upstream of Smith Lake. Measureable flow typically was not present there due to vegetation in the stream and stream depth prohibited the wading necessary to measure depth and velocity.

3.0 Results

3.1 Ashley Lake Outlet Discharge

The 12 stage and discharge measurements collected downstream of Ashley Lake in 2015 were used to develop a preliminary stage-discharge relationship (**Figure 3-1**). The 2015 relationship differs from the one developed in 1996-1997 by the Flathead Lake Biological Station (FLBS) at the same site (Ellis et al. 1998) (**Figure 3-2**). The key difference between these two stage-discharge relationships is that the data used to develop the 2015 relationship was calculated using discharge measured at stages between 0.24 and 0.81 feet whereas the 1996-1997 relationship was based on discharge measured at stages between 0.5 and 3 feet. The 2015 relationship is considered preliminary because it only covered the low end of the hydrograph for Ashley Creek. Additional sampling is planned in 2016 to capture a range of discharge values across the hydrograph. Another difference between the two relationships is that at similar stage values, discharge was greater in 2015. This could be the result of changes in the staff gage or changes in channel dimensions since the 1996-1997 measurements. Note that both of these relationships are erroneous at extremely low stage values. In the case of the FLBS relationship, the discharge decreases as stage increases until around a stage of 0.4 feet, where discharge begins to increase. With regard to the 2015 relationship, at stages less than about 0.2 feet, discharge is calculated to be negative. These errors are the result of the regression equations used to develop the stage-discharge relationships and the lack of data at extremely low flow (near 0 cfs).

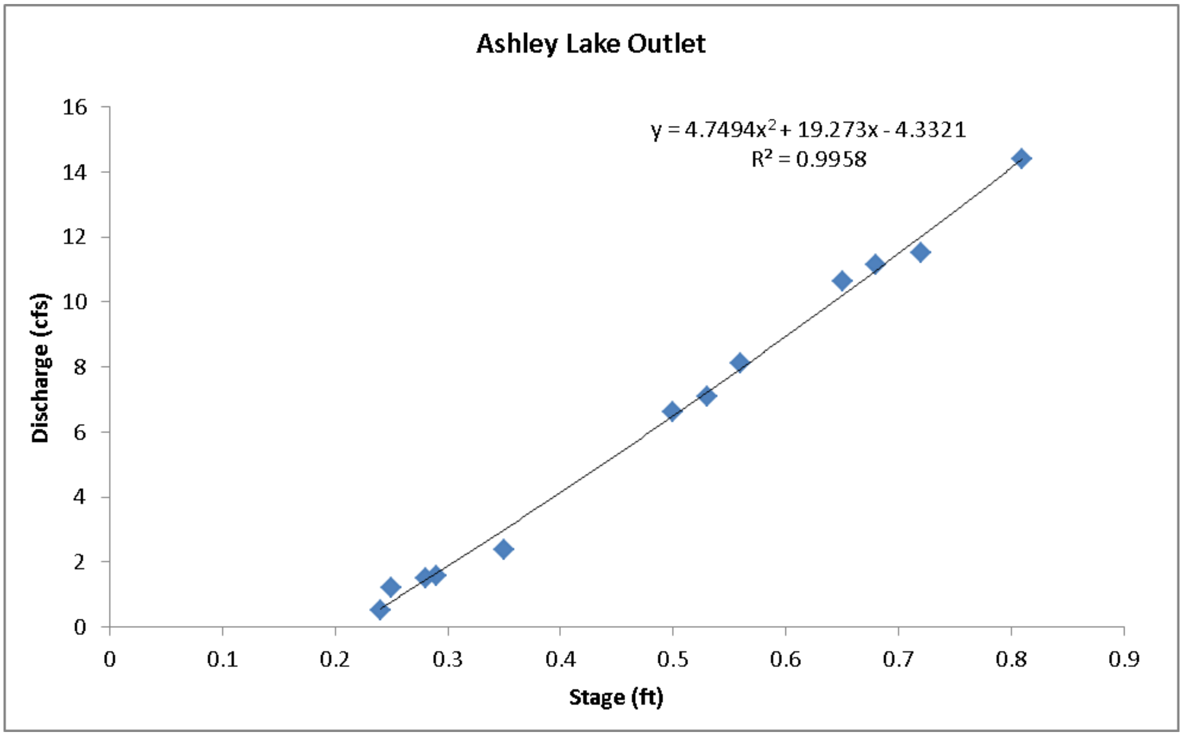

Figure 3-1. Stage-discharge relationship for Ashley Creek downstream of Ashley Lake

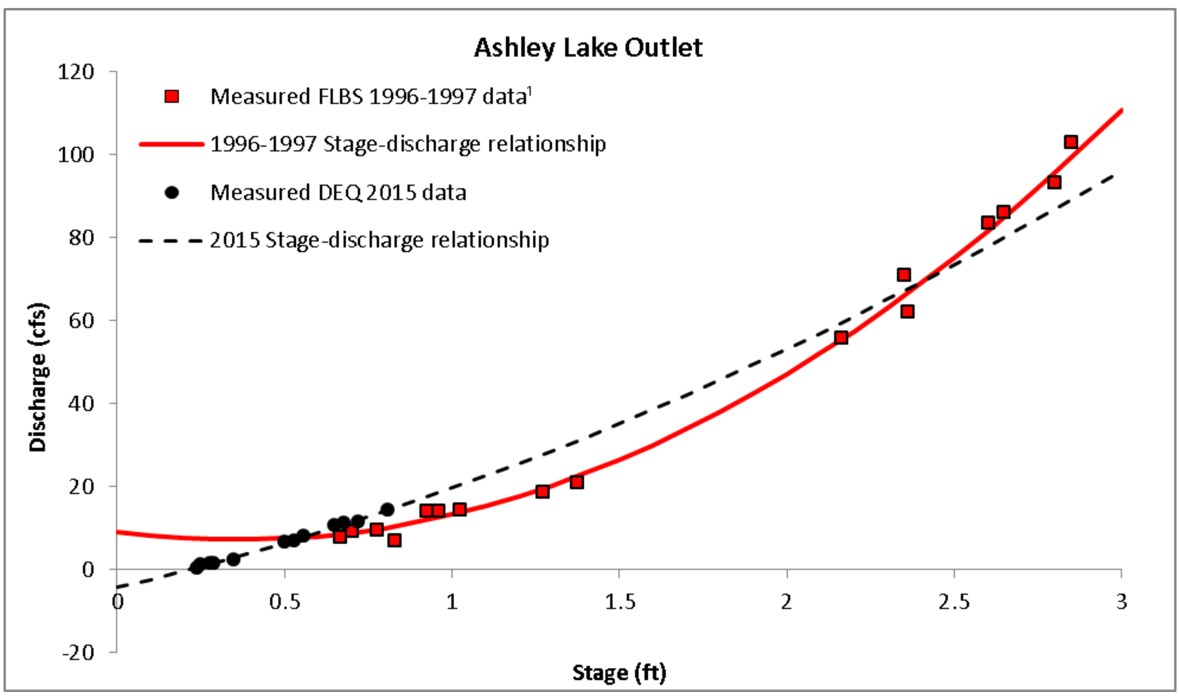

Figure 3-2. The 1996-1997 FLBS and 2015 stage-discharge relationships for Ashley Creek downstream of Ashley Lake

[1] Data points were estimated from Figure 5 in Ellis et al. (1998)

Figure 3-3 shows measured discharge and estimated discharge using the preliminary relationship shown in **Figures 3-1** and **3-2**. Overall, discharge decreased during the sampling period with small peaks occurring as a result of precipitation events. It is also possible that peaks resulted from temporary damming of the site by children. Two very brief and relatively high peaks occurred on September 3 and September 30. These peaks were associated with adjustments made to the Ashley Lake outlet structure by Montana Fish, Wildlife and Parks (**Figure 3-3**). When these peaks occurred, the outlet structure gates were raised and the discharge was increased to allow for debris to be removed from behind the structure before final adjustments were made. Additional adjustments (discharge reduced) to the outlet structure were made on 6/26 and 8/5, but the gates were not raised prior to establishing the final gate height and no peaks were associated with these changes.

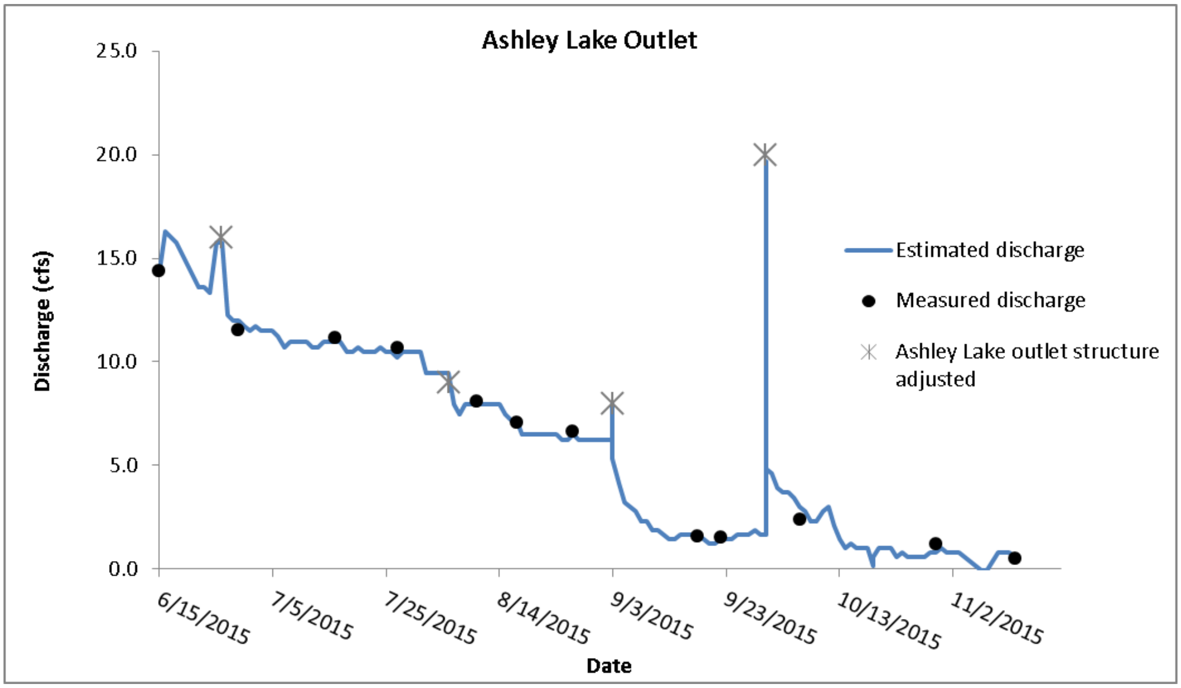

Figure 3-3. Estimated hydrograph and measured discharge for Ashley Creek downstream of Ashley Lake

3.2 Ashley, Idaho, and Truman Creeks Discharge

Figure 3-4 shows the discharge values measured at the time of nutrient sampling for Ashley, Idaho, and Truman creeks. Discharge in Ashley Creek increased from the outlet at Ashley Lake to the Highway 2 crossing in July and September. In August, flow decreased from the lake to the crossing. In both July and August, flow below Smith Lake was less than at the Highway 2 crossing upstream of Smith Lake even though both Idaho and Truman creeks contributed flow to Ashley Creek between these two sites. This reduction in flow was likely due to irrigation withdrawal. Discharge in Idaho Creek was similar in both July and September whereas discharge in Truman Creek was the greatest in July and lowest in September. The discharge values displayed in **Figure 3-4** were used to calculate nutrient loads for their respective site and visit.

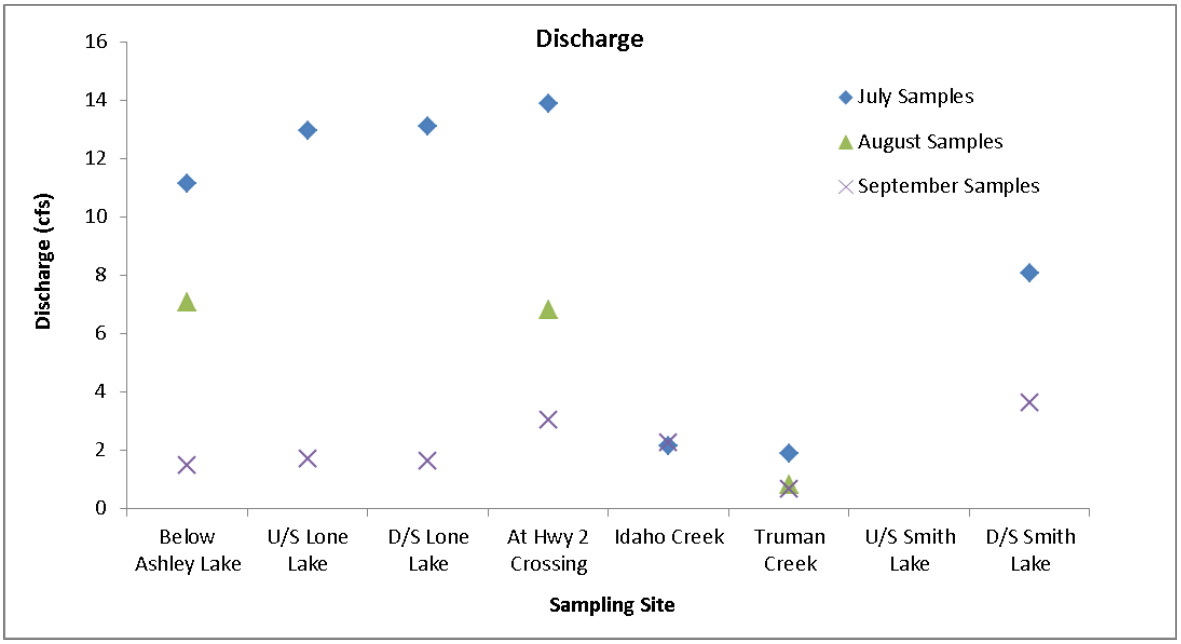

Figure 3-4. Discharge in Ashley, Idaho, and Truman creeks July – September, 2015
Note: Discharge was not sampled at the site upstream of Smith Lake due to stream depth and lack of observed flow

3.3 Nutrient Concentrations and Loading

3.3.1 Nitrogen

Nitrate + nitrite values were typically non-detects (less than 0.01 mg/L) with the exception of Idaho Creek, which had a measured value of 0.04 mg/L in July and 0.05 mg/L in September. These values are well below the 0.1 mg/L used by DEQ to evaluate nitrate + nitrite enrichment in Montana streams (Suplee et al. 2008; Suplee 2013). Ammonia values were non-detects (less than 0.05 mg/L) at all sites on all visits except for downstream of Smith Lake during the September sampling when 0.05 mg/L was measured at a temperature of 59.2°F and pH 8.18. The criterion for ammonia is dependent on temperature and pH and the ammonia concentration of 0.05 mg/L was well below the 1.783 mg/L chronic criteria for early life stages of fish under the observed conditions (DEQ 2012b).

Total nitrogen (includes inorganic and organic forms of nitrogen; TN) concentrations, typically remained stable from below Ashley Lake to upstream of Smith Lake (**Figure 3-5**). Concentrations increased from July to August and then decreased in September at all sites except downstream of Smith Lake. In both July and September, TN concentrations upstream of Smith Lake were below the 0.275 mg/L criteria used by DEQ to evaluate nutrient impairment (DEQ 2014). In August, the sample from Ashley Creek upstream of Smith Lake and the sample collected at the Highway 2 crossing exceeded the criteria. The site downstream of Smith Lake exceeded the criteria on all three visits. Both Idaho and Truman creeks had TN values below the criteria during all visits. As with Ashley Creek, the TN concentration in Truman Creek was the greatest in August.

The consistently higher TN concentrations in August are not due to dilution during the other months, as streamflow was lowest in September. It is possible that the high TN measured below Ashley Lake in August was the result of a phytoplankton bloom die-of; however, no data were collected that could verify such an event. Because the TN in all the July samples contained undetectable amounts of inorganic nitrogen (nitrate, nitrite, and ammonia, which are generally found in human or animal waste or fertilizer), the source of the increased TN is likely not directly from human waste, animal waste, or fertilizer. However, those inorganic forms of nitrogen may be entering the surface waters and creating increased algae and plant growth, which then decays and releases organic nitrogen back into the water. Alternatively, the increased TN could be due to organic nitrogen that is associated with runoff and sediment from surrounding land uses.

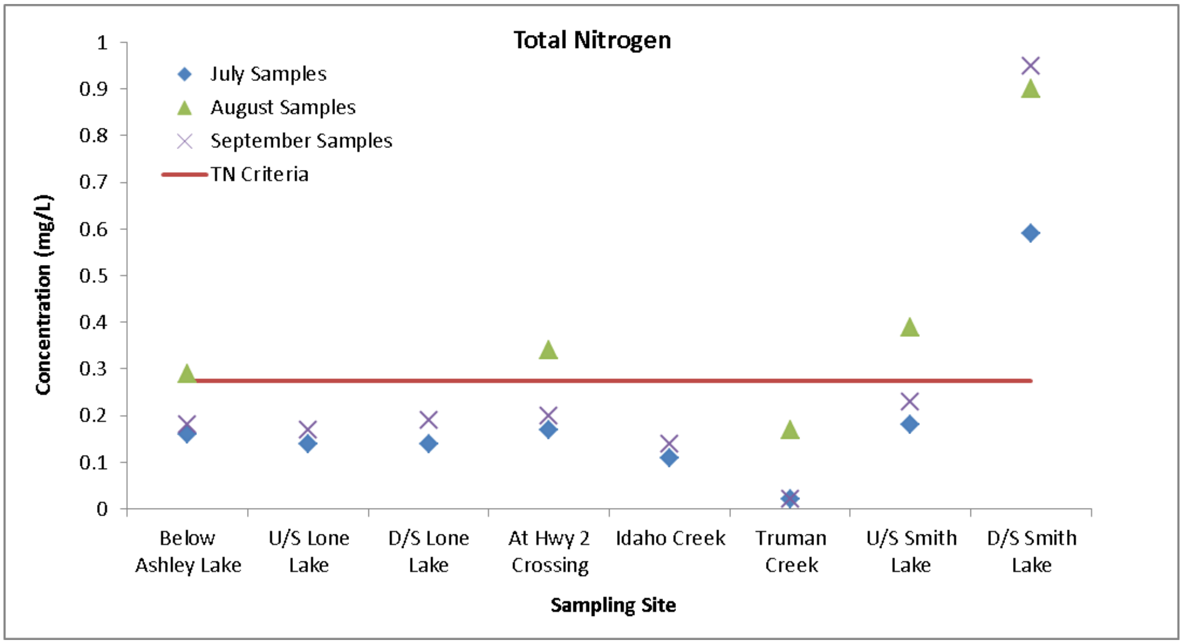

Figure 3-5. Total nitrogen concentration in Ashley, Idaho, and Truman creeks July – September, 2015

Note: TN was not detected in Truman Creek in July and September. One-half the detection limit (0.02 mg/L) was used to represent these data points

TN loading (load = concentration X discharge) in Ashley Creek was stable at the first three sites, increased slightly at the Highway 2 crossing and then doubled downstream of Smith Lake despite the fact that the discharge actually decreased (**Figure 3-6**). Loading in Ashley Creek was typically the greatest in July and lowest in September. Relative to the loading in Ashley Creek at the Highway 2 crossing, Idaho and Truman creeks contributed relatively small loads of TN to Ashley Creek. However, these creeks contributed a substantially larger proportion of the loading to Ashley Creek during September when discharge was the lowest (**Figure 3-6**).

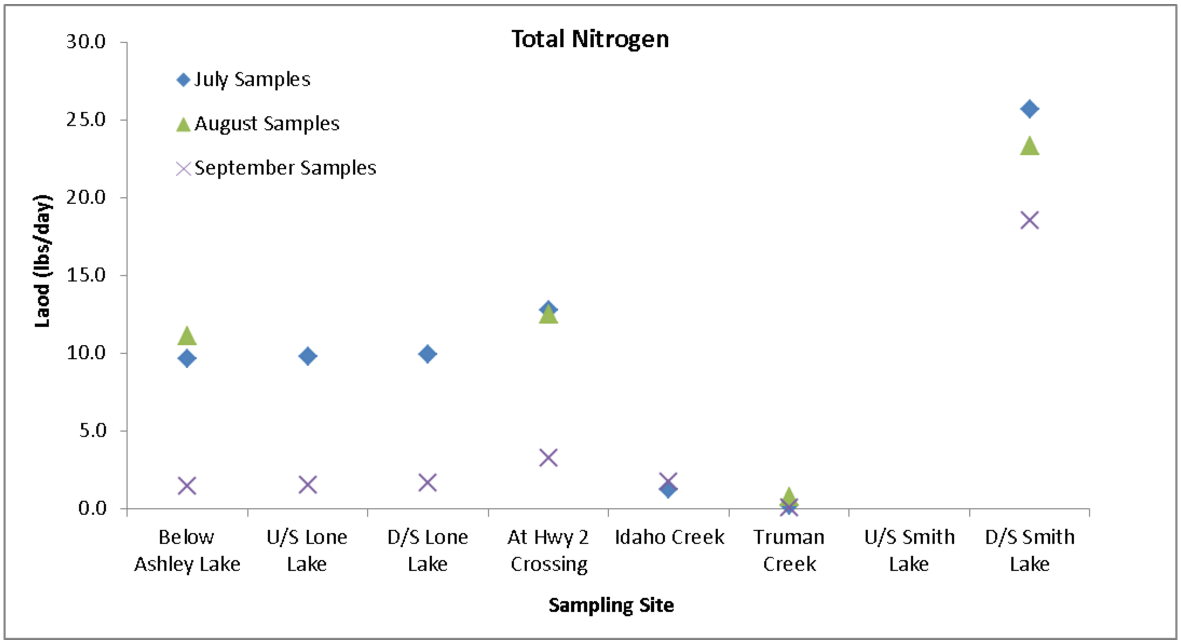

Figure 3-6. Total nitrogen loading in Ashley, Idaho, and Truman creeks July – September, 2015
Note: Loads are not shown for the site upstream of Smith Lake because discharge was not measured. One-half the detection limit (0.02 mg/L) was used to calculate load in Truman Creek for July and September

The data indicate that Smith Lake and the surrounding wetlands contribute a substantial amount of TN to Ashley Creek during the growing season (July through September). The TN load at the site downstream of Smith Lake site is greater than the combined load of the Highway 2 crossing, Idaho Creek, and Truman Creek sites on all three sampling dates. The load at Ashley Creek downstream of Smith Lake was 44.6%, 43.3% and 72.7% greater than the combined load of the three upstream contributing sites during the July, August and September sampling events, respectively. The August sampling event did not include loads from Idaho Creek, but due to the relatively small loads from Idaho Creek compared to that in Ashley Creek, the percent increase for August would likely not change substantially if the load from Idaho Creek had been measured. As the land uses surrounding Smith Lake are similar to the upstream land uses, the increased TN load may be due to instream nutrient cycling processes rather than increased discharges of nitrogen from surrounding land uses or groundwater. Additional water quality sampling during the non-growing season may help to narrow down the potential sources of the increased TN loads.

3.3.2 Phosphorus

Total phosphorus (TP) concentrations in Ashley Creek were generally stable from below Ashley Lake to the Highway 2 crossing, increased at the site upstream of Smith Lake, and then increase more below Smith Lake (**Figure 3-7**). Concentrations decreased from July to August, and then in most cases, increased in September. All TP samples in Ashley Creek were below the 0.025 mg/L criteria used by DEQ to evaluate nutrient impairment (DEQ 2014), except for the September sample upstream of Smith Lake and the three samples downstream of Smith Lake. Both Idaho and Truman creeks had TP values above the criteria in July. The highest TP concentrations in Ashley Creek from below Ashley Lake to the Highway 2 crossing and Idaho and Truman creeks were observed in July, whereas the highest TP concentrations at the Ashley Creek sites upstream and downstream of Smith Lake were observed in

September. This pattern differs from that for TN, which typically had the highest concentrations in August.

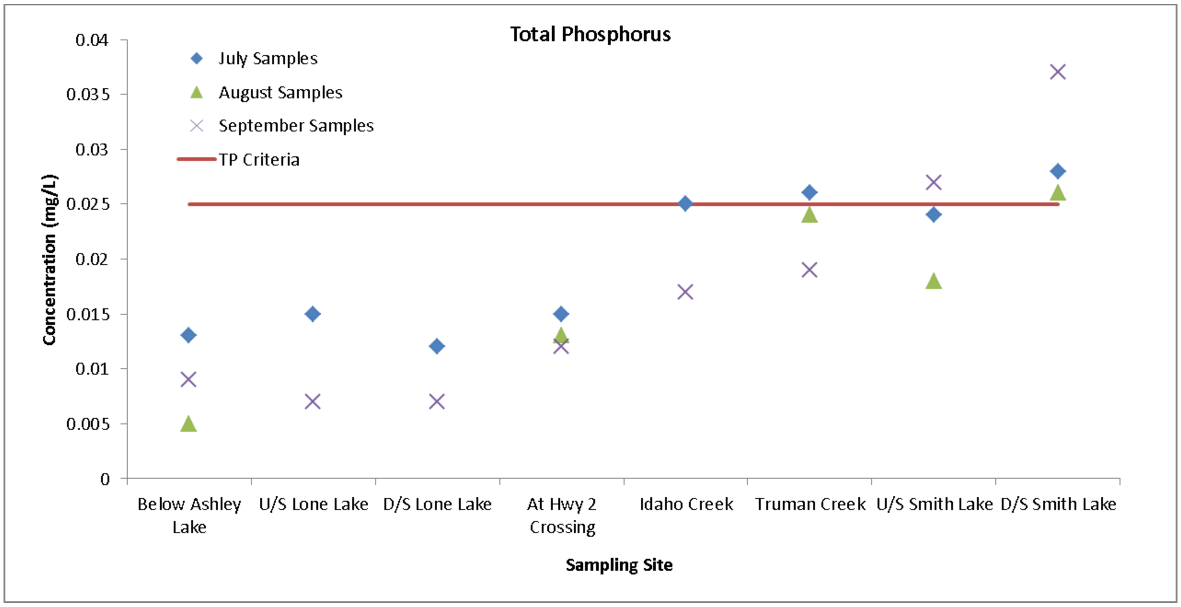

Figure 3-7. Total phosphorus concentration in Ashley, Idaho, and Truman creeks July – September, 2015

Overall, TP loading in Ashley Creek was generally stable from below Ashley Creek to downstream of Lone Lake, increased slightly at the Highway 2 crossing and then increased again downstream of Smith Lake (**Figure 3-8**). Loading in Ashley Creek was typically the greatest in July and lowest in September. The high TP loading in July did not appear to be sediment related as total suspended solids samples all yielded non-detects (less than 4.0 mg/L) or low values (less than 15 mg/L) during all three trips (**Figure 3-9**). Relative to the loading in Ashley Creek at the Highway 2 crossing, Idaho and Truman creeks contributed relatively small loads of TP to Ashley Creek in July and August. Similar to the TN results, during September these creeks contributed a more substantial proportion of the loading to Ashley Creek (**Figure 3-8**).

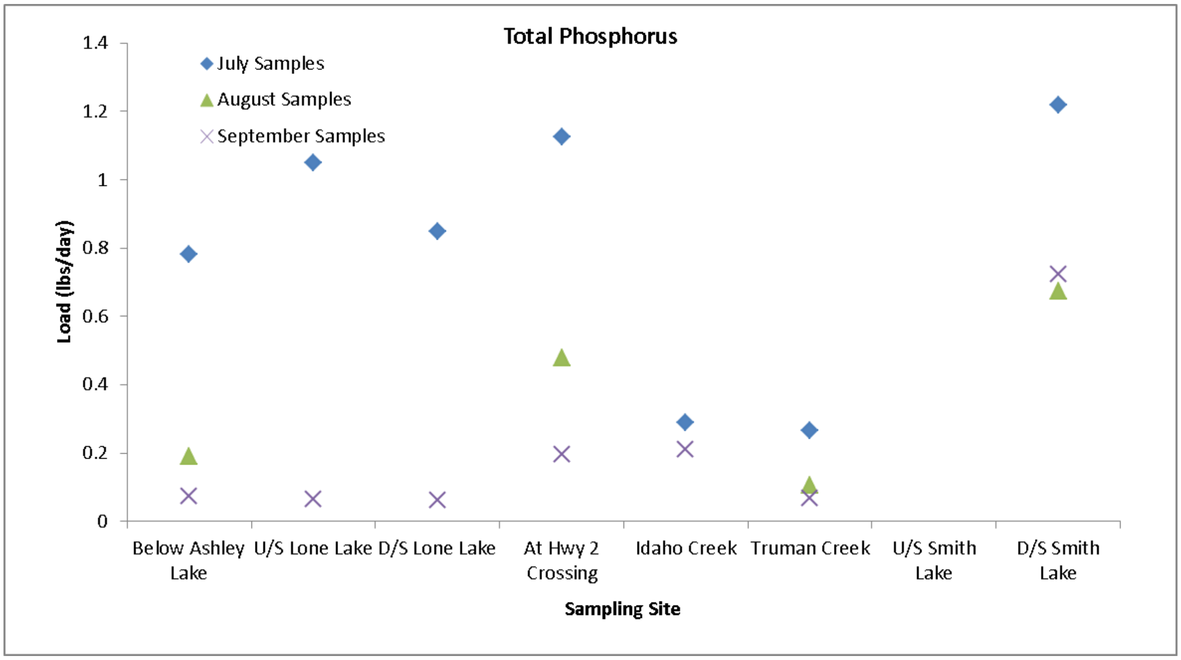

Figure 3-8. Total phosphorus loading in Ashley, Idaho, and Truman creeks July – September, 2015
Note: Loads are not shown for the site upstream of Smith Lake because discharge was not measured

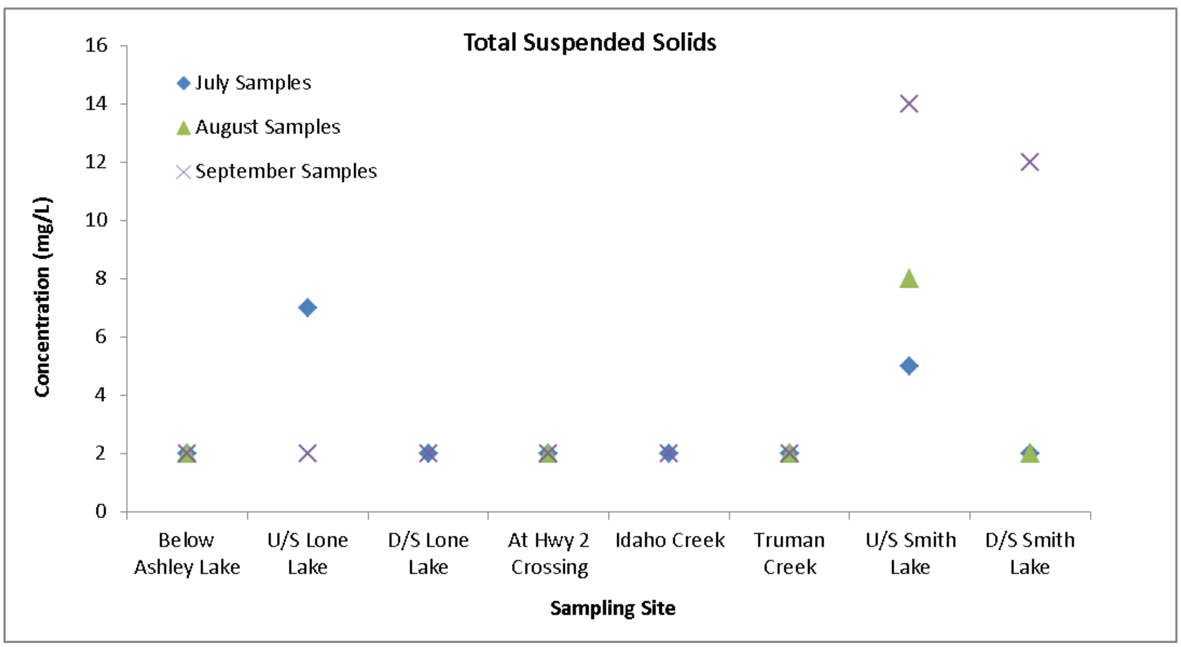

Figure 3-9. Total suspended solids concentration in Ashley, Idaho, and Truman creeks July – September, 2015
Note: One-half the detection limit (2 mg/L) was used to represent samples where TSS was not detected

The data indicate that Smith Lake and the surrounding wetlands act both as a source and a sink of TP during the growing season. The TP load at the site downstream of Smith Lake site was less than the combined load of the Highway 2 crossing, Idaho Creek, and Truman Creek sites during the July sampling event, but greater during the September event (the August loading change could not be determined because the TP load from Idaho Creek was not measured). In July the TP load decreased 27.4%, while in

September the TP load increased 34.6%. Nutrient cycling and decaying vegetation may account for the sources and sinks of TP, but additional water quality sampling during the non-growing season may help to narrow down the changes in TP loading measured during the growing season.

4.0 SUMMARY AND RECOMMENDED FUTURE SAMPLING

In 2015, the discharge at the outlet of Ashley Lake decreased over the June to November sampling period. Throughout this time small peaks occurred as a result of precipitation events and two large peaks were observed that resulted from adjustment of the dam gate on Ashley Lake. The stage-discharge relationship used to calculate flow in 2015 lacked data for high flow conditions and varied from the relationship developed by the FLBS using data from 1996-1997. To address deficiencies in the 2015 stage-discharge relationship, it is recommended that additional sampling occur in 2016. This sampling should begin in mid- to late-April and continue into the fall to ensure that stage and discharge values are collected across the entire range of the hydrograph. Either a camera or a stage recorder should be installed at the Ashley Lake outlet staff gage to provide another hydrograph example for Ashley Creek. To address the issue with erroneous discharge calculations at extremely low staff gage readings, if feasible, a staff gage reading when discharge from the outlet is at or near 0 cfs should be collected (e.g., when the gate structure is adjusted).

Nutrient (TN, TP) values in Ashley Creek change seasonally and spatially throughout the watershed. Near Ashley Lake, nutrient concentrations and loading tend to be the lowest, whereas they tend to be the greatest downstream of Smith Lake. The differences in nutrient values between the site upstream of Smith Lake and the one downstream of Smith Lake indicate that the lake and surrounding wetland complex is a large source of nutrients (particularly nitrogen) to Ashley Creek during the growing season. Similarly, the wetland complex and tributaries between the Highway 2 crossing and the site upstream of Smith Lake are contributing nutrients to Ashley Creek, albeit to a lesser degree.

The forms of nitrogen readily used by plant life (nitrate + nitrite and ammonia) were usually not detected in samples, indicating that either they were being taken up by algae and plants in Ashley Creek or sources of these forms of nutrients are limited. To better evaluate the sources of nutrients to Ashley Creek, winter nutrient sampling is recommended with lower detection limits. During the winter, algae and plant growth is limited and provides the best opportunity to detect inorganic nutrient forms that are used by plant life during summer. When performing winter sampling it is recommended that water samples be analyzed for the same nutrient forms as during the summer with the addition of ortho-phosphate, another form readily used by plants.

The sampling that occurred in the Ashley Creek watershed in 2015 has provided valuable information that can be used to refine the water quality model used in TMDL development. However, additional sampling could be done that will help to further refine the model for Ashley Creek, better define nutrient sources in the watershed, and further identify the steps necessary to reduce nutrient loading.

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