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PPL MONTANA, LLC

PPLM-2301-1943

Magalie R. Salas
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: Filing of Mystic Lake Project 2301 study report meeting summary per the Commission's Integrated Licensing Process

November 1, 2005

Dear Secretary Salas:

PPL Montana filed Mystic Lake Project Year 2005 Study Plan results with the Commission on October 3, 2005 and convened a meeting with stakeholders to discuss these study results on October 18 and 19 in Billings, Montana in accordance with the Commission's Integrated Licensing Process (ILP) rules. PPL Montana herein files a summary report from this meeting including attachments referenced in the summary.

Based on formal Year 2005 ILP study results (and informal 2003 and 2004 studies conducted in collaboration with stakeholders), PPLM and stakeholders agreed at the October 18 and 19 study report meeting in Billings to file a Mystic Project Preliminary Licensing Proposal (PLP) with the Commission on June 1, 2006. A second year of formal studies under the ILP process was determined not necessary. PPL Montana will file remaining 2005 study report data as described in the meeting summary and will consult with stakeholders to develop proposed PM&E measures with implementation schedule for inclusion in the Mystic Project PLP. PPL Montana has also agreed to voluntarily implement certain early (2006 and 2007) water quality, stream flow gauging and other resource conservation measures based on priority needs and available budgets in consultation with stakeholders.

Respectfully Submitted,

J. H. Jourdonnais

Jon H. Jourdonnais,
Director Hydro Licensing and Compliance

Cc: PPL Montana will send Mystic Project stakeholders an email with directions to access the study report meeting summary and attached information at PPL Montana website www.mysticlakeproject.com.

**2005 Study Report Meeting Summary**
Mystic Lake Hydroelectric Project FERC No. 2301-019
October 18-19, 2005
Sheraton Hotel, Billings, Montana

## ***Meeting Objectives***

1) Discuss each ILP study and determine if the study was completed, modifications are required, or a new study is needed.

2) Review and update the Mystic Lake process plan.

3) Prepare a Meeting Summary that reflects any agreements or disagreements related to the Mystic Project 2005 Study Report or process plan.

## ***Individual Study Discussions***

### **Studies 1& 2:** Archaeological Inventory on Potential Project Effects: Mystic Lake, West Rosebud Lake, and Plant Operating Area & Inventory and Evaluation of Plant Operating Facilities

- **Study is complete. No modifications or new studies requested.**
- A supplemental report is attached to this document.
- PPLM proposes to test archeological sites at the Mystic Project in June of 2006. Testing data will be filed with FERC (as a privileged document) and provided to the USFS by December 1, 2006.

### **Study 3:** Jurisdiction of West Rosebud Road

- **Study is complete. No modifications or new studies requested.**
- All stakeholders agreed that sufficient information exists to determine the jurisdiction of West Rosebud Road in the area covered by the approved study. At this time, no stakeholder recommends that this issue be addressed through the FERC ILP proceeding. PPLM, USFS, and Stillwater County will determine road maintenance and cost sharing issues independent of the ILP process.

### **Study 4:** Reliability of Transmission Lines and Feasibility of Eliminating Redundant Line

- **Study is complete. No modifications or new studies requested.**
- Per previous agreement with the USFS via conference call, PPLM did not provide a history of outages, a comparison of standards, and the cost of alternatives as required by the approved study. Nevertheless, all

stakeholders agreed that sufficient information exists and no stakeholder intends to recommend eliminating one of the project's two transmission lines for aesthetic purposes.

**Study 5:** West Rosebud Creek Bypass Reach Habitat and Fish Population Evaluation

- **Study is complete. No modifications or new studies requested.**
- There were no comments or new agreements on this study.

**Study 6:** Hydrologic Characterization of the West Rosebud Creek Bypass Reach between Mystic Lake Dam and the Powerhouse

- **Study is complete. No modifications or new studies requested.**
- A supplemental report is attached to this document. The report clarifies the amount of fish habitat in the bypass reach requested by stakeholders.
- PPLM proposes to evaluate the performance of the fish valve under winter conditions in 2005/2006. PPLM will file the results of this analysis with FERC and stakeholders by April 1, 2006.

**Study 7:** Water temperature monitoring in the Mystic Lake Project Area

- **Study is complete. No modifications or new studies requested.**
- A supplemental report is attached to this document. The report contains additional temperature data collected in 2005 from the upper bypass reach, as well as additional discussion of Mystic Project temperature effects on trout based on a literature review.
- The thermograph in Mystic Lake was not recovered in 2005.
- Study results identify temperature changes that may exceed state water quality standards. PPLM proposes to work with MDEQ, MFWP, and USFS to analyze project-related temperature effects (if any) on fish in West Rosebud Creek. PPLM will file its analysis with FERC and other stakeholders by April 1, 2006. Stakeholders agreed that this work is not required by the approved ILP study plan.

**Study 8:** Mystic Project Effects on Mystic Lake Spill Hydrology

- **Study is complete. Modification to study results schedule requested.**
- A supplemental report explaining the accuracy of without Project flow data is attached to this document as requested by stakeholders.
- All stakeholders agreed that the results of this study should be reviewed concurrently with the results of Study No. 9, which is pending completion. Therefore, all stakeholders agreed to modify the schedule for this study as follows:
    - Study results filed 10/3/05.
    - Disputes/requests to amend this study due 12/15/05.
    - Responses to disputes/amendment requests due 1/16/06.
    - Director's determination on disputes/amendments due 2/15/06.

**Study 9:** Aerial Survey of Riparian Corridor

- **Study is not complete. Modification to study results schedule requested.**
- Aerial photos were not available to complete quantitative analysis.
- All stakeholders agreed to modify the schedule for this study as follows:
  - File remaining study results 11/15/05.
  - Disputes/requests to amend this study due 12/15/05.
  - Responses to disputes/amendment requests due 1/16/06.
  - Director's determination on disputes/amendments due 2/15/06.

**Study 10:** Shoreline Erosion Inventory at Mystic Lake

- **Study is complete. No modifications or new studies requested.**
- Aerial photos will be made available to complete quantitative analysis.
- A supplemental report with shoreline erosion inventory results will be submitted to FERC April 1, 2006.

**Study 11:** Sensitive Plants in the Mystic Lake Hydroelectric Project Area

- **Study is complete. No modifications or new studies requested.**
- There were no comments or new agreements on this study.

**Study 12:** Flow Restoration Action Plan for Flow-line or Penstock Shutoff

- **Study is complete. No modifications or new studies requested.**
- PPLM proposes to complete a 30% design report for a new fish valve and a new penstock shut-off valve(s) and file it with FERC and other stakeholders by April 1, 2006. The design report will include valve flow capacity options and an emergency flow restoration plan.

**Study 13:** Mystic Hydroelectric Project Whitewater Flow Study

- **Study is complete. No modifications or new studies requested.**
- PPLM's flow gauge at the re-regulation dam did not provide reliable results and often could not be correlated to the staff gage at the Pine Grove Campground. Despite these intermittent gauging problems, all stakeholders agreed that sufficient data exists to evaluate whitewater resources.
- PPLM and other stakeholders may recommend that a USGS gage be installed as an early PM&E measure in 2006 below the re-regulation dam as a solution to the flow gauging problems encountered during the study.

**Study 14:** Mystic Hydroelectric Project Recreation Use Counts

- **Study is complete. No modifications or new studies requested.**
- A supplemental report providing updated recreation user data is attached to this document.

**Study 15:** Mystic Hydroelectric Project Water Quality Studies

- **Study is complete. No modifications or new studies requested.**
- PPLM proposes to monitor water quality data in 2006 in cooperation with MDEQ as an early protection, mitigation and enhancement measure. PPLM will file this data with FERC and other stakeholders by December 1, 2006. All stakeholders agreed that collecting this data is not required by the approved ILP study plan.

**Study 16:** Biological Assessment of Federally Listed Species

- **Study is complete. No modifications or new studies requested.**
- PPLM proposes to further consult with the USFWS to review its Biological Assessment and to discuss completing ESA consultation. FERC staff (and any other stakeholder) will attend via conference call.
- PPLM will submit a preliminary draft Biological Assessment (BA) for stakeholder review with its Preliminary Licensing Proposal (PLP) scheduled to be filed with the Commission on June 1, 2006.

**Study 17:** Biological Evaluation of Forest Service Sensitive Species

- **Study is complete. No modifications or new studies requested.**
- PPLM will submit a preliminary draft Biological Evaluation (BE) for stakeholder review with its Preliminary Licensing Proposal (PLP) scheduled to be filed with the Commission on June 1, 2006.

**Study 18:** Evaluation of the Current Fish Population and Habitat in West Rosebud Creek Downstream from Emerald Lake

- **Study is complete. No modifications or new studies requested.**
- PPLM proposes to provide some additional analysis and to edit the existing report which will be filed with FERC and other stakeholders by June 1, 2006, contingent on receiving adjusted fish population estimates from Montana Fish, Wildlife and Parks. All stakeholders agreed that this action is not required by the approved ILP study plan.

**Study 19:** Fish Habitat In and Upstream of Maxie Creek

- **Study is complete. No modifications or new studies requested.**
- There were no comments or new agreements on this study.

**Study 20:** Ramping Rates in West Rosebud Creek

- **Study is complete. No modifications or new studies requested.**
- There were no comments or new agreements on this study.

## Summary of Supplemental Filings

As discussed above, PPLM will make the following filings with FERC and other stakeholders:

| Study No. | Title | Supplemental/Remaining Tasks | Due Date |
|---|---|---|---|
| 1 & 2 | Archaeological & Historic testing | Test sites around Mystic Project in June. | December 1, 2006 |
| 6 | Hydrology of Bypassed Reach | Evaluate performance of fish valve under winter conditions | April 1, 2006 |
| 7 | Water Temperature Monitoring | Literature search and analysis of project-related temperature effects on fish in West Rosebud Creek | April 1, 2006 |
| 9 | Aerial Survey of Riparian Corridor | Quantification of riparian acreages | November 15, 2005 |
| 10 | Shoreline Erosion | Quantification of shoreline erosion acreages | April 1, 2006 |
| 12 | Flow Restoration Action Plan | Complete 30% design of replacement fish valve and shutoff valve(s) | April 1, 2006 |
| 15 | Water Quality | Monitor water quality data in cooperation with MDEQ | December 1, 2006 |
| 18 | Fish downstream of Emerald Lake | Macroinvertebrate lab results and substrate sample lab results | June 1, 2006 |

## Accelerated Licensing Schedule and Process Plan Revisions

Except as noted above, PPLM has completed its studies in the approved Mystic Project ILP study plan. Given that most studies have been completed, PPLM proposes and stakeholders agree to eliminate the second study season in 2006, eliminate the updated study report due 10/3/06, and eliminate the updated study report dispute resolution process. PPLM and stakeholders propose to accelerate filing a Preliminary Licensing Proposal (PLP) from 6/1/07 to 6/1/06 and to accelerate filing a Final License Application from to 12/15/07 to 12/15/06.

**All stakeholders agreed to PPLM's proposal to accelerate the PLP schedule as discussed above. A revised process plan which reflects these agreements is attached.**

| Responsible Entity | Pre-Filing Milestones | Date | FERC Regulation |
|---|---|---|---|
| PPLM | Begin Consulting with Agencies, Tribes, Public | 6/24/03 | 5.1(d) |
| PPLM | Begin Preparing Pre-Application Document (PAD) | 6/24/03 | 5.6 |
| PPLM | Issue Public Notice for NOI/PAD | 6/15/04 | 5.4(d)(2) |
| PPLM | File NOI/PAD | 7/1/04 | 5.5, 5.6 |
| FERC | Tribal Meetings (if any) | None | 5.7 |
| FERC | Issue Public Notice for NOI/PAD; Issue Scoping Document 1 (SD1) | 7/15/04 | 5.8 |
| FERC | Mystic Project Site Visit and Scoping Meetings | 8/10-8/12 | 5.8(b)(3)(viii) |
| All Stakeholders | PAD/SD1 Comments Due | 9/15/04 | 5.9(a) |
| FERC | Issue Scoping Document 2 | None | 5.10 |
| PPLM | File Proposed Study Plan | 11/1/04 | 5.11(a) |
| All Stakeholders | First Proposed Study Plan Meeting | 12/1&2/04 | 5.11(e) |
| All Stakeholders | Proposed Study Plan Comments Due | 2/1/05 | 5.12 |
| PPLM | File Revised Study Plan | 3/1/05 | 5.13(a) |
| All Stakeholders | Revised Study Plan Comments Due | 3/15/05 | 5.13(b) |
| FERC | Director's Study Plan Determination | 3/30/05 | 5.13(c) |
| FS, FWS, MDEQ | Any Study Disputes Due[1] | None | 5.14(a) |
| Dispute Resolution Panel | Third Panel Member Selected | N/A | 5.14(d)(3) |
| Dispute Resolution Panel | Dispute Resolution Panel Convenes | N/A | 5.14(d) |
| PPLM | PPLM's Comments on Study Disputes Due | N/A | 5.14(i) |
| Dispute Resolution Panel | Dispute Resolution Panel Technical Conference | N/A | 5.14(j) |
| Dispute Resolution Panel | Dispute Resolution Panel Recommendations | N/A | 5.14(k) |
| FERC | Director's Study Dispute Determination | N/A | 5.14(l) |
| PPLM | First Study Season | Summer 05 | 5.15 |
| PPLM | Initial Study Report | 10/3/05 | 5.15(c)(1) |
| All Stakeholders | Initial Study Report Meeting | 10/18,19/05 | 5.15(c)(2) |
| PPLM | Initial Study Report Meeting Summary | 11/1/05 | 5.15(c)(3) |
| All Stakeholders | Any Disputes/Requests to Amend Study Plan Due | 12/1/05 | 5.15(c)(4) |
| All Stakeholders | Responses to Disputes/Amendment Requests Due | 1/2/06 | 5.15(c)(5) |
| FERC | Director's Determination on Disputes/Amendments | 2/1/06 | 5.15(c)(6) |
| PPLM | Second Study Season[2] | None | 5.15 |
| PPLM/FERC/FS/Tribes/ SHPO | Meeting to Review Preliminary Draft Historic Properties Management Plan (HPMP) | 5/1/06 | N/A |

[1] Shaded milestones are unnecessary if no disputes.

[2] The following ILP steps have been omitted from this relicensing schedule: (1) a second study season under § 5.15; (2) an Updated Study Report, Meeting and Meeting Summary under § 5.15(f); and (3) an Updated Study Report Dispute Resolution Process under § 5.15(f).

| | | | |
|---|---|---|---|
| PPLM | File Preliminary Licensing Proposal[3] | 6/1/06 | 5.16 |
| All Stakeholders | Preliminary Licensing Proposal Comments Due | 8/30/06 | 5.16(e) |
| **PPLM** | **File Water Quality Certificate (WQC) Application with MDEQ** | **10/2/06** | **5.23(b)** |
| **MDEQ** | **Issue Adequacy Decision on WQC Application** | **11/2/06** | **N/A** |
| **MDEQ** | **Issue Tentative WQC and Public Notice** | **12/1/06** | **N/A** |
| PPLM | Issue Public Notice of License Application | 12/1/06 | 5.17(d)(2) |
| PPLM | File Final License Application[4,5] | 12/15/06 | 5.17(a) |

[3] The Preliminary Licensing Proposal will contain PPLM's preliminary draft: (1) HPMP, (2) Biological Assessment, and (3) Biological Evaluation.

[4] A license application must be file by 12/31/07 (current license expires 12/31/09).

[5] The Final License Application will contain PPLM's draft: (1) HPMP, (2) Biological Assessment, and (3) Biological Evaluation.

## ***Mystic Project Study Report Meeting Attendance***

| Name | Representing | Phone # | Date |
|---|---|---|---|
| Bruce Bugbee | American Lands | 406.728.4176 | 10/18-19/2005 |
| Jeff Frost | American Lands | 604.202.2966 | 10/18-19/2005 |
| Nancy Johnson | American Lands | 406.431.4734 | 10/18-19/2005 |
| Ron Lodders | American Whitewater and Beartooth Paddlers | 406.655.9260 | 10/18/2005 |
| Elisabeth Blaug | FERC | 202.502.8189 | 10/18-19/2005 |
| Steve Hocking | FERC | 202.502.8753 | 10/18-19/2005 |
| Doug Foss | GEI Consultants, Inc. | 406.522.9669 | 10/18-19/2005 |
| Ginger Gillin | GEI Consultants, Inc. | 406.829.3648 | 10/18-19/2005 |
| John Pizzimenti | GEI Consultants, Inc. | 503.936.1049 | 10/18-19/2005 |
| Kristi Overberg | GEI Consultants, Inc. | 406.829.3648 | 10/18-19/2005 |
| Tyler Haddix | GEI Consultants, Inc. | 406.829.3648 | 10/18-19/2005 |
| Christian Levine | MDEQ | 406.444.0371 | 10/18-19/2005 |
| Jim Darling | MFWP | 406.247.2961 | 10/18-19/2005 |
| Jim Olsen | MFWP | 406.328.4636 | 10/18-19/2005 |
| Brent Mabbott | PPL MT | 406.533.3447 | 10/18-19/2005 |
| Frank Pickett | PPL MT | 406.533.3445 | 10/18-19/2005 |
| Jon Jourdonnais | PPL MT | 406.533.3443 | 10/18-19/2005 |
| Lance Elias | PPL MT | 406.533.3510 | 10/18-19/2005 |
| Kim Reid | USFS, Custer National Forest | 406.657.6205 | 10/19/2005 |
| Mark Nienow | USFS, Custer National Forest | 406.657.6205 | 10/18-19/2005 |
| Susan Newell | USFS, Custer National Forest | 406.657.6200 | 10/18-19/2005 |
| Jeff Gildehaus | USFS, Custer National Forest, Beartooth Ranger District | 406.446.2103 | 10/18-19/2005 |

## Attached Supplemental Reports

Study No. 1 & 2 (Updated Report)

Study No. 6 (Updated Report)

Study No. 7 (Updated Report)

Study No. 8 (Supplemental Explanation on Accuracy of Without Project Flows)

Study No. 14 (Updated Report)

# Study No. 1 & 2

## Study 1: Archeological Inventory on Potential Project Effects: Mystic Lake, West Rosebud Lake, and Plant Operating Area

## Study 2: Inventory and Evaluation of Plant Operating Facilities

## November 2005 - Update

## Mystic Lake Hydroelectric Project FERC No. 2301

Mystic Lake, Montana

**PPL Montana**
45 Basin Creek Road
Butte, Montana 59701

November 1, 2005

**MYSTIC HYDROELECTRIC PROJECT**
**FERC PROJECT NO. 2301**
**RELICENSING-CULTURAL RESOURCE MANAGEMENT**

**INITIAL STUDY SEASON REPORT - UPDATE**
**2005 STUDY SEASON**

**October 14, 2005**

# I. INTRODUCTION

Cultural Resource Management (CRM) studies needed for support of the relicensing of the Mystic Hydroelectric Project by the Federal Energy Regulatory Commission (FERC) for FERC Project No. 2301 (hereinafter as Project), during the initial study season of 2005, were identified in the Study Plans submitted by PPL-Montana (PPLM) on March 1, 2005 and approved by the FERC by letter dated March 21, 2005 .[1] These studies were also addressed in more detail, in a general study plan for cultural resources on the Project.[2] The following document provides an initial report on the progress of these studies in the 2005 study season. It was developed in consultations with the Custer National Forest (CNF) Archaeologist.

# II. ARCHAEOLOGICAL STUDIES

## A. Studies Summary

The approved study plans included inventory for Prehistoric Archaeological Properties (PAP) and Historic Archaeological Properties (HAP), on the Project. That inventory was conducted in the summer of 2005, in accordance with the methods set out in the approved study plans. The following are summaries of the areas included in inventory and the properties identified in that inventory. The specific locations of identified properties are not provided, for reasons of confidentiality under provisions of existing Federal law.

Inventory was undertaken for both Prehistoric Archaeological Properties (PAP) and Historic Archaeological Properties (HAP) on the following Project areas:

- **Mystic Lake:** archaeological inventory of the Fluctuation Zone[3] (FZ) and in the Backshore Zone (BZ) from the maximum water elevation to 150

[1] Robinson, J. Mark –FERC; Letter to Peter J. Simonich, PPLM, March 21, 2005.
[2] Legacy Consulting Services, 2004: *Mystic Hydroelectric Project Relicensing-Cultural Resource Study Plan* Legacy Consulting Services, for PPL-Montana.
[3] Defined as the zone between the maximum high-water and maximum draw down elevations at both Mystic and West Rosebud lakes.

feet above that elevation, except in areas of the shoreline which were armored with rock or are rock cliffs.

- **West Rosebud Lake:** archaeological inventory of the Fluctuation Zone (FZ) and in the Backshore Zone (BZ) from the maximum water elevation to 150 feet above that elevation, except in areas of the shoreline which are armored with rock or are rock cliffs.

- **Mystic Lake Plant Operating Area:** archaeological inventory of the operating facilities area, as defined by the project boundary.

Standard field methods for pedestrian inventory were used in all inventory areas. Surfaces were inspected for the occurrence of prehistoric cultural materials and/or of prehistoric cultural features. Inventory was completed on all study areas, as specified in the approved Study Plans.

## A. Prehistoric Archaeological Properties (PAP) Identified or Revisited

Five open air Prehistoric Native American Campsites (PNAC) were identified, or revisited within the Project Boundary and one additional, potential PAP was recorded, outside the Project Boundary. Three of those properties had been having been previously identified and documented to a limited extent. One of the previously recorded properties had inadvertently been recorded twice by separate researchers with a different record number assigned each time. One property had been extensively investigated in the 1970s.

These five PAP are characterized by the occurrence of pieces of chipped stone debitage, occasional chipped stone tools, and stone features. The majority of these features appear to represent either fire hearths, or features reflecting food processing or food preparation activities. In addition, stone features which appear to be stone weirs were also identified at properties 24ST233 and 24ST653. These features suggest the possibility that the acquisition, cooking and processing of fish may have been undertaken by prehistoric peoples occupying at least two PAP at the Project. However, there is considerable question as to when fish would have been available as a food resource in some parts of the study area. For example, the stocking of fish in the West Rosebud drainage is only reported to date to as early as 1909, when rainbow trout were reported to have been planted in area lakes. There are also other possible origins of these weir-like structures, and these will be investigated.

Culturally and temporally diagnostic projectile point forms have been found at all PAP, both during 2005, and in the past by previous researchers. The occurrence of these diagnostic projectile points suggest occupation of these properties throughout the last 9-10,000 years. In addition to the occurrence of temporally/functionally diagnostic projectile points, numerous stone features were recorded. The majority of these features apparently represent either simple, roughly circular hearths; or stone platform features consisting most commonly of an ovoid stone platform surfaces presumably constructed for roasting food products intended for either immediate or later use. Associated surface materials at all PAP consist of moderate amounts of chipped stone debitage, and occasional formed tools. Notably, all chipped stone materials were of apparent or definite origin. In addition, other unusual features were identified at property 24ST233/24ST652. At this PAP, it appears that the naturally occurring stony surface, which characterizes most of the area, has been modified by removal of larger stones. These areas suggest the creation of more useable living surfaces, potentially for lodgings and/or task areas. Most of these areas are circular in form.

Given the above information on identified PAP, within the Project Boundary, they appear to contain archaeological data sufficient to be eligible for listing in the National Register of Historic Places (NRHP) under NRHP Criterion D. Additional studies, in the form of archaeological testing, would be needed in order to confirm the NRHP eligibility of these properties, and to design any specific measures for potential archaeological data recovery aimed at addressing any project-related effects to those found eligible.

Another PAP, 24ST651 was revisited in the 2005 inventory. It had been identified in the 1970s, extensively investigated at that time, and found eligible for NRHP listing. It was revisited in 2005 in order to ascertain it's current status. It remains as it was at the end of the 1970s studies. Potential effects to it from future, Project-Associated Actions would be addressed in the *Historic Properties Management Plan* (HPMP), required by the FERC in the relicensing process.

Finally, a single property was identified outside of the Project Boundary. It consists of a stone alignment, which, at the time of the 2005 inventory, was under 18" to 20" of water in a small pond. The origins of this property are unknown. Since it is outside the Project Boundary, it would not be potentially effected by operation of the Project. It was recorded as identified and the information on it will be provided to the Custer National Forest.

One other locale consists of three cairn and hearth features. The character of these features as well as the total lack of any other associated cultural materials strongly suggest they reflect recent, non-historic recreational activities.

## B. Historic Archaeological Properties Identified

Inventory identified two HAP reflecting the historic construction and subsequent use of the Mystic Lake Hydroelectric facilities. One HAP is a locale containing primarily food containers. That HAP appears to reflect domestic activities by work crews who were constructing project facilities. The second HAP consists of an area used as a general dump during both historic and recent times. Several pit features representing other activities of an unknown nature are present. The pits could represent filled-in trash pits from historic occupation of the area since ca. 1926 to unknown dates.

**TABLE 1: PAP AND HAP IDENTIFIED OR REVISITED**

| State # (if assigned to-date) | Field # | Summary Description | Cultural Complexes Represented |
|---|---|---|---|
| - | Mystic-A | Prehistoric Native American Campsite | Pelican Lake |
| - | Mystic-B | Prehistoric Native American Campsite | U/K |
| 24ST233, 24ST652, | Mystic-C | Prehistoric Native American Campsite | Agate Basin, Alberta, Bitterroot, Hanna, and Pelican Lake |
| 24ST232 | Mystic-D | Prehistoric Native American campsite . | Pelican Lake; Late Prehistoric |
| 24ST653 | Mystic D[1] | Prehistoric Native American campsite | Hell Gap, Mummy Cave, Pelican Lake, Late Prehistoric |
| 24ST651 | N/A | Prehistoric Native American campsite[4] | Mummy Cave, Pelican Lake, Late Prehistoric |
| - | Mystic-E | Trash features in the area of the powerhouse and operator camp. | |
| - | F | Stone alignment, located in a shallow pond, on CNF lands, located outside Project Boundary | |
| - | Mystic -G | Historic Dump | |
| | Mystic-H | Apparently recent, non-historic stone features | |

[4] This PAP was identified and extensively investigated in the 1970s and is discussed above. It has been previously determined eligible for NRHP listing. It was revisited in the 2005 inventory.

## III . HISTORIC ARCHITECTURAL-ENGINEERING STUDIES (H-A&E)

### A. Plant Facilities and Operator Camp

The approved Study Plan included inventory of Historic Architectural-Engineering Properties (H-A&E) on the Project. That inventory was conducted in the summer of 2005, in accordance with the methods set out in the approved Study Plans. The inventory included all Plant Operating Facilities, other than the associated electric transmission lines, which had been previously inventoried. The following is a summary of the H-A&E properties identified in inventory.

A total of thirty-two buildings and structures were recorded. Of those, twenty-four are components of the hydroelectric generating plant facilities and eight are in the operators' camp.

Preliminary assessment of the Mystic Project Operating Facilities (POF) is that the facility is eligible for listing in the National Register of Historic Places as a District. The District appears to be significant under Criteria A and B, and to retain integrity sufficient to represent it's significance. Of the thirty-one resources buildings and structures historically associated with the Mystic Development POF, thirteen have integrity and would contribute to a district, two lack integrity and would not contribute, while the remaining nine consist of buildings and structures of insufficient in size, scale and significance to count as a district resource. The overall integrity of the hydroelectric plant facilities is exceptional. Neither the concrete arch dam nor the powerhouse have been altered in a significant manner since construction and, although the flowline was completely reconstructed in recent years, the other primary components of the water delivery system (intake structure, shaft and tunnel, surge chamber, valve house and penstocks) have seen little modification and retain integrity sufficient to demonstrate their historic, engineering significance.

The operators' camp has four potentially contributing buildings, two non-contributing buildings, and two buildings of insufficient size, scale and significance to count as a district resource. All four of the contributing buildings are primary resources dating from project construction. They are the community house, foreman's house, and two cottages.

### B. Mystic Lake Trail

The Mystic Lake Trail was investigated with the goal of determining if it was representative of the work completed by the Civilian Conservation Corps (CCC) in Montana's National Forests during the 1930s depression, as had been suggested in consultations prior to inventory.

A recent and very thorough review of CCC projects in the Custer National Forest found no record or mention of the Mystic Lake Trail.[5] Sections of the trail average 2 to 3 feet wide, has a dirt path, and is lined by dry-laid rock walls. Rocks in the walls were obviously procured from the adjacent talus slopes. Walls along the lower end of the trail near the powerhouse are only one to two courses high. Much steeper sections of trail further up the mountain slope, however, have very substantial rock walls, standing well over 10 feet tall in places. No physical evidence of CCC construction was identified in the 2005 inventory.

Other possible origins of the trail, in particular the dry-laid, rock walls on portions of it, are possible. Consultations with the Custer National Forest suggest that the walls in particular may have been constructed by Montana Power Company. This may have been done as part of the original construction, or later in the history of the project. Additional research is ongoing, utilizing information provided by Custer National Forest and as available from the records of the Montana Power Company. That information will be incorporated into the evaluation of Plant Operating Facilities.

[5] Brownell, Joan L. 2002 - "Civilian Conservation Corps-Bearthooth Ranger District-Custer National Forest" A survey of the records of the CCC on work done in the Custer National Forest. Billings, Montana.

**TABLE 2: List of Historic Engineering and Architectural Resources Mystic Lake Development and Evaluation of NRHP Status**

| Field No. | MPC Record No. | Name/Function | Construction Date | Potential District Status |
|---|---|---|---|---|
| **Hydroelectric Generating Plant** | | | | |
| 1 | | concrete arch gravity dam | 1926 | contributing |
| 2 | | earth filled embankment | 1926 | contributing |
| 3 | | lake house at dam | 2003? | non contributing |
| 4 | | outhouse at dam | l924-25? | not of size/scale |
| 5 | | helipad at dam | modern | not of size/scale |
| 6 | | intake structure | 1924-25 | contributing |
| 7 | | shaft and tunnel | 1924-25 | contributing |
| 8 | | flowline | rebuilt 1950s-90s | non contributing |
| 9 | | snow shed along flowline | between 1925 and 1939 | not of size/scale |
| 10 | | surge chamber | 1924-25 | contributing |
| 11 | | valve house | 1924-25 | contributing |
| 12 | | penstocks | 1924-25 | contributing |
| 13 | | inclined railroad line | 1923-24 | contributing |
| 14 | | tram hoist house | 1924-25 | contributing |
| 15 | | engine shed | modern | not of size/scale |
| 16 | | heliport at surge chamber | modern | not of size/scale |
| 17 | | outhouse at tram hoist house | 1924-1925? | not of size/scale |
| 18 | | railroad signal shack | 1923-24? | not of size/scale |
| 19 | 9 | powerhouse | 1924-25 | contributing |
| 20 | | tailrace flumes | 1924-25 | contributing |
| 21 | | weirs | 1924-25 | contributing |
| 22 | 24-25 | domestic water supply system | 1924-25? | contributing |
| 23 | | fountain in powerhouse yard | 1935 | not of size/scale |
| 24 | | USGS gauging station | 1930s? | non contributing |
| **Operators' Camp** | | | | |
| 25 | 8 | community house | 1925 | contributing |
| 26 | 7 | foreman's house | 1925 | contributing |
| 27 | 2 | four-room cottage | 1925 | contributing |
| 28 | 27 | hydrant house | 1937 | not of size/scale |
| 29 | 4 | four-room cottage | 1925 | contributing |
| 30 | | log cabin | ca. 1948 | non contributing |
| 31 | | six-stall garage | ca. 2003 | non contributing |
| /32 | 13 | outhouse | 1937 | not of size/scale |

## IV. TRADITIONAL CULTURAL PROPERTIES

Custer National Forest recommended a review of an ethnographic overview developed by that agency for information on these properties.[6] That overview has been reviewed. Conducted between 1992 and 1995, the extensive study involved both a review of ethnographic and archaeological data; as well as an extensive series of interviews and meetings with knowledgeable representatives of various tribes with potential interests throughout the Custer National Forest. The study is impressive in the lengths it went to in contacting and interviewing cultural representatives of contemporary tribal communities in order to identify information about areas they considered culturally sensitive within Custer National Forest. The study included consideration of potential TCP in the Beartooth Ranger District of CNF, which is the district within which the Project is located. No TCP were identified in that study within the Beartooth Mountain areas of Custer National Forest.

Consultations continued with the tribes expressing an interest in CRM issues for the relicensing, in both 2004 and the 2005 Study Season. PPLM invited both the Eastern Shoshone and the Crow tribes to participate in the 2005 inventory for PAP. The Eastern Shoshone declined to participate, by letter dated March 21, 2005.[7] The Crow Tribe did not respond at all to the invitation to participate.

PPLM will submit the final inventory report to the Shoshone and the Crow and ask for their comments and recommendations as to the PAP identified in that report. In addition, PPLM will attempt to organize a meeting with the Shoshone, and Crow tribal representatives and Custer National Forest. , in order to review any of the data in that report which the tribes may have questions about from their review of the inventory report and to gather any additional comments the tribes may have on the PAP identified in the 2005 inventory. Any concerns they may express as regards the PAP identified in the 2005 inventory, would then be taken in account in development of the Historic Properties Management Plan. All consultations with the tribes would be undertaken in accordance with FERC policy on tribal consultations.

## V. FUTURE WORK

A detailed report on the archaeological inventory studies conducted in 2005 is in preparation. The report will detail the inventory work undertaken, methods, results and evaluations of the eligibility of identified PAP and HAP for listing in the National Register of Historic Places (NRHP). When completed, that report will be submitted to the FERC, CNF and the Montana State Historic Preservation Officer (SHPO).

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[6] LaPoint, Halcyon 2003

[7] Meeks, Edward (Eastern Shoshone Tribe): Letter to John Brumley, Ethos Consultants, March 21, 2005.

Detailed documentation on the inventory of Plant Operating Facilities (POF) and evaluations of NRHP eligibility of those facilities is under preparation. When completed, that documentation would be submitted to the FERC, CNF and the SHPO, in order to seek consensus determinations of eligibility for NRHP listing of POF at the Project.

Consultations with the Custer National Forest, suggest that PPLM would sponsor testing of properties identified in the 2005 inventory, within the Project Boundary, during 2006. This would be followed by consultations towards a consensus of NRHP eligibility among the FERC, Custer National Forest and the Montana SHPO. In addition, assessment of the effects of Project operation, and development of an overall plan to address effects would be undertaken. That assessment will consider effects to PAP and HAP, arising from Project operation, such as the erosion of these types of properties from the normal operational cycles of Project reservoirs, an/or from other, Project-Associated Actions which could be proposed in the future operation of the Project.  The assessment will also consider potential effects to H-A&E properties, which could arise in the future operation of the Project.

All of this would be embodied in the HPMP. The draft HPMP would address the properties as if they had been formally determined eligible for NRHP listing; specify that technical studies for testing and formal evaluation of NRHP eligibility are ongoing; provide an initial assessment of effects, and an initial plan to address effects found. The HPMP would then be amended, as additional tasks are accomplished, with updated information.  The specific measures aimed at addressing the effects of Project operation, would be implemented after FERC relicensing.

# Study No. 6

# Hydrologic Characterization of the West Rosebud Creek Bypass Reach Between Mystic Lake Dam and the Powerhouse – November 2005 update

## Mystic Lake Hydroelectric Project FERC No. 2301

Mystic Lake, Montana

**PPL Montana**
45 Basin Creek Road
Butte, Montana 59701

Prepared by:
**GEI Consultants, Inc.**
127 E. Front Street Ste 216
Missoula, Montana 59802

November 1, 2005

# Table of Contents

# 1.0 Executive Summary

The purpose of this study was to determine the proportion of water released by the fish valve relative to the amount of water that is measured at the upper weir. The upper weir has traditionally been the location where bypass channel flows have been measured to maintain minimum flows for compliance purposes. The question has been raised as to whether or not the flows measured at the lowermost reach of the bypass channel are reflective of the actual flows at the upstream end of the bypass reach. The study presented in this document presents the findings of two summer seasons of analysis of the flows in the bypass reach. The goal of this analysis was to differentiate between the flow emitted by the fish valve vs. flow originating from other sources. This November 2005 update contains supplemental information on fish habitat and fish populations in the bypass reach. This information is found in the discussion section.

Whenever the project is spilling over the dam, there is no need to operate the fish valve since the flows throughout the entire bypass reach are well above the 10 cfs minimum required flow. Based on the analysis, it is evident that fish valve releases in summer months are sometimes low relative to flow from other sources such as leakage, tributary inflows, and other sources. Our evidence for this conclusion is based on the observation that changes in the fish valve position result in highly correlated changes in the observed flow at the upper weir. In many cases, the fish valve is closed for extended periods during summer months when no intentional spill is coming from the dam, but when the lake elevation is above crest. In this case, significant leakage from the flashboards could be responsible for the reduced need for additional fish valve release flows. The data clearly indicate that during the summer, significant portions of the required 10 cfs minimum flows are from origins other than the fish valve. If bypass flows become low enough, as SCADA data has shown, operators will adjust the fish valve to compensate and increase flows to make certain that the 10 cfs minimum flow is sustained, but for most of the summer, the fish valve is often completely closed, and all bypass flow is provided by leakage, tributary inflows and sources other than the fish valve.

No data for wintertime conditions have yet been collected. Flow data from the fish valve and the upper weir will be gathered though the winter of 2005 and into the spring of 2006. An additional analysis will be performed to gauge the proportion of fish valve flows to bypass flows under low flow, low runoff, and low lake elevation conditions. At that point, definitive conclusions about the performance of the fish valve under the full range of operating conditions will be available.

As a result of the habitat and fish surveys were conducted in the bypass reach during 2004. These studies concluded that fish habitat is adequate in the bypass reach, and that rainbow

trout are abundant in this reach. As a result, the Mystic Project fisheries resource group decided that no further fish habitat studies were needed to assess the impacts of the Mystic Dam on the instream habitat or fisheries of the bypass reach.

# 2.0 Bypass Channel Flow Augmentation Facilities

## Introduction

The purpose of this study was to determine the proportion of water released by the fish valve relative to the amount of water that is measured at the upper weir. The upper weir has traditionally been the location where bypass channel flows have been measured to maintain minimum flows for compliance purposes. The question has been raised as to whether or not the flows measured at the lowermost reach of the bypass channel are reflective of the actual flows at the upstream end of the bypass reach. The study presented in this document presents the findings of two summer seasons of analysis of the flows in the bypass reach. The goal of this analysis was to differentiate between the flow emitted by the fish valve vs. flow originating from other sources.

This November 2005 update contains supplemental information on fish habitat and fish populations in the bypass reach. This information is found in the discussion section (section 4.0).

## Description of Project Facilities

The Mystic Lake hydroelectric project consists of a high mountain reservoir, a five-foot diameter steel flow line, a steep penstock and a powerhouse. Water is diverted from the reservoir to the powerhouse via a flow line and penstock. Minimum bypass channel flows of 10 cfs in the summer (June 1 – August 31) and 3 cfs in the winter (September 1 – May 31) are required to maintain compliance. In order to sustain flows in the upper bypass channel, a small valve (called a fish valve) is used to bypass water at the uppermost point of the steel flow line to maintain adequate flows throughout the year.

Figure 1 shows an aerial view of the location where this valve is located. Figure 2 shows a view of the fish valve in operation. This photograph was taken in the afternoon on August 31, 2005. At the time this photograph was taken, the valve was discharging an estimated five cfs of flow. The discharge pipe is 12 inches in diameter. In the background, some flow from the waterfall (also visible in Figure 1) can be seen flowing, although the lake level was below crest elevation when this photograph (Figure 2) was taken. Therefore, all of the flow coming from the waterfall in the background is due to seepage through and under the dam and not to intentional spill.

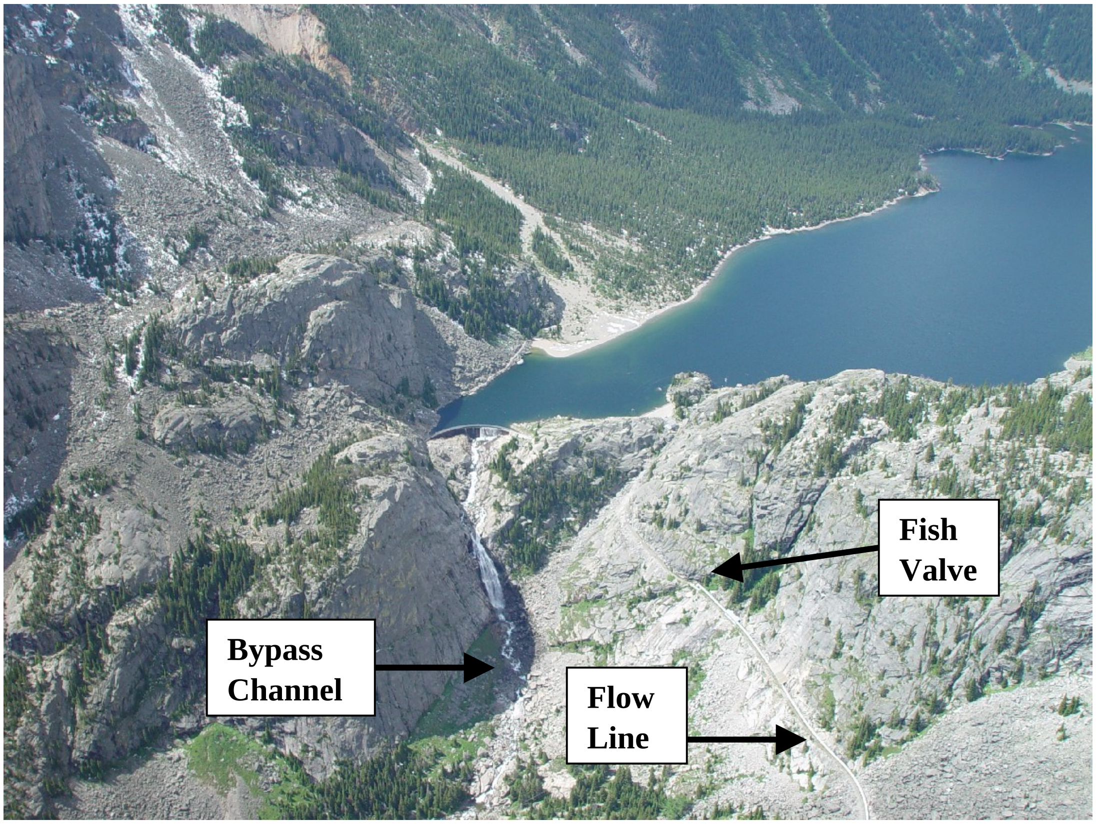


Figure 1

Figure 2

A short distance downstream of the fish valve is Maxie Creek (Figure 3); the largest tributary in the bypass reach. This photograph was taken (August 31, 2005). Numerous other small rivulets supply flow to the upper bypass channel in small amounts. At the bottom end of the bypass channel, a small weir is positioned across the creek and is fitted with a stilling well that contains a vented pressure transducer that allows the differential pressure between the pool depth and atmospheric pressure to be measured. This sensor is regularly polled by the plant PLC and data from these sensor measurements are stored in a database at the plant and on an Internet based database. Determination of the pressure differential allows for depth upstream of the weir to be accurately measured. Using the upstream depth in conjunction with a weir formula allows for the flow aross the weir to be calculated. These calculations are stored by both plant and remote databases for archiving and future analysis.

Figure 4 shows a view of the upper weir at the lowermost reach of the bypass channel. This weir provides accurate measurements of flows at low discharge levels. The PLC records measurements taken at this weir at approximately 10-minute intervals around the clock. These data were collected in the summer of 2004 and from June 2005 to present. All available data were assembled and the relative percent opening of the fish valve was noted. For each data point, the pool elevations at Mystic Lake, and the rate of upper weir flow for each 15-minute interval were noted. A total of 10418 data points were evaluated. In situations where the fish valve flows were adjusted, the changes in flow at the lower weir were observed.  It was assumed that the rapid flow changes observed at the upper weir that exactly corresponded to changes in the percent opening of the fish valve were entirely attributable to the fish valve adjustment.  Hence a means of noting the amount of the position change in the fish valve resulted in a corresponding change in flow at the upper weir.

Figure 3. Maxie Creek

Several independent examples of this were observed, and in each case, identical results were obtained.  From this evaluation, given the available data, it was possible to definitively estimate the amount of flow released by the fish valve during summer months as a function of the pool elevation (at values close to crest), the fish valve percent opening, and the observed flow at the upper weir.

Figure 4. Upper weir on West Rosebud Creek.

# 3.0 Results

Based on the analysis, it is evident that fish valve releases in summer months are sometimes low relative to flow from other sources such as leakage, tributary inflows, and other sources. Our evidence for this conclusion is based on the observation that changes in the fish valve position result in highly correlated changes in the observed flow at the upper weir. In many cases, the fish valve is closed for extended periods during summer months when no intentional spill is coming from the dam, but when the lake elevation is above crest (Figure 5). In this case, significant leakage from the flashboards could be responsible for the reduced need for additional fish valve release flows. The data clearly indicate that during the summer, significant portions of the required 10 cfs minimum flows are from origins other than the fish valve. If bypass flows become low enough, as SCADA data has shown, operators will adjust the fish valve to compensate and increase flows to make certain that the 10 cfs minimum flow is sustained, but for most of the summer, the fish valve is often completely closed, and all bypass flow is provided by leakage, tributary inflows and sources other than the fish valve.

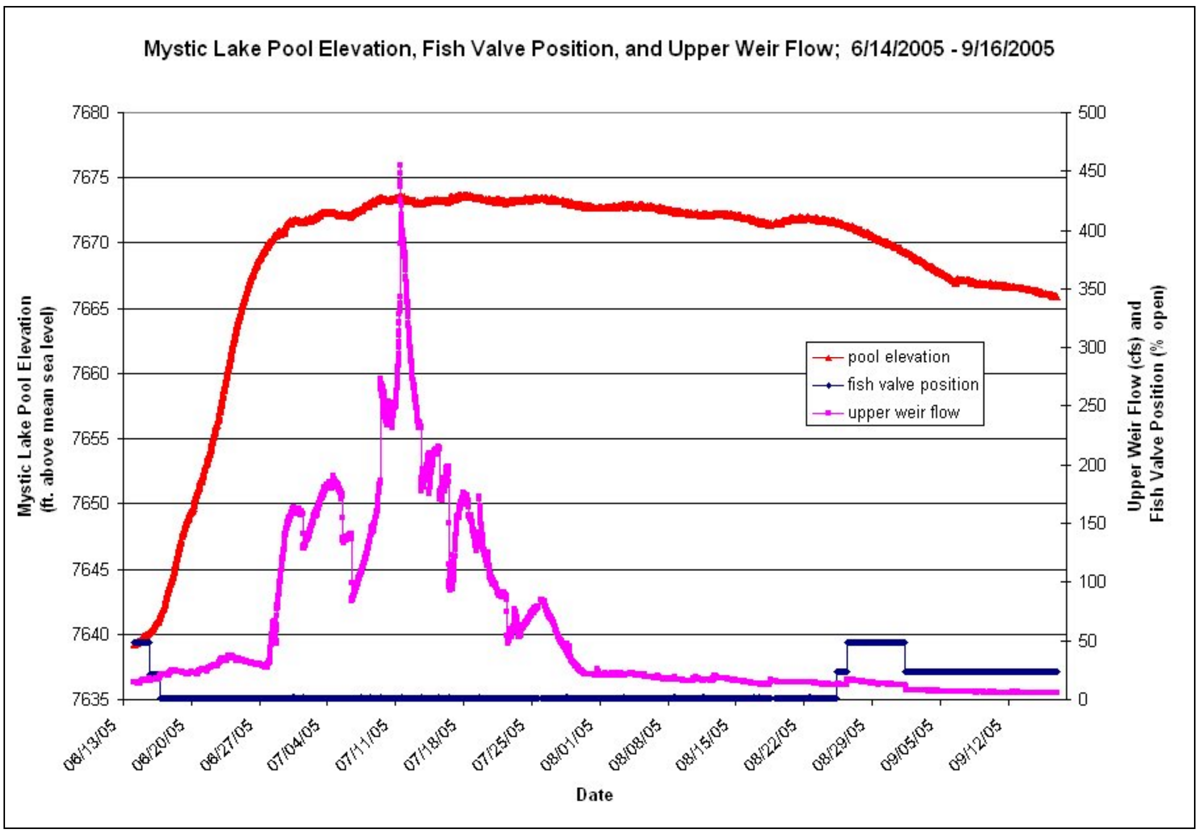


Figure 5

A series of responses to fish valve adjustments were analyzed to estimate the amount of change in flow that was experienced due to a change in fish valve position. It is notable that in many cases, the fish valve would be completely closed, so that all flow in the upper bypass channel was due to tributary influx, or subduction of flows under or through the dam. Cases where the dam was spilling are automatically excluded from the observation set because the fish valve is never open during spill events. Figure 5 shows the data set for the summer of 2005. Figure 6 shows a close-up view of the area in the lower right side of Figure 5 at the point where the fish valve was opened. This is one of two examples where the positions of the fish valve were changed from zero to 25% and then from 25% to 50% open and then back down from 50% to 25%. Flows at the lower weir were measured and the changes in flow were calculated.

At the point where the fish valve is opened from fully closed to 25% open, the change noted at the lower weir was 0.83 cfs. The valve was opened from 25% to 50% a short time later, with a resulting change in flow at the lower weir of 4.11 cfs. When the valve was later closed back down to 25% from the original 50%, the corresponding decrease in flow at the lower weir was 4.2 cfs; almost exactly the same amount of decrease as was yielded by the increase when the valve was opened by that amount earlier on. Based on these resultant changes in flow, it can be concluded that when the fish valve was first opened from 0% to 25,

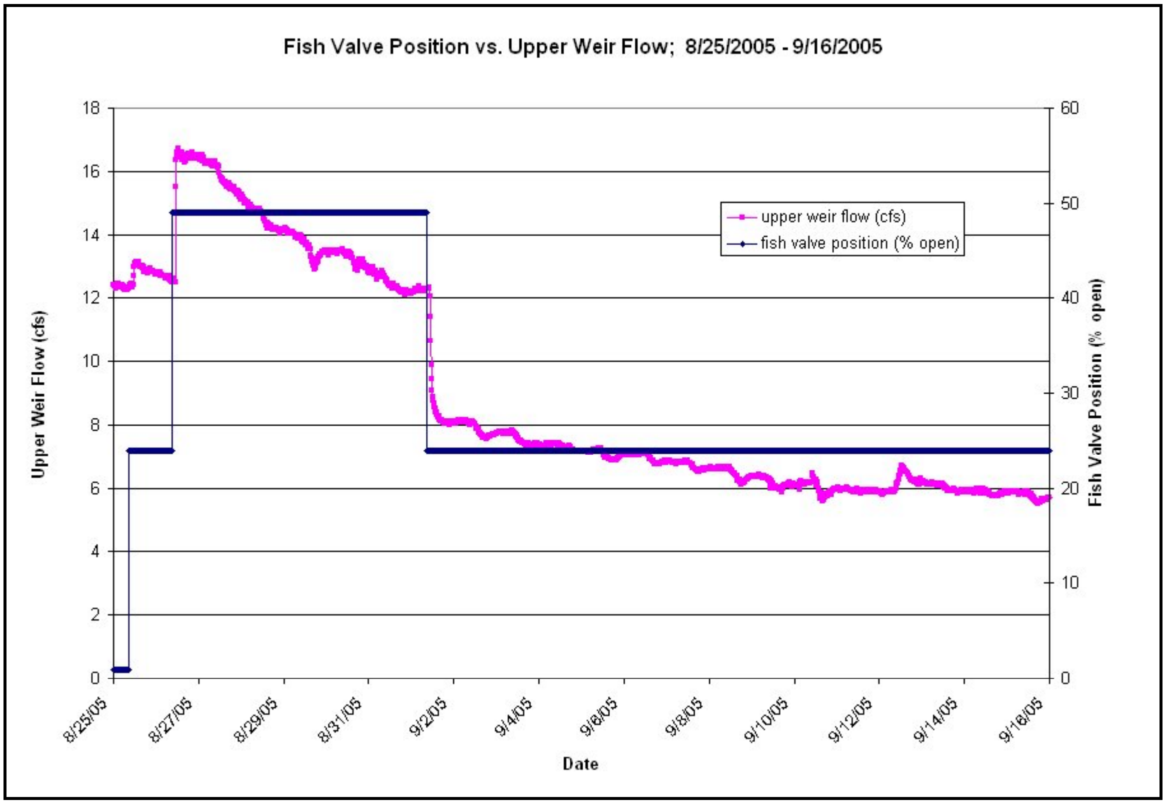


Figure 6

the contribution to flow in the bypass channel was initially zero. The increase in flow that occurred was about 0.83 cfs, because the river flow rate at the upper weir changed from 12.3 to 13.13 cfs. This represents 0.49% of the total flow at the upper weir. When the fish valve was soon opened further to 50% open, the change in flow at the upper weir went from 12.59 to 16.7 cfs. This represents a change in flow of 4.11 cfs when changing the valve from 25% open to 50% open. Adding the 0.83 cfs for the 0 to 25% portion brings the total flow through the valve to 4.94 cfs. Since the total flow at the upper weir was measured at 16.7 cfs, the percentage at that point coming through the fish valve was 29.6% of the total bypass channel flow. The effect was nearly identical later on when the valve was closed back down from 50% open to 25% open. In that case, the flow rate decreased from 12.3 to 8.1 cfs, which totals a drop of 4.2 cfs, nearly identical to the 4.11. cfs increase observed during the opening from 25% to 50%.

Figure 7 shows the responses when during fish valve position changes made in 2004. In this case, the valve was adjusted between fully closed and openings up to 65%. This time, the change from 0% open to 25% open resulted in a flow increase from 12.09 to 12.87 (0.78 cfs). When the valve was opened from 25% to 50%, the flow increase changed from 12.46 to 16.56 cfs (4.1 cfs). These are practically identical to the results obtained in 2005. Increasing the valve opening from 50% to 65% cased a flow increase from 11.75 to 14.3 cfs (2.55 cfs) for a total flow through the fish valve of 7.43 cfs; or approximately 52% of the total bypass channel flow when the fish valve is 65% open.

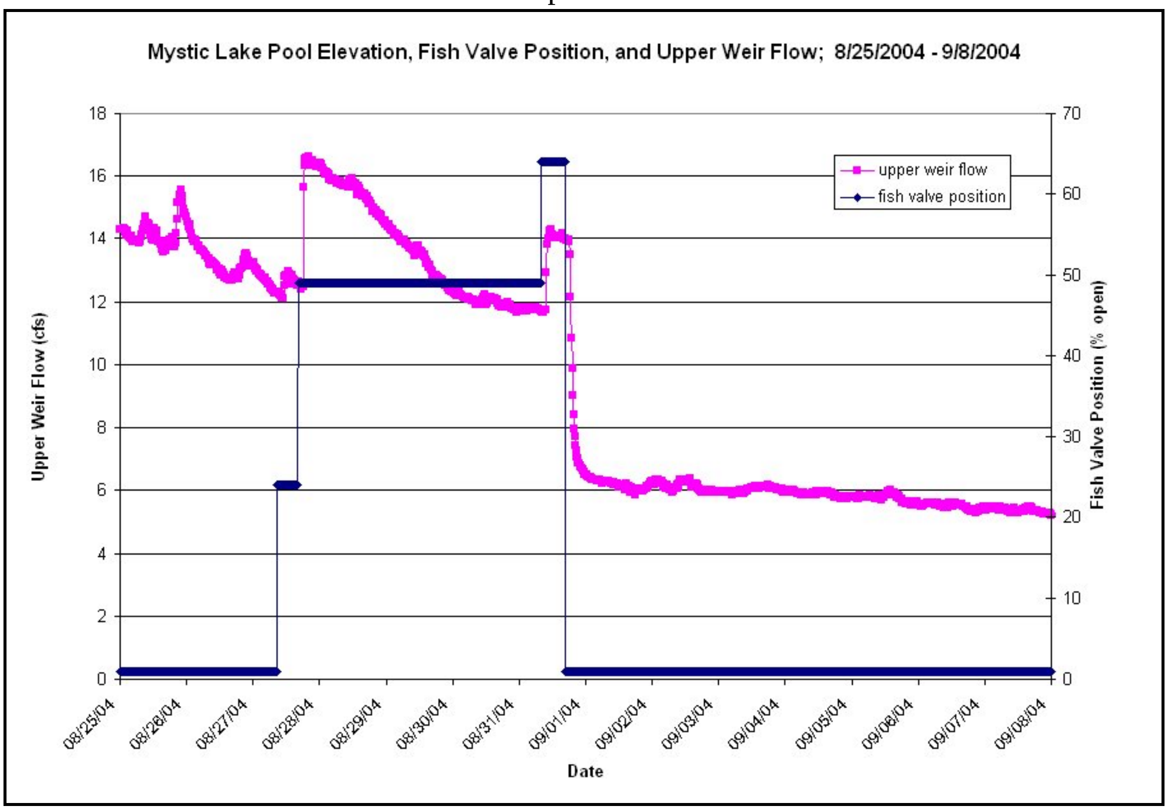


Figure 7

Based on these results, a chart was constructed to display the observed relationship between the valve setting and the resulting discharge at near full pool lake elevations. This chart appears in Figure 8.  No data for winter months have yet been collected, so we will need to evaluate the performance of the fish valve under wintertime conditions at low lake elevations and at a variety of fish valve position settings.

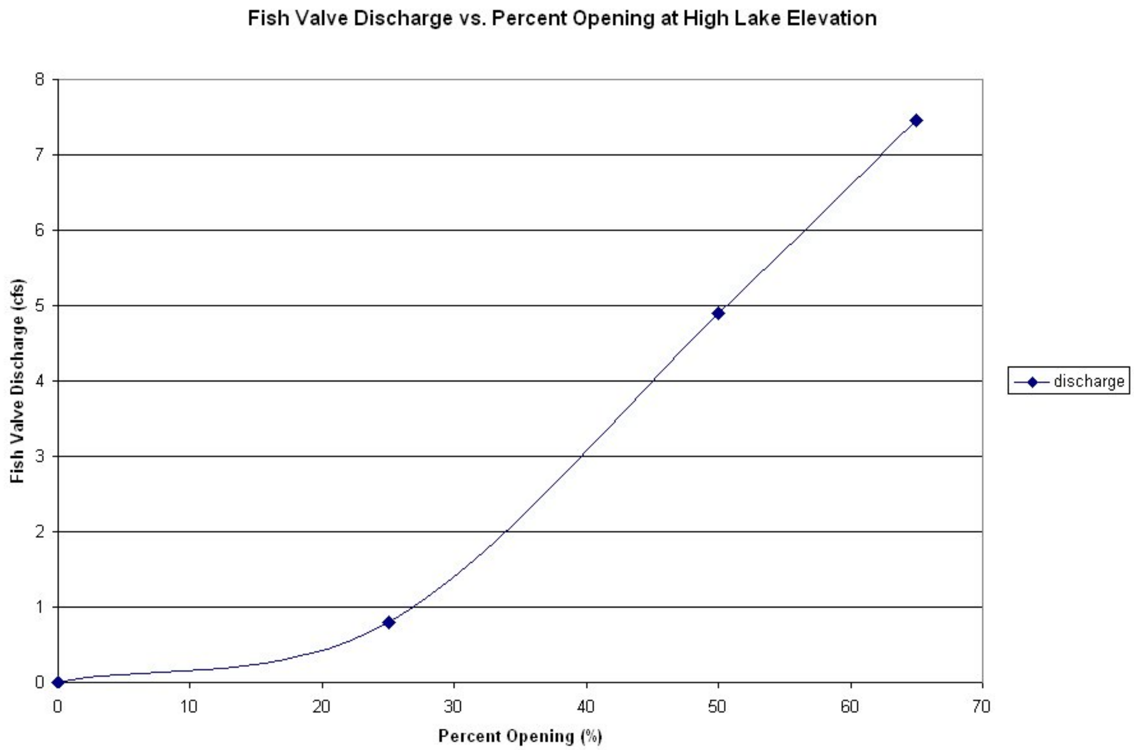


Figure 8

Since no data for wintertime conditions have yet been collected, flow data from the fish valve and the upper weir will need to be gathered though the winter of 2005 and into the spring of 2006. At that point, a second analysis will be performed to gauge the proportion of fish valve flows to bypass flows under low flow, low runoff, and low lake elevation conditions. At that point, definitive conclusions about the performance of the fish valve under the full range of operating conditions will be available.

# 4.0 Discussion

This study was undertaken because of a concern about flow in West Rosebud Creek, and the fish and fish habitat that inhabit this reach of stream. Additional studies have been done to address this question directly, with the results found in the 2005 *Mystic Lake Final Study Plan* (FSP) delivered to the FERC on March 1, 2005. The FSP contained the final report for Study No. 5 *Mystic Project Effects on West Rosebud Creek Bypass Reach Habitat and Fish Populations*. During this study the West Rosebud Creek bypass channel was broken into three general sections, one at the lower elevation near the PPL Montana powerhouse, one in the middle of the bypass channel, and one in the upper elevations closer to the Mystic Dam. Both cross sectional and longitudinal surveys were made during varying flows. Two pools were surveyed in each section with two separate cross sectional transects surveyed within each pool during the various flows. Flow was measured at the upper weir just upstream of the powerhouse and at each site with a pygmy current meter. A photographic tour of each site at differing flows was also compiled during the study. The photographs were taken at the same location looking in the same direction at differing flows, therefore giving visual perspective of how the aquatic habitat changes with varying discharge.

Fish sampling by means of backpack electrofishing also occurred in the same three sections that were surveyed for habitat on August 3 and 4, 2004 and a modified USFS R1/R4 habitat survey was conducted in the bypass reach on November 3 and 3, 2004. Three larger study sections were sampled, one beginning at the upper weir just upstream of the powerhouse to the downstream end of the bedrock gradient barrier, the second from the hiking trail bridge upstream to the upper end of the previously surveyed middle habitat section, and from the upstream end of the previously surveyed upper habitat section upstream of Maxie Creek, near the base of the Mystic Dam.

The cross sectional, longitudinal, and the modified R1/R4 habitat surveys indicated that during low flow periods sufficient depth occurs within pools to over winter rainbow trout. In addition, the average depths of the riffles are most likely adequate for the movement of rainbow trout between habitat units. The fish sampling data is a good indicator of the overall quality of the instream habitat for trout.

Rainbow trout are found in high abundance within all sections of the bypass reach. Extrapolated estimates of abundance for rainbow trout in the bypass reach ranged from 242 to 435 fish per 100 m of stream. An estimate of 4,883 fish per mile was calculated for the middle section, which is the highest estimate of density for trout that MFWP has estimated for all the streams they monitor in Region 5 (Jim Olsen, MFWP Region 5 fish biologist, Personal Communication September 28, 2004). Although these fish are not large, that is to be expected since the bypass reach is a steep gradient stream at a high elevation. Due to the combined results of the habitat and fish surveys conducted in the bypass reach during 2004, the Mystic Project fisheries resource group decided that no further studies were needed to assess the impacts of the Mystic Dam on the instream habitat or fisheries of the bypass reach. For further detail please see the Mystic FSP.

Only a limited amount of flow data was collected during study number 5, but these data indicate that flows increase in a downstream direction within the bypass. This information agrees with the results of this investigation that, at some times of the year, the fish valve provides a relatively small proportion of the flow in the bypass reach. However, adequate flows are present in all portions of the bypass reach to provide for healthy fish habitat and fish populations.

# Study No. 7

## Water Temperature Monitoring in the Mystic Lake Project Area – November update

## Mystic Lake Hydroelectric Project FERC No. 2301

Mystic Lake, Montana

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Prepared by:
**GEI Consultants, Inc.**
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November 1, 2005

# Introduction

The Pre-Application Document (PAD) filed by PPL Montana on July 1, 2004 describes the existing information about the Mystic Lake Project. The physical and chemical parameters of the water in the Mystic Lake Project are described in Section 3.2.3 of that document. Water temperature information was available for Mystic Lake, West Rosebud Lake, and Emerald Lake and that information is summarized in the PAD. However, water temperature data for West Rosebud Creek was not available.

The existing data on the lakes do not indicate the project is creating water temperature problems. However, the Resource Work Groups expressed an interest in gathering water temperature data on West Rosebud Creek to verify the Project is not having a detrimental impact on water temperature.

In 2004 PPL Montana monitored water temperatures throughout West Rosebud Creek from Mystic Lake to its confluence with East Rosebud Creek. Optic Stowaway thermographs were placed in a total of 8 locations including: Mystic Lake penstock intake, above powerhouse, below powerhouse, below West Rosebud Lake, Emerald Lake Outlet, West Rosebud Creek at Allen Grade Bridge (approximately three miles above Fiddler Creek), West Rosebud Creek above the confluence with East Rosebud Creek at the Rosebud Isle Fishing Access Site, and East Rosebud Creek above the confluence with West Rosebud Creek at the 419 Bridge Crossing.

A report on the 2004 water temperature monitoring was prepared and submitted to the FERC in March 2005. This report concluded that summer water temperatures are generally in the preferred range for salmonids in West Rosebud Creek within the project area. The maximum temperatures recorded in the bypass reach (above powerhouse), below the powerhouse, and below West Rosebud Lake were approximately 15$^{o}$C. There is no indication that the Mystic Lake Hydroelectric Project is causing water to warm to a level that could pose any danger to salmonids at any location.

The 2005 Mystic Lake Hydroelectric Project study plan number 7 called for continuing water temperature data collected through 2005. The initial report on the 2005 water temperature study was submitted to the FERC on October 3, 2005. This November update contains additional data on water temperature in the upper bypass reach that was not available in time for the October 3 report. In addition, it contains an expanded literature review on salmonid response to water temperature, prepared in response to questions raised by the stakeholder group.

# Methods

PPL Montana installed thermographs in 7 locations including: above the powerhouse, below the powerhouse, below West Rosebud Lake, at Emerald Lake Outlet, West Rosebud Creek at Allen Grade Bridge (approx. three miles above Fiddler Creek, also known as the section 2 bridge), West Rosebud Creek above the confluence with East Rosebud Creek, and East Rosebud Creek above the confluence with West Rosebud Creek. In addition, a thermograph was installed at the upstream end of the bypass reach, in the same area where stream habitat data are being collected. This thermograph was installed in the fall of 2004 and retrieved in September 2005. This thermograph was installed in response to a request by the U.S. Forest Service to gather data about fall and winter water temperatures in the bypass reach.

Thermographs were set to collect half-hourly data (Figure 1). The thermographs were installed around May 3 and removed around September 16, 2005 (dates varied slightly at different sites). The bypass reach thermograph collected data from September 30, 2004 until September 30, 2005. The thermograph installed in Mystic Lake is still in place as of this writing (November 1, 2005). An attempt to recover this thermograph in October 2005 was unsuccessful, and the thermograph may be lost. Another attempt will be made to recover the data in the spring of 2006, however the data may be lost.

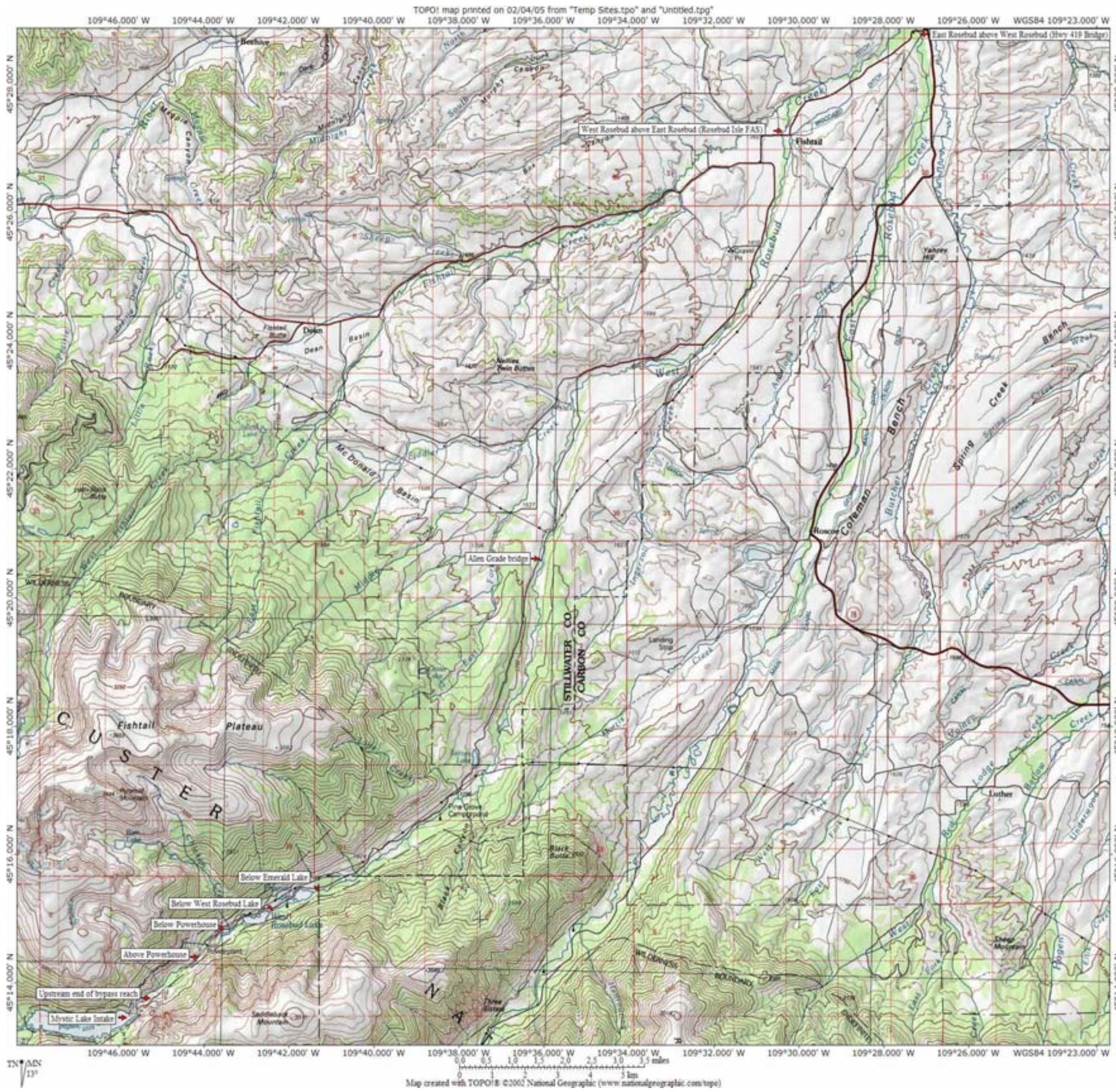


**Figure 1. Location of thermographs for the 2005 water temperature study in the Mystic Lake Project area.**

# Results

Water temperatures were collected in East Rosebud Creek to provide a comparison to West Rosebud Creek. The East Rosebud Creek drainage is similar to the West Rosebud Creek drainage in terms of geology, size, aspect, and the presence of lakes. However, East Rosebud Creek does not contain a hydroelectric plant. This makes comparisons to East Rosebud Creek helpful in potentially describing hydropower impacts.

The temperature of East Rosebud Creek measured at the 419 Bridge, upstream of the confluence with West Rosebud Creek, is depicted in Figure 2.

In 2004, the temperature of East Rosebud Creek fluctuated during May, with the coldest temperatures occurring during mid-May, then gradually warmed from the end of May through July. Peak temperatures occurred late July. The warmest water temperature recorded between May 3 and September 18 was 22.14$^{o}$C, which occurred on July 23 and 31. The coldest water temperature, 3.39$^{o}$C, occurred on May 11 and 12. Temperatures in excess of 20$^{o}$C occurred occasionally, but were short in duration.

The temperature of West Rosebud Creek is depicted in Figure 3. In 2004, the temperature of West Rosebud Creek followed the same general seasonal pattern between May 3 and September 18 as the temperature of East Rosebud Creek. Peak water temperature occurred on July 21, 2005 in West Rosebud Creek at 20.52 $^{o}$C. The coldest water temperature at this site on West Rosebud Creek during the period of record was 1.22$^{o}$C, which occurred on May 11. Temperatures in excess of 20$^{o}$C were uncommon and short in duration.

In order to make a direct comparison between water temperature in the two streams, the difference between their temperatures was calculated and plotted in Figure 4.

The water temperature of the two streams was very similar throughout the measurement period. During May, East Rosebud Creek was generally warmer than West Rosebud Creek by up to 3$^{o}$C, except at the end of the month when West Rosebud Creek was warmer by about 1 – 2$^{o}$C. During the first half of June, East Rosebud Creek was slightly warmer than West Rosebud Creek by from 0 – 1$^{o}$C. During the second half of June, West Rosebud Creek was warmer than East Rosebud Creek by 1 – 2.5$^{o}$C. During the remainder of the measurement period, East Rosebud Creek was warmer than West Rosebud Creek. Only on rare occasions was the temperature difference between the two streams in excess of 2$^{o}$C, and the temperature difference on any given day never exceeded 3$^{o}$C.

The next upstream temperature monitoring site on West Rosebud Creek was at the Allen Grade Bridge, also known as the Section 2 bridge (Figure 5). This site is approximately three miles upstream of Fiddler Creek and approximately nine miles upstream of the confluence with East Rosebud Creek.

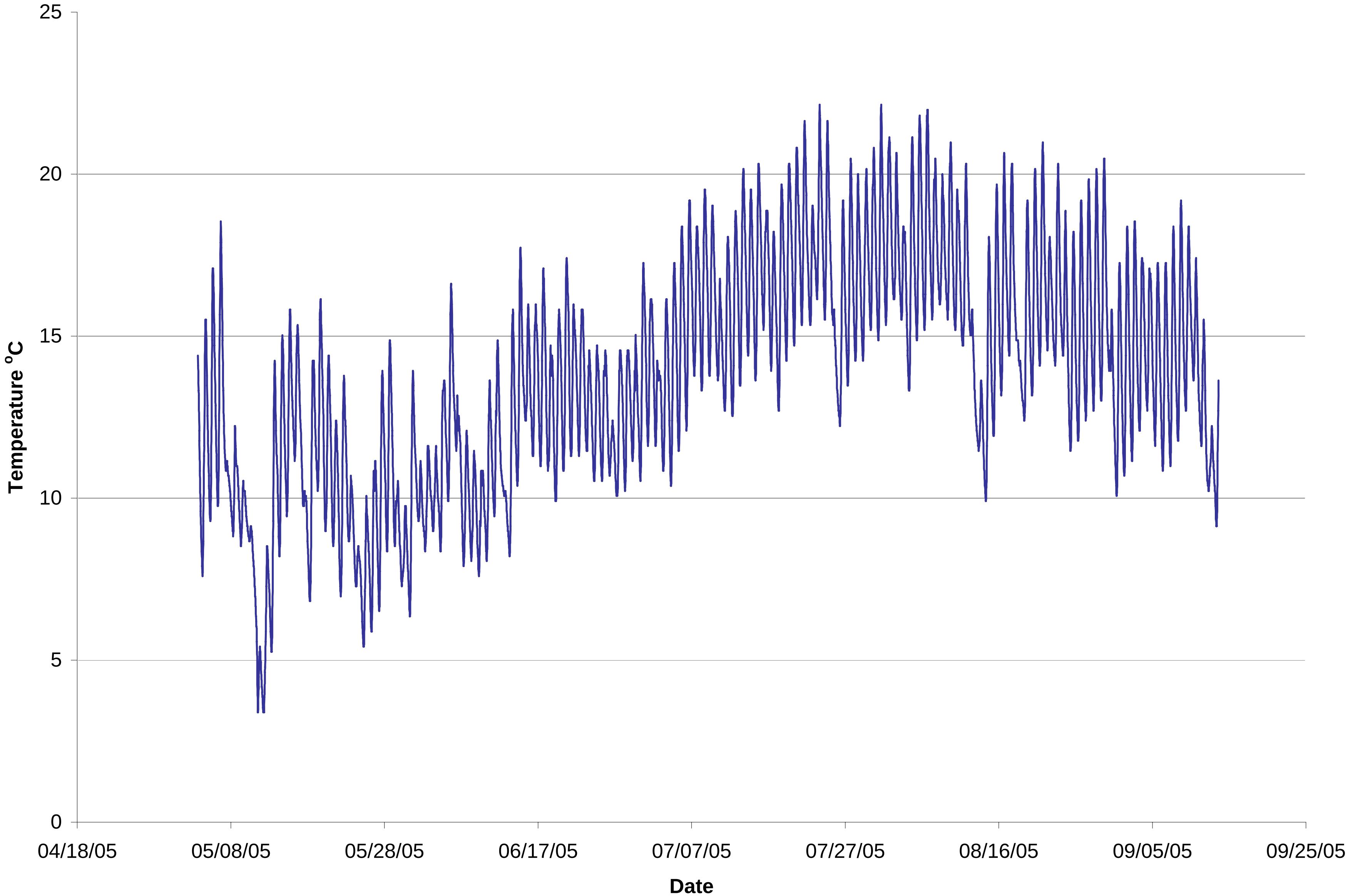


Figure 2. Temperature of East Rosebud Creek measured at the Highway 419 Bridge, just upstream of the confluence with West Rosebud Creek.

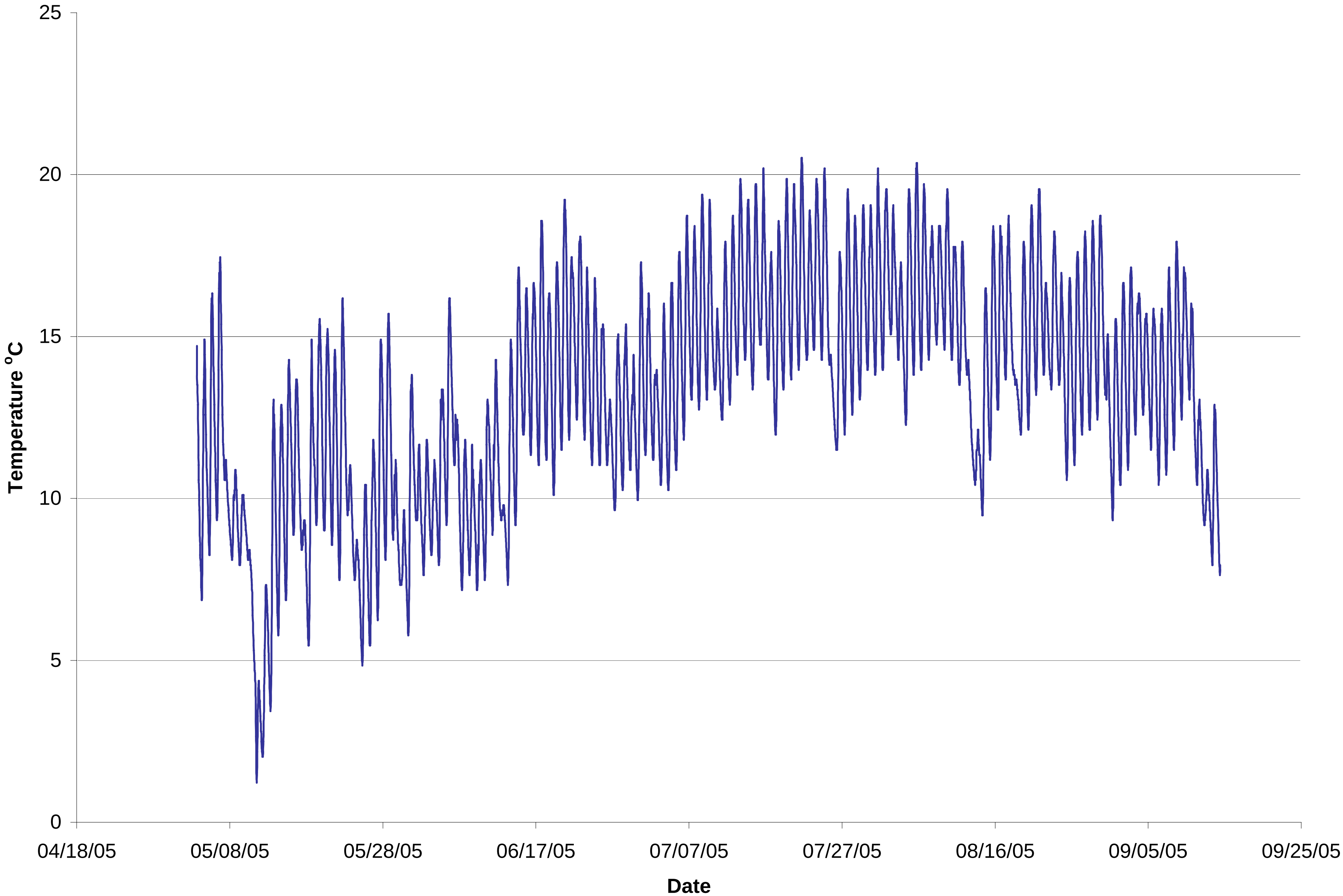


Figure 3. Water temperature of West Rosebud Creek measured at the Rosebud Isle Fishing Access Site, just upstream of the confluence with East Rosebud Creek.

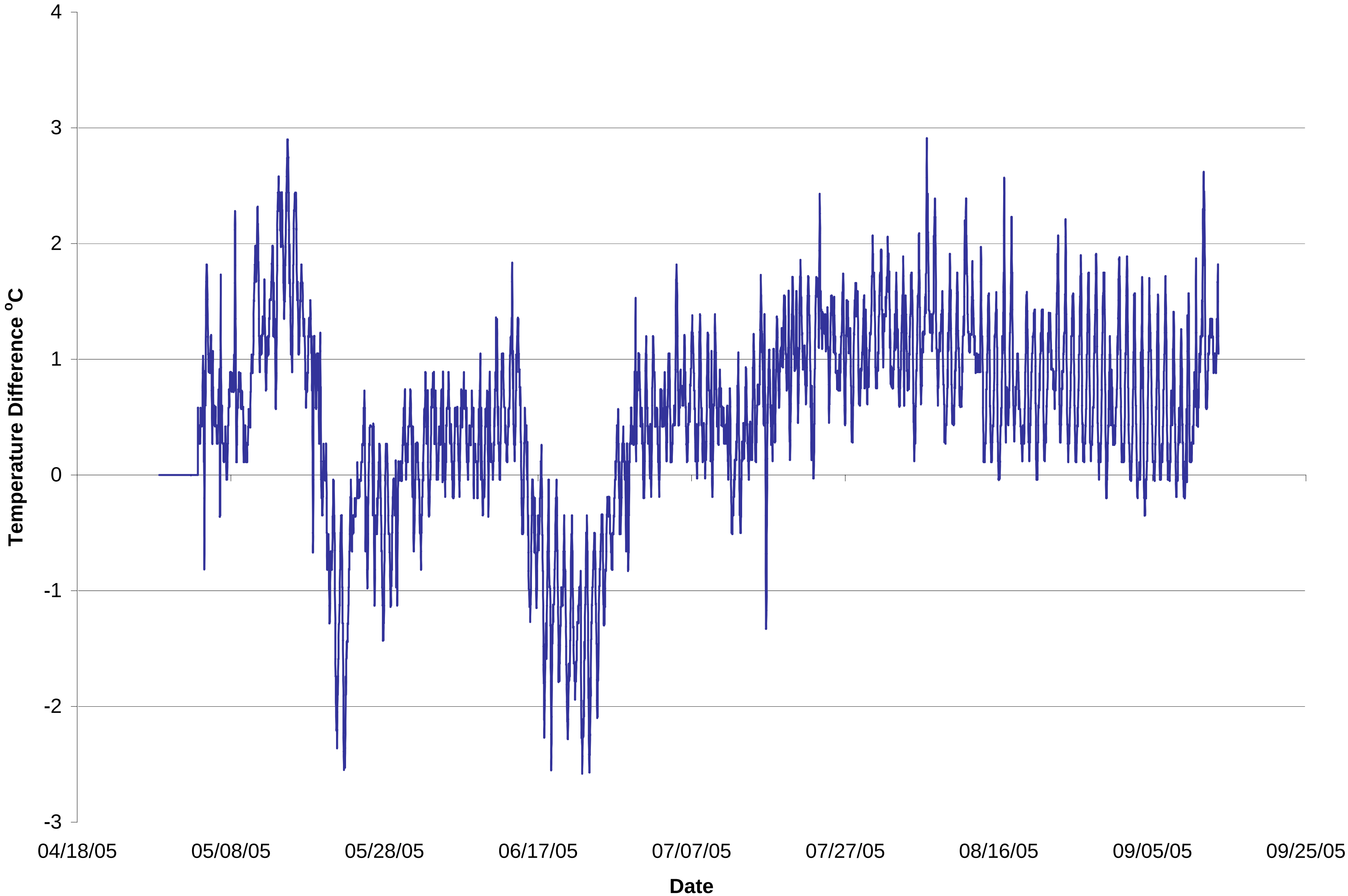


Figure 4. Water temperature difference between East Rosebud Creek (at Hwy 419 Bridge) and West Rosebud Creek (at Rosebud Isle FAS) for a given date and time. Values above zero indicate that East Rosebud Creek was warmer. Values less than zero indicate that West Rosebud Creek was warmer.

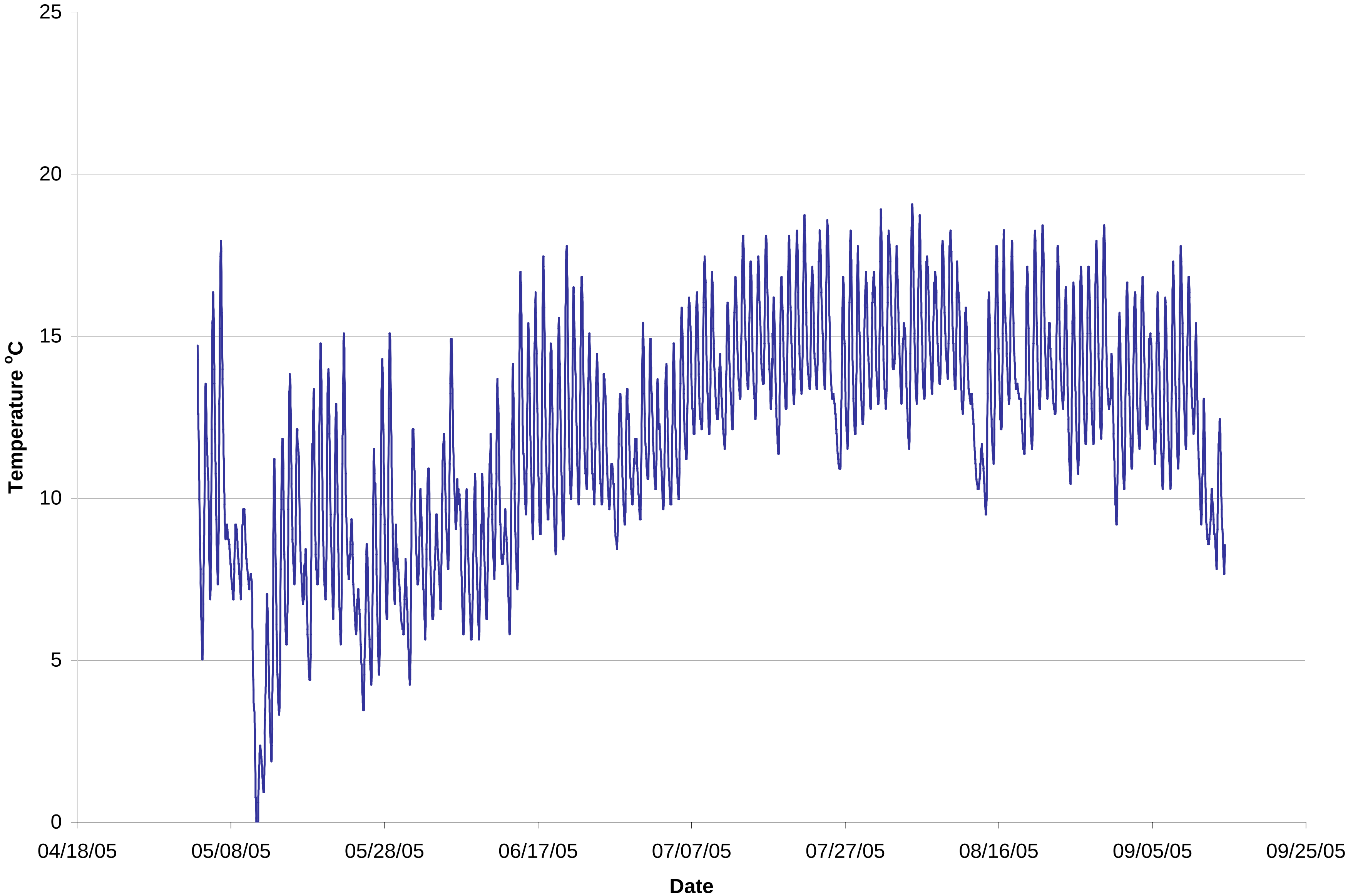


Figure 5. Water temperature of West Rosebud Creek measured at the Allen Grade Bridge (Section 2 Bridge), approximately three miles above the confluence with Fiddler Creek and approximately nine miles above the confluence with East Rosebud Creek.

In 2004, the temperature of West Rosebud Creek at the Allen Grade Bridge (also known as the Section 2 bridge) also followed the same general seasonal pattern as the temperatures measured further downstream. Peak temperatures occurred during early August. The warmest water temperature recorded between May 3 and September 18 was 19.07°C, which occurred on August 4. The coldest water temperature was –0.02°C, which occurred on May 11. Temperatures did not exceed 20°C.

In order to make a direct comparison between water temperature in the two lower measuring sites on West Rosebud Creek, the difference between their temperatures was calculated and plotted in Figure 6.

It is clear from Figure 6 that water temperatures in West Rosebud Creek warm as the stream moves downstream from the Allen Grade Bridge. Only on rare occasions is the water warmer at the upstream measuring site. Generally, the difference in temperature between the two sites ranges from 0 to 3°C, although there were a few events in May and June when the downstream site was warmer by > 4°C. It is not unusual or unexpected for a stream to be warmer in downstream reaches if the stream is exposed to solar radiation as it moves downstream.

The next upstream measurement site was downstream of Emerald Lake. Temperatures in West Rosebud Creek at that location are depicted in Figure 7.

Water temperature in West Rosebud Creek below Emerald Lake was clearly colder than downstream reaches of West Rosebud Creek, staying well below 18°C at all times during 2004. Maximum temperature was 16.48°C on August 4 and 5. Minimum water temperature during the measurement season (May – September) was 1.22°C on May 11.

The next upstream measurement site on West Rosebud Creek was downstream of the re-regulating dam on West Rosebud Lake. As a part of the water quality monitoring study, a DataSonde® 4 water quality multi probe data logger, manufactured by Hydrolab®, was used to measure turbidity (nephelometric turbidity units (NTU)), temperature (C), and dissolved oxygen (mg/l) in three locations within the Mystic Project Area. The unit in West Rosebud Lake was deployed from June 15, 2005 – August 2, 2005. The water temperature data from the West Rosebud Lake Hydrolab and the below West Rosebud Lake Optic Stowaway thermograph are depicted in Figure 8.

The water temperatures in West Rosebud Lake and below West Rosebud Lake were nearly identical during the period when both sites had temperature recorders in place (June 15, 2005 – August 2, 2005). This result confirms that the instruments were recording water temperature accurately. The maximum water temperature below the re-regulating dam was 14.93°C on July 23 and August 1 (Figure 8). The minimum water temperature during the period of measurement (May – September 2004) at the below West Rosebud Lake site was 1.56°C on May 12 and 13. This site has noticeably colder water temperature than the site downstream of Emerald Lake, indicating that the broad surface area of Emerald Lake (a natural lake, not a part of the Mystic Hydropower project) results in warming of water temperatures. In addition, water temperature below

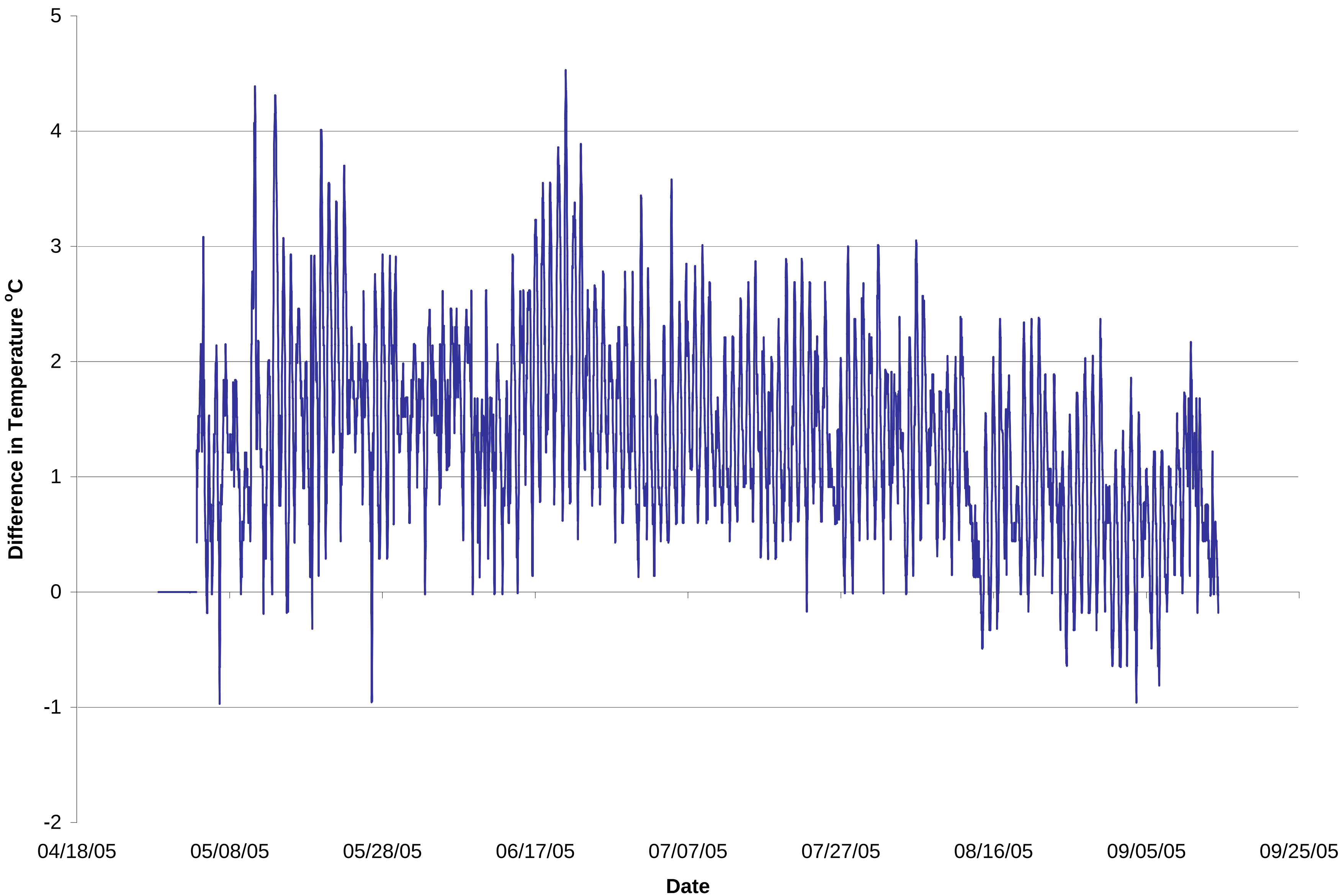


Figure 6. Water temperature difference between West Rosebud Creek at Rosebud Isle FAS and West Rosebud Creek at Allen Grade Bridge for a given date and time. Values above zero indicate that West Rosebud Creek at Rosebud Isle FAS was warmer than water temperature at the Allen Grade Bridge on the same date and time. Values less than zero indicate that West Rosebud Creek at Allen Grade Bridge was warmer.

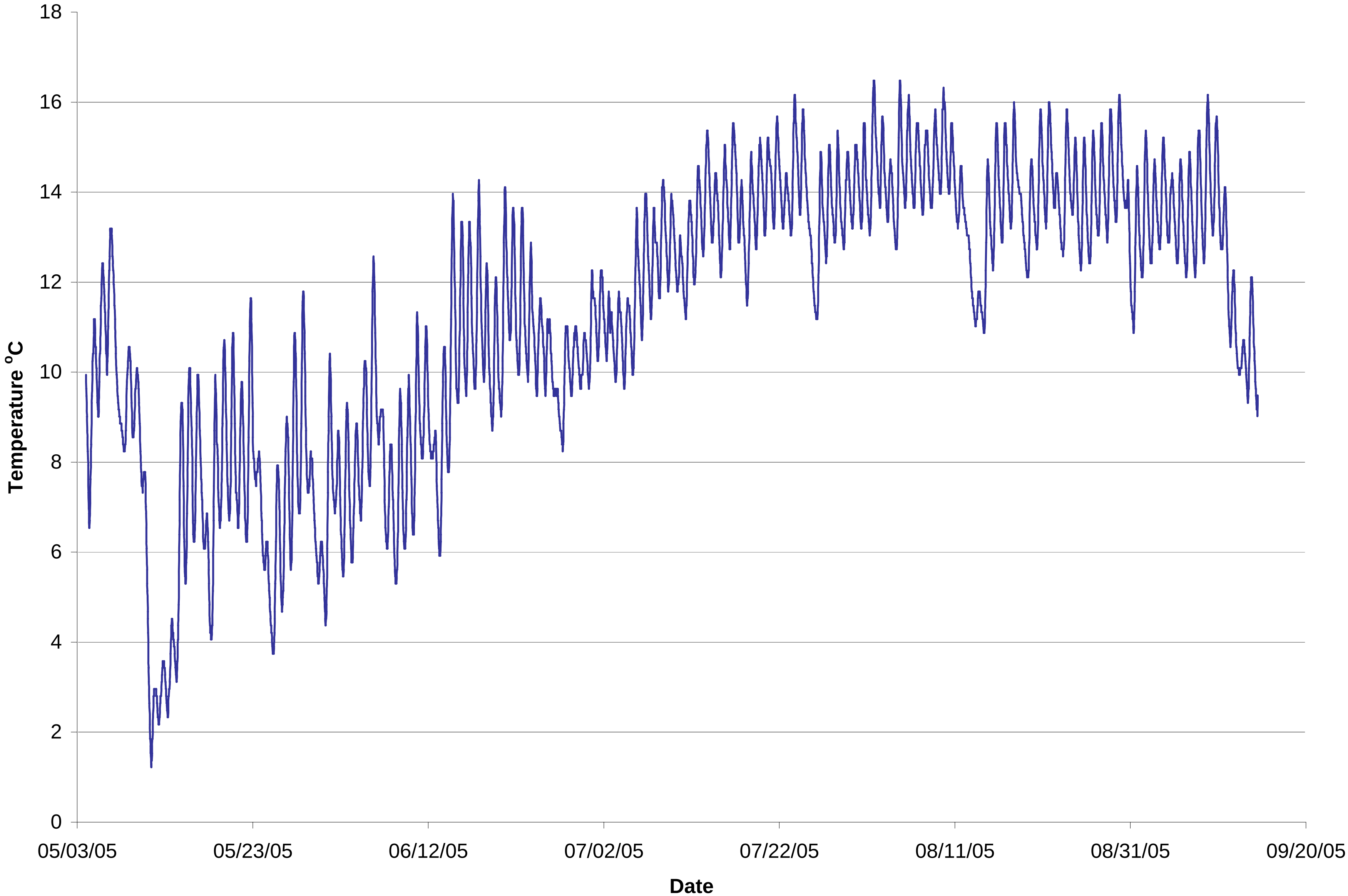


Figure 7. Water temperature measured below Emerald Lake in 2005.

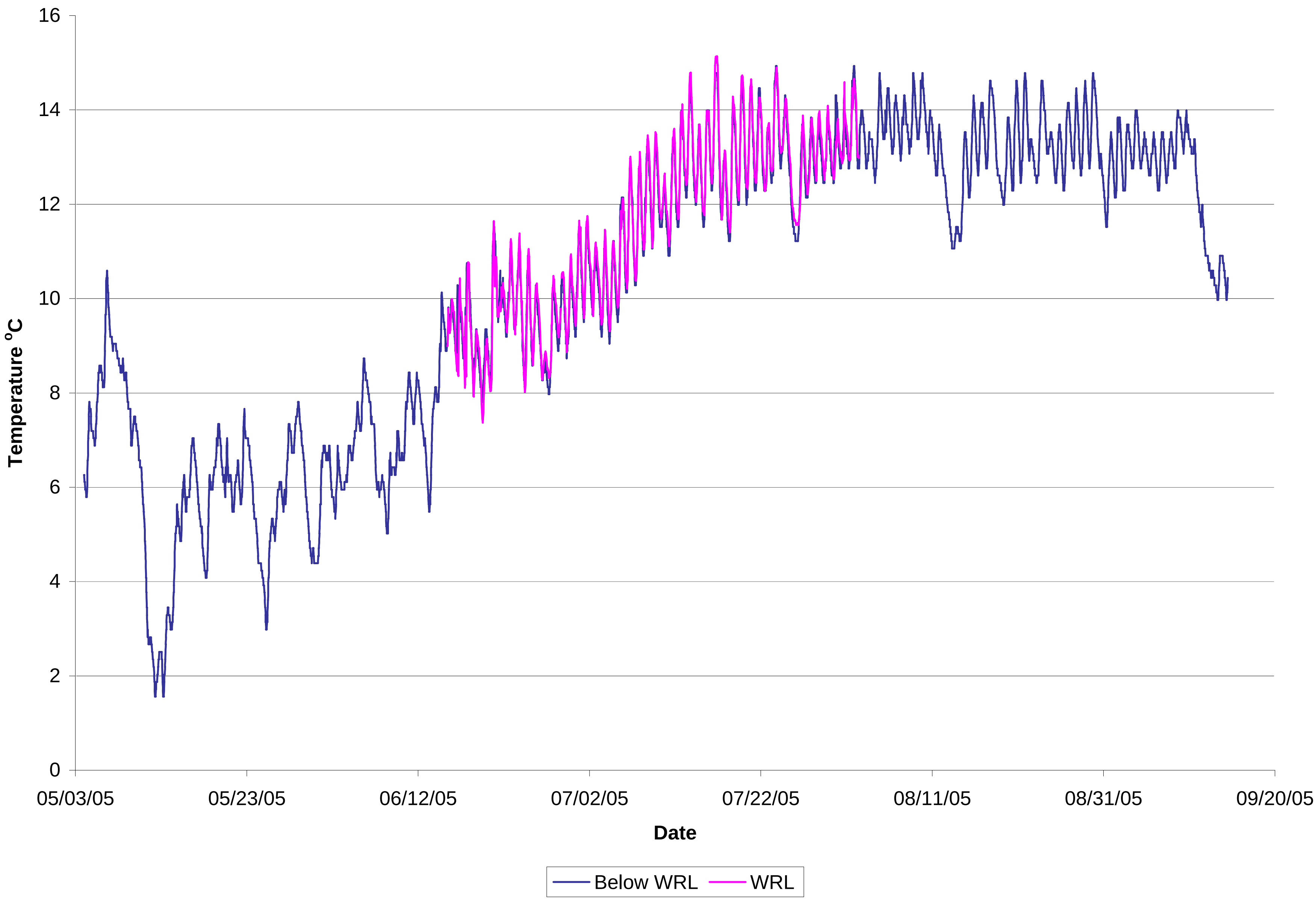


Figure 8. Water temperature of West Rosebud Creek below re-regulating dam on West Rosebud Lake and water temperature as measured in West Rosebud Lake.

West Rosebud Lake appears to fluctuate less over a diel cycle than in downstream areas. That is, there is less of a difference between day and night temperatures in water temperatures in and below West Rosebud Lake than below Emerald Lake.

The temperature difference between water exiting West Rosebud Lake and water exiting Emerald Lake is further illustrated in Figure 9.

As can be seen in Figure 9, water exiting Emerald Lake fluctuates in temperature between day and night a great deal more than water existing West Rosebud Lake. Water below Emerald Lake is generally between 0 – 4$^{o}$C warmer than water below West Rosebud Lake. Later in the summer and into September, nighttime water temperatures are approximately equal or can be 1$^{o}$C cooler below Emerald Lake than nighttime water temperatures below West Rosebud Lake. During peak runoff, the difference in temperature of the water exiting the two lakes is less than at other times of the year. During high flows retention times decrease, resulting in less warming of the water in Emerald Lake relative to West Rosebud Lake.

Average daily water temperature for the four downstream-most sites on West Rosebud Creek and the East Rosebud Creek site are plotted in Figure 10. This figure illustrates how water temperature gradually warms downstream of the Mystic Hydroelectric Project. In addition, it is apparent that East Rosebud Creek near the mouth is approximately the same temperature, or a little warmer, than West Rosebud Creek near the mouth.

Water temperature measured below the powerhouse (at the lower weir) is depicted in Figure 11. Water at this site comes from a mixture of 1) water drawn from Mystic Lake and passed through the flowline and penstock and through the powerhouse, 2) spill (when Mystic Lake is at full pool), 3) water released from the “fish valve” and passed down the bypass channel, 4) tributary inflow below Mystic Lake, and 5) any groundwater inflow and seepage. As shown in Figure 11, in 2005 water temperature at this location was consistently below 15$^{o}$C throughout the summer months.

The difference in temperature between water exiting from West Rosebud Lake and the water exiting the powerhouse is depicted in Figure 12. From the middle of June through the middle of September, the water temperature at each site was within 1 – 2$^{o}$C of each other. Earlier in the spring (early May though mid-June), water temperatures were warmer coming out of West Rosebud Lake than the powerhouse.

In Figure 13, water temperature from three sites is compared, the below powerhouse site, below West Rosebud Lake site, and the Emerald Lake site. It is apparent that water temperature increased in a downstream direction, and that water temperatures fluctuate less between day and night during the peak runoff.

Water temperature measured above the powerhouse, at the upper weir, is displayed in Figure 14. The warmest temperature recorded at this site was 15.56$^{o}$C, measured on July 23, 2005. The coldest water temperature between May 3 and September 18 was -0.04$^{o}$C, measured on May 11, 2005.

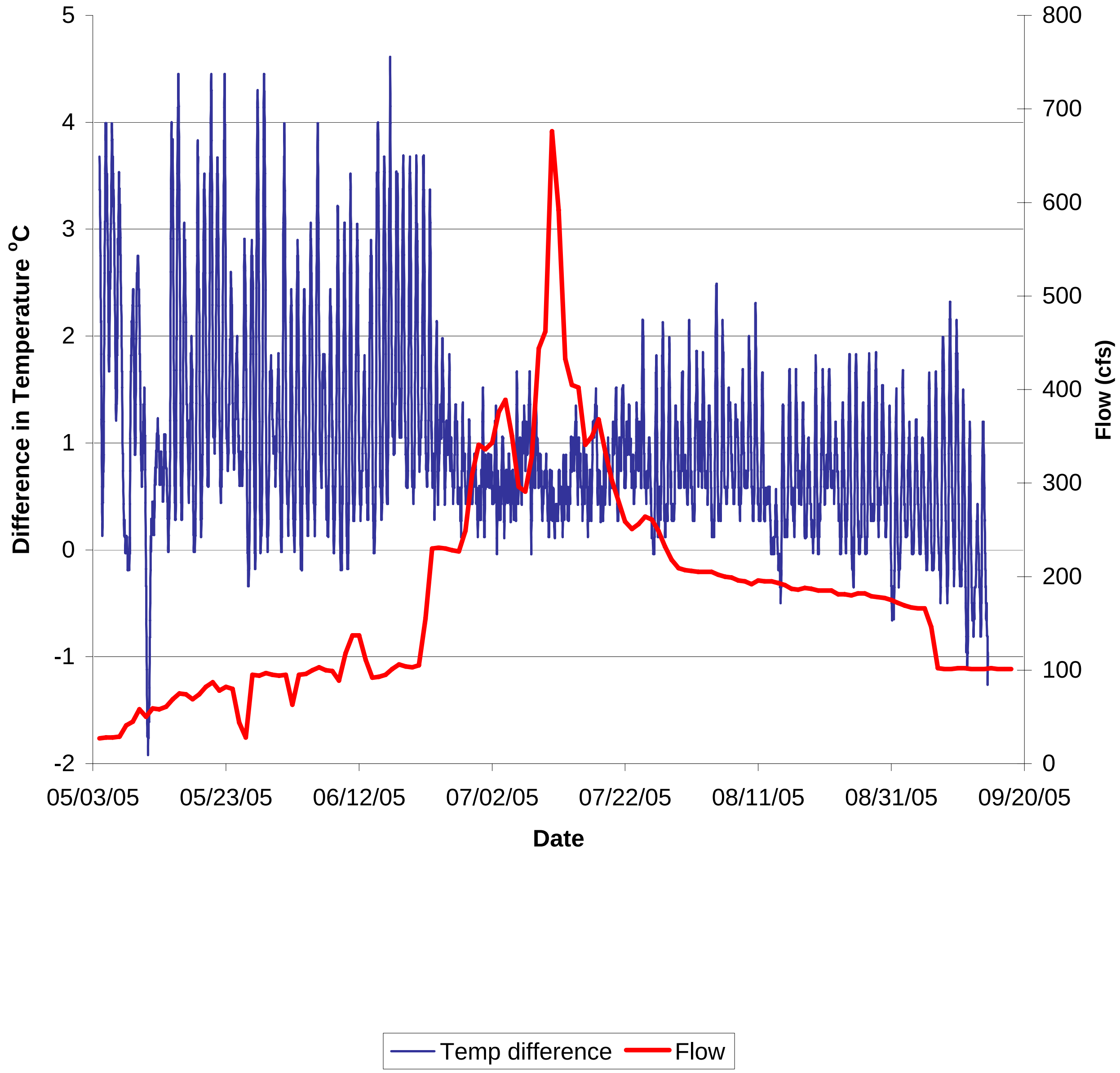


Figure 9. Water temperature exiting Emerald Lake minus water temperature exiting West Rosebud Lake.
Values greater than zero indicate water exiting Emerald Lake is warmer than water exiting West Rosebud Lake. Flow data is average daily flow measured downstream of the powerhouse. (Source: U.S. Geological Survey).

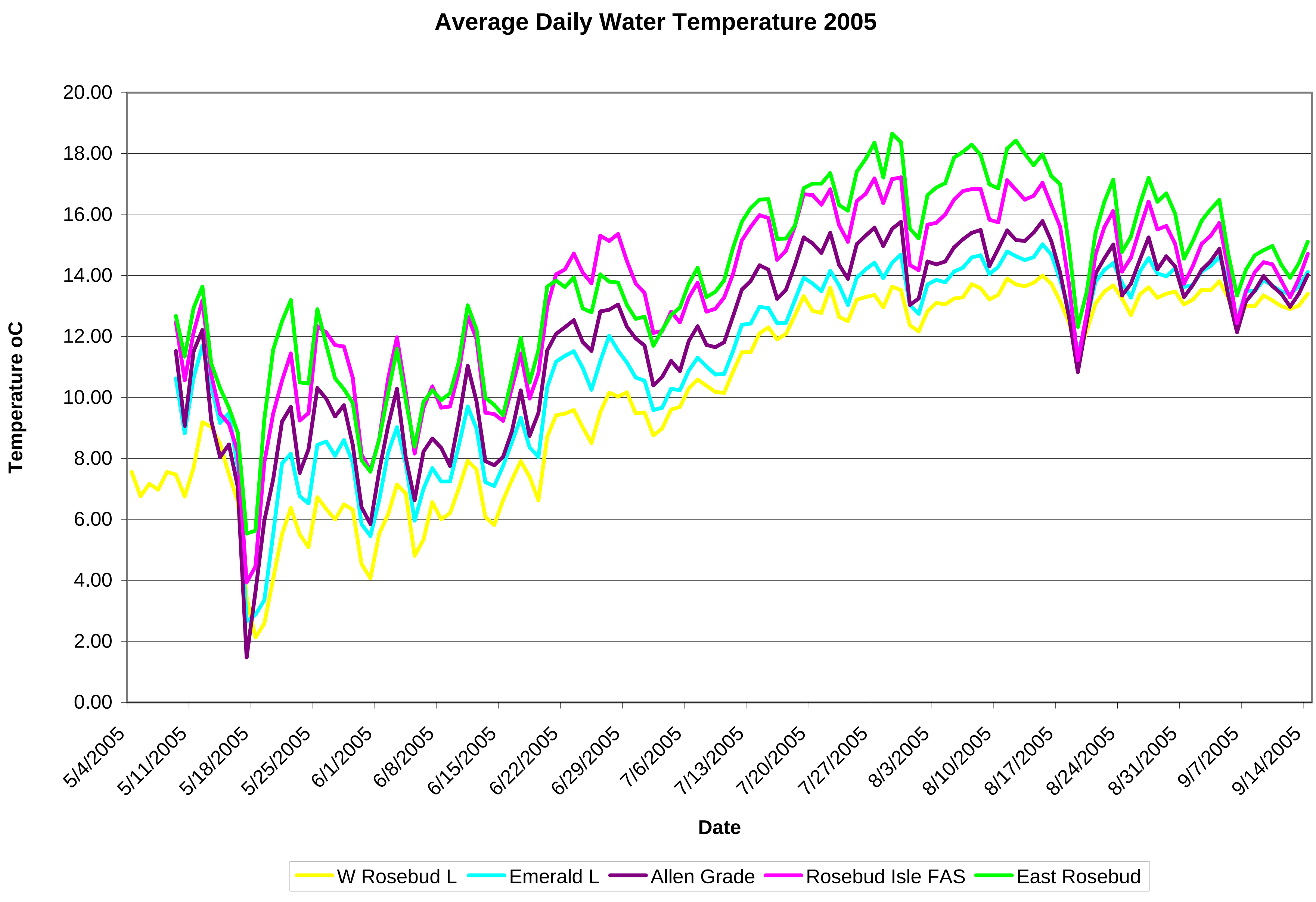


Figure 10. Average daily water temperature in the four downstream-most sites on West Rosebud Creek and East Rosebud Creek.

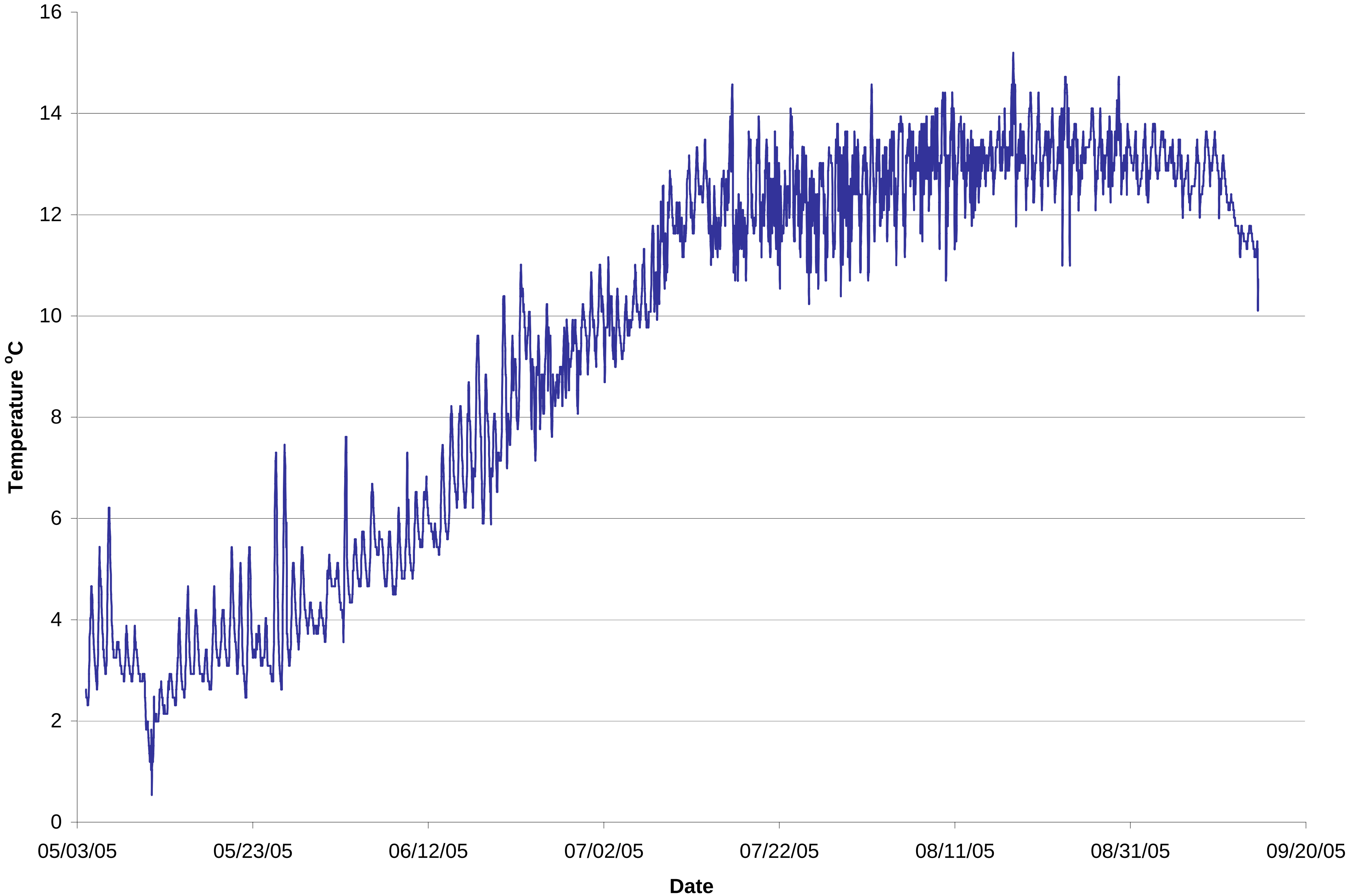


Figure 11. Water temperature in West Rosebud Lake below the powerhouse.

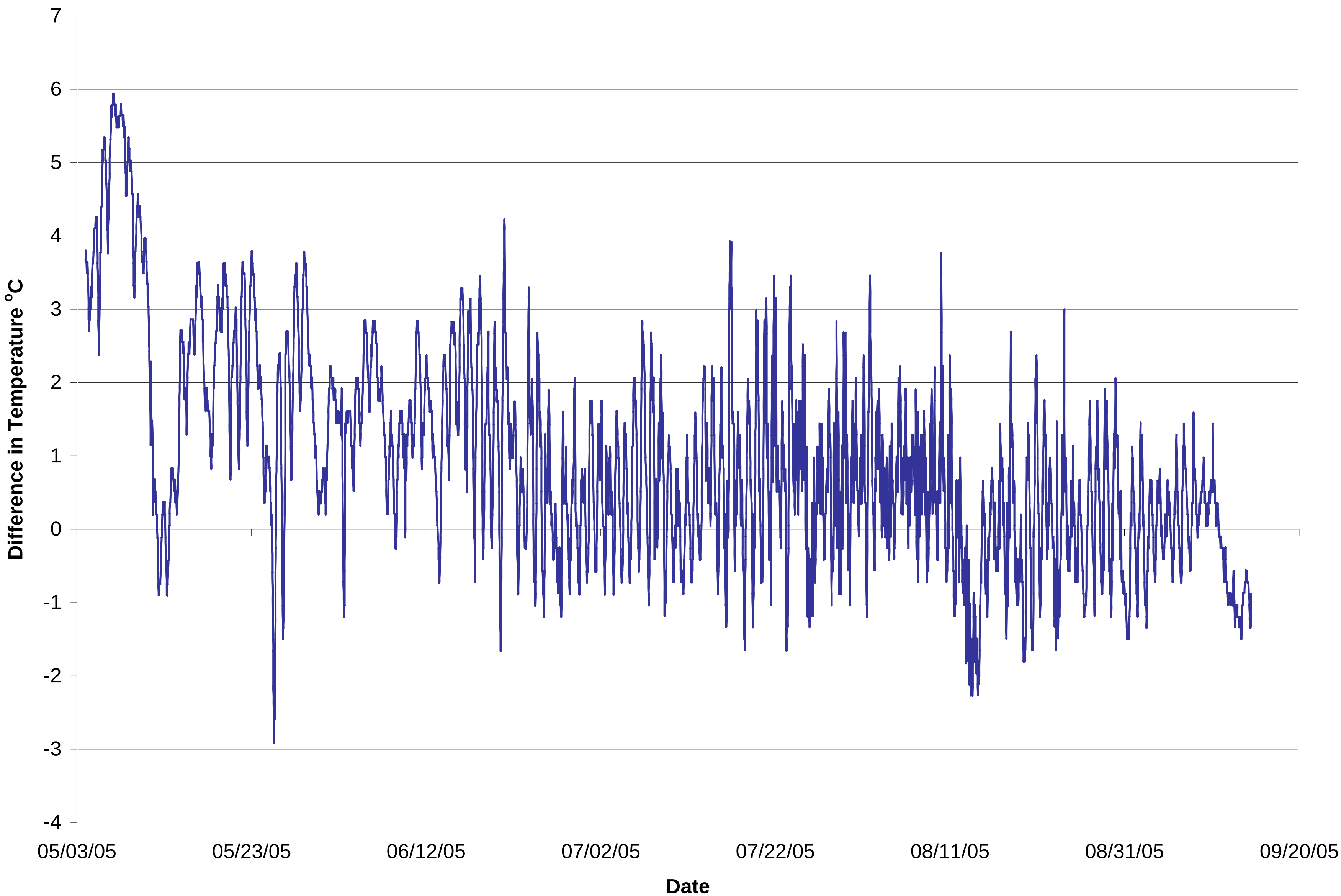


Figure 12. Water temperature difference between the below West Rosebud Lake site and the below powerhouse measuring site.
Values above zero indicate that water temperatures were warmer below West Rosebud Lake than below the powerhouse.

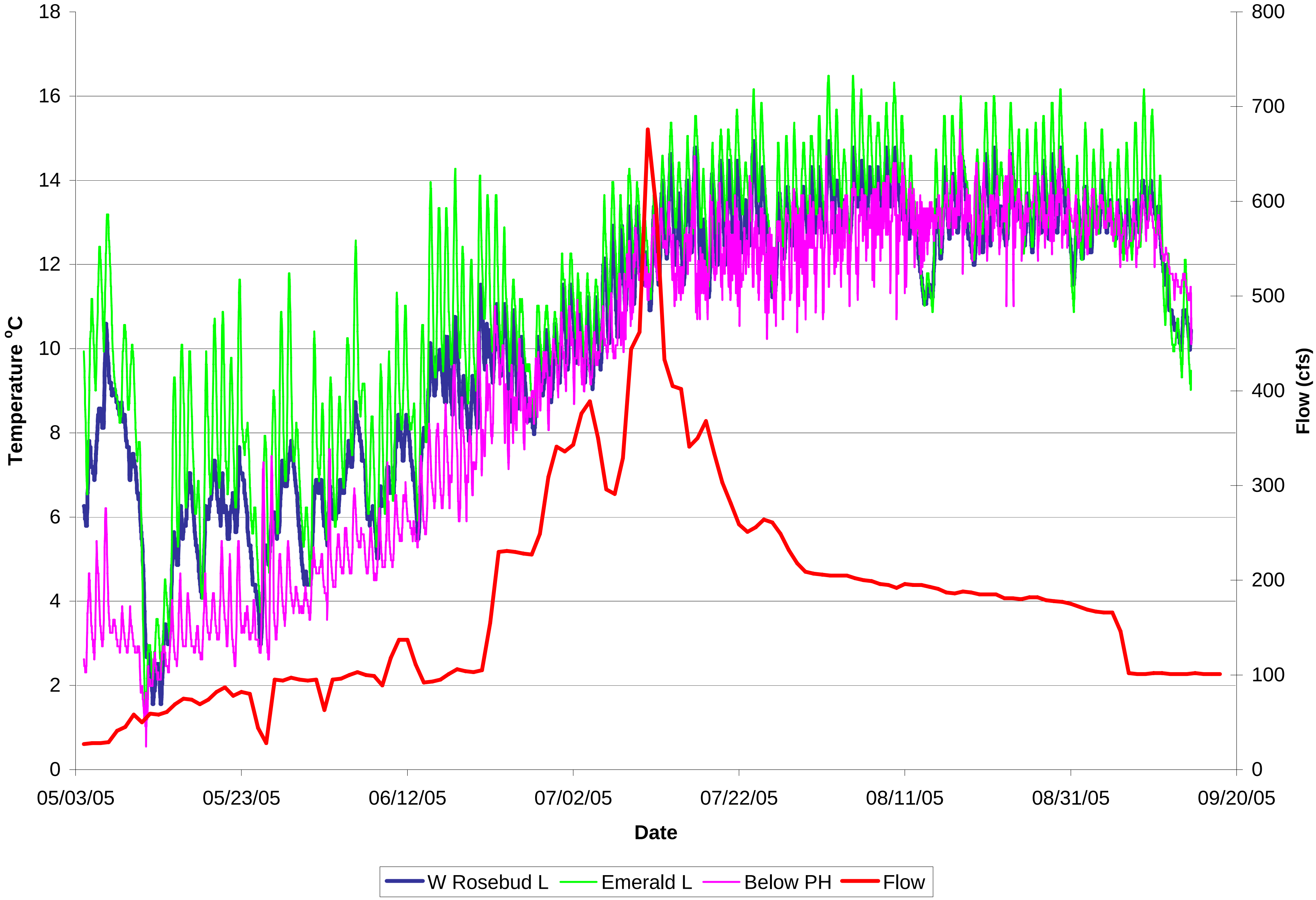


Figure 13. Water temperature below Emerald Lake, below West Rosebud Lake, and below the powerhouse. Flow in cfs (Source: USGS).

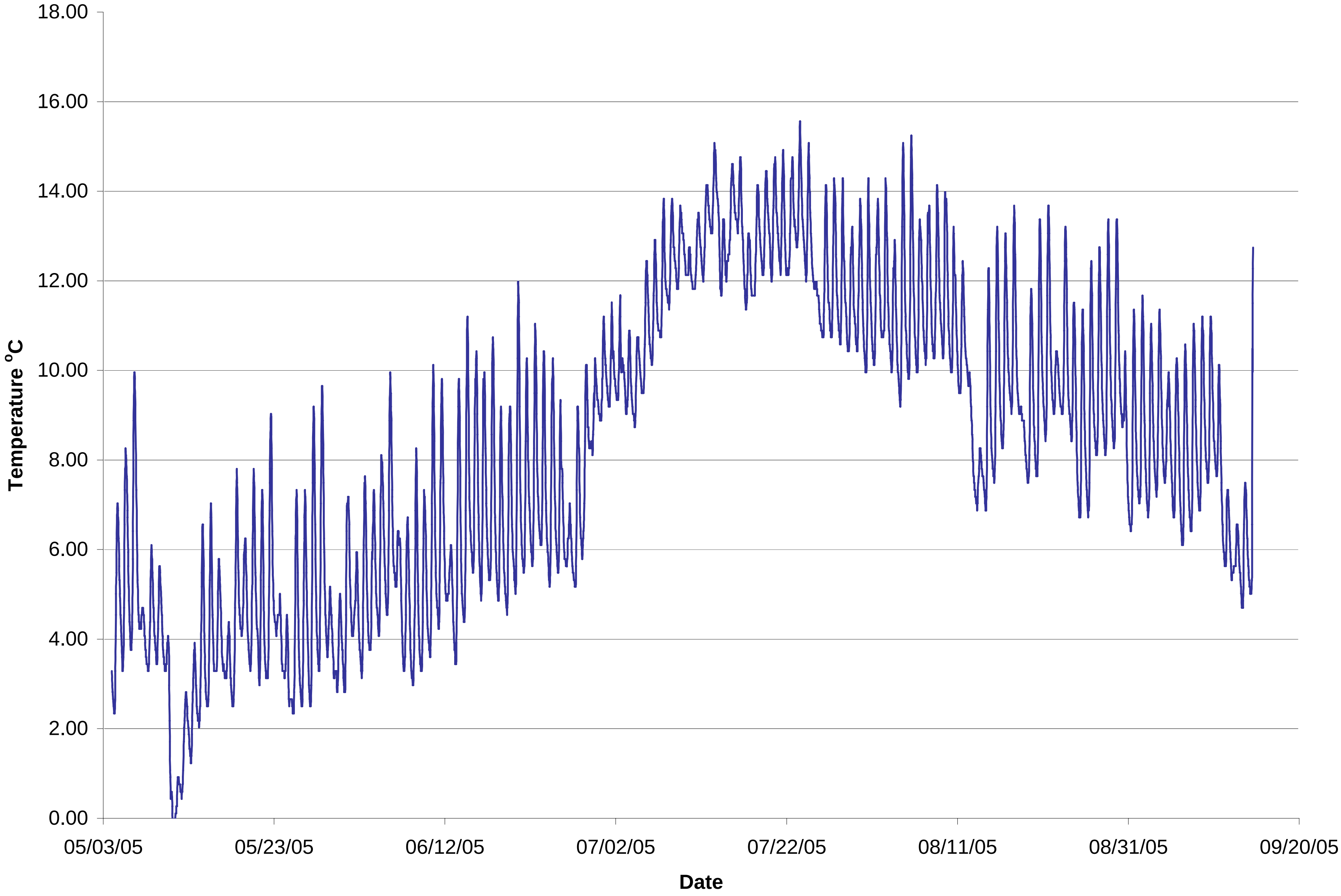


Figure 14. Temperature of West Rosebud Creek above the powerhouse, at the upper weir.

The water temperature above the powerhouse is compared to water temperature below the powerhouse in Figure 15. The warmest water temperatures at both sites were approximately 15°C. From mid-August through September water temperatures cooled more rapidly in the above powerhouse site than at the below powerhouse site. Diel fluctuations were greater at the above powerhouse site.

The U.S. Forest Service expressed concern about water temperatures in the fall and winter months in the Mystic Project area. A temperature recorder was installed in West Rosebud Creek, just downstream of the fish valve in the upper bypass reach, on September 30, 2004. This thermograph was in place until September 30, 2005. Data are depicted in Figure 16. Water temperature dropped from about 8°C in early October 2004 over the fall until the end of November 2004. Through the winter months, water temperatures were approximately 0 - 2°C. Water temperatures began warming in early April, and peaked in late July, with a maximum temperature of 15.45°C on July 22 and 23. Water temperature gradually declined over August and September 2005.

The Montana Department of Environmental Quality has expressed concern that the Mystic Hydroelectric Project causes an increase in water temperature downstream of the powerhouse. Water temperature downstream of the powerhouse is warmer than water temperature upstream of the powerhouse during part of August and September. Average daily water temperature is depicted in Figure 17 for three sites: the upper bypass (measured just downstream of the fish valve flow), the lower bypass (above the powerhouse), and below the powerhouse. The average daily water temperature below the powerhouse was similar to, or cooler than, the average daily water temperature in the bypass reach during the spring and early summer. After August 11, the bypass reach began to cool more quickly than the below powerhouse reach. From August 11 until at least the middle of September, the average daily water temperature below the powerhouse was about 13°C, while the water temperature in the lower bypass cooled to about 9 – 10 °C.

Several factors can explain this pattern. Water in the bypass reach comes from a mixture of sources: releases from the fish valve, spill over Mystic Lake Dam, tributary inflow, groundwater, and seepage from Mystic Lake. Water coming from tributary inflow, groundwater, and seepage through Mystic Lake may be cooler than water from the fish valve or spilling over the top of the dam. In addition, the relatively small volume of water in the bypass reach means that nighttime cooling occurs when air temperatures begin to cool in late summer and early fall. In fact, as shown in Figure 17, water temperatures cool within the bypass reach during much of the summer and early fall. Water temperature is actually cooler in the lower bypass reach (above the powerhouse) than it is in the upper bypass reach.

Water temperature below the powerhouse is a mixture of water from the bypass reach and water from the penstock. Water from the penstock is drawn from Mystic Lake at a depth of approximately 60 feet. Because this water is drawn directly from the lake, and lake water temperatures are relatively stable, especially at depth, the temperature of the water

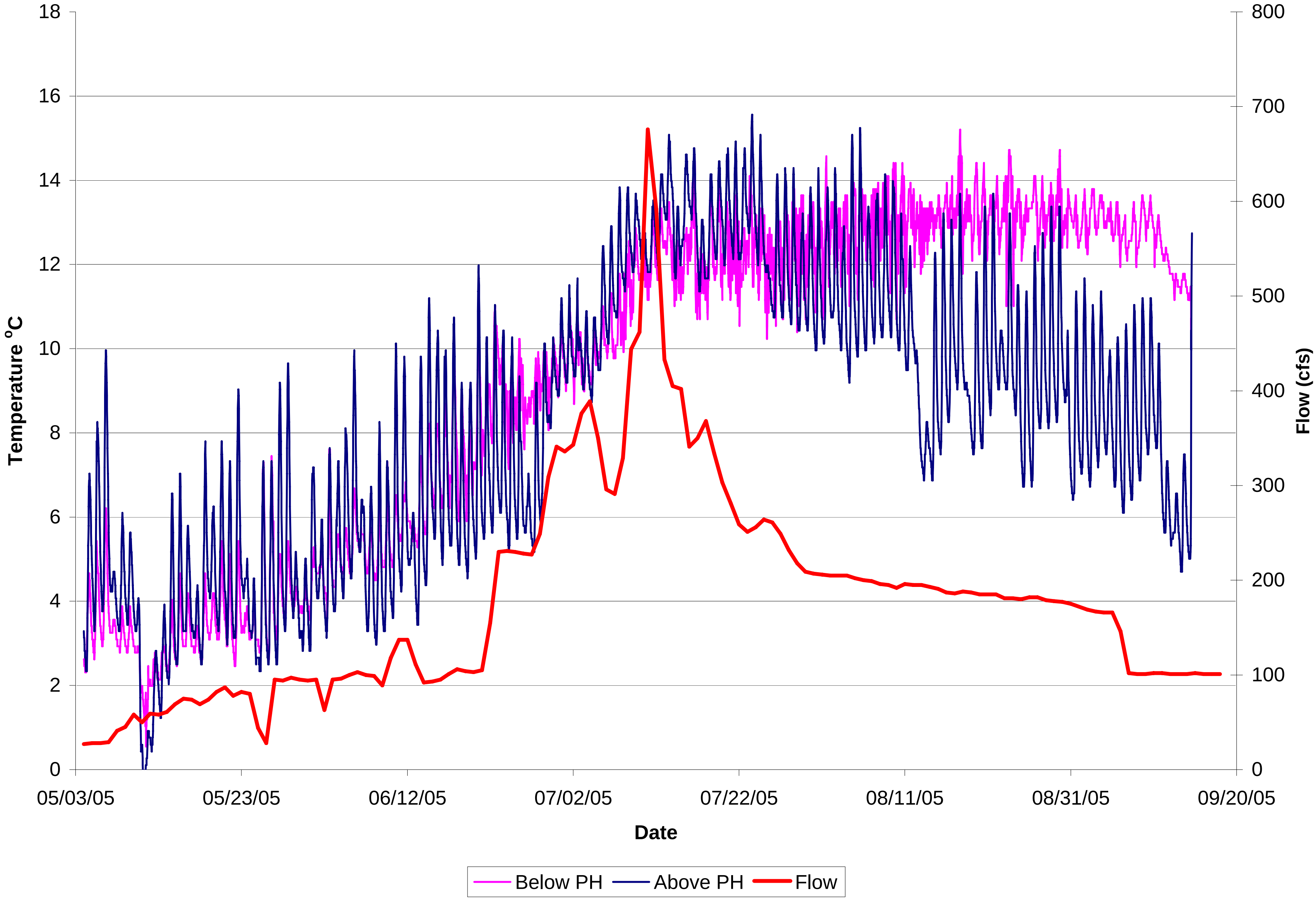


Figure 15. Comparison between the above powerhoues water temperatures and the below powerhouse water temperature.

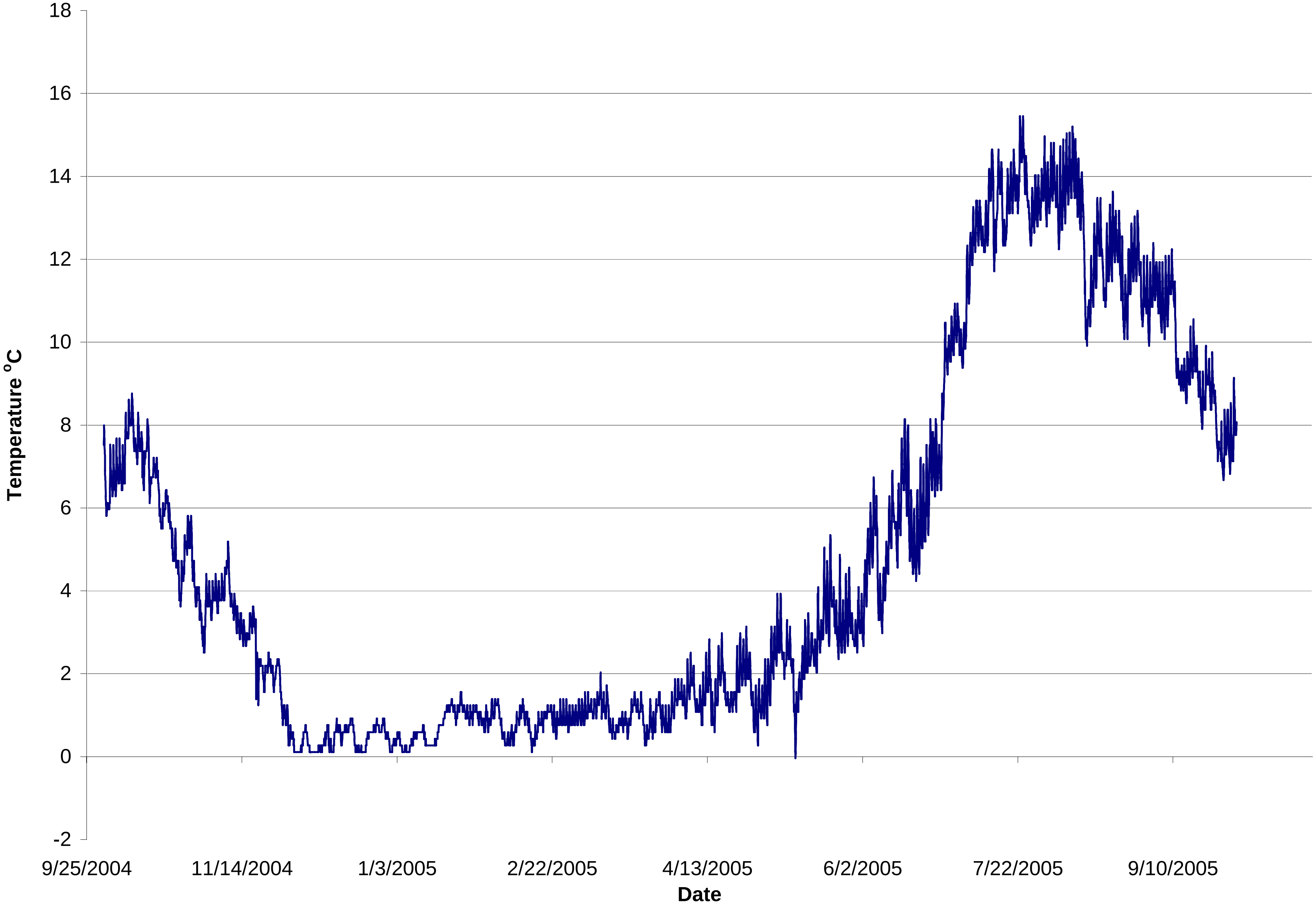


Figure 16. Water temperature measured in the upper bypass reach, measured just below the fish valve from September 30, 2004 to September 30, 2005.

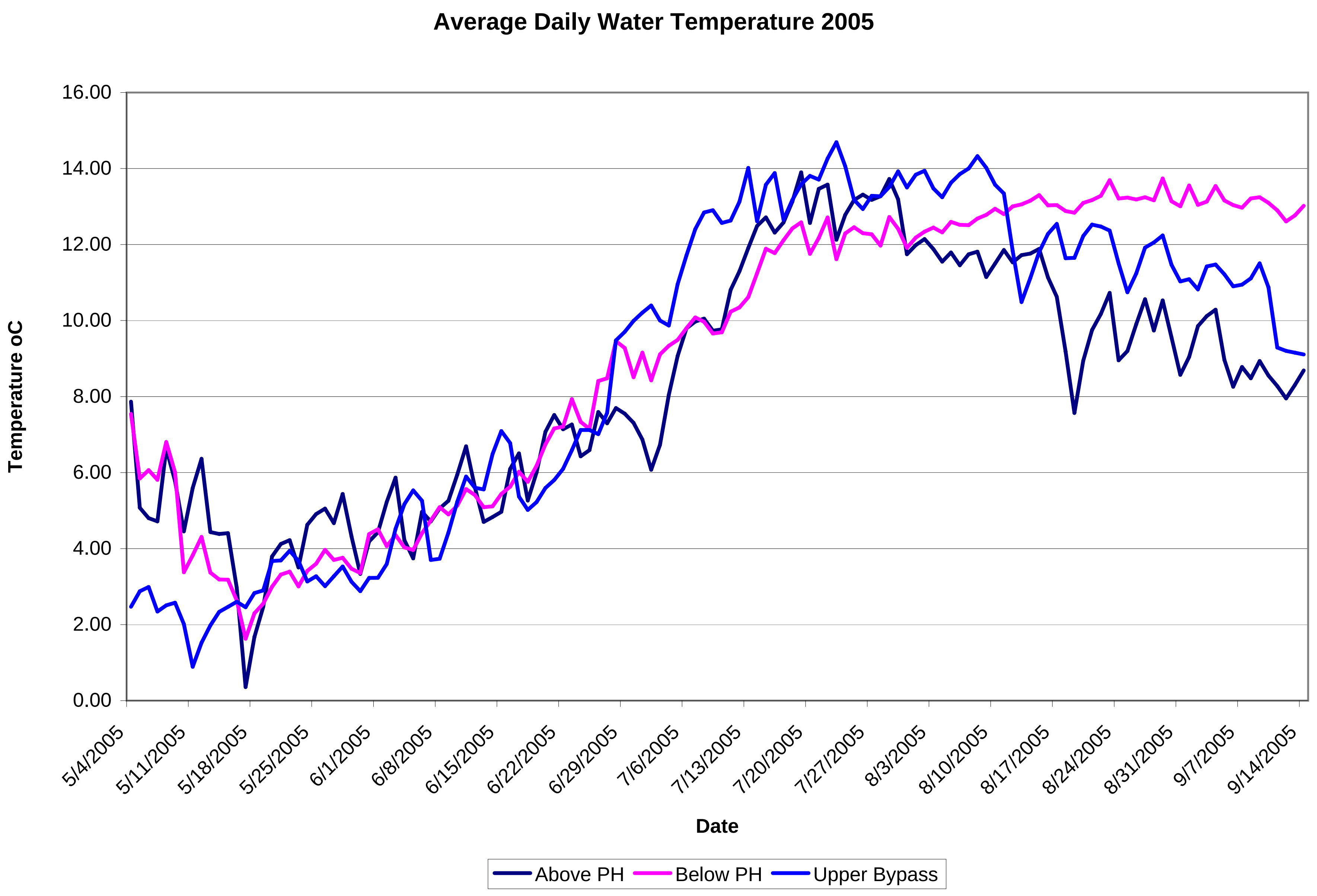


Figure 17. Average daily water temperature measured in the upper bypass reach, the lower bypass reach (above the powerhouse) and below the powerhouse.

entering the penstock is relatively constant. The temperature of this water does not fluctuate greatly over a diel cycle, and it changes with the season relatively slowly (Figure 15).

The maximum, minimum, and mean of the average daily temperatures for the eight sites sampled over the 2005 summer season are depicted in Table 1. The coolest mean average daily temperature is found at the above powerhouse site. However, the maximum mean daily temperature is coolest at the below powerhouse site. All three of the upstream-most sites were within 1$^{o}$C of one another in mean, minimum, and maximum average daily water temperature.

The Rosebud Isle FAS site (the downstream-most site on West Rosebud Creek) had slightly cooler mean, minimum, and maximum average daily temperatures than the East Rosebud Creek site. East Rosebud Creek is a similar drainage, but does not contain a hydropower project. Therefore, these data indicate that the Mystic Hydropower Project does not cause an increase in water temperature in West Rosebud Creek.

**Table 1. Statistics based on the mean daily water temperature ($^{o}$C) (April 28, 2005 – September 14, 2005) measured in the Mystic Hydroelectric Project area and downstream.**

| | *Upper Bypass* | *Above PH* | *Below PH* | *Below WRL* | *Below Emerald* | *Allen Grade* | *Rosebud Isle FAS* | *East Rosebud* |
|---|---|---|---|---|---|---|---|---|
| *Mean* | 8.88 | 8.25 | 9.25 | 10.22 | 11.33 | 11.94 | 13.28 | 13.84 |
| *Max* | 14.69 | 13.90 | 13.74 | 14.00 | 15.02 | 15.79 | 17.22 | 18.65 |
| *Min* | 0.89 | 0.36 | 1.63 | 2.13 | 2.66 | 1.48 | 3.93 | 5.54 |

# Discussion

Water temperature is of interest primarily because of its potential to influence the habitat suitability of the project area lakes and streams for salmonids. Salmonids are coldwater fish with definite temperature requirements. Although some populations of salmonids have adapted to warmer temperatures, in general salmonids are not present if summer water temperatures consistently exceed 22$^{o}$C (Griffith 1999). However, in small streams where daily maximum temperatures approach the upper lethal values, salmonids can thrive if the temperature is high for only a short time and then declines into the optimum range (Bjornn and Reiser 1991).

The lower lethal, upper lethal, optimum, and preferred temperatures for different species of salmonids have been determined through a variety of measures. In general, the lower lethal temperature for salmonids living in a natural environment, where acclimation to cold temperatures is gradual, is 0$^{o}$C (Bjornn and Reiser 1991).

The upper lethal temperature for salmonids varies with acclimation temperature. Generally, the upper lethal temperature for brook, rainbow, and brown trout has been estimated at ≥ 25$^{o}$C and < 30$^{o}$C (Bjornn and Reiser 1991). Upper lethal temperature for cutthroat trout was estimated by Bell (1986, cited in Bjornn and Reiser 1991) at 22.8$^{o}$C.

Although fish may survive at temperatures near the extremes of the suitable range, growth is reduced at low temperatures, because metabolic processes are slowed; and at high temperatures, because most or all food is used for maintenance (Bjornn and Reiser 1991). Brown trout can survive and thrive in warmer waters (18-24$^{o}$C) than other species of trout (Wydoski and Whitney 2003). Rainbow trout generally prefer water < 21$^{o}$C, although they can inhabit water with temperatures from 0-26$^{o}$C. Brook trout usually do best with water temperatures less than 20$^{o}$C, with optimum temperatures being 13-19$^{o}$C. Cutthroat trout preferred temperature range is 10-21$^{o}$C (Wydoski and Whitney 2003).

From the above discussion, it is apparent that summer water temperatures in West Rosebud Creek are generally within the preferred range for salmonids. In downstream areas of West Rosebud Creek, near the confluence with East Rosebud Creek, summer water temperatures warm to degree that could discourage brook and cutthroat trout. However, water temperatures in this location are still suitable for brown and rainbow trout.

Winter water temperatures in the bypass reach hover near the lower tolerance limit for trout. The elevation of this site is near 2,300 m and winter conditions are severe. Therefore, very cold water temperatures would be expected at this location during the winter months.

Clearly temperature is in the tolerable range for trout in West Rosebud Creek. However, there are temperature differences between sites. In particular, the water temperature below the powerhouse is warmer than the water temperature above the powerhouse from mid-August until at least the end of September. Therefore, the question of the optimum temperature for trout becomes pertinent. Is the temperature regime found downstream of the powerhouse detrimental to trout, in comparison to the temperature regime found upstream of the powerhouse?

Optimum temperature has been estimated using a variety of measures, including: temperature preference, growth, efficiency of converting food to tissue, standing crops, scope for activity, and swimming performance (Bjornn and Reiser 1991). Scope for activity is defined as the amount of oxygen that is physiologically available to fish for activity. A summary of some of the literature on optimum temperatures for trout is found in Table 2. Some of the earliest work on this topic was done by Brett (1952), who placed five species of Pacific salmon in a vertical temperature gradient. All of the species tended to congregate in the 11 – 14°C stratum. Further studies have found that optimum temperature varies by species, strain, size of fish, food supply, acclimation temperature, and temperature fluctuations.

**Table 2. Summary of selected literature on optimum temperatures for trout.**

| *Species* | *Estimated Optimum Temperature °C* | *Citation* | *Measure used* |
|---|---|---|---|
| Brook trout | 15 | Beamish 1964 | Measured by scope for activity |
| Brook trout | 16 | Graham 1949 | Measured by scope for activity |
| Brook trout | 16 - 20 | Graham 1949 | Swimming speed |
| Brook trout | 13 – 16 | Dwyer et al. 1983 | Growth and condition factor |
| Brown trout | 12.8 – 13.6 | Elliott 1975 (a) | Growth when fed maximum rations |
| Brown trout | 4 – 13 | Elliott 1975(b) | Growth when fed reduced rations |
| Brown trout | 13.9 | Elliott and Hurley 1999 | Growth when fed maximum rations |
| Brown trout | 13.9 | Elliott and Hurley 2000 | Growth when fed invertebrates |
| Brown trout | 17.0 | Elliott and Hurley 2000 | Growth when fed fish |
| Brown trout | 16 | Forseth and Jonsson 1994 | Growth of piscivorous trout |
| Cutthroat trout | 15 | Dwyer and Kramer 1975 | Scope for activity |
| Rainbow trout | 17 | Hokanson et al 1977 | Growth |
| Rainbow trout | >15 | Filbert and Hawkins 1995 | Growth and condition |
| Rainbow and brook trout | 13 better than 18 | Magoulick and Wilzback 1998 | Growth[1] |

[1] Growth of both species was higher at 13°C than at 18°C.

Many studies have found that acclimation temperature has an effect on thermal tolerance. As early as 1895 there were mentions in the scientific literature of the acclimation of organisms to high temperature (Davenport and Castle 1895, cited in Brett 1952). Brett (1952) found that acclimation temperature modified preferred temperatures a relatively small amount for Pacific salmon, with the range of preferred temperatures being 11 – 14°C. Myrick and Cech (2005) found that Nimbus-strain steelhead acclimated to 19°C tolerated temperatures that were 2°C higher than those tolerated by 11°C-acclimated fish.

Food supply is another factor that can affect the growth of trout at different temperatures. Elliott (1975b) found that the optimum temperature for growth decreased progressively with decreasing ration size from about 13°C at maximum ration to about 4°C at a ration size just above the maintenance ration. Elliott and Hurley (2000) found that the optimum temperature for maximum growth in energy terms was 13.9°C for brown trout feeding on invertebrates. The optimum temperature increased to 17.0°C for brown trout feeding on fish.

Temperature cycling is another factor that influences temperature tolerance. Fish exposed to regular diurnal temperature fluctuations are characterized by higher heat tolerances than are those acclimated to constant temperatures equivalent to the daily mean (Otto 1974, Threader and Houston 1983). Most of the data collected on thermal preferences of fish is collected on fish acclimated to a constant temperature. Therefore, there is reason to suspect that current assay practices may underestimate actual fish capabilities (Threader and Houston 1983).

Threader and Houston (1983) concluded that acclimation to a lower amplitude thermal cycle (± 4°C) produced more pronounced, but less persistent, increases in thermal tolerance in comparison to a higher amplitude thermal cycle of ± 6.5°C. This is evidence that there may be optimum ranges of thermal cycling.

# Conclusions

Summer water temperatures are generally in the preferred range for salmonids in West Rosebud Creek within the project area. The maximum temperatures recorded in the bypass reach (above powerhouse), below the powerhouse, and below West Rosebud Lake were approximately 15°C. There is no indication that the Mystic Lake Hydroelectric Project is causing water to warm to a level that approaches the upper lethal limit for salmonids at any location.

Water temperatures warm in a downstream direction. Both West Rosebud Lake and Emerald Lake have a slight warming influence on downstream water temperatures. Water temperature continues to warm downstream of Emerald Lake.

At the downstream-most site on West Rosebud Creek, just above the confluence with East Rosebud Creek, water temperatures reach a maximum of over 21°C. West Rosebud Creek temperature range is very similar to the temperature range of East Rosebud Creek, a similar stream that does not contain a hydroelectric facility.

The optimum temperature for trout varies depending on a variety of factors, so it is not possible to determine with pinpoint accuracy what the optimum temperature for trout is in the Mystic Hydroelectric Project area. However, it is clear from the literature that the 13°C water temperature, which occurs downstream of the powerhouse in the late summer and fall, is probably within a few degrees of the optimum temperature for trout. The water temperature in the lower portion of the bypass reach during this same period of time is about 10°C. This is slightly lower than most measurements of optimum temperature for trout found in the literature, although under reduced food rations this temperature could be optimum.

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# Study No. 8

# Mystic Project Effects on Mystic Lake Spill Hydrology - Supplement

## Mystic Lake Hydroelectric Project FERC No. 2301

Mystic Lake, Montana

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November 1, 2005

# Study No. 8 Supplement

The Mystic Lake Hydroelectric Project No. 2301 (hereafter referred to as the Project) is situated in south-central Montana. The construction of Mystic Lake Dam enlarged natural Mystic Lake providing an increase in water storage for power generation. It was assumed that lake expansion altered the timing and magnitude of peak flows (spill) below Mystic Lake Dam and the rate of change in discharge for flows during the ascending limb of the annual hydrograph. This study was designed to evaluate hydrologic alterations in the Project area and potential impacts of these flow alterations.

The report for this study was submitted to FERC on October 3, 2005. An initial study report meeting was held October 18-19, 2005. The objectives of this meeting were to discuss each ILP study and determine if the study was completed, modifications are required, or a new study is needed; review and update the Mystic Lake process plan; and prepare a meeting summary that reflects any agreements or disagreements related to the Mystic Project Initial Study Report or process plan. At this meeting the stakeholders requested a supplemental report for Study No. 8, explaining the accuracy of without Project flow data.

The daily inflow to Mystic Lake (without Project flows) was calculated by computing the difference between the total daily amount of water extracted from the lake and the net change in lake volume over the same interval. An elevation vs. capacity table for the lake was used to calculate the volume of water the lake gained or lost in a 24-hour period. The volume of water gained or lost over the 24-hour period due to spill, fish valve discharge, and power plant operations were taken from the daily measurement set. The change in lake volume minus power and spill discharge yielded the net inflow the lake received from upstream sources. This available inflow was used as the baseline values, referred to as flows without Project.

Pool elevation measurements are subject to several combining errors that affect the outcome of the calculation of the daily changes in pool volume that are used to calculate net inflows. There are limits to the resolution of the calculation of the pool volume that are functions of the amount of change in the elevation of the pool. Typically, the resolution of the sensor is limited to about 0.04 ft. and additional fluctuations due to variations in ice cover, temperature, uncertainty in the accuracy of the elevation capacity curve for the lake, and other factors tend to contribute to error in the measurement. This error tends to be less prominent at higher pool elevations and at higher net inflows than it is at relatively low pool elevations and lower net inflows; essentially because under those conditions, the errors are small relative to the magnitudes of the flows.

Figure 1 shows a graph of average inflows and the number of times over the period from 1983 to 2002 when the calculated inflow into the lake was computed as a negative value. The tendency to compute negative inflows (a product of limitations in pool elevation measurement resolution at low inflows) tended to be highest during periods of low net inflow.

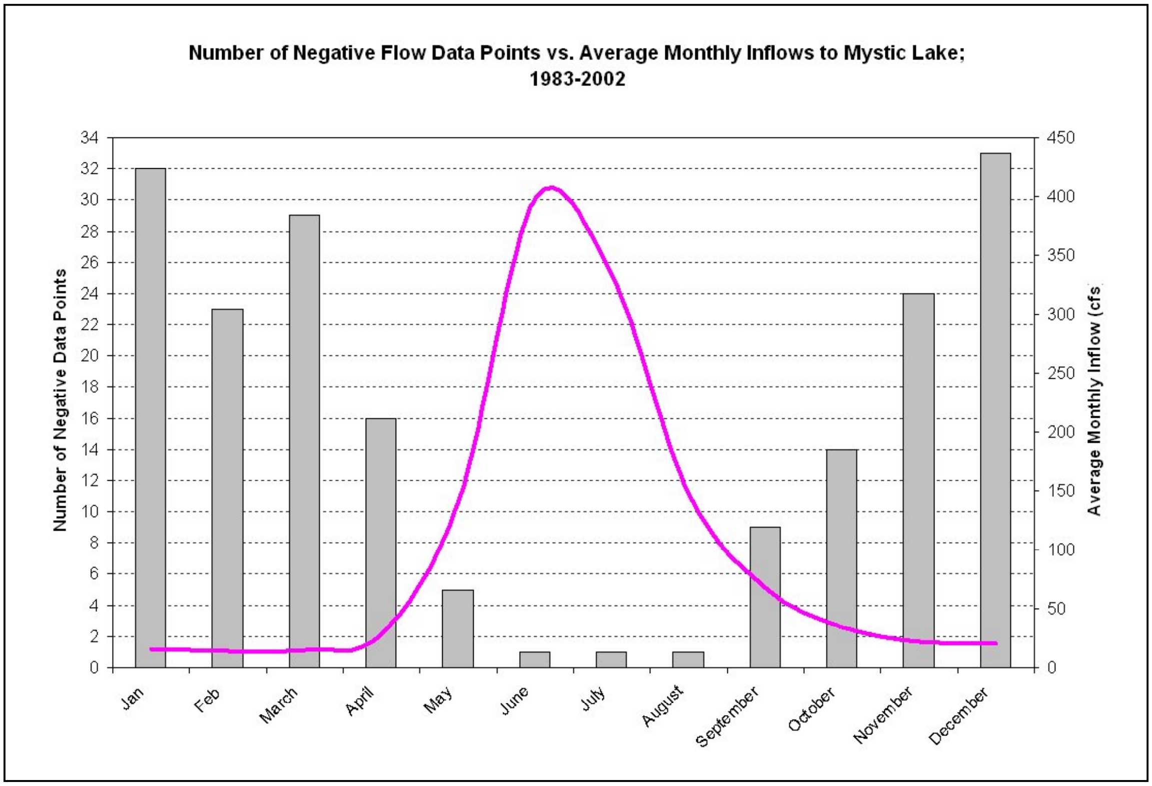



Figure 1. Gray bars indicate the number of negative data points. The pink line is the average monthly inflow in cfs.

Figure 2 shows a tabular representation of Figure 1. A marked correlation between the calculated inflow to Mystic Lake and the number of negative calculated inflows is again evident. Neither effect is exceptionally strong, however. The correlation between the

| Month | Average Inflow | Number of Negative Inflow Values |
|---|---|---|
| Jan | 15.68 | 32 |
| Feb | 13.87 | 23 |
| Mar | 14.90 | 29 |
| Apr | 28.40 | 16 |
| May | 142.04 | 5 |
| Jun | 398.32 | 1 |
| Jul | 333.56 | 1 |
| Aug | 146.76 | 1 |
| Sep | 67.89 | 9 |
| Oct | 33.94 | 14 |
| Nov | 21.60 | 24 |
| Dec | 19.76 | 33 |

number of negative points and the monthly average inflow was 0.77. Correlation between the pool elevation and the average number of negative points in a particular month was 0.53.

Figure 3 shows a graph of the pool elevation for each month relative to the number of calculated negative inflow values in each month from 1983 to 2002.

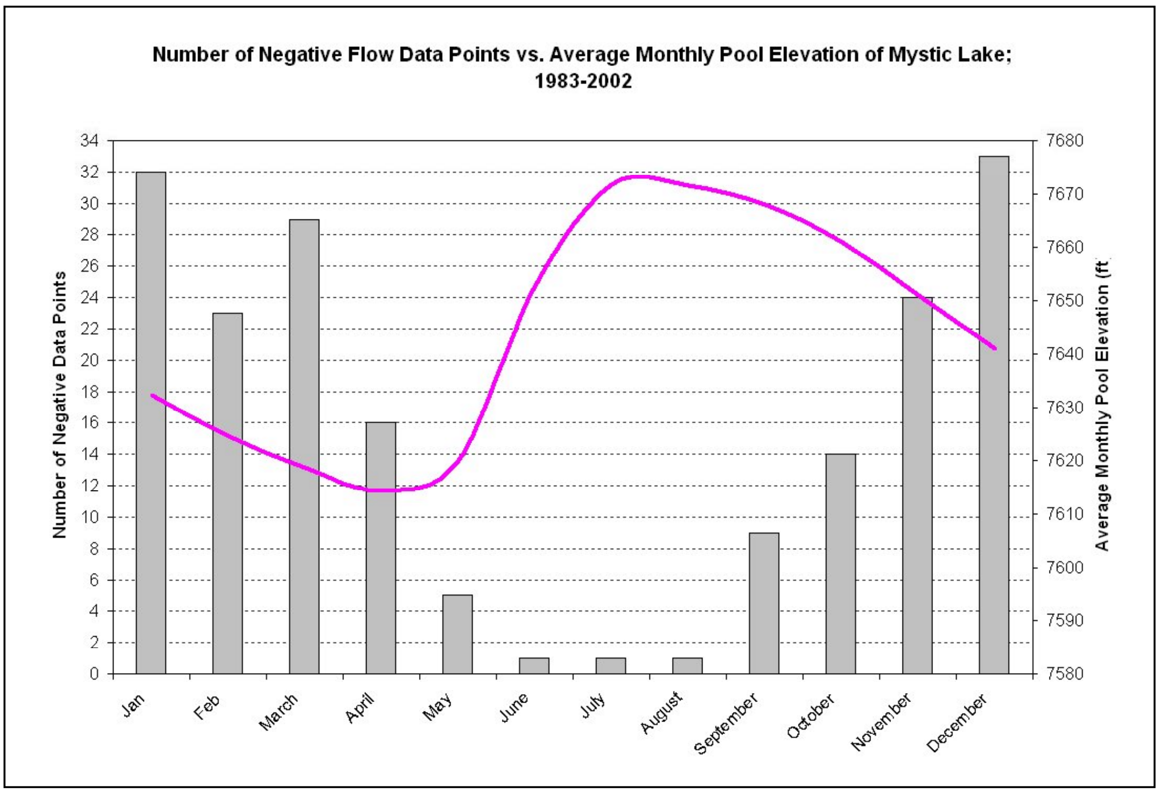



Figure 3. The gray bars indicate the number of negative data points, the pink line is the average monthly pool elevation in feet.

Measurement resolution limitations could be improved by the application of a two step solution; 1) obtain a more accurate bathymetric profile of Mystic Lake and use it to develop a more accurate elevation capacity relationship for the lake, and 2) install more accurate level sensors and signal converters to more precisely resolve the variation in depth of Mystic Lake between the elevations of 7612 ft and 7673.5 ft above mean sea level.

# Study No. 14

## Mystic Lake Hydroelectric Project Recreation Use Counts

## November 2005 - update

## Mystic Lake Hydroelectric Project FERC No. 2301

Mystic Lake, Montana

**PPL Montana**
45 Basin Creek Road
Butte, Montana 59701

November 1, 2005

# Mystic Recreation Use Count Study Report

## October 10, 2005

*Prepared for:*

**PPL Montana**

*By:*

**American Lands Co. and REC Resources**

# Summary

- PPL Montana and the Forest Service monitored vehicle and trail use in the Mystic Hydroelectric Project area in 2005.
- Two vehicle counters were installed on West Rosebud Road, one at the Forest boundary and the second at the Mystic Lake Hydroelectric Project boundary.
- The number of vehicles using the corridor (crossing the Forest boundary) per week ranged from 263 to 704 and averaged 365, between June 30 and September 7. Use was highest near the July 4th Holiday.

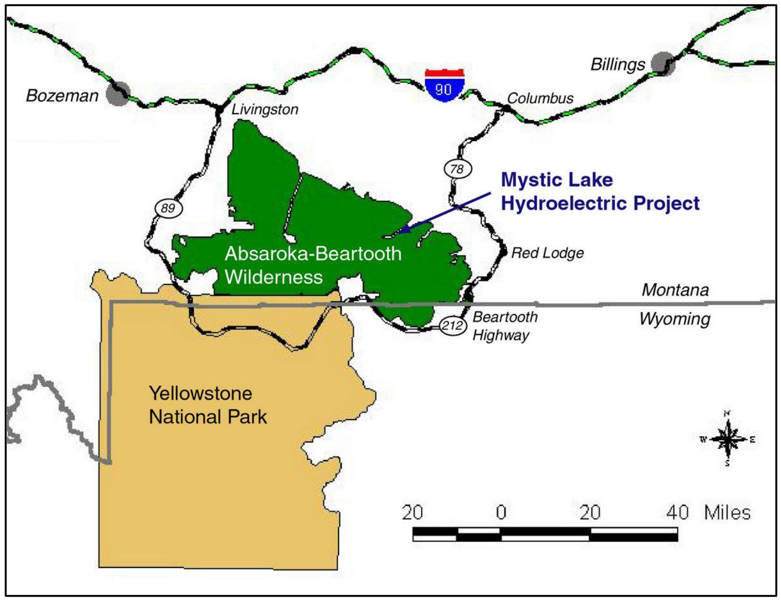

Mystic Lake Trail

- Vehicle use of the corridor was highest on Friday, Saturday and Sunday, with use on these three days accounting for 61 percent of the July-August total.
- The number of vehicles using the upper portion of the road (crossing the Project boundary) averaged 17 percent more than the number of vehicles entering the corridor, because many visitors accessed the upper portion of the corridor more than once during their visit.
- Four trail counters were installed in the Mystic Lake area, one on Mystic Lake Trail and three on trails above Mystic Lake (Phantom Creek, Huckleberry Creek, and Island Lake Trails).
- Mystic Lake Trail received 72 percent of the total use counted on the four trails. It received 5.9 times more use than Phantom Creek Trail, 10.6 times more use than Huckleberry Creek Trail, and 7.5 times more use than Island Lake Trail.
- About 3600 people used Mystic Lake Trail between July 2 and September 28. Use of Mystic Lake Trail was more consistent over the study period than the higher-elevation trails, which experienced peak use later in the season.
- About 60 percent of Mystic Lake Trail users only used that trail, while the other 40 percent also used the higher elevation trails.

# Contents

# Background

PPL Montana operates the Mystic Lake Hydroelectric Project within the West Rosebud watershed on Custer National Forest land.



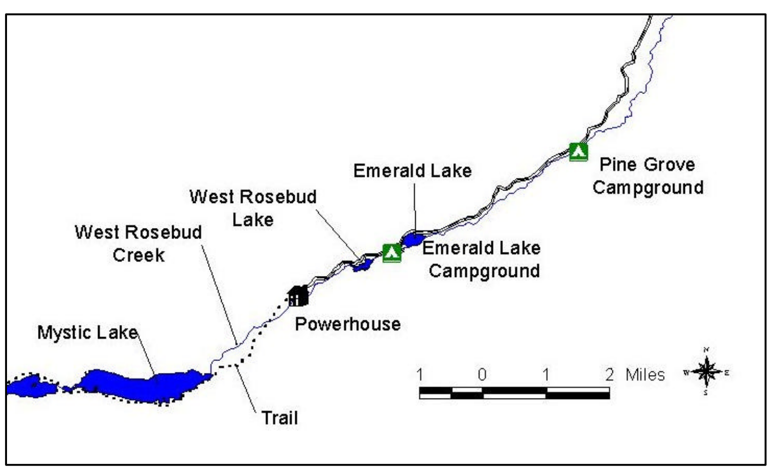

The linear corridor along West Rosebud Creek offers a range of forest-based recreation experiences, with opportunities becoming more primitive as visitors progress up the watershed. Project lands are situated within the portion of the corridor that provides a transition between the developed and primitive recreation opportunities.

West Rosebud Road provides vehicular access to developed campgrounds, day use areas, and the Mystic Lake Trail. Pine Grove Campground and Day Use Area are located eight miles from the Project boundary. Emerald Lake Campground and Emerald Lake Fishing Access Sites are one mile from the boundary. At the road end and adjacent to the Project boundary is the Mystic Lake Trailhead. Mystic Lake Trail provides backcountry access to day hikers and backpackers and is a major portal to the Absaroka-Beartooth Wilderness.

Located within the Project boundary are the West Rosebud Lake Fishing Access Sites, a portion of the Mystic Lake Trail near the powerhouse, and lands at Mystic Lake below elevation 7673.5 feet (above mean sea level). Surrounding much of the Project is the Absaroka-Beartooth Wilderness.

Understanding the amount of recreation use associated with these areas is important for resource management. Of particular interest because of the Project's FERC relicensing, is the proportion of recreation use associated with lands and facilities near or within the Project boundary.

Although the Forest Service monitors the amount of use at its two developed campgrounds, use of other areas is largely undocumented. While previous PPL Montana and Forest Service studies have provided information about the qualities of recreation use (activities, duration, visitor preferences, etc.), the amount of use within the corridor has not been systematically quantified.



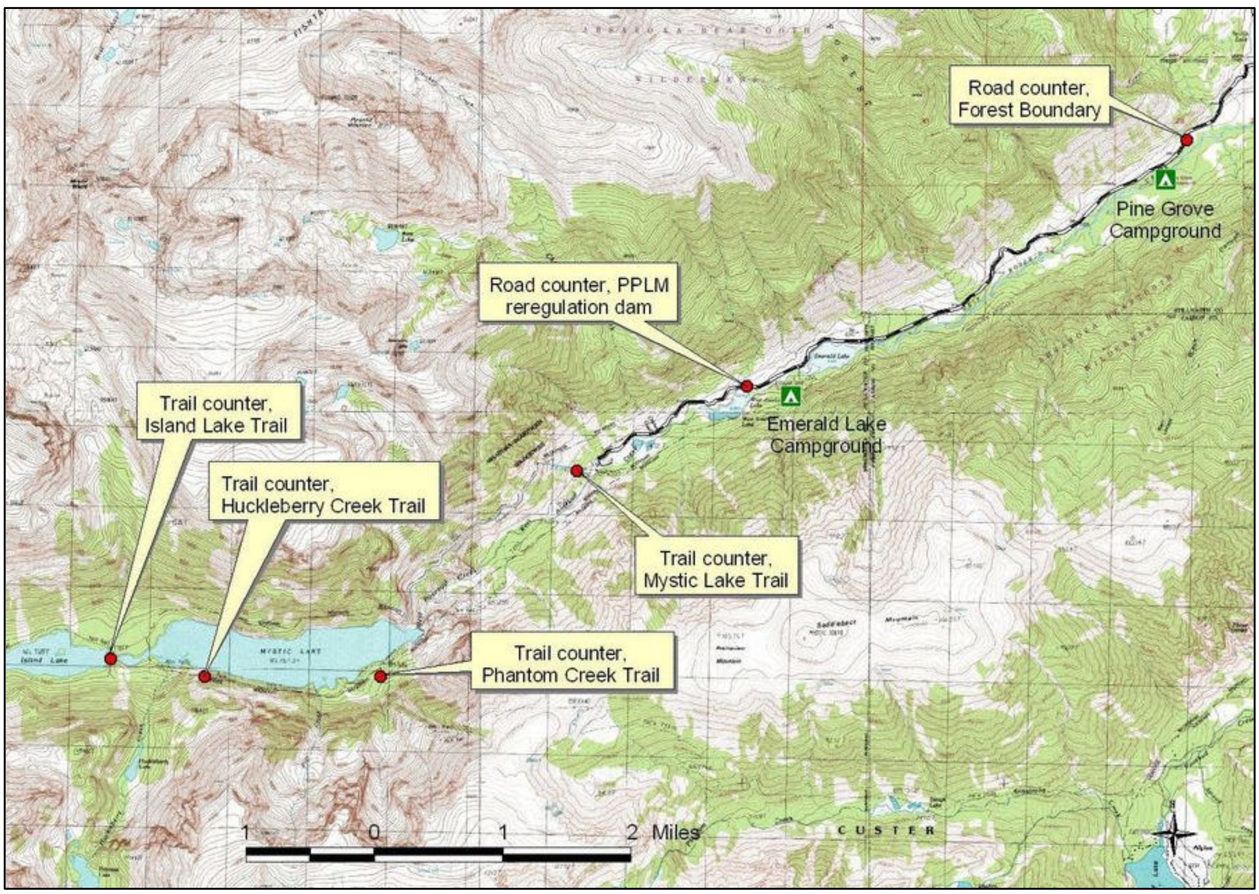

In 2005 PPL Montana and the Forest Service monitored vehicle use on West Rosebud Road and trail use associated with Mystic Lake and its surrounding backcountry.

Vehicle counts were made at two road locations. One counter was located at the Forest boundary, immediately before Pine Grove Campground, and captured all vehicles entering and leaving the corridor. The second vehicle counter was located near the Project boundary, adjacent to PPL Montana's reregulation dam at West Rosebud Lake. This counter recorded all vehicles using the upper portion of the road, which provides access to the Mystic Lake Trail and day use areas at West Rosebud Lake.

Although both vehicle counters captured some non-recreational use (associated with administration of Forest or PPL Montana facilities), it was assumed to be a relatively small proportion of the total use and was not estimated. The number of recreationists that the vehicle counts represent was not estimated because it was felt that, for the purposes of understanding relative resource demand and tracking change over time, vehicle counts would be sufficient as a proxy.

Trail counters were installed at four locations. One trail counter was installed on the lower Mystic Lake Trail, which captured all trail users heading towards or returning from Mystic Lake. Three other trail counters were located on trails (Phantom Creek, Huckleberry Creek, and Island Lake Trails) leading from Mystic Lake to more remote destinations.

Most trail users that passed a counter probably passed it two times, on their way up and down the trail. This is especially true at the Mystic Lake Trail. Although some of the Mystic Trail traffic was one-way only (trips routes that used other Absaroka-Beartooth Wilderness portals in addition to Mystic), that amount was thought to be relatively small.




Counter Locations

# Vehicle Count Results

Two vehicle counters were used to monitor traffic on West Rosebud Road. The first counter was placed at the Forest boundary and the second counter was located at the Project boundary near PPL Montana's reregulation dam.

Recreationists passed the counter at the Forest boundary twice per trip to the corridor, once when they entered and again when they left. The number of vehicle trips to the corridor can therefore be estimated by dividing counts from this location in half. The counter unit installed by PPL Montana at the Forest boundary for this study was dislodged and became inoperable, but data were recorded from June 30 to July 7. Another nearby Forest Service road engineering counter had problems early in the season, but recorded vehicles from July 8 to September 7. Fortunately and coincidently, the time periods when these two counters were operational provide a full season of vehicle counts for 70 days. The two different units were assumed to make comparable counts.

For analysis, counter data were grouped into ten, seven-day periods. Each weekly period began on a Thursday and ended the following Wednesday.

The number of vehicles entering the corridor (crossing the Forest boundary) per week ranged from 263 to 704 and averaged 365. Weekly Forest boundary counts were relatively consistent throughout the study period, with the notable exception of the week that included the Fourth of July Holiday, which received counts about double the other high-use weeks. Fifty-eight percent of the July-August use occurred in July. As expected, use in the corridor peaked on weekends, with counts on Friday, Saturday and Sunday amounting to 61 percent of the July-August total.

Two developed campgrounds and several day use areas are located between the Forest boundary counter and the counter at the Project boundary. Visitors passed the counter at the Project boundary to access the Mystic Lake Trail or day-use areas at West Rosebud Lake. It is expected that some campers and day users limited their activity to Pine Grove or Emerald Lake and never passed the Project boundary counter. Other campers at Pine Grove and Emerald Lake, especially those on multi-day trips, probably passed the Project boundary several times during their stay to fish at West Rosebud Lake or day hike up to Mystic Lake. Visitors coming to the corridor exclusively to access the backcountry passed both vehicle counters an equal number of times on their drive to and from the Mystic Lake Trailhead.

The number of vehicles entering the upper portion of the road corridor (crossing the Project boundary) per week ranged from 318 to 708 and averaged 429. Overall, the Project boundary received 17 percent more vehicle use than the Forest boundary. In other words, many visitors accessed the upper portion of the road more than once during their visit to the corridor. Use of the upper portion of the road relative to the lower portion was the same early in the season, but increased and peaked in early August.

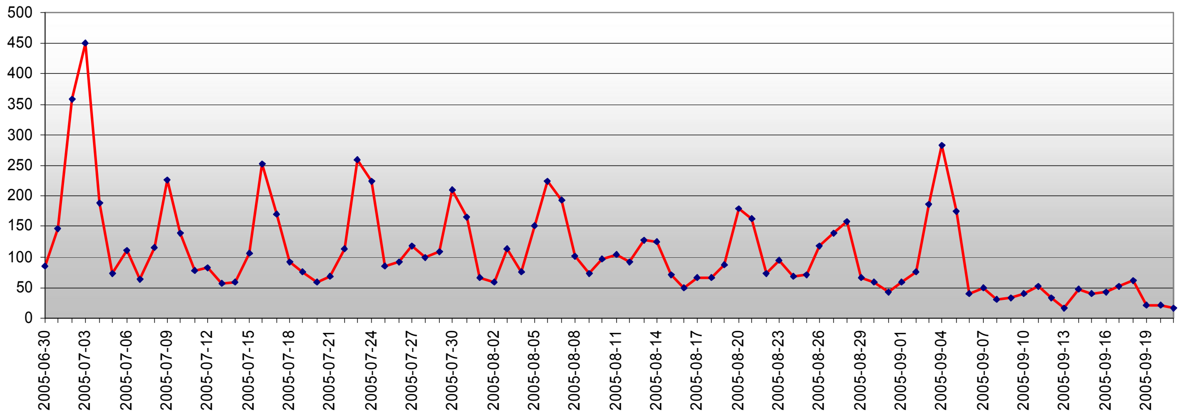
**Vehicle Counts**
June 30 – Sept 7, 2005
(traffic heading in either direction)

| Time Period | Forest Boundary Counts | Project Boundary Counts | Project Bdy Relative to Forest Bdy |
|---|---|---|---|
| Jun 30 – Jul 6 | 1407 | 1416 | 101% |
| Jul 7 – 13 | 761 | 759 | 100% |
| Jul 14 – 20 | 688 | 816 | 119% |
| Jul 21 – 27 | 750 | 960 | 128% |
| Jul 28 – Aug 3 | 677 | 819 | 121% |
| Aug 4 – 10 | 665 | 916 | 138% |
| Aug 11 – 17 | 546 | 635 | 116% |
| Aug 18 – 24 | 601 | 731 | 122% |
| Aug 25 – 31 | 525 | 651 | 124% |
| Sept 1 - 7 | 684 | 868 | 127% |
| Total | 7304 | 8571 | 117% |

Estimates of the number of vehicles can be made by dividing the counts by two.

Although higher, Project boundary counts otherwise mirrored Forest boundary counts, with use spiking near the July 4th Holiday and on weekends. Project boundary counts on Friday, Saturday and Sunday amounted to 63 percent of the July-August total.

**Daily Project Boundary Counts**
**June 30 - Sept 21, 2005**

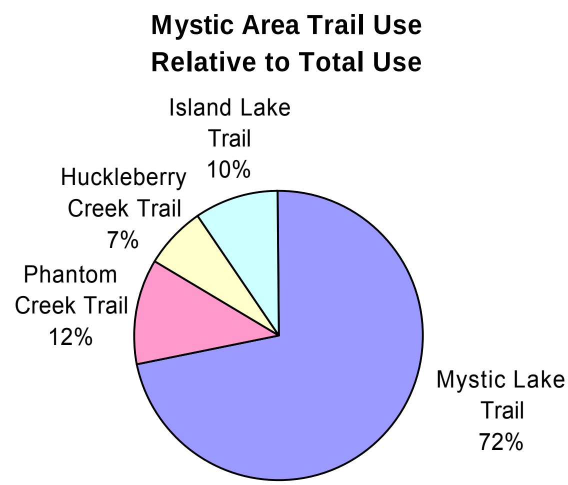


# Trail Use Count Results

Four trail counters were used to track use on the trail to Mystic Lake and trails to backcountry destinations above the lake. Trail counters were placed at: (1) lower Mystic Lake Trail near the lower footbridge, (2) Phantom Creek Trail from the lake toward the Froze to Death Plateau, (3) Huckleberry Creek Trail from the lake up Huckleberry Creek, and (4) Island Lake Trail beyond the west end of the lake.

Trail counters were installed on July 2, 2005, soon after the upper elevations were snow free, and were read periodically throughout the season until September 28. Although some trail use occurs earlier and later, this timeframe provides a good sample of peak season use. All counters recorded traffic heading in both directions on the trails. Because most recreationists used the same trail coming and going, general estimates of the number of users can be made by dividing the counts in half.

Counts indicate that about 3600 recreationists used the Mystic Lake Trail during the study period. Mystic Lake Trail received 72 percent of the total trail use in the area, 2.5 times the combined use of the three upper-elevation trails. Mystic Lake Trail received 5.9 times more use than Phantom Creek Trail, 10.6 times more use than Huckleberry Creek Trail, and 7.5 times more use than Island Lake Trail.



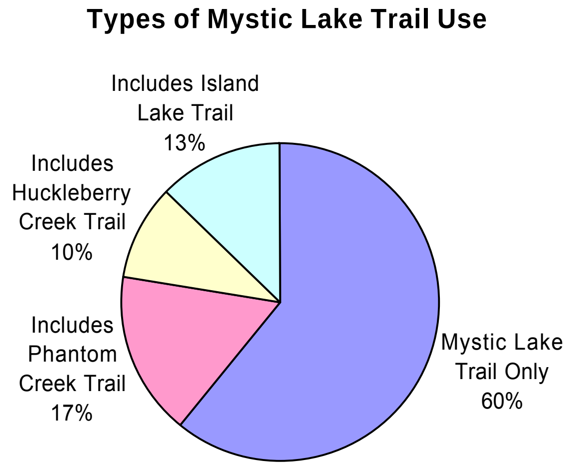

Counts also indicate that the Mystic lake Trail receives a higher proportion of its use in the early season compared to the higher-elevation trails. By August 5, the Mystic Lake Trail had received 52 percent of its total use while the upper trails had received 32 percent of their combined total use. This probably reflects more backpacking and climbing activity at higher elevations later in the season.

**Trail Counter Readings**
(July 2 - Sept 28, 2005)

| Date | Mystic Lake Trail | Phantom Creek Trail | Huckleberry Creek Trail | Island Lake Trail |
|---|---|---|---|---|
| July 2 | 0 | 0 | 0 | 0 |
| July 17 | 1448 | 106 | 64 | 82* |
| July 23 | 2214 | 204 | 64 | 231 |
| Aug 5 | 3713 | 431 | 146 | 337 |
| Aug 15 | 4835 | 679 | 239 | 495 |
| Aug 20 | 5333 | 775 | 324 | 590 |
| Aug 26 | 5663 | 909 | 456 | 658 |
| Sept 12 | 6916 | 1154 | 676 | 881 |
| Sept 28 | 7152 | 1204 | 676 | 953 |

* The Island Lake Trail counter needed to be reset on July 17. An estimate of Island Lake Trail use between July 2 and July 17 was made from relative use at Phantom Creek and Huckleberry Creek Trails during that period.

It can be assumed that almost all traffic on the three trails above Mystic Lake also passed the counter on the Mystic Lake Trail. In other words, the higher-elevation trail users also used the Mystic Lake Trail, but continued farther into the backcountry. It can also be generally assumed that users of the higher-elevation trails only used one of those trails on each trip (one exception to this would be campers near Mystic Lake that made day hikes to more than one high-elevation destination). Therefore, counts on the three higher-elevation trails can be considered subsets or types of total Mystic Lake Trail use.




Conversely, other Mystic Lake Trail users limited their activity to the Mystic Lake Trail or the shoreline at the lake. Because they weren't counted at the upper trails, the amount of this type of Mystic Lake Trail use can be estimated as the difference between total Mystic Lake Trail counts and upper trail counts.

Viewed in this way, 60 percent of Mystic Lake Trail use involved only that trail. Some of these users also reached Mystic Lake's shoreline. The other 40 percent of Mystic Lake Trail use is related to trips that also included higher-elevation destinations.

Mystic Lake Trailhead