Appendix C -
Analysis and Interpretation of Trout Standing Crop and Habitat Relations

Technical Support Document: Proposed Site-Specific Selenium Criterion, Sage and Crow Creeks, Idaho

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LIST OF ACRONYMS

BURP – Beneficial Use Reconnaissance Plan

CSE – Channel Stability Evaluation

EECA – Engineering Evaluation/Cost Analysis

HQI - Habitat Quality Index

HSI - Habitat Suitability Index

IDEQ – Idaho Department of Environmental Quality

IDFG – Idaho Department of Fish and Game

IFIM – Instream Flow Incremental Methodology

LWD – Large Wood Debris

ODA – Overburden Disposal Area

PHABSIM – Physical Habitat Simulation System Method

RSI – Riffle Stability Index

SHI – Stream Habitat Index

SI – Suitability Index

SRI – Stream Reach Inventory

SSSC – Site-Specific Selenium Criterion

USEPA – United States Department of Environmental Quality

USFS – United States Forest Service

USGS – United States Geological Survey

WBAG – Water Body Assessment Guidance

WDEQ – Wyoming Department of Environmental Quality

WUA – Weighted Useable Area

YCT – Yellowstone Cutthroat Trout

1.0 INTRODUCTION

The J.R. Simplot Company (Simplot) owns and operates the Smoky Canyon phosphate mine (the Site) in Southeastern Idaho (Figure 1). A Site Investigation was conducted at the Site during 2003 and 2004, with the final report submitted in July 2005 (NewFields 2005). A draft Engineering Evaluation/Cost Analysis (EECA) (NewFields 2006) that addresses source areas where unacceptable risks to the environment were identified in the Site Investigation was subsequently completed. A portion of the EECA focused on the actions necessary to reduce transport of selenium to Hoopes Spring and other surface water features. The EECA indicated that implementation of source control actions for the Pole Canyon Overburden Disposal Area (ODA), and other source areas identified through the SI, would reduce selenium loading to the Wells Formation and subsequently to Hoopes Spring to acceptable concentrations.

Additional information regarding the nature of impacts from Hoopes Spring and South Fork Sage Creek Springs selenium loading to the Sage Creek and Crow Creek drainages is relevant to the development and analysis of a final remedy for the Site. Specific considerations to be addressed are whether the current releases of selenium are adversely impacting the aquatic biota of downstream areas, and, if so, to what levels must concentrations be reduced to avoid future impacts. Although there is substantial information on selenium toxicity in the aquatic environment, there is considerable uncertainty as to whether the current Idaho Surface Water Standard appropriately considers the setting and species of interest within the Crow Creek drainage. To address these data needs, a Final Work Plan – *Field Monitoring Studies for Developing a Site-Specific Selenium Criterion* (NewFields 2007) was prepared. Simplot has been working collaboratively with the Site-Specific Selenium Criterion (SSSC) Workgroup, which is comprised of agency personnel from the Idaho Department of Environmental Quality (IDEQ), Idaho Fish and Game (IDFG), United States Forest Service (USFS), Wyoming Department of Environmental Quality (WDEQ), U.S. Environmental Protection Agency (USEPA) headquarters, and USEPA Region 10. This workgroup provided review and comments to define the methods and approach for these monitoring studies. The field monitoring studies compose one component of the overall approach for developing a SSSC (NewFields 2008) and are complemented by laboratory studies and an ongoing literature review.

As described in the Work Plan, the monitoring activities were conducted as part of a seasonal monitoring approach that was used to fully characterize the ambient conditions of the exposure areas, as well as upstream areas. The Fall 2008 event was the fifth and last monitoring event. Following is a brief synopsis of the monitoring event dates:

- Initial field monitoring (Fall 2006) commenced on August 31, 2006 and was completed on September 8, 2006. From October 22, 2006 to October 26, 2006, additional field monitoring was conducted to evaluate brown trout redds and the conditions where brown trout spawn.

- Spring 2007 field monitoring commenced on May 7, 2007 and was completed on May 15 2007.

- Fall 2007 field monitoring commenced on August 23, 2007 and was completed on August 29, 2007. Additional habitat quality assessment continued through September 3, 2007.

- Spring 2008 field monitoring commenced on May 12, 2008 and was completed May 18, 2008. Due to high flows in South Fork Tincup Creek, monitoring at SFTC-1 could not be conducted in May and monitoring at this location was conducted from June 9 through June 27, 2008.

- Fall 2008 field monitoring commenced on September 3, 2008 and was completed September 9, 2008.

Up to eleven locations were sampled for a range of chemical, biological, and physical characteristics (Table 1). Location LSV-4, which was sampled during the first two field monitoring events, was not included in the Fall 2007, Spring 2008 or Fall 2008 monitoring due to denial of property access by the private land owner. Work conducted during the monitoring events to document and evaluate existing ambient conditions included collection of water, sediment, periphyton, benthic invertebrates, and fish tissue for chemical analyses of selenium concentrations. Benthic community, fish population and community, and physical habitat quality assessments were also conducted. Results from these activities document selenium exposure conditions in the study area. Fish communities were sampled to characterize their density and diversity. Physical habitat attributes were measured to document the qualities of habitat conditions that exist at each location. Results of the monitoring events are presented in the Final Data Report (NewFields and HabiTech 2009). This report provides an analysis and interpretation of the trout and habitat data.

1.1 Purpose and Objectives

This study is being developed to document and evaluate the current physical conditions in Hoopes Spring and downstream receiving waters. Figure 2 shows Hoopes Spring and the downstream receiving waters, as well as the other streams in the study area. The purposes of this report are to: 1) investigate the relationship of available trout habitat over several seasons and years to the standing crops of trout supported at these stream locations, and 2) compare available stream habitat and trout standing crops between background locations and those locations downstream potentially impacted by selenium.

Physical habitat quality and quantity data were collected at each location during each field visit. The purpose of quantifying habitat is that it is a major factor that controls aquatic community quality, characteristics, structure, and function. The quality of trout populations, the carrying capacity of streams, and the aquatic community as a whole are directly related to availability of quality habitat. Physical habitat quality can also play a role in water quality conditions, such as temperature, turbidity, and dissolved oxygen, among others.

Several different metrics of stream habitat quality or condition were utilized to meet study objectives. These include the Stream Reach Inventory and Channel Stability Evaluation (SRI/CSE), the Riffle Stability Index (RSI), the Habitat Quality Index (HQI), the Habitat Suitability Index (HSI) models for both brown trout and cutthroat trout, IDEQ's Stream Habitat Index (SHI), and the Physical Habitat Simulation (PHABSIM) protocol. As described in the sections that follow, each assessment methodology provides data for and allows for specific characterization of a broad or very refined group of habitat parameters. The objectives of these assessments are to:

- Document and compare physical habitat quality and quantity at and between sample locations;
- Investigate relationships between physical habitat quality and quantity and the standing crops of trout supported at the sample locations thereby identifying key habitat parameters and metrics which help to explain trout population variability within the project area; and
- Compare physical habitat quality and trout standing crop between reference/background locations identified for this assessment and downstream receiving water locations.

The following sections describe the monitoring locations (Section 2), detail the sampling methods utilized and describe differences from the Work Plan (NewFields 2007) (Section 3), summarize results from the field activities (Section 4), present a discussion of the data (Section 5), summarize key findings (Section 6), and present conclusions (Section 7).

2.0 LOCATIONS

Up to eleven locations were monitored as part of this study, with location selection based on the criteria presented in the Final Work Plan (NewFields 2007). During Fall 2007, Spring 2008 and Fall 2008, only ten locations were monitored. Figure 2 illustrates the localized watershed and the spatial distribution of streams including Hoopes Spring, Sage Creek, and Crow Creek. Monitoring locations and descriptions are summarized in Table 1 and are illustrated in Figure 3. Upstream locations, as well as locations downgradient of the Site, were sampled. A reference location (SFTC-1) was added to the field monitoring program beginning with the Spring 2007 monitoring event. The reference location is located on South Fork Tincup Creek upstream of the confluence with Tincup Creek (Figure 4). The downstream location LSV-4 (Sage Creek upstream of the confluence with Crow Creek) was monitored during the Fall 2006 and Spring 2007 events; however, access to this downstream location was denied by the private land owner for the Fall 2007, Spring 2008 and Fall 2008 events.

Color photographs depicting the physical condition of each study location during the monitoring events are presented in the *Final Data Report, Fall 2006-Fall 2008 Field Monitoring Studies for Developing a Site-Specific Selenium Criterion*, Appendix I (NewFields and HabiTech 2009).

3.0 METHODS

The methods utilized in the field to collect physical habitat data during the monitoring events were in accordance with the Work Plan (NewFields 2007). Deviations from the Work Plan are noted below. Data analysis and modeling were also conducted in accordance with the Work Plan (NewFields 2007).

3.1 Physical Habitat Quality

Field observations and measurements for physical habitat quality focused on collecting data necessary to assess the quality and quantity of instream habitat characteristics at each study location. Several approaches are included as assessment strategies vary in their strengths and characteristics considered. The SRI/CSE system from Pfankuch (1975) was used to evaluate channel stability and condition, while the RSI (Kappesser 2002) was used to assess the stability of bed particles in riffles and gain insight into watershed condition at locations where point bars were present. The HQI procedure (Binns 1982) was the primary method used to quantify trout carrying capacity based on habitat quality. Physical Habitat Simulation System Method (PHABSIM) (Bovee 1997) was used to quantify and compare species and life-stage specific physical (hydraulic) habitat area available at each location over a range of flow conditions. HSIs for brown trout (Raleigh et al. 1986) and cutthroat trout (Hickman and Raleigh 1982) were used to evaluate possible habitat limiting factors for different trout life stages. The SHI is IDEQ's standard metric for assessing habitat quality in Idaho streams and allows comparison to statewide reference stream conditions (Grafe et al. 2002). To evaluate spawning characteristics and locations within the study area, redd surveys were conducted for both brown trout and Yellowstone cutthroat trout (YCT).

Additional parameters were also measured to satisfy the various habitat metrics described above, including: bankfull width (ft), reach length (ft), stream gradient, Rosgen stream type, sinuosity, width/depth ratio, stream bank condition, bank stability, stream bank cover, # pools, pool variability, predominant habitat type, overhead cover, pool substrate character, bank angle, and % undercut banks.

3.1.1 Stream Reach Inventory and Channel Stability Evaluation (SRI/CSE)

The SRI/CSE procedure was completed at each study location following the guidance of Pfankuch (1975). The SRI/CSE was developed to provide a systematic measurement and evaluation of the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production (Pfankuch 1975). This ocular system involves the numerical evaluation of 15 hydraulic indicators found within three major stream zones: upper banks, lower banks, and channel bottom. Basically designed for application on second- to fourth-order streams, the procedure is flexible in that it can be used in the physical evaluation of stream reaches of various lengths. Scoring is based on four stability categories, excellent, good, fair, and poor, with a numerical value assigned to each of the 15 indicators within each category. The total reach score is found by summing the values recorded under each category. The reach score is then compared to a series of numerical intervals, thereby determining the reach to either be excellent, good, fair, or poor, in terms of hydraulic stability. The 15 indicators evaluated are described on the rating form presented in Table 2.

During the SRI/CSE, the linear footage of eroding banks was also measured on both banks within each reach. Eroding banks were identified as those that were uncovered and showed visible signs of damage resulting in exposed bank soils that were actively being deposited into the stream. Damage may have been due to trampling by cattle, bank failure due to undercutting, and/or road crossings, among other factors. The linear footage of eroding banks was divided by the total reach length times two (each bank) to derive the percentage of eroding banks. While measuring bank erosion, cover was also measured along each bank. Cover was quantified by measuring the width, depth, and linear feet of bank overhang or other structure that provided trout cover. These data were also used for the HQI and SHI assessments.

3.1.2 Riffle Stability Index (RSI)

To evaluate stream bed stability, a RSI assessment was conducted following the procedures described by Kappesser (2002). At each location, a riffle and adjacent point bar was selected. Field measurements included: 1) measuring the size of 200 bed particles along transects through the riffle, 2) measuring the size of the 30 largest bed particles found deposited on a point bar near the riffle, and 3) locating the mean size of the point bar particles on the particle size distribution plot developed for the riffle thereby determining the RSI value, the percentage of riffle particles smaller than the mean point bar particle size. Since the largest particles on the point bar represent the largest bed particles moved by the stream during a recent channel altering event, the RSI provides an assessment of the percentage of stream bed materials mobilized by the event and a measure of relative stream bed stability.

The higher the RSI value, the less stable the stream bed. Based on research in both Idaho and Virginia, RSI scores less than 70 are indicative of watersheds and stream reaches in good condition (stable channel and watershed conditions), values between 70 and 85 indicate fair condition (moderate instability), and values above 85 suggest poor condition (high instability) (Kappesser 2002). Increasing scores suggest increasing sediment production from the watershed which can lead to pool filling and riffle loading by finer sediments thereby reducing stream habitat quality and complexity for aquatic organisms.

RSI assessments were hampered over the monitoring period by a lack of clearly identifiable point bars at several locations and sample times. Causes for this included: heavy deposition of finer sediments, high flows at time of sampling, and in 2007, the lack of sufficient spring runoff flows to initiate bedload transport. The RSI assessments could only be conducted at six locations in Fall 2006.

3.1.3 Habitat Quality Index (HQI)

The HQI procedure was used as the primary method to quantify potential trout carrying capacity at each location. The HQI model was applied because it is one of the few habitat evaluation procedures that has been developed and tested to predict potential trout carrying capacity for streams based primarily upon physical habitat characteristics (Binns 1982). Parameters were collected at each of the study locations during each sampling period in accordance with the guidelines given by Binns (1982). Developed by the Wyoming Game and Fish Department, the HQI is designed specifically to quantify aquatic stream habitat and predict trout standing crop potential (i.e., carrying capacity). While the protocol has been used primarily in Wyoming, it is believed to be applicable to these locations based upon their proximity to Wyoming and their location within the Salt River watershed, a stream system that was used in model development and testing.

Two HQI models are available and the attributes from each were characterized. Table 3 shows the types of measurement data that were collected, while Tables 4 and 5 show the mathematical equations used to generate a HQI. Because the data used to derive the HQI models are based on late summer/fall conditions, the model is not particularly applicable to spring conditions and therefore habitat measures needed for HQI were not collected during spring sampling. For this assessment of potential trout carrying capacity, the HQI Model II was applied, based on the recommendation of the author that Model II is preferred because it estimates trout standing stock with better precision (Binns 1982).

The late summer stream flow and annual stream flow variation attributes were rated by observations of channel-flow conditions at each location at the time of sampling, comparison of these conditions with written and photographic descriptions provided by Binns (1982), and by analysis of ten years of US Geological Survey (USGS) stream flow records available for gage station 13025500, Crow Creek near Fairview, WY, located downstream of the Site. These were the only such records a search of the National Water Information System found. The HQI model and both HSI models for trout include variables for stream temperature. Water temperature data loggers were installed at each location during early May 2007, and have recorded continually through Fall 2008 (Attachment 1). The temperature logger at HS was discontinued in Spring 2008 because of the narrow range of temperatures recorded at that location. The logger at SFTC-1 stopped recording data in August 2008.

HQI estimates for Fall 2006 and Fall 2007 have been revised as of the Draft Fall 2008 Interim Report, based on a revised derivation method for benthic density (fish food). This revised derivation method was used for the 2008 HQI estimates to allow for a more consistent comparison of the HQI values across time periods. Predicted standing crop estimates were variable at each location across the three different time periods but highest during Fall 2006. During this period, variables such as temperature and stream flow variation were estimated due to lack of long-term data. Subsequent HQI estimates are based on more and longer-term temperature and stream flow data and are believed to be a more accurate representation of predicted standing crop.

Nitrate-nitrogen and fish food abundance and diversity samples were collected and analyzed as described earlier. Cover, eroding banks, substrate, water velocity and stream width were measured following Binns (1982).

3.1.4 Habitat Suitability Index (HSI)

Similar to the models discussed above, HSIs were used as an index by which habitat quality is compared. Data were collected during high flow periods in Spring 2008 for the HSI models. Many of the variables needed for these HSIs overlap with the variables needed for the models described above; therefore, using the HSI models provides an alternative mechanism by which to compare trout populations, habitat quality, habitat quantity, and life-stage-dependent factors. In fact, because the HSI models are largely based on empirical data, the scores for different life-stage-dependent variables allow for a relative interpretation of possible limiting factors for a particular life stage.

Individual HSIs for brown trout (Raleigh et al. 1986) and cutthroat trout (Hickman and Raleigh 1982) are available and each model is comprised of several habitat variables. Important characteristics for different life stages of each species are included in these models in the form of suitability index (SI) curves that are based on field-defined characterization of optimal to poor ranges of a characteristic. Each characteristic is rated based on the SI curve to obtain a score. SI scores are then used in the life stage appropriate model to derive a HSI. The methods for calculation of HSI scores can be found at http://www.nwrc.usgs.gov/wdb/pub/hsi/hsi-124.pdf for brown trout and at: http://www.nwrc.usgs.gov/wdb/pub/hsi/hsi-005.pdf for cutthroat trout. Tables 6 and 7 show the HSI model variables for brown trout and cutthroat trout, respectively. The equal components method was used to calculate overall HSI scores and the results of this assessment are presented in Section 4.

3.1.5 Stream Habitat Index (SHI)

IDEQ's Water Body Assessment Guidance (WBAG) and Beneficial Use Reconnaissance Plan (BURP) protocols (Grafe et al. 2002) use the SHI to evaluate physical habitat quality and quantity. While habitat quality data were collected during both spring and fall seasonal sampling, IDEQ's BURP protocols establish an index period of June through mid-September. The SHI uses data collected for the following ten habitat parameters: instream cover, large wood debris (LWD), percent fines (<2 mm), embeddedness, substrate size classes (Wolman), channel shape, % bank vegetation, % canopy cover, disruptive pressure, and zone of influence.

3.1.6 Trout Spawning Surveys and Redd Investigations

3.1.6.1 Brown Trout

During the week of October 23, 2006 a brown trout redd survey was conducted to identify and characterize stream sections which provide trout spawning habitat throughout the study area (Figure 5). The water depth, velocity and substrate size data collected at redd locations have been used to verify trout spawning habitat suitability curves used within the PHABSIM and HSI evaluations. The methods for this survey are described below.

The brown trout redd survey was conducted in the vicinity of each study location where brown trout had been collected earlier (all locations except DC-600) (Figure 5). Suspected redds were identified based upon surficial disturbance of the substrate, presence of pit and tail-spill morphology within the substrate, and, whenever possible, the presence of adult brown trout exhibiting spawning behavior. To avoid mortality to developing embryos, redd locations were not excavated to verify the presence of eggs, thus findings should be regarded as "putative". At each identified redd location, water depth and velocity (at 0.2, 0.6 and 0.8 of depth) at the upstream edge of the pit and the intermediate axis diameter of ten substrate particles from the tail-spill were measured. GPS coordinates were recorded and periodic photographs and water temperature measurements were taken (Attachment 2). Immediately adjacent to the area of greatest redd density at each location, three substrate core samples were collected using a McNeil-Ahnell sampler (McNeil and Ahnell 1960) for dry-sieve analysis.

3.1.6.2 Yellowstone Cutthroat Trout (YCT)

Because a key variable in YCT spawning is water temperature, as influenced by runoff, an initial reconnaissance of YCT redds was conducted on April 27 and 28, 2007. Crow Creek through the Simplot Meade Peak Ranch property (encompassing locations CC-1A and CC-3A) and about a thousand feet of stream in the vicinity of locations CC-350 and CC-75, both on Forest Service lands, were traversed and inspected for the presence of redds. Access to these locations was good, with no lowland snow remaining. Ten suspected redds were identified in the vicinity of CC-1A and CC-3A (Figure 6) and sampled as described above for brown trout.

During May and again in June 2007, locations of potential redds were scouted; using the identification process described above, however, no additional redds were located.

3.1.7 Physical Habitat Simulation (PHABSIM)

(PHABSIM modeling is an approach developed by the US Fish and Wildlife Service's Instream Flow Group who compiled the Instream Flow Incremental Methodology (IFIM) (Stalnaker et al. 1995; Bovee et al. 1998). PHABSIM uses field-measured hydraulic parameters (water depth, flow velocity, substrate, and cover) at different flow levels and relates them to known preferences of different species and life stages. PHABSIM was used to quantify and compare species and life-stage specific physical (hydraulic) habitat area available at each location over a range of flow conditions. Cross-sections established for measuring flow for the reach were augmented with cross-sections placed in each mesohabitat. Habitat availability was modeled over a range of flows at each location to provide a dynamic view of habitat availability. PHABSIM modeling requires flow data from several (usually three) different flow periods.

The physical trout habitat present at 10 of the 11 monitoring locations was evaluated in 2007 and 2008 using the PHABSIM approach. Due to the extensive aquatic vegetation and lack of flow variability, hydraulic and habitat modeling at the HS location was not possible. Staff gage readings at CC-150 and CC-3A indicated that sufficient change in the stage of the water had occurred during the Fall 2007 monitoring to allow gathering the second round of PHABSIM flow data. Therefore, during the Fall 2007 monitoring event, PHABSIM field data collection was conducted at all study locations (except at HS) at one or two stream flow levels. Field data collection was then completed during the spring and early summer of 2008. This effort was undertaken to complement the other habitat evaluation metrics measured at each location (also described in this report) and to provide species and life-stage-specific information regarding physical habitat availability.

The PHABSIM protocol was applied following the guidance of Bovee (1997) and USGS (2001). At each location, a clearly defined hydraulic control was present and functioning at the downstream end. Each location was divided into contiguous units of relatively homogenous habitat (e.g., riffles, runs, pools, glides) and microhabitat elements (e.g., woody debris, boulders, undercut banks). A cross-channel transect was then placed to bisect each habitat unit. Transects were established with head/tail pins, which were placed above the bankfull water elevation. Across each transect, 15 to 25 sampling points were established at uniform intervals and water depth and mean velocity (at 6/10 of depth) were measured with a top-setting rod and Marsh-McBirney Model 2000 current meter at either two or three flow levels. Also at each vertical, the channel index was classified as follows:

Code	Description
1	Sod/organics
2	Silt/clay
3	Sand (.04 - .24 in)
4	Fine gravel (0.25 - 0.99 in)
5	Coarse gravel (1.00 - 2.99 in)
6	Cobble (3.00 - 11.99 in)
7	Boulder (> 12.0 in)
8	Bedrock
9	Aquatic vegetation.

Each study location was surveyed longitudinally, with distances recorded from each transect to the upstream and downstream boundaries of the channel unit or cell. Each location was also sketched in a field book to represent channel geometry and location features. A benchmark was installed at each location and was assigned a reference relative elevation of 100.0 ft. A rod and level (or GPS) survey was then conducted to record elevations of each head and tail pin as well as water surface elevations at each transect at each sampling time. A staff gage was installed at each location and was read periodically during each sampling period to note any short-term flow changes that may have occurred during the measurement period.

3.1.7.1 PHABSIM Data Analysis and Modeling

Data analysis and modeling were undertaken using the PHABSIM for Windows approach (USGS 2001). The PHABSIM model is a series of computer programs that link stream channel hydraulics over a range of flow conditions with physical habitat utilization by aquatic organisms, primarily fish. The simulation sequence is a multi-step process that incorporates the physical data from specific transects with biological data on habitat suitability to develop habitat, expressed as weighted usable area (WUA; sq. ft. per 1,000 ft of stream), versus stream flow (Q; cfs) relationships for each location.

The hydraulic algorithms of PHABSIM were calibrated to field data and predictions made of water velocity and depth at unmeasured discharges over a stable range of channel boundary conditions. Hydraulic decks were calibrated according to the USGS (2001) guidelines and the recommended prediction limits of 0.4 to 2.5 times field measured flows were followed, with the exception of the SFTC-1 location, where the average spring monitoring flow was 3.4 times the largest flow used for PHABSIM modeling. The predicted channel hydraulics were then coupled with fish species and life stage habitat suitability criteria for water velocity, depth and channel index to produce WUA versus Q relations for each study location over a range of flows.

For this analysis, the fish species of interest were brown trout *Salmo trutta*, an introduced species, and cutthroat trout *Oncorhynchus clarki*, a native species. Of the two species, only *O. clarki* were present at the SFTC-1 and DC-600 locations, and only *S. trutta* was found at the

HS-3 location. The species were sympatric at the remainder of the locations. Habitat suitability curves applied for brown trout were those for adult, juvenile and spawning habitat developed in similar-sized, spring-fed streams in southwestern Montana which had sympatric populations of brown and cutthroat trout (Reiser 1995; HabiTech, Inc. 1999). Cutthroat trout suitability curves used for adults and juveniles were validated for smaller streams in the Snake River basin by R2 Resource Consultants, Inc (2007). As cutthroat spawning suitability curves were not available, the curves for brown trout were assumed to be applicable as the size structures of the populations were similar and in most cases, the species co-existed within the same stream habitats. The spawning curves used were verified with the data collected during the redd surveys within the study area. Habitat suitability information used for the PHABSIM modeling is provided in Table 8.

Because the objective of the PHABSIM analysis was to compare available physical habitat by species and life stage between locations, and not to recommend an instream flow prescription, it was necessary to identify a relative flow level between locations that would allow an equitable comparison. To do this, flow measurements were averaged from each location during the fall 2006, 2007 and 2008 monitoring periods and likewise for the spring 2007 and 2008 monitoring periods. These flow values are presented in Table 9 and on Figure 7. It should be noted that only one spring and one fall flow measurement were available for LSV-4, and only two fall measurements were available for SFTC-1.

3.2 Integration and Analysis of Trout Population – Habitat Data

The trout population data used for this analysis were collected at each location and sampling time by means of a 3-pass removal estimate as described in the Final Work Plan (NewFields 2007). All fish population data collected during the monitoring period are provided in NewFields Boulder, LLC and HabiTech, Inc. (2009). For this analysis, kg/Ha was selected as the standard trout standing crop metric.

For data consistency between locations and years, two locations (HS and LSV-4) and one sampling season (Fall 2006) were omitted from the analyses presented in this report. Location HS is a source location for selenium and was excluded because: 1) it is a spring, and as such its' habitat is not directly influenced by highly variable fluvial processes such as stream flow and sediment transport; 2) the dense aquatic vegetation present during all field visits prevented effective fish sampling of the total wetted surface area; 3) vegetation removal efforts to facilitate electrofishing likely re-distributed fish into the remaining wetted marsh-like habitat which could not be effectively sampled; and 4) fish movement into and out of the area is limited by the lack of surface flow upstream of the location and a rock outcrop just downstream that is a likely fish barrier. Location LSV-4 was omitted because it could only be sampled in fall 2006 and spring 2007 due to landowner access restrictions. Fall 2006 data were not included because: 1) no data were collected at location SFTC-1 (it was not added to the study until 2007); 2) no water temperature data other than instantaneous measurements were available which resulted in high HQI scores at many locations; and 3) the inability to effectively sample locations CC-1A and CC-3A due to deep water, unwadeable conditions. All other locations and sampling times were included within the analysis as appropriate for the metrics being evaluated (e.g., HQI is based on late summer conditions only).

Linear regression was used to investigate relationships between fall trout standing crop estimates (kg/Ha) (dependent variables) and habitat quality scores obtained from HQI, SRI/CSE, SHI, and HSI (for both brown and cutthroat trout) (independent variables). Log-transformed total trout standing crop was the dependent variable used in all analyses except for those with HSI, which is species-specific. Fall estimates were used because the habitat models applied are based primarily upon attributes to be measured at late summer, low-flow conditions. Linear regression was also used to investigate relations between the dependent variable and specific habitat attributes contained within the different habitat models. Given the variability inherent within field data such as these, statistical significance was set at $p <= 0.10$. STATISTIX 8 software was used for the analyses (Analytical Software 2003).

The non-parametric Wilcoxon Rank Sum Test was used to compare trout standing crop and available habitat between reference/background locations (SFTC-1, DC-600, CC-75, CC-150 and CC-350) and the downstream locations potentially impacted by selenium (HS-3, LSV-2C, CC-1A and CC-3A). The non-parametric equivalent of the 2-sample T-test was used due to the high variability of the data and the lack of a normal distribution in some cases (Analytical Software 2003). Spring trout standing crops were also compared with fall estimates and Fall 2007 habitat scores with those for 2008 using the Wilcoxon Signed Rank Test, the non-parametric equivalent of the Paired T-test. Statistical significance was set at $p <= 0.10$ given the inherent variability within field data such as these.

4.0 RESULTS

This section summarizes the results of the physical habitat quality evaluations and the analyses of trout-habitat relations.

4.1 Physical Habitat Quality

4.1.1 Stream Reach Inventory and Channel Stability Evaluation (SRI/CSE)

SRI/CSE scores are presented for four of the five monitoring periods (Table 10). High flow, turbid water conditions, and late vegetative growth during Spring 2008 suggested that more representative habitat data would be obtained in the fall. Based on Pfankuch's total score ranges for channels in "good" (range 39 - 76) and "fair" (range 77 - 114) condition, six of the ten study locations evaluated were in good condition and four were in fair condition (Table 11) in Fall 2008. From Fall 2006 to Fall 2008, each location was fairly consistent in the SRI/CSE scores that resulted from the field observations. Evidence of instability was greatest at the CC-350 location (score range = 87 - 103). The DC-600 and HS locations were found to be consistently in the most stable condition with overall scores ranges of 55 to 63 and 52 to 60, respectively. One location (CC-75) was found to be in a somewhat improved condition in Fall 2008 when compared to Fall 2006 and 2007 scores.

Eroding stream bank, measured each fall, indicates bank conditions at all locations except DC-600, HS, CC-150, and the reference location SFTC-1 have declined since the previous fall monitoring events. This is likely due to the substantially high volume of spring runoff experienced during the spring of 2008. Eroding bank percentages at the Deer Creek location, Hoopes Spring, and the upper Crow Creek location CC-150 stayed relatively constant across the three fall monitoring events.

4.1.2 Riffle Stability Index (RSI)

The RSI procedure was completed at six of the ten monitoring locations during the Fall 2006 monitoring event following the guidance of Kappesser (2002) to evaluate stream bed stability and watershed condition throughout the project area (Table 10). The requisite measurements were taken at one riffle/point bar complex within each of these locations. The RSI could not be conducted at monitoring locations CC-1A, LSV-2C, HS, and HS-3, as these channel types did not provide the point bar features necessary for such an evaluation. During Fall 2007, RSI measurements were not collected. Snowmelt runoff, that would typically increase stream flows, was low during Spring 2007. Inspection of sampling locations in Spring and Fall 2007 indicated that coarse sediment transport due to runoff had not occurred in any of the streams, thereby negating any new deposition of coarse materials on the point bars. Only very fine sediments were found deposited on what few point bars were still in evidence. Conduct of the RSI was not feasible during 2007 given these conditions. Due to higher flows following the 2008 spring runoff, no point bars were visible during Fall 2008; therefore, no RSI data could be collected.

RSI values for the six monitoring locations that could be evaluated during Fall 2006 ranged from lows of 54 and 72 at CC-150 and CC-75, to highs in the upper 80’s to mid-90's at lower CC monitoring locations and near the mouths of both Sage and Deer Creeks (Table 11; Figures 8, 9, and 10). These results suggest declining watershed conditions in a downstream direction, with both channel stability and habitat quality influenced by the higher probability of stream bed particle mobilization.

4.1.3 Habitat Quality Index (HQI)

The HQI model is based upon field data collected during the late summer sampling period. HQI data are summarized for the three late summer/fall monitoring events while the HQI score for each location was calculated using Model II, the model recommended by Binns (1982). As described previously in the methods, HQI relies on a number of parameters, some of which are best evaluated using longer-term data collection, such as annual flow variation and maximum stream temperature. Temperature data logs for 2007 and 2008 are presented in Attachment 1 while summary statistics for temperature loggers are presented in Tables 12 and 13.

HQI scores varied widely between locations, with the lowest score of 1.9 kg/Ha at SFTC-1 in 2007 and the highest, 265 kg/Ha, at DC-600 (Table 14). Scores also varied widely between Fall periods evaluated. For example, HQI estimated at LSV-2C ranged from 411 kg/Ha in Fall 2006 to 73 kg/Ha in Fall 2008. The high estimates observed in Fall 2006 were influenced by maximum water temperatures based only on several instantaneous readings taken during the field visit to each location and not on the longer-term observations from the data loggers.

4.1.4 Habitat Suitability Index (HSI)

All HSI model scores are scaled from 0.0 (no habitat value for species and life stage of interest) to 1.0 (optimum habitat for species and life stage of interest). Total (overall), life stage component, and individual parameter HSI scores for both brown trout and YCT are provided in Tables 15 to 18, respectively. Stream habitat quality at the nine study locations varied over a fairly broad spectrum. Based on results presented here and in the Final Field Data Report (NewFields and HabiTech 2009), locations CC-350 and HS-3 generally fell on the lower end of this range, while location DC-600 typically was at or near the high end. For YCT, overall habitat quality ranged up to 90 percent of optimum at CC-75 with a low of 35 percent of optimum at HS-

3, while for brown trout, habitat quality varied from 76 percent of optimum at CC-150 and SFTC-1 to a low of 10 percent at HS-3 (Tables 17 and 18). Other locations varied within these ranges with most falling into the 70 to 85 percent of optimum range.

4.1.5 Stream Habitat Index (SHI)

IDEQ SHI raw data and scores are presented in Tables 19 and 20, respectively. Data were collected for ten parameters either as part of ongoing habitat quality metrics or independently to satisfy the data requirements of SHI. The maximum possible score for each habitat measure is 10, while the maximum total score is 100.

Overall, SHI scores typically ranged lowest at locations HS-3 and CC-350, and highest at DC-600. Generally, scores were consistently higher across locations in 2008 than in 2007, perhaps the result of a higher and more prolonged spring runoff in 2008. Canopy cover and large organic debris were lacking at most locations in both sampling years, resulting in lower scores.

IDEQ condition categories are also presented on Table 20. These categories are for the Northern and Middle Rockies Ecoregion and, based on the scoring, are either:

- 1 = <58 = <10th percentile of reference;
- 2 = 58-65 = 10th-25th percentile of reference; or
- 3 = > 66 = 25th percentile of reference.

Only the background Deer Creek (DC-600) location scored higher than Condition Category 1 during both years (Category 2 in 2007 and Category 3 in 2008). The reference location (SFTC-1) improved from Category 1 in 2007 to Category 2 in 2008 following an exceptionally high spring runoff season.

4.1.6 Trout Redd Investigations

4.1.6.1 Brown Trout

Evidence of brown trout spawning activity during the week of October 23, 2006 was observed at or in the vicinity of seven of the nine study locations where brown trout had earlier been collected. No evidence of spawning activity was found near locations CC-350 and HS. In total, 74 suspected redds were identified and measured, with the most extensive activity found at or near locations CC-1A, CC-3A, and CC-150 (Table 21 and Figures 11-13).

Water depths at suspected redds averaged 0.64 ft, with a range of 0.26 to 1.16 ft, while mean water velocity (measured at 0.6 depth in water column) averaged 1.70 feet per second (fps) with a range of 0.36 to 2.75 fps (Table 22). Tailspill substrate size averaged about 29 mm, which corresponds to coarse gravel on the modified Wentworth scale reported in Gordon et al. (1992). Core samples collected in undisturbed areas adjacent to suspected redd locations indicated the percent fines less than 2 mm diameter (sand and finer) varied from about 11 to 42 percent, with most in the range of 20 to 25 percent (Figure 14). Water temperatures during the redd survey ranged from 3 degrees C in the early mornings to 11 degrees C in late afternoon, while flows were stable, moderate and clear. While the redd survey was completed on October 24, 2006, brown trout exhibiting spawning behavior and new suspected redds were observed throughout the week.

4.1.6.2 Yellowstone Cutthroat Trout

In late April, 2007 an attempt was made to locate YCT redds throughout the spring/early summer sampling period. However, the only suspected redds located with sufficient certainty to take habitat measurements were observed near locations CC-1A and CC-3A on 27 April 2007.

Flow was moderate throughout Crow Creek with turbidity increasing in a downstream direction. Flow at the downstream end of location CC-1A was 39.1 cfs at 14:30 hours on 27 April. The stream bed was visible at all locations despite the somewhat turbid conditions. Water temperatures ranged from 6 to 15º C during the survey. To be certain that there was no mis-identification of YCT activity as brown trout activity from October 2006, several of the brown trout redd locations first identified in October 2006 were revisited and found to be well-covered with fine sediment deposition. This eliminated the possibility of incorrect species identification.

Ten potential YCT redds were identified during the survey, all located in the vicinity of locations CC-1A and CC-3A (Table 23). At or near the other locations, there were several areas which met one or two of the criteria presented above, but none which met all three.

The water depth, velocity and surficial substrate measurements taken at these ten locations are presented in Table 23, while the particle size distributions from streambed core samples collected adjacent to these locations on 10 May 2007 are presented in Figure 15. It is not known what effect low, and early, spring runoff in 2007 may have had on YCT spawning activity.

Water depths at suspected redds averaged 0.66 ft, with a range of 0.5 to 0.76 ft, while mean water velocity (measured at 0.6 depth in water column) averaged 1.94 feet per second (fps) with a range of 1.38 to 2.53 fps. Tailspill substrate size averaged about 30 mm, which corresponds to coarse gravel on the modified Wentworth scale reported in Gordon et al. (1992). Core samples collected in undisturbed areas adjacent to suspected redd locations indicated the percent fines less than 2 mm diameter (sand and finer) varied from about 10 to 30 percent (Figure 15).

4.1.7 Physical Habitat Simulation (PHABSIM)

The 10 monitoring locations studied as well as the dates, stream flows and number of cross-channel transects sampled at each location are described in Table 24.

WUA-stream flow relations for each monitoring location are presented in Figures 16 to 25, while the relative WUA (sq. ft. per 1,000 ft of stream) for each species and life stage at the average fall and spring monitoring flows are compared across locations in Table 25. The actual amounts of WUA (sq. ft.) per location are presented in Table 26. The ratios of WUA (sq. ft.) to total wetted surface area (sq. ft.), an indicator of habitat quality, are compared across locations, species, life stages and flows in Table 27.

Overall, WUA for each species and life stage evaluated was greatest at locations CC-1A and CC-3A, and commonly least at SFTC-1, DC-600 and HS-3. Physical habitat availability as measured by PHABSIM tended to increase in a downstream direction with increasing stream size and water depth. Similarly, physical habitat quality was consistently highest at CC-1A and CC-3A and least at HS-3 and SFTC-1.

Trout spawning habitat tended to be the most abundant habitat type present throughout the study area. Spawning habitat was most abundant in the spring when YCT would be spawning and tended to increase in a downstream direction with increasing stream size, decreasing gradient, and reduced substrate size.

Juvenile habitat availability for both trout species tended to be more abundant than adult habitat at most locations. Juvenile habitat for cutthroat and brown trout tended to be similar, with cutthroat habitat more abundant in the fall than the spring. Adult habitat availability was similar for both species, with cutthroat adult habitat more abundant in spring than in fall. Seasonal differences were slight for brown trout adult habitat.

4.2 Trout and Habitat Relations

Estimated total trout standing crop ranged from a low of 11.6 kg/Ha at location CC-350 in spring 2007 to a high of 277 kg/Ha at location LSV-2C in fall 2008 (Table 28). Brown trout were collected at 9 of the 10 study locations, being absent only from location DC-600, and ranged up to 231 kg/Ha at location LSV-2C. YCT were found at all locations and ranged up to 126.9 kg/Ha at DC-600 in the Fall 2008 samples. No differences in total trout standing stocks were found between spring and fall sampling seasons ($n = 18$; $p = 0.2575$).

Total habitat metrics served as independent variables for the regression analyses and are summarized in Table 29. HQI scores varied widely between locations, with the lowest score of 1.9 kg/Ha at SFTC-1 in 2007 and the highest, 265 kg/Ha, at DC-600. No difference was observed in HQI scores between 2007 and 2008 (n = 9; p = 0.7671). SRI/CSE scores ranged from a low of 55 (good condition and stability) at DC-600 to a high of 103 (fair condition and moderately unstable) at CC-350. No difference was observed in channel stability scores between 2007 and 2008 (n = 9; p = 0.3433). SHI scores were consistently highest at DC-600 (59 in 2007 and 71 in 2008) and lowest in 2007 at HS-3 (32) and at CC-350 in 2008 (39). Overall, SHI scores ranked higher in 2008 than in 2007 (n = 9; p = 0.0137).

All HSI model scores are scaled from 0.0 (no habitat value for species and life stage of interest) to 1.0 (optimum habitat for species and life stage of interest). Total (overall), life stage component, and individual parameter HSI scores for both brown trout and YCT are provided in Tables 17-18 and the Attachment 3 tables. For brown trout, overall scores ranged from 0.10 at HS-3 to 0.76 at CC-150 and SFTC-1. YCT overall HSI scores typically ranged higher than those for brown trout (n = 9; p = 0.0039), with CC-75 having the highest habitat quality (0.90) and HS-3 the lowest (0.35).

Overall HQI scores explained little variation in trout standing crop among the nine study locations (n = 18; p = 0.976) (Table 30). Likewise, neither the HQI food index (n = 18; p = 0.939) nor the HQI shelter index (n = 18; p = 0.145) was found to be significantly related to standing crop, although the shelter index did explain about 13 percent of the variation in trout biomass. Of the individual HQI attributes, trout cover was found to be a significant predictor of standing crop (n = 18; p = 0.015), explaining about 32 percent of the variation in biomass between locations. No other attribute explained more than about 5 percent of the variation.

Total SRI/CSE score was found to be strongly related to trout standing crop, explaining over 21 percent of the variation in biomass among locations (n = 18; p = 0.055) (Table 30). The slope of the best-fit line was negative, indicating declining standing crop with decreasing channel stability and condition. Within the SRI/CSE, lower bank scores, including ratings for channel capacity, bank rock content, flow obstructions/deflectors, bank cutting, and sediment deposition, were significantly related to trout standing crop (n = 18; p = 0.0705), explaining about 19 percent of the variation. Upper bank and channel bottom scores were not found to be significant.

SHI total scores explained little variation in trout standing crop among the nine study locations (n = 18; p = 0.870) (Table 30). While none of the individual attributes within the model were found to be significant, canopy cover (n = 18; p = 0.271), riffle embeddedness (n = 18; p = 0.306), and trout cover (n = 18; p = 0.315) explained the greatest amount of variation in trout biomass, about 6 to 7 percent.

Overall, the HSI models performed better than the HQI, SHI and SRI/CSE in the investigation of trout standing crop and habitat relations (Table 31). The overall cutthroat trout model scores explained over 40 percent of the variation in YCT standing crops across both years and locations combined (n = 18; p = 0.003), while adult, juvenile and fry habitat scores were also strongly related to YCT biomass (n = 18; p = 0.001, 0.002 and 0.018, respectively). Perhaps this is not surprising as YCT is the native trout species for all of the nine study locations. As measurements of physical conditions at suspected YCT redds were made in the vicinity of just two locations (CC-1A and CC-3A), regression analysis using the cutthroat embryo component was not possible. Embryo HSI scores at these two locations were 0.60 and 0.58, respectively. Several individual HSI parameters were also found to be significantly related to YCT standing crop and explained up to 61 percent of the variation in the data. These parameters included juvenile cover (n = 18; p = 0.0001), adult cover (n = 18; p = 0.0126), dominant riffle substrate (n = 18; p = 0.0408), and percent pools (n = 18; p = 0.0837).

HSI overall, adult, juvenile, and fry habitat scores for the non-native brown trout were not found to be strongly related to brown trout standing crop (n = 18; p = 0.700, 0.881, 0.455, and 0.939, respectively) (Table 31). Only the “Other” component score was found to be significant, explaining about 39 percent of the variation in brown trout biomass (n = 18; p = 0.005). Habitat attributes integrated within this component include HSI ratings for maximum water temperature, minimum dissolved oxygen, percent cover, percent bank vegetation, percent stable bank, pH, base flow regime, percent fines in riffles, percent shaded, and nitrate nitrogen. As with YCT, evidence of brown trout spawning was not found at all study locations, so regression analysis using the embryo component was not performed. Where suspected redds were found and physical measurements taken, HSI embryo component scores ranged from 0.48 at LSV-2C to 0.62 at HS-3.

4.3 Comparisons Between Background and Downstream Locations

No differences were found when we compared total trout standing crops between background and downstream locations for all sampling seasons (n = 20; p = 0.152), for fall samples (n = 8; p = 0.259) and for spring samples (n = 8; p = 0.487) (Table 32). When species abundance was compared separately, we found no differences in YCT standing crop between background and downstream locations (n = 20; p = 0.390). However, a significant difference was detected in brown trout standing crop (n = 20, p = 0.0028), with abundance ranging higher at downstream locations.

Habitat models had mixed results when we compared metrics between background and downstream locations. No differences in habitat quality were found when we compared locations with HQI (n = 10; p = 0.931), SRI/CSE (n = 10; p = 0.985), and brown trout HSI (n = 5; p = 0.159). Differences in habitat quality were detected based on SHI results (n = 10; p =

0.089) and cutthroat trout HSI ($n = 5$; $p = 0.008$). In both cases, habitat quality at the background locations ranged higher than at the downstream locations.

5.0 DISCUSSION

The four habitat models we applied varied widely in their relation to estimated trout standing crop. The HQI and SHI performed poorly in their ability to predict trout abundance while the HSI cutthroat trout model and the SRI/CSE protocol outputs were more strongly related. Such results are not surprising given that trout populations are regulated by both biotic and abiotic factors within the stream environment and the habitat models do not include all potential limiting factors influencing population size. Such factors as angler-induced mortality, other predation by fish, mammals and birds, disease, water quality, reproductive success, restricted fish passage, non-native competition, short-term localized flow reductions, and many others can influence population size (Adams 2002, Kohler and Hubert 1999, Meehan 1991). Measurement error associated with both fish and habitat sampling can also affect trout-habitat relations. While accepted sampling protocols were followed as closely as field conditions allowed, the 95 percent confidence limits reported about the population estimates give an indication of the measurement error inherent within such sampling. From the standpoint of identifying potential limiting factors, it is likely more insightful to examine the individual attributes, variables and components which comprise the overall habitat models that were applied.

Overall, 72 individual habitat attributes or variables were evaluated for inclusion within the habitat models utilized. While a great deal of duplication exists between models in the names assigned to variables, most have a distinct definition, procedure and rating scale. The HQI is based upon 10 attributes, only one of which, trout cover, was found to be significantly and positively related to trout standing crop. However, inspection of individual cover ratings indicates cover availability was poor (rating of 0 or 1) for at least one sampling time at seven of the nine study locations. Likewise, maximum summer water temperature was rated as poor at four locations in 2007, ranging over 25 degrees C at SFTC-1, CC-150, CC-350, and LSV-2C, while eroding bank rated poor at HS-3, LSV-2C and CC-1A following the large 2008 spring runoff.

SHI results were somewhat similar to those for HQI. Habitat variables commonly found to be less than 50 percent of optimum included large woody debris, canopy cover, and fish cover. Substrate embeddedness (5 locations) and percent fine sediments in riffles (3 locations) were also identified as problematic.

The SRI/CSE consists of 15 rated attributes divided between upper banks, lower banks, and channel bottom. Lower bank scores were significantly and negatively related to trout standing crop. The two lower bank attributes contributing substantially to this negative relationship were the degree of stream bank erosion (locations SFTC-1, CC-75, CC-350, HS-3, CC-1A, and CC-3A) and the deposition of finer sediments on bars (CC-350 and CC-1A). Other attributes commonly rated fair to poor included upper bank vegetative cover and mass wasting potential, and channel bottom particle size distribution and bed scour and deposition. Debris jam potential was consistently rated good to excellent from the standpoint of channel stability. However, from the standpoint of trout habitat, the lack of large woody debris is a negative.

Two of the 18 cutthroat trout HSI variables were consistently rated as less than 50 percent of optimum, average summer maximum water temperature and percent shade (7 locations each). The percent substrate (10 to 40 cm) available for winter and escape cover by fry and small juveniles was less than 50 percent of optimum at four locations, while the percent of fine sediment found adjacent to likely redds was problematic (<= 25 percent of optimum) at both locations (CC-1A and CC-3A) where YCT spawning activity was observed. Brown trout HSI variable ratings showed similar trends. Percent shade was less than 50 percent of optimum at seven locations, while percent fine sediments in suspected redds was problematic (< 25 percent of optimum) at all six locations where spawning activity was observed. Adult cover, percent substrate 10 to 40 cm, and percent pools were less than 50 percent of optimum at three locations each.

The trout redd surveys indicated that spawning activity was present and widely distributed throughout much of the Crow Creek watershed project area, especially for brown trout. Likewise, the PHABSIM analyses suggest trout spawning habitat is abundant and widespread throughout the study area. While the quantity of spawning habitat available appears to be more than sufficient to maintain trout populations, the core sampling data near redd locations suggests the quality of that habitat may be far less than optimum. Fine sediment (<6.35 mm) within the project area spawning bars was found to commonly comprise 40 percent or more of the stream bed substrate. Numerous fishery researchers have attempted to relate fine sediment content in spawning gravels to salmonid incubation and emergence success. While results have spanned a fairly wide range with high variability, the general trend has been reduced embryo survival with increasing fine sediment content (Bjornn and Reiser 1991). In a recent summary of these findings, Kondolph et al. (2008) reported that at levels of 30 percent < 6.35 mm, survival-to-emergence may be in the 50 percent range, with escalating mortality as levels increase. This finding is supportive of the HSI results discussed above that suggest intergravel habitat quality is < 25 percent of optimum.

Linking the PHABSIM results to trout standing crop estimates was not attempted because the field data were collected over several field seasons and could not be directly associated with specific population estimates. The lack of flow variability in 2007 necessitated completion of data collection during the spring and summer of 2008. Also, while PHABSIM results are useful for describing and comparing hydraulic (water depth, velocity, channel roughness) habitat availability, the model is limited in scope because it does not consider numerous other potential limiting factors such as water quality, temperature, and riparian condition (Instream Flow Council 2004).

An advantage of PHABSIM is that results are species and life stage specific, and are linked to stream flow. As described earlier, the analyses conducted allowed for the following determinations: 1) spawning habitat was abundant throughout the study area; 2) adult and juvenile habitat availability for both brown trout and cutthroat trout were similar; and 3) physical (hydraulic) habitat availability and quality tended to increase in a downstream direction with increasing stream size and water depth. The linkage of PHABSIM results to stream flow can allow habitat availability to be assessed temporally, not just spatially, across seasons and water years if appropriate discharge records are available. Such results can then be used to develop instream flow prescriptions and evaluate trade-offs between different water management scenarios (Instream Flow Council 2004). While these outcomes were not necessary to meet the objectives of this study, future information needs may require such analyses.

The habitat deficiencies observed are symptomatic of stream reaches affected by heavy livestock grazing in the riparian zone, extensive road development within the contributing watershed, and high demand for irrigation water withdrawal (Platts 1991; Furniss et al. 1991; Meehan 1991; Wesche and Isaak 1999; Kohler and Hubert 1999). The lack of riparian shading has undoubtedly contributed to higher summer water temperatures, especially for YCT, and reduced input of woody debris for trout cover. Trampling by large herbivores has contributed to extensive stream bank erosion and increased mass wasting potential resulting in elevated fine sediment levels within potential spawning gravels, pool filling, and loss of cover for all trout life stages. Road development and extensive off-road vehicle use within the watershed have likely contributed as well to these fine sediment related issues. Fine sediment intrusion into suspected trout redds is reflected in reduced HSI embryo component scores and likely contributes to elevated embryo mortality and reduced emergence success. Overall, while trout habitat quality is quite good at most study locations and supportive of naturally reproducing trout populations, these watershed-based land use impacts are likely limiting the affected stream reaches from achieving their full potential.

6.0 SUMMARY OF KEY FINDINGS

Based upon the results and analyses presented, a summary of key findings includes:

1. No differences in total trout standing crop were found between spring and fall sampling seasons.

2. The four habitat models that were applied varied widely in their relation to estimated trout standing crop, with the HSI cutthroat trout model and the SRI/CSE exhibiting the strongest relationships.

3. Stream habitat quality at the nine study locations varied over a fairly broad spectrum, with CC-350 and HS-3 generally near the lower end of the range and DC-600 near the higher end.

4. When trout standing crop and habitat quality were compared between background and downstream locations, no differences were found in total trout and YCT standing crops, and HQI, SRI/CSE and brown trout HSI scores. Differences were found for brown trout standing crop (higher at downstream locations) and SHI and cutthroat trout HSI scores (higher at background locations).

5. Individual stream habitat attributes identified as potentially limiting to trout populations include the lack of riparian shading, high water temperatures, low levels of woody debris recruitment, lack of cover for all trout life stages, extensive bank erosion, and elevated fine sediment levels in likely spawning gravels. The degree of each habitat deficiency varies by sampling location and location within the watershed.

6. Trout spawning activity is occurring throughout much of the Crow Creek watershed study area and spawning habitat appears to be both abundant and wide spread. Trout spawning habitat quality is likely diminished by elevated fine sediment levels which may be impairing embryo survival-to-emergence.

7. Physical (hydraulic) trout habitat tended to increase in a downstream direction with increasing stream size and water depth. Based on PHABSIM analysis, adult habitat for both trout species was similar, as was juvenile habitat. Habitat quality was consistently highest at locations CC-1A, CC-3A and CC-150 and least at locations HS-3 and SFTC-1.

8. The habitat deficiencies observed are symptomatic of stream reaches affected by heavy livestock grazing in the riparian zone, extensive non-engineered road development, stream crossing, and off-road vehicle use, and irrigation diversion and return flows in the watershed. Overall, while trout habitat quality is quite good at most study locations and supportive of naturally reproducing trout populations, watershed-based land use impacts are likely limiting the affected reaches from achieving their full potential.

7.0 CONCLUSIONS

The four habitat models that were applied varied widely in their relation to estimated trout standing crop. The HQI and SHI performed poorly in their ability to predict trout abundance while the HSI cutthroat trout model and the SRI/CSE protocol outputs were more strongly related. Such results are not surprising given that trout populations are regulated by both biotic and abiotic factors within the stream environment and the habitat models do not include all potential limiting factors influencing population size. Such factors as angler-induced mortality, other predation by fish, mammals and birds, disease, water quality, reproductive success, restricted fish passage, non-native competition, short-term localized flow reductions, and many others can influence population size (Adams 2002, Kohler and Hubert 1999, Meehan 1991). Measurement error associated with both fish and habitat sampling can also affect trout-habitat relations. While accepted sampling protocols have been followed as closely as field conditions allow, the 95 percent confidence limits reported about the population estimates give an indication of the measurement error inherent within such sampling. From the standpoint of identifying potential limiting factors, it is likely more insightful to examine the individual attributes, variables and components which comprise the overall habitat models that were applied.

The habitat deficiencies observed are symptomatic of stream reaches affected by heavy livestock grazing in the riparian zone, development and use of non-engineered roads and stream crossings (i.e., two track roads and non-culverted fords), and water management (irrigation diversion/return flows, draw down of base stream levels) within the contributing watershed (Platts 1991; Furniss et al. 1991; Meehan 1991; Wesche and Isaak 1999; Kohler and Hubert 1999). The lack of riparian shading has undoubtedly contributed to higher summer water temperatures, especially for YCT, and reduced input of woody debris for trout cover. Trampling by large herbivores has contributed to extensive stream bank erosion and increased mass wasting potential. Cattle grazing and nearstream bank trampling is evident at several locations, but is most pronounced at CC-75, CC-350, HS-3, CC-1A and CC-3A. Recently, management actions have been taken near locations CC-1A and CC-3A to minimize cattle access to the stream.

Development and use of non-engineered roads and stream crossing (i.e., extensive off-road vehicle use) within the watershed have likely contributed as well to these fine sediment related issues. Improperly designed and constructed roads and stream crossings have long been problems on USFS lands. Numerous agencies have dedicated programs to addressing management issues related to road development in watersheds that aid in minimizing sedimentation issues that arise. However, poorly conceived or illegal road development (i.e., through popular use) can result in erosive runoff that leads to excessive sedimentation in nearby streams if appropriate precautions and management measures are not implemented (Furniss et al. 1991).

Water management, through irrigation diversions and returns, can contribute to stream channel erosion. Reductions in normal base flows lower water levels that can dry the rooting zone of nearstream vegetation, making banks more fragile and prone to failure. In-channel scour of deposited sediments is reduced as flows are diverted, thus affecting sediment transport processes. Irrigation diversion and return channels convey water away from and back to the stream. Often, the conveyance channels that form may continually erode, delivering large loads of finer sediments to the stream. A prime example of this can be seen in Sage Valley where irrigation water returning to Sage Creek has created channels >5 feet deep as they near the stream. Several of these channels are actively head-cutting due to the volume of return flow. In this case, sediment runoff to the Sage Creek stream system is extensive.

The results of excessive erosion and sedimentation are elevated fine sediment levels within potential spawning gravels, pool filling, and loss of cover for all trout life stages. Fine sediment intrusion into suspected trout redds is reflected in reduced HSI embryo component scores and likely contributes to elevated embryo mortality and reduced emergence success. Overall, while trout habitat quality is quite good at most study locations and supportive of naturally reproducing trout populations, these watershed-based land use impacts are likely limiting the affected stream reaches from achieving their full potential.

8.0 REFERENCES

Adams, S. M. (Ed.) 2002. Biological indicators of aquatic ecosystem stress. American Fisheries Society, Bethesda, MD. 644p.

Analytical Software. 2003. Statistix 8 Users Manual. Tallahassee, FL.

Binns, N.A. 1982. Habitat quality index: procedure manual. Wyoming Fish and Game Department. Cheyenne, Wyoming. 209 pages.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements in streams. Ch. 4, pp.83 – 138, In (W. R. Meehan, ed.) Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitat. American Fisheries Society Special Publication 19. Bethesda, MD.

Bovee, Ken D. 1997. Data collection procedures for the Physical Habitat Simulation System. U. S. Geological Survey, Biological Resources Division, Mid-Continent Ecological Science Center, Fort Collins, CO.

Bovee, K. D., B. L. Lamb, J. M. Bartholow, C. B. Stalnaker, J. Taylor, and J. Henriksen. 1998. Stream habitat analysis using the instream flow incremental methodology. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004. viii 131 pp.

Furniss, M. J., T. D. Roelofs and C. S. Yee. 1991. Road construction and maintenance. Chapter 8 in, W. R. Meehan (ed.), Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication No. 19, Bethesda, MD.

Gordon, N.D., T.A. McMahon, and B.L. Finlayson. 1992. Stream Hydrology. An Introduction for Ecologists. John Wiley & Sons, N.Y.

Grafe, C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier. 2002. The Idaho Department of Environmental Quality Water Body Assessment Guidance, Second Edition-Final. Idaho Department of Environmental Quality; Boise, Idaho.

HabiTech, Inc. 1999. Warm Springs Creek instream flow study. Project completion report to ARCO Environmental Remediation, Anaconda, MT.

Hickman, T. and R.F. Raleigh. 1982. Habitat Suitability Index Models: Cutthroat Trout. US Department of Interior, Fish and Wildlife Service, FWS/OBS-82)10.5.

Instream Flow Council. 2004. Instream Flows for Riverine Resource Stewardship, Revised Edition. IFC publication. Cheyenne, WY.

Kappesser, G. B. 2002. A Riffle Stability Index to Evaluate Sediment Loading to Streams. Journal American Water Resources Association 38 (4): 1069 - 1081.

Kohler, C. C. And W. A. Hubert. 1999. Inland fisheries management in North America, 2nd edition. American Fisheries Society, Bethesda, MD.

Kondolf, G. M., J. G. Williams, T. C. Horner and D. Milan. 2008. Assessing physical quality of spawning habitat. American Fisheries Society Symposium 65:249-274. Bethesda, MD.

McNeil, William J., and Warren H. Ahnell. 1960. Measurement of Gravel Composition of Salmon Stream Beds. Fish. Res. Inst. University of Washington, Seattle, WA, Circ. 120: 7 p.

Meehan, W. R. (Ed.). 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication No. 19, Bethesda, MD.

NewFields. 2005. Site Investigation Report for the Smoky Canyon Mine Caribou County, Idaho. Prepared for J.R. Simplot Company. July.

NewFields. 2006. Engineering Evaluation/Cost Analysis Smoky Canyon Mine Caribou County, Idaho. Prepared for J.R. Simplot Company. May.

NewFields. 2007. Final Work Plan - Field Monitoring Studies for Developing a Site-Specific Selenium Criterion. Prepared for J.R. Simplot Company. April.

NewFields. 2008. Revised Draft Summary of Approach for Developing a Site-Specific Selenium Criterion. Prepared for J.R. Simplot Company. February.

NewFields Boulder, LLC and HabiTech, Inc. 2009. Draft Final Data Report-Fall 2006-Fall 2008 Field Monitoring Studies for Developing a Site-Specific Selenium Criterion. Prepared for J.R. Simplot Company. May. Errata May 2010.

Pfankuch, D.J. 1975. Stream Reach Inventory and Channel Stability Evaluation: A Watershed Management Procedure. USDA, Forest Service, Northern Region.

Platts, W. S. 1991. Livestock grazing. Chapter 11 in, W. R. Meehan (ed.), Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication No. 19, Bethesda, MD.

R2 Resource Consultants, Inc. 2007. Test of regional habitat suitability curves: Validation of Snake River basin adjudication curves with empirical data and comparison of curves developed independently for the Big Creek and upper American River projects, Sierra Nevada, California. R2 Project 1415.01, Technical Memorandum 2, Prepared for U. S. Forest Service.

Raleigh, R.F., L.D. Zucherman, and P.C. Nelson. 1986. Habitat Suitability Index Models and Instream Flow Suitability Curves: Brown Trout. US Department of Interior, Fish and Wildlife Service, Biological Report 82(10.124).

Reiser, D. W. 1995. Expert report of Dudley W. Reiser, PhD. State of Montana v. Atlantic Richfield Company, No. CV-83-317-HLN-PGH, U. S. District Court, District of Montana, Helena Division.

Stalnaker, C., B. L. Lamb, J. Henriksen, K. Bovee, and J. Bartholow. 1995. The Instream Flow Incremental Methodology – A Primer for IFIM. Biological Report 29, March 1995, U.S. Department of the Interior, National Biological Service, Fort Collins, Colo.

U. S. Geological Survey. 2001. PHABSIM for Windows: user's manual and exercises. Open File Report 01-340, Mid-Continent Ecological Science Center, Fort Collins, CO.

Wesche, T. A. and D. J. Isaak. 1999. Watershed management and land use practices. Ch 9 in, C. C. Kohler and W. A. Hubert (eds.), Inland fisheries management in North America, 2nd edition. American Fisheries Society, Bethesda, MD.

TABLES

Table 1
Monitoring Locations, Coordinates, and Sampling Activity for Sampling in Support of Deriving a Site-Specific Selenium Criterion

Location	Reach	Reach Boundary	Easting	Northing	Water and Sediment Quality	Benthic and Periphyton Tissues	Fish Tissue	Fish Population	Benthic Community	Habitat Quality
Reference										
SFTC-1	South Fork Tincup Creek u/s of confluence with Tincup Creek	Downstream	486372	4758414	X	X	X	X	X	X
		Upstream	486376	4758324						
Upstream of Sage Creek										
CC-75	Crow Creek u/s of Wells Canyon	Downstream	486291	4710432	X	X	X	X	X	X
		Upstream	486267	4710376						
CC-150	Crow Creek u/s of Deer Creek	Downstream	487193	4712682	X	X	X	X	X	X
		Upstream	487113	4712612						
CC-350	Crow Creek d/s of Deer Creek	Downstream	489397	4715486	X	X	X	X	X	X
		Upstream	489410	4715422						
DC-600	Deer Creek u/s of Crow Creek	Downstream	487309	4715077	X	X	X	X	X	X
		Upstream	487231	4715120						
Hoopes Spring and Sage Creek										
HS	Hoopes Spring	Downstream	490613	4721469	X	X	X	X	X	X
		Upstream	490590	4721514						
HS-3	Hoopes Spring (Discharge Channel)	Downstream	491238	4720612	X	X	X	X	X	X
		Upstream	491187	4720674						
LSV-2C	Lower Sage Creek d/s Hoopes Spring	Downstream	491340	4720392	X	X	X	X	X	X
		Upstream	491332	4720463						
LSV-4	Lower Sage Sage Creek u/s Crow Creek	Downstream	491663	4718584	X	X	X	X	X	X
		Upstream	491599	4718642						
Downstream of Sage Creek										
CC-1A	Crow Creek d/s Sage Creek	Downstream	493395	4719100	X	X	X	X	X	X
		Upstream	493345	4719057						
CC-3A	Crow Creek d/s Sage Creek and CC-1A	Downstream	494968	4720417	X	X	X	X	X	X
		Upstream	494874	4720281						

Coordinates are UTM NAD83, Zone 12T
d/s = downstream
u/s = upstream

Table 2
Stream Reach Inventory and Channel Stability Evaluation (SRI/CSE) Ratings by Attribute

	Attribute	Excellent		Good		Fair		Poor	
	Upper Banks								
1	Landform slope	Bank slope gradient <30%	2	Bank slope gradient 30-40%	4	Bank slope gradient 40 - 60%	6	Bank slope gradient 60%+	8
2	Mass wasting hazard	No evidence of past or any potential for future mass wasting into channel	3	Infrequent and/or very small. Mostly healed over. Low future potential	6	Moderate frequency and size, with some raw spots eroded by water during high flows.	9	Frequent or large, causing sediment nearly yearlong or imminent danger of same	12
3	Debris jam potential	Essentially absent from immediate channel area	2	Present but mostly small twigs and limbs.	4	Present, volume and size are both increasing.	6	Moderate to heavy amounts, predominantly larger sizes.	8
4	Vegetation bank protection	90% + plant density. Vigor and variety suggests a deep, dense, soil binding, root mass	3	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	6	50-70%density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	9	<50% density plus fewer species and less vigor indicate poor, discontinuous, and shallow root mass.	12
	Lower Banks								
5	Channel capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7	1	Adequate. Overbank flows rare. W/D ratio 8 to 15.	2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	3	Inadequate. Overbank flows common.W/D ratio >25	4
6	Bank rock content	65% with large, angular boulders 12"+ numerous	2	40 to 65%, mostly small boulder to cobbles 6-12"	4	20 to 40% with most in the 3-6" diameter class.	6	<20%rock fragments of gravel sizes, 1-3" or less.	8
7	Obstructions - Flow deflectors, sediment traps	Rocks and old logs firmly embedded. Flow pattern without cutting or deposition. Pools and riffles stable	2	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	4	Moderately frequent, moderately unstable obstructions and deflectors move with high water causing bank cutting and filling of pools.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8
8	Cutting	Little or non evident. Infrequent raw banks less than 6" high generally	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	8	Significant. Cuts 12 to 24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
9	Deposition	Little or no enlargement of channel or point bars	4	Some new increase in bar formation, mostly from coarse gravels.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposits of predominantly fine particles. Accelerated bar development.	16
	Channel Bottom								
10	Rock Angularity	Sharp edges and corners, plan surfaces roughened	1	Rounded corners and edges, surfaces smooth and flat.	2	Corners and edges well rounded in two dimensions.	3	Well rounded in all dimensions, surface smooth.	4
11	Brightness	Surface dull, darkened, or stained. Generally not "bright"	1	Mostly dull, but may have up to 35% bright surfaces.	2	Mixture, 50-50% dull and bright, range: 35 - 65%	3	Predominantly bright, 65%+ exposed or scoured surfaces.	4
12	Consolidation or particle packing	Assorted sizes tightly packed and/or overlapping	2	Moderately packed with some overlapping.	4	Mostly a loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8
13	Bottom size distribution and percent stable materials	No changes in sizes evident. Stable materials 80-100%	4	Distribution shift slight. Stable materials 50-80%.	8	Moderate change in sizes. Stable materials 20-50%.	12	Marked distribution change. Stable materials 0-20%.	16
14	Scouring and deposition	Less than 5% of the bottom affected by scouring and deposition	6	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30-50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
15	Clinging aquatic vegetation (moss and algae)	Abundant. Growth largely moss-like, dark green, perennial. In swift water too.	1	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	2	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	3	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
	Overall rating								

Add each column, add column scores — <38 = Excellent, 39-76 = Good, 77-114 = Fair, 115+ = Poor.

Table 3
Stream Habitat Attributes Used in the Habitat Quality Index (HQI)

Attribute	Symbol	Rating Characteristics				
		0	1	2	3	4
Late summer streamflow	x1	Inadequate to support trout (Critical period flow <10% average discharge	Very limited; potential for trout support is sporadic (CPF 10-15% AD)	Limited, CPF may severely limit trout stock every few years (CPF 16-25% AD)	Moderate; CPF may occasionally limit trout numbers (CPF 26-55% AD)	Completely adequate; CPF very seldom limiting to trout (CPF >55%)
Annual stream flow variation	x2	Intermittent stream	Extreme fluctuation, but seldom dry; base flow very limited	Moderate fluctuation, but never dry; base flow occupies 2/3 of channel	Small fluctuation, base flow stable	Little or no fluctuation
Maximum summer stream temp. (C)	x3	<6 or >26.4	6-8 or 24.4-26.3	8.1-10.3 or 21.5-24.1	10.4-12.5 or 18.7-21.4	12.6-18.6
Nitrate Nitrogen (mg/L)	x4	<0.01 or >2.0	0.01-0.04 or 0.91-2.0	0.05-0.09 or 0.51-0.90	0.10-0.14 or 0.26-0.50	0.15-0.25
Fish food abundance (no./0.1m^2)	x5	<25	26-99	100-249	250-500	>500
Fish food diversity (Ds)[a]	x6	<0.80	0.80-1.19	1.20-1.89	1.90-3.99	>4.0
Cover (%)[b]	x7	<10	25-Oct	26-40	41-55	>55
Eroding Banks (%)[c]	x8	75-100	50-74	25-49	10-24	<10
Substrate	x9	Submerged Aquatic vegetation (SAV) lacking	Little SAV	Occasional patches of SAV	Frequent patches of SAV	Well developed and abundant SAV
Water velocity (ft/sec)[d]	x10	<0.25 or >4.0	0.25-0.49 or 3.5-3.99	0.5-0.99 or 3.0-3.49	1.0-1.49 or 2.5-2.99	1.5-2.49
Stream width (ft)[e]	x11	<2 or >150	2-6 or 75-149	7-11 or 50-74	12-17 or 23-49	18-22

Source: Binns 1982.

[a]For the purpose of the HQI, diversity score (Ds) is defined as follows: DS=anti-log /D/, where D is calculated for each taxon from the formula: Ds=Pi log10Pi. When Pi is defined as 1/n, and n is the number of organisms, then the formula reduces to D=log10n, as discussed in Watt (1968). /D/ is then the mean of all the values for the sample.

[b]%cover=total amount of cover/total area in study section.

[c]%eroding banks=total length of eroding stream banks (both sides) in section/total length (one side) of study section.

[d]Time of travel water velocity, using fluorescent dye. Velocity=thalweg length/time required for dye to traverse section.

[e]Width of water surface, less width of any islands.

TABLE 4
HQI Model I Derivation

Stream_____________________________ Date _____________________________
Study Sites #_______________________ Transect #________________________
Location __________________________ Calculations by _________________

Rating Characteristic

x1= ____________ P = (x4) (x3) (x6) (x7) (X8) (x10) (x11)
X2= ____________ P = ( ) ( ) ( ) ( ) ( ) ( ) ( )
X3= ____________ P = _____________________________________

Intermediate Calculations

Log10(1+x1) = Log10 =______________
Log10(1+x2) = Log10 =______________
Log10(1+x3) = Log10 =______________
Log10(1+P) = Log10 =______________

HQI Calculation

Log10(HQI+1) = [(-1.18257)+(.97329)Log10(1+x1)+(1.65824)Log10(1+x2)+ (1.44821)Log10(1+x3)+(0.30762)Log10(1+P)] *[1.12085]

HQI (kg/h) = [(Antilog10 _______)*(1.12085)]-1.0

Variables	Rating
X1 = Late Summer Streamflow	
X2 = Annual streamflow Variation	
X3 = Maximum Summer Stream Temperature	
P = (X4) (X5) (X6) (X7) (X8) (X10) (X11)	
X4 = Nitrate Nitrogen	
X5 = Fish Food Abundance	
X6 = Fish Food Diversity	
X7 = Cover	
X8 = Eroding Stream Banks	
X10 = Water Velocity	
X11 = Stream Width	

(SOURCE: Binns 1982, Wyoming Game and Fish Department)

TABLE 5
HQI Model II Calculation Sheet

Stream____________________________ Date ____________________________
Study Sites #______________________ Transect #_______________________
Location _________________________ Calculations by _________________

Rating Characteristic

X_1= ____________ F = ( ) ( ) ( ) ( ) = ________________
X_2= ____________ S = ( ) ( ) ( ) = _____________________
X_3= ____________

Intermediate Calculations
$Log_{10}(1+x_1) = Log_{10}$ =______________
$Log_{10}(1+x_2) = Log_{10}$ =______________
$Log_{10}(1+x_3) = Log_{10}$ =______________
$Log_{10}(1+F) = Log_{10}$ =______________
$Log_{10}(1+S) = Log_{10}$ =______________

$Log_{10}(HQI+1) = [(-.903)+(.807)Log_{10}(1+x_1)+(.877)Log_{10}(1+S_2)+(1.233)Log_{10}(1+x_3)+(.631)Log_{10}(1+F)+(.182)Log_{10}(1+S)] *[1.12085]$

HQI (kg/h) = [(Antilog10 _______)*(1.12085)]-1.0

Variables	Rating
X_1 = Late Summer Streamflow	
X_2 = Annual streamflow Variation	
X_3 = Maximum Summer Stream Temperature	
F = Food Index = (X_3) (X_4) (X_9) (X_{10}) =	
S = Shelter Index = (X_7) (X_8) (X_{11}) =	
X_4 = Nitrate Nitrogen =	
X_7 = Cover =	
X_8 = Eroding Stream Banks =	
X_9 = Substrate =	
X_{10} = Water velocity =	
X_{11} = Stream Width =	

(SOURCE: Binns 1982, Wyoming Game and Fish Department).

Table 6
Relationship Among Model Variables, Components, and Habitat Suitability Index (HSI) for Brown Trout

Habitat Variables	Model Components
% instream Cover (V5A) % pools (V9) Pool Class Rating (V14)	Adult
% instream Cover (V5J) % pools (V9) Pool Class Rating (V14)	Juvenile
% substrate size class (V7) % pools (V9) % fines (V15b)	Fry
Average max temp (V2) Average min DO (V3) Average water velocity (V4) % gravel size in spawning areas (V6) %fines (V15c)	Embryo
Max Temperature (V1, V2) Average Min DO (V3) pH (V12) Average base flow (V13) Dominant substrate type (V8)b % streamside vegetation (V10)b % fines (V15d) % stream stability (V11)b % midday shade (V16)b mg/l nitrate-nitrogen (V17)b Peak flow (V18)	Other

All model components → **HSI**

Source: Raliegh et al. 1986
A = Adult
J = Juvenile
a = Variables that affect all life stages
b = Optional variables
c = spawning
d = riffle-run

Table 7
Relationship Among Model Variables, Components, and Habitat Suitability Index (HSI) for Cutthroat Trout

Habitat Variables	Model Components
Average thalweg depth (V4) % adult cover (V6A) % pools (V10) Pool Class Rating (V15)	Adult
% juvenile cover (V6J) % pools (V10) Pool Class Rating (V15)	Juvenile
% substrate size class (V8) % pools (V10) % riffle fines (V16b)	Fry
Average max temp (V2) Average min DO (V3) Water velocity (V5) Average gravel size (V7) %fines (V16a)	Embryo
Max Temperature (V1) Average Min DO (V3) pH (V12) Base flow (V14) Dominant substrate type (V9) % vegetation (V11) % vegetation erosion (V12) % riffle fines (V16b)	Other*

HSI

Source: Hickman and Raliegh 1982
A = Adult
J = Juvenile
a = spawning
b = riffle-run
* Variables that affect all life stages

Table 8

Habitat Suitability Information Used for PHABSIM Modeling at the 10 Simplot Monitoring Locations

	Cutthroat Trout							Brown Trout					
	Vel	SI	Depth	SI	Substrate	SI		Vel	SI	Depth	SI	Substrate	SI
Adult	0	0.2	0	0	0	1		0	1	0	0	0.0	0.0
	0.5	1	0.5	0	100	1		0.5	1	0.5	0	0.9	0.0
	2	1	2	1				1	0.7	1	0.8	1.0	0.4
	3	0	100	1				1.5	0.5	1.3	1	3.9	0.4
	100	0						3	0	100	1	4.0	1.0
								6	0			7.9	1.0
								100	0			8.0	0.4
												8.9	0.4
												9.0	1.0
												9.9	1.0
												100.0	0.0

	Cutthroat Trout							Brown Trout					
	Vel	SI	Depth	SI	Substrate	SI		Vel	SI	Depth	SI	Substrate	SI
Junvenile	0	0	0	0	0	1		0	1	0	0	0.0	0.0
	0.2	0.15	0.3	0.2	100	1		0.5	1	0.5	0.12	0.9	0.0
	0.3	0.9	0.6	0.65				1.5	0.7	1	1	1.0	0.4
	0.5	0.97	1	0.96				2	0.25	5	1	1.9	0.4
	0.7	1	1.2	1				2.5	0	100	1	2.0	0.4
	1.2	1	2	1				4	0			3.9	0.4
	2	0	100	1				100	0			4.0	1.0
	100	0										6.9	1.0
												7.0	0.4
												8.9	0.4
												9.0	1.0
												100.0	1.0

	Brown and Cutthroat						
	Vel	SI	Depth	SI	Substrate	SI	Substrate Codes
Spawning	0	0	0	0	0.0	0	1 grass, wood, bare ground
	0.4	0	0.2	0	1.0	0	2 silt/clay
	1.5	1	0.7	1	3.9	0	3 sand
	2.25	1	2	1	4.0	1	4 fine gravel
	3.9	0	100	1	5.0	1	5 coarse gravel
	100	0			5.9	1	6 cobble
					6.0	0	7 boulder
					100.0	0	decimal number
							5.5 = 50% coarse gravel, 50% cobble

Table 9
Flow for All Sampling Events and Mean Spring and Fall Flows

Stream	Location	Date	Flow (cfs)	Mean Spring Flow (cfs)	Mean Fall Flow (cfs)
Reference					
SF Tincup Creek	SFTC-1	5/7/2007	17.4	19.2	0.5
		8/29/2007	0.1		
		6/9/2008	21.0		
		9/9/2008	0.9		
Upstream of Sage Creek					
Crow Creek	CC-75	9/2/2006	4.2	11.5	3.5
		5/8/2007	7.6		
		8/23/2007	2.5		
		5/12/2008	15.3		
		9/3/2008	3.9		
	CC-150	9/3/2006	8.1	21.7	7.7
		5/9/2007	15.9		
		8/24/2007	3.2		
		5/12/2008	27.5		
		9/3/2008	11.7		
	CC-350	8/31/2006	16.9	32.5	19.2
		5/8/2007	28.9		
		8/23/2007	16.4		
		5/13/2008	36.0		
		9/4/2008	24.2		
Deer Creek	DC-600	9/7/2006	2.6	13.4	2.6
		5/13/2007	6.8		
		8/27/2007	2.0		
		5/18/2008	20.0		
		9/8/2008	3.3		
Hoopes Spring and Sage Creek					
Hoopes Spring	HS-3	9/6/2006	5.2	6.1	5.4
		5/12/2007	5.4		
		8/28/2007	5.9		
		5/17/2008	6.8		
		9/5/2008	5.1		
Sage Creek	LSV-2C	9/6/2006	8.0	10	9.9
		5/12/2007	7.7		
		8/28/2007	6.6		
		5/17/2008	12.4		
		9/5/2008	15.1		
	LSV-4	9/5/2006	15.3	12.3	15.3
		5/9/2007	12.3		
Downstream of Sage Creek					
Crow Creek	CC-1A	9/1/2006	32.3	51	30.5
		5/10/2007	41.1		
		8/25/2007	21.6		
		5/14/2008	61.0		
		9/6/2008	37.5		
	CC-3A	9/4/2006	35.7	56.1	34.5
		5/11/2007	47.0		
		8/26/2007	25.1		
		5/15/2008	65.2		
		9/7/2008	42.7		

Table 10
Stream Reach Inventory/Channel Stability Evaluation (SRI/CSE) Scores and Riffle Stability Index (RSI) Scores for the Eleven Locations Sampled, Fall 2006 - Fall 2008

	Attribute	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	LSV-4	CC-1A	CC-3A
Fall 2006												
Upper Banks												
1	Landform Slope	-	2	2	2	2	2	2	2	2	2	2
2	Mass Wasting hazard	-	6	3	6	3	6	9	3	3	3	3
3	Debris Jam Potential	-	4	4	4	4	2	2	4	4	2	4
4	Vegetation Cover	-	9	6	6	3	6	6	9	6	6	6
	Upper Bank Score:	-	**21**	**15**	**18**	**12**	**16**	**19**	**18**	**15**	**13**	**15**
Lower Banks												
5	Channel Capacity	-	2	2	2	2	1	2	2	3	2	2
6	Bank Rock Content	-	8	8	8	4	8	8	8	8	8	8
7	Flow Obstructors & Deflectors	-	4	4	4	2	2	2	4	4	4	6
8	Cutting	-	8	8	12	4	4	12	8	8	8	12
9	Deposition	-	12	6	16	10	4	6	4	10	8	12
	Lower Bank Score:	-	**34**	**28**	**42**	**22**	**19**	**30**	**26**	**33**	**30**	**40**
Channel Bottom												
10	Rock Angularity	-	2	2	2	2	2	2	2	2	2	2
11	Brightness	-	1	1	1	2	2	1	1	1	1	1
12	Consolidation/Particle Packing	-	4	4	4	4	4	4	4	4	4	4
13	Bottom Size Distribution	-	10	8	12	6	4	8	8	8	8	8
14	Bed Scour and Deposition	-	15	12	18	12	6	9	12	15	12	18
15	Clinging Aq Veg	-	3	2	3	3	1	2	1	2	2	3
	Channel Bottom Score:	-	**35**	**29**	**40**	**29**	**19**	**26**	**28**	**32**	**29**	**36**
	Total Score:	-	**90**	**72**	**100**	**63**	**54**	**75**	**72**	**80**	**72**	**91**
	Riffle Stability Index	-	**72**	**54**	**94**	**88**	**-**	**-**	**-**	**97**	**-**	**95**
Spring 2007												
Upper Banks												
1	Landform Slope	2	2	2	2	4	2	2	2	2	2	2
2	Mass Wasting hazard	9	3	3	3	3	3	3	7	6	3	3
3	Debris Jam Potential	4	4	4	4	4	2	2	2	4	4	3
4	Vegetation Cover	6	6	6	9	3	6	6	6	6	6	6
	Upper Bank Score:	**21**	**15**	**15**	**18**	**14**	**13**	**13**	**17**	**18**	**15**	**14**
Lower Banks												
5	Channel Capacity	2	2	2	2	2	2	2	2	2	2	2
6	Bank Rock Content	6	6	6	8	4	8	8	6	8	8	8
7	Flow Obstructors & Deflectors	4	4	4	4	3	2	3	3	4	4	5
8	Cutting	12	8	8	12	4	4	10	4	8	8	12
9	Deposition	4	4	8	12	6	4	6	6	12	12	12
	Lower Bank Score:	**28**	**24**	**28**	**38**	**19**	**20**	**29**	**21**	**34**	**34**	**39**
Channel Bottom												
10	Rock Angularity	2	2	2	2	2	2	2	2	2	2	2
11	Brightness	2	2	2	2	2	2	3	2	2	2	2
12	Consolidation/Particle Packing	2	4	4	4	4	4	4	4	4	4	4
13	Bottom Size distribution	8	8	8	8	4	4	6	6	8	12	10
14	Bed Scour and Deposition	12	12	12	12	8	6	6	12	18	18	18
15	Clinging Aq Veg	3	2	3	3	3	1	1	1	3	3	3
	Channel Bottom Score:	**29**	**30**	**31**	**31**	**23**	**19**	**22**	**27**	**37**	**41**	**39**
	Total Score:	**78**	**69**	**74**	**87**	**56**	**52**	**64**	**65**	**89**	**90**	**92**

Table 10
Stream Reach Inventory/Channel Stability Evaluation (SRI/CSE) Scores and Riffle Stability Index (RSI) Scores for the Eleven Locations Sampled, Fall 2006 - Fall 2008

	Attribute	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	LSV-4	CC-1A	CC-3A
Fall 2007												
Upper Banks												
1	Landform Slope	2	2	2	2	2	2	2	2	-	2	2
2	Mass Wasting hazard	9	9	6	9	5	3	9	6	-	3	3
3	Debris Jam Potential	4	4	4	4	3	2	2	2	-	2	3
4	Vegetation Cover	8	9	3	9	3	6	9	9	-	3	3
	Upper Bank Score:	**23**	**24**	**15**	**24**	**13**	**13**	**22**	**19**	-	**10**	**11**
Lower Banks												
5	Channel Capacity	2	2	2	2	2	2	2	2	-	2	2
6	Bank Rock Content	4	8	8	8	4	8	8	8	-	8	8
7	Flow Obstructors & Deflectors	4	4	4	4	3	2	3	3	-	4	3
8	Cutting	8	10	8	12	4	4	10	4	-	8	12
9	Deposition	4	8	8	8	6	4	6	8	-	10	8
	Lower Bank Score:	**22**	**32**	**30**	**34**	**19**	**20**	**29**	**25**	-	**32**	**33**
Channel Bottom												
10	Rock Angularity	2	2	2	2	2	2	2	2	-	2	2
11	Brightness	1	2	2	2	2	2	2	2	-	1	2
12	Consolidation/Particle Packing	2	4	4	4	3	4	4	4	-	3	4
13	Bottom Size distribution	6	8	10	10	5	6	8	6	-	12	12
14	Bed Scour and Deposition	12	15	10	12	8	6	8	9	-	15	15
15	Clinging Aq Veg	2	2	2	2	3	2	2	1	-	1	2
	Channel Bottom Score:	**25**	**33**	**30**	**32**	**23**	**22**	**26**	**24**	-	**34**	**37**
	Total Score:	**70**	**89**	**75**	**90**	**55**	**55**	**77**	**68**	-	**76**	**81**
Fall 2008												
Upper Banks												
1	Landform Slope	2	2	2	2	2	2	2	2	-	2	2
2	Mass Wasting hazard	6	6	3	9	4	3	6	6	-	3	3
3	Debris Jam Potential	4	4	4	4	4	2	4	3	-	4	4
4	Vegetation Cover	5	7	5	8	3	6	6	6	-	6	6
	Upper Bank Score:	**17**	**19**	**14**	**23**	**13**	**13**	**18**	**17**	-	**15**	**15**
Lower Banks												
5	Channel Capacity	2	2	2	3	2	2	3	2	-	2	3
6	Bank Rock Content	6	8	8	7	4	8	8	7	-	8	8
7	Flow Obstructors & Deflectors	4	3	4	4	2	2	3	3	-	4	4
8	Cutting	10	8	6	10	4	4	10	5	-	8	10
9	Deposition	8	6	5	14	8	4	8	7	-	12	8
	Lower Bank Score:	**30**	**27**	**25**	**38**	**20**	**20**	**32**	**24**	-	**34**	**33**
Channel Bottom												
10	Rock Angularity	2	2	2	3	2	2	2	2	-	3	3
11	Brightness	1	2	2	3	2	2	2	2	-	2	2
12	Consolidation/Particle Packing	4	4	5	6	4	4	4	4	-	4	4
13	Bottom Size distribution	10	6	12	12	6	9	8	8	-	12	12
14	Bed Scour and Deposition	14	9	15	16	9	9	8	8	-	12	14
15	Clinging Aq Veg	3	1	1	2	3	1	1	1	-	1	2
	Channel Bottom Score:	**34**	**24**	**37**	**42**	**26**	**27**	**25**	**25**	-	**34**	**37**
	Total Score:	**81**	**70**	**76**	**103**	**59**	**60**	**75**	**66**	-	**83**	**85**

Notes: For the Spring 2007 monitoring event, low flows were measured and it was not possible to conduct a riffle stability evaluation.

For Fall 2007, since no higher flows had occurred since spring, movement of larger bar substrates had not occurred, thus no changes in RSI scores.

Table 11
Summary of the Stream Reach Inventory/Channel Stability Evaluation (SRI/CSE) Scores and Comparison of Seasonal Conditions

Location	Reach	Channel Stability Score				Fall 2008 Channel Condition	% Eroding bank (Fall 2006)	% Eroding bank (Fall 2007)	% Eroding bank (Fall 2008)
		Fall 2006	Spring 2007	Fall 2007	Fall 2008		(linear feet/total reach length *2)		
Reference									
SFTC-1	South Fork Tincup Creek near mouth	-	78	70	81	**Fair**	-	18 (167/940)	2 (20/940)
Upstream of Sage Creek									
CC-75	Crow Creek u/s of Wells Canyon	90	69	89	70	**Good**	11 (78/700)	13 (93/700)	29 (201/700)
CC-150	Crow Creek u/s of Deer Creek	72	74	75	76	**Good**	5 (53/1000)	5 (55/1000)	5 (55/1000)
CC-350	Crow Creek d/s of Deer Creek	100	87	90	103	**Fair**	35 (414/1200)	24 (294/1200)	46 (546/1200)
DC-600	Deer Creek u/s of Crow Creek, d/s of NFDC	63	56	55	59	**Good**	0 (0/630)	<1 (1/630)	0
Hoopes Spring and Sage Creek									
HS	Hoopes Spring	54	52	55	60	**Good**	6 (20/350)	1 (4/350)	0
HS-3	Hoopes Spring (Discharge Channel)	75	64	77	75	**Good**	25 (182/720)	28 (203/720)	61 (442/720)
LSV-2C	Lower Sage Creek d/s Hoopes Spring	72	65	68	66	**Good**	5 (38/800)	8 (64/800)	50 (403/800)
LSV-4	Lower Sage Sage Creek u/s Crow Creek	80	89	-	-	No Data Collected Since Fall 2006	15 (124/830)	-	-
Downstream of Sage Creek									
CC-1A	Crow Creek d/s Sage Creek	72	90	76	83	**Fair**	11 (130/1200)	8 (102/1200)	14 (172/1200)
CC-3A	Crow Creek d/s Sage Creek and CC-1A	91	92	81	85	**Fair**	43 (692/1620)	25 (406/1620)	50 (806/1620)

Score Ranges: <38 Excellent, 39-76 Good, 77-114 Fair, >115 Poor

Table 12
Temperature Logger Summary Statistics (degrees C)

Location	Count	Minimum	Maximum	Mean	Median	Standard Dev	Start Date	End Date
SFTC-1	43,326	0.05	25.02	7.13	5.15	6.81	5/7/2007	8/1/2008
CC-75	73,814	1.75	18.27	7.20	5.92	4.27	5/8/2007	7/7/2009
CC-150	73,940	-0.12	22.42	7.62	6.99	4.94	5/9/2007	7/9/2009
CC-350	73,820	0.00	24.48	7.44	6.79	5.73	5/8/2007	7/9/2009
DC-600	73,453	-0.06	17.82	6.83	6.69	3.39	5/13/2007	7/9/2009
HS	35,424	9.61	12.90	11.63	11.61	0.32	5/14/2007	5/17/2008
HS-3	73,978	0.52	24.17	10.22	9.68	3.31	5/12/2007	7/9/2009
LSV-2C	74,067	0.00	25.33	9.23	8.47	4.25	5/12/2007	7/9/2009
LSV-4	11,028	5.44	23.21	13.47	12.61	4.18	5/9/2007	9/1/2007
CC-1A	73,655	-0.03	22.87	8.02	7.14	5.74	5/10/2007	7/9/2009
CC-3A	66,150	-0.28	23.76	7.65	6.36	6.34	5/11/2007	4/26/2009

Table 13
Summer (July 1 - September 15) Temperature Logger Summary Statistics (degrees C)

Location	Count	Minimum	Maximum	Mean	Median	Standard Dev
SFTC-1	10,452	6.86	25.02	15.88	15.93	3.49
CC-75	15,418	6.43	18.15	12.23	12.07	2.25
CC-150	14,424	6.71	22.42	13.17	12.36	3.59
CC-350	14,507	5.62	24.48	14.31	13.95	3.84
DC-600	14,712	5.72	17.82	10.63	10.12	2.22
HS	7,390	11.13	12.53	11.90	11.88	0.20
HS-3	15,590	7.12	24.17	13.15	12.12	3.48
LSV-2C	15,591	6.18	25.33	13.53	12.61	3.84
LSV-4	5,997	7.32	23.21	14.24	13.38	3.91
CC-1A	15,612	7.14	22.87	15.00	14.84	3.27
CC-3A	14,783	7.54	23.76	15.66	15.61	3.15

Table 14

Habitat Quality Index (HQI) Attribute Ratings and HQI Model II Scores for the Locations Sampled During Fall 2006, Fall 2007 and Fall 2008

#	Attribute	SFTC-1		CC-75			CC-150			CC-350			DC-600			HS			HS-3			LSV-2C			LSV-4			CC-1A			CC-3A		
		Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008
X_1	Late summer stream flow (LSSF)	(2)	(2)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	NS	(4)	(4)	(4)	(4)	(4)	(4)
X_2	Annual stream flow variation (ASFV)	(2)	(2)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)		(4)	(4)	(4)	(4)	(4)	(4)
X_3	Temperature in C°	25.6	21.1	12.8 (1500)	17.2	18.1	16.4 (1505)	24.4	21.6	15.0 (1530)	24.4	21.6	10 (1410)	13.9	17.8	11.1 (1745)	12.8	12.2	16.7 (1230)	23.9	24.2	17.8 (1500)	25.6	24.1	13.9 (1425)	23.3		13.4 (1445)	23.3	21.8	15.6 (1515)	23.3	21.4
		(1)	(3)	(4)	(4)	(4)	(4)	(1)	(2)	(4)	(1)	(2)	(2)	(4)	(4)	(3)	(4)	(3)	(4)	(2)	(2)	(4)	(1)	(2)	(4)	(2)		(4)	(2)	(2)	(4)	(2)	(2)
X_4	NO_3N (mg/L)	0.01	0.02	0.07	0.02	0.01	0.07	0.02	0.02	0	0.02	0.01	0.02	0.02	0.00	0.05	0.01	0.11	0.03	0.02	0.03	0.01	0.03	0.03	0.04	-		0.04	0.01	0	0.01	0.01	0.01
		(1)	(1)	(2)	(1)	(1)	(2)	(1)	(1)	(0)	(1)	(1)	(1)	(1)	(0)	(2)	(1)	(3)	(1)	(1)	(1)	(1)	(1)	(1)	(1)			(1)	(1)	(0)	(1)	(1)	(1)
X_{10}	Velocity (ft/sec)	<0.25	0.37	1.14	0.74	1.01	1.33	0.76	1.45	1.89	1.50	1.83	1.50	1.40	1.45	2.06	0.85	2.3	1.80	1.96	1.84	1.80	1.47	2.08	1.69	-		2.09	1.53	1.84	1.81	1.57	1.9
		(0)	(1)	(3)	(2)	(3)	(3)	(2)	(3)	(4)	(4)	(4)	(4)	(3)	(3)	(4)	(2)	(4)	(4)	(4)	(4)	(4)	(3)	(4)	(4)	-		(4)	(4)	(4)	(4)	(4)	(4)
	Fish Food																																
X_5	Abundance (#/0.1 m^2)	263	324	1375	1348	219	1228	642	356	635	1428	328	140	530	170	332	460	30	1588	521	93	721	709	185	1186	-		649	602	309	620	670	333
		(3)	(3)	(4)	(4)	(2)	(4)	(4)	(3)	(4)	(4)	(3)	(2)	(4)	(2)	(3)	(3)	(1)	(4)	(4)	(1)	(4)	(4)	(2)	(4)			(4)	(4)	(3)	(4)	(4)	(3)
X_6	Diversity	5.04		5.876	7.41		4.608	5.924		6.68	6.94		5.448	10.22		13.662	14.67		4.024	6.10		7.458	10.09		6.208			6.166	10.57		5.096	11.04	
		(4)		(4)	(4)		(4)	(4)		(4)	(4)		(4)	(4)		(4)	(4)		(4)	(4)		(4)	(4)		(4)			(4)	(4)		(4)	(4)	
X_9	Substrate (based on macro data)	(3)	(3)	(4)	(4)	(2)	(4)	(4)	(3)	(4)	(4)	(3)	(2)	(4)	2	(3)	(3)	(1)	(4)	(4)	(1)	(4)	(4)	(2)	(4)			(4)	(4)	(3)	(4)	(4)	(3)
X_7	Cover - Binns (%)	21.8	23.5	30.2	23.0	25.1	28.9	23.5	26.5	14	11.5	12.2	13.1	11.1	15	74.2	74.2	74.2	20.5	2.8	6.6	42.4	41.2	47.4	5.7			33.7	35.6	29.6	21.7	21.3	20.9
		(1)	(1)	(2)	(1)	(2)	(2)	(1)	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(4)	(4)	(4)	(1)	(0)	(0)	(3)	(3)	(3)	(0)			(2)	(2)	(2)	(1)	(1)	(1)
X_8	Eroding Bank (%)	17.8	2.0	11.0	13.3	29.0	5.3	5.5	5.0	34.5	24.5	46.0	0.0	0.2	0.0	5.7	1.1	0.0	25.3	28.2	61.0	4.6	8.0	50.0	14.9			9.0	8.5	14.0	45.8	25.1	50.0
		(3)	(4)	(3)	(3)	(2)	(4)	(4)	(4)	(2)	(3)	(2)	(4)	(4)	(4)	(4)	(4)	(4)	(2)	(2)	(1)	(4)	(4)	(1)	(3)			(4)	(4)	(3)	(2)	(2)	(1)
X_{11}	Width (ft)	8.2	7.9	10.1	10.8	10.7	11.8	12.0	13.1	19.3	17.3	18.3	9.8	9.4	9.7	3.4	3.6	4.5	11.0	14.2	12.1	13.9	13.6	12.3	17.2	18.1		27.0	28.5	28.8	23.7	23.1	23.5
		(2)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(4)	(3)	(4)	(2)	(2)	(2)	(1)	(1)	(1)	(2)	(3)	(3)	(3)	(3)	(3)	(3)	(4)		(3)	(3)	(3)	(3)	(3)	(3)
F	Food Index = $X_3(X_4)X_9)X(_{10})$	0	9	96	32	24	96	8	18	0	16	24	16	48	0	72	24	36	64	32	8	64	12	16	64			64	32	0	64	32	24
S	Shelter Index = $X_7(X_8)(X_{11})$	6	8	12	6	8	24	12	24	8	9	8	8	8	8	16	16	16	4	0	0	36	36	9	0			24	24	18	6	6	3
	HQI (lbs/acre)	**1.7**	**27**	**390**	**176**	**154**	**440**	**27**	**83**	**19**	**39**	**82**	**64**	**237**	**19**	**260**	**174**	**169**	**254**	**65**	**28**	**366**	**42**	**65**	**189**			**341**	**118**	**11**	**270**	**93**	**70**
	HQI (kg/Ha)	**1.9**	**30**	**437**	**197**	**173**	**493**	**30**	**93**	**22**	**44**	**92**	**72**	**265**	**22**	**291**	**195**	**189**	**285**	**73**	**32**	**411**	**47**	**73**	**212**			**382**	**132**	**13**	**303**	**105**	**79**

Values in parentheses are the HQI rating value based on the parameter value. When no specific parameter value is given, the rating was estimated based on available data.

Parameter ratings are provided in Table 3; HQI model II derivaiton procedures is identified in Table 4-8 of the Work Plan.

Food Index verified using maroinvertebrate abundance and diversity data.

NS = Not sampled.

Table 15
HSI Habitat Variables for Brown Trout at the Ten Simplot Study Locations Where Fish Populations Were Sampled

HSI Habitat Variable	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	CC-1A	CC-3A
V_1 - Average maximum temperature - ^{O}C	22 ***0.63***	17 ***1.0***	20 ***0.9***	20 ***0.9***	16 ***1.0***	12 ***1.0***	21 ***0.75***	20 ***0.9***	20 ***0.9***	20 ***0.9***
V_2 - Average maximum temperature for embryos - ^{O}C	3.6 ***0.52***	7.5 ***1.0***	9.4 ***1.0***	9.4 ***1.0***	8.4 ***1.0***	12.4 ***1.0***	13.6 ***0.64***	12.5 ***1.0***	8.2 ***1.0***	7.6 ***1.0***
V_3 - Average minimum DO - mg/L	9.6 ***1.0***	8.2 ***1.0***	9.3 ***1.0***	9.0 ***1.0***	8.3 ***1.0***	5.2 ***0.1***	7.2 ***0.65***	6.7 ***0.48***	9.1 ***1.0***	8.9 ***1.0***
V_4 - Average thalweg depth - cm	29.9 ***1.0***	23.6 ***0.68***	24.1 ***0.7***	40.1 ***0.91***	22.6 ***0.64***	15.0 ***0.26***	16.9 ***0.32***	34.8 ***1.0***	48.9 ***1.0***	56.3 ***1.0***
V_5 - Average velocity at redds - cm/s	NS	47.2 ***1.0***	68.6 ***1.0***	NS	NS	NS	39.6 ***0.99***	33.8 ***0.76***	47.5 ***1.0***	61.3 ***1.0***
V_6 - % Cover	23.5 ***0.68 A*** ***1.0 J***	25.1 ***0.7 A*** ***1.0 J***	26.5 ***0.72 A*** ***1.0 J***	12.2 ***0.34 A*** ***0.82 J***	15.0 ***0.41 A*** ***1.0 J***	74.2 ***1.0 A & J***	6.6 ***0.18 A*** ***0.47 J***	47.4 ***1.0 A & J***	29.6 ***0.84 A*** ***1.0 J***	20.9 ***0.59 A*** ***1.0 J***
V_7 - Average spawning substrate size - cm	NS	2.6 ***1.0***	3.5 ***1.0***	NS	NS	NS	2.9 ***1.0***	2.8 ***1.0***	2.3 ***1.0***	2.7 ***1.0***
V_8 - % substrate 10-40 cm	40 ***1.0***	8 ***0.83***	4 ***0.4***	8 ***0.83***	14 ***1.0***	4 ***0.4***	8 ***0.83***	6 ***0.6***	2 ***0.2***	2 ***0.2***
V_9 - Dominant riffle substrate type	A ***1.0***	B ***0.6***	B ***0.6***	B ***0.6***	B ***0.6***	A ***1.0***	C ***0.3***	B ***0.6***	C ***0.3***	C ***0.3***
V_{10} - % Pools	25 ***0.6***	32 ***0.7***	45 ***0.9***	33 ***0.72***	13 ***0.36***	10 ***0.3***	0 ***0.1***	15 ***0.4***	32 ***0.7***	69 ***1.0***
V_{11} - Average % Vegetation	183.0 ***1.0***	145.5 ***1.0***	147.9 ***1.0***	126.0 ***0.93***	170.0 ***1.0***	150.0 ***1.0***	135.9 ***1.0***	143.8 ***1.0***	153.1 ***1.0***	125.5 ***0.93***
V_{12} - Average % stable bank	90.1 ***1.0***	82.2 ***1.0***	94.7 ***1.0***	65.0 ***0.95***	99.9 ***1.0***	97.7 ***1.0***	61.8 ***0.93***	79.1 ***1.0***	89.5 ***1.0***	59.7 ***0.90***
V_{13} - Max or Min pH	8.52 ***0.58***	8.29 ***0.7***	8.58 ***0.51***	8.89 ***0.32***	8.24 ***0.72***	7.60 ***1.0***	8.46 ***0.60***	8.56 ***0.52***	8.44 ***0.61***	8.47 ***0.59***
V_{14} - Base Flow Regime % ADF	20 ***0.4***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***
V_{15} - Pool Class Rating	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.3***	***0.6***	***0.6***	***0.6***
V_{16A} - % Fines in redds	NS	31.0 ***0.22***	31.0 ***0.22***	NS	NS	NS	28.3 ***0.24***	28.7 ***0.24***	29.7 ***0.23***	35.7 ***0.19***
V_{16B} - % Fines in riffles	4.7 ***1.0***	12.5 ***0.99***	12.2 ***1.0***	12.9 ***0.98***	4.3 ***1.0***	8.9 ***1.0***	28.8 ***0.72***	5.9 ***1.0***	22.6 ***0.85***	13.8 ***0.97***
V_{17} - % Shaded	60 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	50 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***
V_{18} - NO_3N mg/L	0.015 ***0.25***	0.033 ***0.25***	0.037 ***0.25***	0.01 ***0.25***	0.013 ***0.25***	0.057 ***0.50***	0.027 ***0.25***	0.023 ***0.25***	0.017 ***0.25***	0.01 ***0.25***

HSI scores are bold/italicized.
NS - Not sampled.

Table 16
HSI Habitat Variables for Cutthroat Trout at the Ten Simplot Study Locations Where Fish Populations Were Sampled

HSI Habitat Variable	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	CC-1A	CC-3A
V_1 - Average maximum temperature ^{O}C	21 ***0.22***	17 ***0.88***	20 ***0.46***	20 ***0.46***	16 ***0.97***	12 ***1.0***	21 ***0.22***	20 ***0.46***	20 ***0.46***	20 ***0.46***
V_2 - Average maximum temperature for embryos - ^{O}C	11.5 ***1.0***	13.0 ***0.95***	15.3 ***0.6***	17.0 ***0.3***	11.3 ***1.0***	13 ***0.95***	17.3 ***0.28***	17.0 ***0.3***	15.3 ***0.6***	14.3 ***0.76***
V_3 - Average minimum DO - mg/L	9.6 ***1.0***	8.2 ***0.95***	9.3 ***1.0***	9.0 ***1.0***	8.3 ***0.95***	5.2 ***0.1***	7.2 ***0.77***	6.7 ***0.64***	9.1 ***1.0***	8.9 ***0.99***
V_4 - Average thalweg depth - cm	29.9 ***1.0***	23.6 ***0.93***	24.1 ***0.94***	40.1 ***0.96***	22.6 ***0.88***	15.0 ***0.52***	16.9 ***0.65***	34.8 ***1.0***	48.9 ***1.0***	56.3 ***1.0***
V_5 - Average velocity at redds - cm/s	NS	NS	NS	NS	NS	NS	NS	NS	59.1 ***1.0***	59.1 ***1.0***
V_6 - % Cover	23.5 ***1.0 A & J***	25.1 ***1.0 A & J***	26.5 ***1.0 A & J***	12.2 ***0.77A*** ***0.97J***	15.0 ***0.84A*** ***1.0 J***	74.2 ***1.0 A & J***	6.6 ***0.53A*** ***0.73J***	47.4 ***1.0 A & J***	29.6 ***1.0 A & J***	20.9 ***0.97A*** ***1.0 J***
V_7 - Average spawning substrate size - cm	NS	NS	NS	NS	NS	NS	NS	NS	3.0 ***1.0***	3.0 ***1.0***
V_8 - % substrate 10-40 cm	40 ***1.0***	8 ***0.83***	4 ***0.4***	8 ***0.83***	14 ***1.0***	4 ***0.4***	8 ***0.83***	6 ***0.6***	2 ***0.2***	2 ***0.2***
V_9 - Dominant riffle substrate type	A ***1.0***	B ***0.6***	B ***0.6***	B ***0.6***	B ***0.6***	A ***1.0***	C ***0.3***	B ***0.6***	C ***0.3***	C ***0.3***
V_{10} - % Pools	25 ***0.9***	32 ***0.97***	45 ***1.0***	33 ***0.98***	13 ***0.66***	10 ***0.57***	0 ***0.3***	15 ***0.7***	32 ***0.97***	69 ***1.0***
V_{11} - Average % Vegetation	183.0 ***1.0***	145.5 ***1.0***	147.9 ***1.0***	126.0 ***0.93***	170.0 ***1.0***	150.0 ***1.0***	135.9 ***1.0***	143.8 ***1.0***	153.1 ***1.0***	125.5 ***0.93***
V_{12} - Average % stable bank	90.1 ***1.0***	82.2 ***1.0***	94.7 ***1.0***	65.0 ***0.95***	99.9 ***1.0***	97.7 ***1.0***	61.8 ***0.93***	79.1 ***1.0***	89.5 ***1.0***	59.7 ***0.90***
V_{13} - Max or Min pH	8.52 ***0.84***	8.29 ***0.92***	8.58 ***0.81***	8.89 ***0.52***	8.24 ***0.94***	7.60 ***1.0***	8.46 ***0.88***	8.56 ***0.82***	8.44 ***0.89***	8.47 ***0.87***
V_{14} - Base Flow Regime % ADF	20 ***0.4***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***
V_{15} - Pool Class Rating	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.3***	***0.6***	***0.6***	***0.6***
V_{16A} - % Fines in redds	NS	NS	NS	NS	NS	NS	NS	NS	27 ***0.25***	35 ***0.19***
V_{16B} - % Fines in riffles	4.7 ***1.0***	12.5 ***0.99***	12.2 ***1.0***	12.9 ***0.98***	4.3 ***1.0***	8.9 ***1.0***	28.8 ***0.72***	5.9 ***1.0***	22.6 ***0.85***	13.8 ***0.97***
V_{17} - % Shaded	60 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	50 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***

Bold and italicized are HSI scores.

NS - Not sampled.

Table 17

HSI Component and Overall Scores for Brown Trout at the Ten Simplot Study Locations Where Fish Populations Were Sampled

HSI Component Score	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	CC-1A	CC-3A
C_{Adult}	0.74	0.68	0.72	0.77	0.55	0.26	0.10	0.79	0.82	0.88
$C_{Juvenile}$	0.73	0.77	0.83	0.71	0.36	0.30	0.10	0.67	0.77	0.87
C_{Fry}	0.77	0.80	0.75	0.81	0.36	0.30	0.10	0.56	0.54	0.66
C_{Embryo}	-	0.60	0.60	-	-	-	0.62	0.48	0.61	0.58
C_{Other}	0.79	0.75	0.72	0.66	0.79	0.77	0.57	0.69	0.62	0.62
HSI (4 Equal Components)	0.76	0.75	0.76	0.74	0.36	0.26	0.10	0.67	0.68	0.75
HSI (5 Equal Components)	-	0.72	0.72	-	-	-	0.10	0.63	0.66	0.71

Table 18
HSI Component and Overall Scores for Cutthroat Trout at the Nine Simplot Study Locations Where Fish Populations Were Sampled

HSI Component Score	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS-3	LSV-2C	CC-1A	CC-3A
C_{Adult}	0.90	0.89	0.90	0.83	0.78	0.30	0.87	0.91	0.91
$C_{Juvenile}$	0.83	0.86	0.87	0.85	0.75	0.30	0.77	0.86	0.87
C_{Fry}	0.95	0.94	0.80	0.94	0.81	0.30	0.74	0.63	0.66
C_{Embryo}	-	-	-	-	-	-	-	0.60	0.58
C_{Other}	0.75	0.91	0.76	0.70	0.88	0.58	0.74	0.65	0.62
HSI (4 Equal Components)	0.85	0.90	0.83	0.83	0.80	0.35	0.78	0.75	0.75
HSI (5 Equal Components)	-	-	-	-	-	-	-	0.72	0.72

Table 19

IDEQ SHI Raw Data for Fall 2007 and Fall 2008[1]

Habitat Measure	SFTC-1		CC-75		CC-150		CC-350		DC-600	
	Fall 2007	Fall 2008	Fall 2007	Fall 2008	Fall 2007	Fall 2008	Fall 2007	Fall 2008	Fall 2007	Fall 2008
% Cover	21.8	23.5	23	25.1	23.5	26.5	11.5	12.2	11.1	15
# Large Organic Debris	0	0	0	0	1	0	0	0	1	2
% Fines	14.6	4.6	8.1	11.9	13.8	11.3	7.6	12.6	12.3	4
# Wolman Classes	6	6	6	8	6	8	8	8	7	8
Channel Shape	Lt 17' Rt 63' Lt 30' Rt 70' Lt 19' Rt 33'	Lt 23º Rt 53º Lt 25º Rt 42º Lt 34º Rt 32º	Lt 155' Rt 135' Lt 140' Rt 135' Lt 140' Rt 37'	Lt 90º Rt 120º Lt 115º Rt 120º Lt 115º Rt 75º	Lt 140' Rt 90' Lt 12' Rt 53' Lt 34' Rt 30'	Lt 120º Rt 100º Lt 22º Rt 85º Lt 70º Rt 28º	Lt 37' Rt 140' Lt 22' Rt 12' Lt 45' Rt 135'	Lt 35º Rt 115º Lt 15º Rt 32º Lt 22º Rt 40º	Lt 127' Rt 55' Lt 70' Rt 70' Lt 25' Rt 15'	Lt 110º Rt 46º Lt 85º Rt 85º Lt 32º Rt 85º
% Bank Vegetation	91.7	97.9	92	95.9	96.5	97.1	87.7	79.5	99.8	100
% Canopy cover[2]	60	60	<10	<10	<10	<10	<10	<10	50	50

Habitat Measure	HS		HS-3		LSV-2C		CC-1A		CC-3A	
	Fall 2007	Fall 2008	Fall 2007	Fall 2008	Fall 2007	Fall 2008	Fall 2007	Fall 2008	Fall 2007	Fall 2008
% Cover	74.2	74.2	2.8	6.6	41.2	47.4	35.6	29.6	21.3	20.9
# Large Organic Debris	0	0	0	0	0	0	1	1	0	0
% Fines	0	7.9	20.6	28.5	21.5	6	19.5	22.6	6.5	13.8
# Wolman Classes	6	7	7	9	7	7	6	6	6	5
Channel Shape	Lt 25' Rt 80' Lt 52' Rt 90' Lt 30' Rt 65'	Lt 25º Rt 80º Lt 52º Rt 90º Lt 30º Rt 65º	Lt 10' Rt 30' Lt 90' Rt 35' Lt 25' Rt 50'	Lt 17º Rt 22º Lt 65º Rt 65º Lt 20º Rt 70º	Lt 90' Rt 5' Lt 20' Rt 30' Lt 140' Rt 22'	Lt 78º Rt 8º Lt 75º Rt 45º Lt 115º Rt 20º	Lt 142' Rt 78' Lt 55' Rt 135' Lt 72' Rt 85'	Lt 120º Rt 65º Lt 110º Rt 50º Lt 120º Rt 60º	Lt 140' Rt 150' Lt 90' Rt 42' Lt 130' Rt 36'	Lt 63º Rt 130º Lt 90º Rt 54º Lt 115º Rt 24º
% Bank Vegetation	100	100	89.7	90.6	97.5	95.9	97.3	95.1	80.4	78.5
% Canopy cover[2]	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

[1] Embeddedness, disruptive pressure and zone of influence were scored in the field using IDEQ criteria.

[2] Estimated from location photographs.

Table 20
IDEQ SHI Scores for Fall 2007 and Fall 2008

#	Habitat Measure	SFTC-1		CC-75		CC-150		CC-350		DC-600		HS		HS-3		LSV-2C		CC-1A		CC-3A	
		2007	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
1	% Cover	4	7	4	7	4	7	3	6	3	8	9	9	1	4	7	8	6	8	4	8
2	# Large Organic Debris	0	0	0	0	1	0	0	0	1	2	0	0	0	0	0	0	1	1	0	0
3	% Fines	6	9	7	6	6	6	7	6	6	9	10	7	4	3	4	8	5	4	8	6
4	Embeddedness	6	4	6	7	4	5	7	3	9	8	6	7	7	7	7	7	4	3	4	7
5	# Wolman Classes	6	6	6	8	6	8	8	8	7	8	6	7	7	9	7	7	6	6	6	5
6	Channel Shape	1	2	9	8	3	5	4	3	3	5	3	3	1	2	2	4	7	6	7	6
7	% Bank Vegetation	9	10	9	10	10	10	8	5	10	10	10	10	8	9	10	10	10	10	6	5
8	% Canopy Cover	7	7	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0
9	Disruptive Pressure	5	7	4	5	7	7	6	4	10	8	6	7	2	5	2	5	7	7	7	7
10	Zone of Influence	5	6	5	5	6	8	4	4	4	7	4	7	2	6	2	6	4	6	2	7
	Total Score[1]	**49**	**58**	**50**	**56**	**47**	**56**	**47**	**39**	**59**	**71**	**54**	**57**	**32**	**45**	**41**	**55**	**50**	**51**	**44**	**51**
	Condition Category[2]	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

[1] Maximum possible score is 100, 10 for each habitat measure.

[2] Condition Categories are for the Northern and Middle Rockies Ecoregion scoring criteria.

1 <58 = <10th percentile of reference

2 58 - 65 = 10th-25th percentile of reference

3 >66 = >25th percentile of reference

Table 21
Locations of Brown Trout Redds, Numbers Observed and Measured, and Reach Lengths Surveyed
During the October 2006 Redd Survey

Reach	Description	# Redds observed	Date/Time	Reach Length Feet (meters)	Northing	Easting	UTM Zone	Elevation (ft)
CC-75	d/s end reach			2130	4710432	486291		
	Redd 1	1	24-OCT-06 2:48:48PM	(649)	4710363	486303	12	6741
	Redd 2	1	24-OCT-06 3:03:35PM		4710126	486370	12	6757
	Redd 3 -4	2	24-OCT-06 3:13:42PM		4710089	486352	12	6762
	u/s end of reach		24-OCT-06 3:22:20PM		4710029	486348	12	6769
CC-150	d/s end reach		24-OCT-06 4:03:18PM	598	4713432	487291	12	6644
	Redds 1-3	3	24-OCT-06 4:08:08PM	(182)	4713423	487281	12	6646
	Redd 4	1	24-OCT-06 4:20:55PM		4713403	487268	12	6644
	Redd 5-12	8	24-OCT-06 4:41:48PM		4713372	487223	12	6650
	u/s end of reach		24-OCT-06 4:51:42PM		4713365	487205	12	6651
CC-350	d/s end reach	0		4525	4715486	489397		
	u/s end of reach		23-OCT-06 5:01:48PM	(1379)	4714805	489122	12	6579
DC-600	lower dam of area evalauted		25-OCT-06 10:49:49AM		4714801	488074	12	6650
	upper dam of area evaluated		25-OCT-06 11:20:59AM		4714857	487846	12	6677
	Crow Creek Culvert		26-OCT-06 8:13:54AM		4718592	491679	12	6462
	Deer Creek Culvert		26-OCT-06 12:25:51PM		4714574	488847	12	6551
HS	u/s end of reach		24-OCT-06 11:45:45AM	1065	4721217	490728	12	6645
	d/s end reach		24-OCT-06 11:53:53AM	(325)	4720954	490863	12	6633
HS-3	u/s end of reach		24-OCT-06 9:12:05AM	696	4720728	491174	12	6587
	Redds 1 -2	2	24-OCT-06 9:27:51AM	(212)	4720683	491181	12	6599
	Redds 3 -4	2	24-OCT-06 9:36:49AM		4720613	491233	12	6587
	d/s end reach		24-OCT-06 9:48:47AM		4720609	491281	12	6591
LSV-2C	u/s end of reach		24-OCT-06 9:48:47AM	1813	4720609	491281	12	6591
	Redds 1-2	2	24-OCT-06 10:04:49AM	(552)	4720439	491349	12	6587
	Redd 3	1	24-OCT-06 10:19:30AM		4720360	491352	12	6585
	d/s end reach		24-OCT-06 10:26:37AM		4720250	491403	12	6580
LSV-4	d/s end reach			1124	4718584	491663		
	Redd 1	1	24-OCT-06 1:01:09PM	(324)	4718616	491623	12	6460
	Redd 2	1	24-OCT-06 1:08:15PM		4718641	491607	12	6462
	Redd 3-5	3	24-OCT-06 1:23:43PM		4718657	491587	12	6471
	Redd 6	1	24-OCT-06 1:29:29PM		4718680	491588	12	6467
	Redd 7-8	2	24-OCT-06 1:34:44PM		4718676	491574	12	6468
	u/s end of reach		24-OCT-06 1:47:09PM		4718702	491502	12	6466
CC-1A	Begin Reach u/s end			2329	4719057	493345		
	Redd 18	1	23-OCT-06 1:31:10PM	(710)	4719077	493429	12	6420
	Redds 19 and 20	2	23-OCT-06 1:53:12PM		4719142	493362	12	6415
	Redds 21 -26	6	23-OCT-06 2:05:49PM		4719153	493397	12	6404
	Redds 27-31	5	23-OCT-06 2:33:37PM		4719268	493538	12	6402
	Redd 32	1	23-OCT-06 3:02:19PM		4719297	493569	12	6403
	Redds 33-43; d/s end of reach	11	23-OCT-06 3:09:06PM		4719289	493588	12	6400
CC-3A	Begin Reach d/s end				4720411	495176		
	Redds 1 - 4	4	23-OCT-06 9:49:32AM	7600	4720149	494676	12	6359
	Redd 5	1	23-OCT-06 10:26:36AM	(2316)	4720106	494653	12	6346
	Redds 6 - 10	5	23-OCT-06 10:54:59AM		4720057	494643	12	6363
	Redd 11	1	23-OCT-06 11:18:26AM		4719934	494513	12	6374
	Redds 12-14	3	23-OCT-06 11:34:47AM		4719782	494502	12	6371
	Redd 15	1	23-OCT-06 12:05:31PM		4719707	494492	12	6374
	Redds 16 -17	2	23-OCT-06 12:09:19PM		4719691	494471	12	6379
	End Reach u/s end		23-OCT-06 1:07:10PM		4719668	494413	12	6394

Table 22
Summary of Habitat Characteristics Measured at Suspected Brown Trout Redds, October 2006

Location	Number of redds	Mean Depth (ft)	Depth Range (ft)	[1]Mean $V_{.6}$ (fps)	$V_{.6}$ Range (fps)	[2]Mean $V_{.2}$ (fps)	$V_{.2}$ Range (fps)	[3]Mean $V_{.8}$ (fps)	$V_{.8}$ Range (fps)	Average Substrate (mm)
Upstream of Sage Creek										
CC-75	4	0.40	0.32 - 0.45	1.55	1.3 - 1.78	1.81	1.3 - 2.35	1.36	0.96 - 1.78	26.3
CC-150	12	0.90	0.65 - 1.16	2.25	1.93 - 2.38	2.30	1.82 - 2.75	2.05	1.53 - 2.32	34.6
Hoopes Spring and Sage Creek										
HS-3	4	0.38	0.34 - 0.40	1.30	1.07 - 1.62	1.74	1.24 - 2.38	0.97	0.64 - 1.25	29.3
LSV-2C	3	0.59	0.26 - 0.92	1.11	0.36 - 1.79	1.44	1.20 - 1.85	0.90	0.08 - 1.64	28.1
LSV-4	8	0.72	0.48 - 1.00	2.11	0.56 - 3.00	2.55	1.95 - 3.36	2.04	1.60 - 2.72	32.9
Downstream of Sage Creek										
CC-1A	26	0.73	0.56 - 1.10	1.56	0.78 - 2.17	1.69	0.83 - 2.58	1.39	0.66 - 2.04	23.4
CC-3A	17	0.76	0.53 - 1.02	2.01	0.89 - 2.75	2.18	1.03 - 3.02	1.79	0.74 - 2.64	27.2
Total	74									
All Locations		0.64	0.26 - 1.16	1.70	0.36 - 2.75	1.96	1.03 - 3.36	1.50	0.64 - 2.72	28.8

[1]$V_{.6}$ is velocity measured at 0.6 depth
[2]$V_{.2}$ is velocity measured at 0.2 depth
[3]$V_{.8}$ is velocity measured at 0.8 depth
ft - feet
fps = feet per second
mm - millimeters

Table 23

Habitat Characteristics Measured at Suspected Yellowstone Cutthroat Trout Redds on Crow Creek Through Hartman Ranch Near Locations CC-1A and CC-3A on 27 April 2007

Redd #	GPS Location		Water Depth (ft)	Water Velocity[1] (0.6) (ft/s)	Water Velocity[2] (0.2) (ft/s)	Water Velocity[3] (0.8) (ft/s)	Mean Particle Size[4] (mm)	Particle Size Range[4] (mm)
1	12T 0493440	4719076	0.56	2.26	2.36	1.64	29.00	20 - 42
2	12T 0493372	4719104	0.75	1.90	1.80	1.31	30.90	18 - 41
3	12T 0493546	4719283	0.50	1.44	1.41	1.12	21.20	11 - 38
4	12T 0493264	4719049	0.75	2.17	2.23	0.95	26.80	21 - 32
5	12T 0493264	4719049	0.72	2.13	2.30	1.71	32.50	28 - 43
6	12T 0493264	4719049	0.76	2.13	2.43	1.74	29.10	18 - 44
7	12T 0493264	4719049	0.74	2.53	2.69	2.23	36.10	26 - 46
8	12T 0493264	4719049	0.57	1.57	2.03	1.15	35.70	27 - 52
9	12T 0493030	4719113	0.62	1.38	1.35	1.05	27.40	21 - 39
10	12T 0493030	4719113	0.68	1.90	2.00	1.64	29.30	20 - 42
		Mean	**0.66**	**1.94**	**2.06**	**1.45**	**29.80**	**-**
		Range	**0.50 - 0.76**	**1.38 - 2.53**	**1.35 - 2.69**	**0.95 - 2.23**	**21.2 - 36.1**	**11 - 52**

[1] Velocity at 0.6 depth

[2] Velocity at 0.2 depth

[3] Veloctiy at 0.8 depth

[4] Based on ten particles from surface of tailspill

Table 24
Summary of PHABSIM Monitoring Locations and Sampling Information

Stream Name	Location	Date	PHABSIM Flows (cfs)	Reach Length (ft)	# Transects	Reach Slope (%)
*South Fork Tincup	SFTC-1	6/6/2007	5.6	470	11	1.48
		7/13/2007	0.4			
Crow Creek	CC-75	6/1/2007	5.0	355	14	0.68
		7/10/2007	2.9			
		5/12/2008	15.7			
	CC-150	6/2/2007	4.6	500	18	0.51
		9/3/2007	3.0			
		5/19/2008	20.0			
	CC-350	6/6/2007	14.0	600	10	0.73
		9/3/2007	13.0			
		6/30/2008	34.0			
Deer Creek	DC-600	6/5/2007	5.1	315	10	2.03
		7/12/2007	2.6			
		6/28/2008	15.8			
Hoopes Spring	HS-3	5/31/2007	4.4	360	9	1.58
		7/9/2007	6.3			
		6/29/2008	8.7			
Lower Sage Valley	LSV-2C	5/30/2007	9.4	400	14	0.7
		7/9/2007	8.6			
		6/29/2008	24.0			
	LSV-4	6/3/2007	12.3	415	11	0.59
		7/10/2007	14.7			
Crow Creek	CC-1A	6/3/2007	25.5	720	11	0.22
		7/10/2007	27.8			
		6/30/2008	65.0			
	CC-3A	6/4/2007	31.2	810	14	0.32
		9/2/2007	27.1			
		7/1/2008	65.0			

*Only two samplings.

Table 25

Weighted Usable Area (ft^2/1,000 ft) for Brown and Cutthroat Trout at the Simplot Monitoring Locations at the Average Fall and Spring Monitoring Flows

Location	Avg Fall Q (cfs)	Avg Spring Q (cfs)	Average Fall WUA (ft^2/1000' linear)			Average Spring WUA (ft^2/1000' linear)	
			Brown Adult	Brown Juv	Spawning	Brown Adult	Brown Juv
SFTC-1	0.5	19.2	-	-	-	-	-
CC-75	3.5	11.5	1482	2293	920	1963	2885
CC-150	7.7	21.7	3665	4827	3277	3608	4312
CC-350	19.2	32.5	2766	3900	6036	3131	3897
DC-600	2.6	13.4	-	-	-	-	-
HS-3	5.4	6.1	64	795	2185	99	875
LSV-2C	9.9	10	1940	2774	3498	1938	2766
LSV-4	15.3	12.3	2998	3812	4325	3253	4211
CC-1A	30.5	51	9605	12717	12294	9642	12037
CC-3A	34.5	56.1	8281	10044	11350	8833	9827

Location	Avg Fall Q (cfs)	Avg Spring Q (cfs)	Average Fall WUA (ft^2/1000' linear)		Average Spring WUA (ft^2/1000' linear)		
			Cutthroat Adult	Cutthroat Juv	Cutthroat Adult	Cutthroat Juv	Spawning
SFTC-1	0.5	19.2	410	766	2190	2226	918
CC-75	3.5	11.5	771	3556	1962	3845	4621
CC-150	7.7	21.7	2240	5500	4043	3972	6889
CC-350	19.2	32.5	2711	5158	3873	3928	8555
DC-600	2.6	13.4	307	2157	1085	2335	3140
HS-3	5.4	6.1	-	-	-	-	2594
LSV-2C	9.9	10	1473	3788	1478	3769	3525
LSV-4	15.3	12.3	2208	3325	2169	3988	4417
CC-1A	30.5	51	7833	14654	11520	11923	18189
CC-3A	34.5	56.1	8624	9814	10458	8291	12855

- species not present

Table 26

Weighted Usable Area (ft^2) for Brown and Cutthroat Trout at the Simplot Monitoring Locations at the Average Fall and Spring Monitoring Flows

Location	Avg Fall Q (cfs)	Avg Spring Q (cfs)	Average Fall WUA (ft^2)			Average Spring WUA (ft^2)	
			Brown Adult	Brown Juv	Spawning	Brown Adult	Brown Juv
SFTC-1	0.5	19.2	-	-	-	-	-
CC-75	3.5	11.5	526	814	327	697	1024
CC-150	7.7	21.7	1832	2414	1638	1804	2156
CC-350	19.2	32.5	1660	2340	3622	1879	2338
DC-600	2.6	13.4	-	-	-	-	-
HS-3	5.4	6.1	23	286	787	36	315
LSV-2C	9.9	10	776	1110	1399	775	1106
LSV-4	15.3	12.3	1244	1582	1795	1350	1748
CC-1A	30.5	51	6916	9156	8852	6942	8667
CC-3A	34.5	56.1	6708	8136	9194	7155	7960

Location	Avg Fall Q (cfs)	Avg Spring Q (cfs)	Average Fall WUA (ft^2)		Average Spring WUA (ft^2)		
			Cutthroat Adult	Cutthroat Juv	Cutthroat Adult	Cutthroat Juv	Spawning
SFTC-1	0.5	19.2	193	360	1029	1046	431
CC-75	3.5	11.5	274	1262	697	1363	1640
CC-150	7.7	21.7	1120	2750	2022	1986	3444
CC-350	19.2	32.5	1627	3095	2324	2357	5133
DC-600	2.6	13.4	97	679	342	736	989
HS-3	5.4	6.1	-	-	-	-	934
LSV-2C	9.9	10	589	1515	591	1508	1410
LSV-4	15.3	12.3	916	1380	900	1655	1833
CC-1A	30.5	51	5640	10551	8294	8585	13096
CC-3A	34.5	56.1	6985	7949	8471	6716	10413

- species not present

Table 27

Ratio of Weighted Usable Area (ft^2) to Total Wetted Surface Area (ft^2) for Brown and Cutthroat Trout at Each of the Simplot Monitoring Locations at the Average Fall and Spring Monitoring Flows

Location	Event	Brown Trout		Cutthroat Trout		Spawning
		Adult	Juvenile	Adult	Juvenile	
SFTC-1	Fall	-	-	0.05	0.10	0.00
	Spring	-	-	0.19	0.19	0.08
CC-75	Fall	0.14	0.21	0.07	0.33	0.09
	Spring	0.17	0.26	0.17	0.34	0.41
CC-150	Fall	0.28	0.37	0.17	0.42	0.25
	Spring	0.25	0.30	0.28	0.27	0.47
CC-350	Fall	0.15	0.21	0.14	0.27	0.32
	Spring	0.15	0.18	0.18	0.19	0.41
DC-600	Fall	-	-	0.03	0.24	0.09
	Spring	-	-	0.09	0.20	0.27
HS-3	Fall	<0.01	0.06	-	-	0.16
	Spring	0.01	0.06	-	-	0.18
LSV-2C	Fall	0.14	0.20	0.11	0.28	0.25
	Spring	0.14	0.20	0.11	0.27	0.26
LSV-4	Fall	0.19	0.24	0.12	0.23	0.25
	Spring	0.17	0.22	0.13	0.19	0.26
CC-1A	Fall	0.34	0.45	0.28	0.52	0.44
	Spring	0.34	0.42	0.40	0.42	0.63
CC-3A	Fall	0.35	0.42	0.36	0.42	0.48
	Spring	0.36	0.40	0.42	0.34	0.52

- species not present

Table 28

Summary of Trout Standing Crop Estimates (kg/Ha) from the Nine Simplot Study Locations Used for Trout and Habitat Analyses

		Dependent Variables											
	Location	All Trout Standing Crop				Brown Trout Standing Crop				Cutthroat Trout Standing Crop			
		Fall 2007	Fall 2008	Spring 2007	Spring 2008	Fall 2007	Fall 2008	Spring 2007	Spring 2008	Fall 2007	Fall 2008	Spring 2007	Spring 2008
Control	SFTC-1	62.7	27.9	56.7	93.4	0.0	0.0	0.1	0.0	62.7	27.9	56.6	93.4
	CC-75	74.5	62.8	73.3	27.7	72.5	45.0	67.5	22.3	2.0	17.8	5.8	5.4
	CC-150	105.9	114.7	82.2	135.6	86.6	83.8	67.0	90.2	19.3	30.8	15.2	45.4
	CC-350	43.1	49.2	11.6	39.4	14.2	18.3	3.9	2.8	28.9	30.9	7.7	36.6
	DC-600	76.2	126.9	93.3	54.7	0.0	0.0	0.0	0.0	76.2	126.9	93.3	54.7
Test	HS-3	95.1	47.1	35.1	100.6	95.1	45.8	31.2	86.7	0.0	1.2	3.9	13.9
	LSV-2C	197.0	277.0	262.7	162.0	154.1	231.1	146.3	109.3	42.9	45.9	116.4	52.7
	CC-1A	69.3	73.1	49.2	48.6	40.2	48.0	30.5	24.0	29.1	25.1	18.7	24.7
	CC-3A	118.6	87.5	53.9	107.5	56.3	58.6	38.1	54.7	62.3	28.9	15.8	52.8

Table 29
Summary of HQI, SRI/CSE, SHI and HSI Scores for the Nine Simplot Study Locations used for Trout and Habitat Analyses

Independent Variables									
	Location	Habitat Quality Index_Total Score (HQI - kg/Ha)		Stream Reach Inventory/Channel Stability Evaluation_Total Score (SRI/CSE)		IDEQ Stream Habitat Index_Total Score (SHI)		Habitat Suitability Index_Total Score (HSI)	
		2007	2008	Fall 2007	Fall 2008	2007	2008	Brown Trout	Cutthroat Trout
Control	SFTC-1	1.9	30	70	81	49	58	0.76	0.85
	CC-75	197	173	89	70	50	56	0.75	0.90
	CC-150	30	93	75	76	47	56	0.76	0.83
	CC-350	44	92	90	103	47	39	0.74	0.83
	DC-600	265	22	55	59	59	71	0.36	0.80
Test	HS-3	73	32	77	75	32	45	0.10	0.35
	LSV-2C	47	73	68	66	41	55	0.67	0.78
	CC-1A	132	13	76	83	50	51	0.68	0.75
	CC-3A	105	79	81	85	44	51	0.75	0.75

Table 30

Results of Linear Regression Analysis Relating Log-Transformed Standing Crop (kg/Ha) to HQI, SRI/CSE and SHI Habitat Metrics for the Nine Simplot Locations in Fall 2007 and 2008

Model	Attribute	Sample Size	R^2	p
HQI	Overall Score	18	0.0001	0.9760
	Cover	18	**0.3152**	**0.0153**
	Width	18	0.0231	0.5469
	Velocity	18	0.0562	0.3435
	Macro Abundance	18	0.0022	0.8542
	Eroding bank	18	0.0034	0.8194
	Max Temp	18	0.0163	0.6142
	Nitrate as N	18	0.0119	0.6662
	Food Index	18	0.0004	0.9393
	Shelter Index	18	0.1278	0.1452
SRI/CSE	Total Score	18	**0.2110**	**0.0551**
	Upper Banks	18	0.0787	0.2595
	Lower Banks	18	**0.1901**	**0.0705**
	Channel Bottom	18	0.0778	0.2624
SHI	Total Score	18	0.0017	0.8696
	%Cover	18	0.0631	0.3148
	Large Organic Debris	18	0.0206	0.5699
	% Fines	18	0.0011	0.8962
	Embeddedness	18	0.0652	0.3063
	# Wolman Classes	18	0.0062	0.7557
	Channel Shape	18	0.0074	0.7337
	% Bank Vegetation	18	0.0247	0.5330
	% Canopy Cover	18	0.0752	0.2708
	Disruptive Pressure	18	0.0214	0.5624
	Zone of Influence	18	0.0041	0.8009

Values in bold indicate significance at $p = 0.10$.

Table 31

Results of Linear Regression Analysis Relating Log-Transformed Brown and Cutthroat Standing Crop (kg/Ha) to HSI Component Scores for the Nine Simplot Locations in Fall 2007 and 2008

Year	Species	HSI Component	N	R^2	p
2007	Brown Trout	Overall	9	0.0020	0.9087
2007	Brown Trout	Adult	9	0.0012	0.9301
2007	Brown Trout	Juvenile	9	0.0186	0.7261
2007	Brown Trout	Fry	9	0.0035	0.8801
2007	Brown Trout	Other	9	**0.4090**	**0.0636**
2008	Brown Trout	Overall	9	0.0233	0.6952
2008	Brown Trout	Adult	9	0.0123	0.7761
2008	Brown Trout	Juvenile	9	0.0575	0.5342
2008	Brown Trout	Fry	9	0.0004	0.9575
2008	Brown Trout	Other	9	**0.3809**	**0.0766**
2007 and 2008	Brown Trout	Overall	18	0.0097	0.6976
2007 and 2008	Brown Trout	Adult	18	0.0014	0.8812
2007 and 2008	Brown Trout	Juvenile	18	0.0353	0.4553
2007 and 2008	Brown Trout	Fry	18	0.0004	0.9395
2007 and 2008	Brown Trout	Other	18	**0.3948**	**0.0052**
2007	Cutthroat Trout	Overall	9	0.2906	0.1342
2007	Cutthroat Trout	Adult	9	**0.4304**	**0.0550**
2007	Cutthroat Trout	Juvenile	9	**0.3845**	**0.0749**
2007	Cutthroat Trout	Fry	9	0.1916	0.2387
2007	Cutthroat Trout	Other	9	0.0052	0.8543
2008	Cutthroat Trout	Overall	9	**0.6662**	**0.0073**
2008	Cutthroat Trout	Adult	9	**0.6334**	**0.0103**
2008	Cutthroat Trout	Juvenile	9	**0.6103**	**0.0129**
2008	Cutthroat Trout	Fry	9	**0.4945**	**0.0346**
2008	Cutthroat Trout	Other	9	0.3260	0.1083
2007 and 2008	Cutthroat Trout	Overall	18	**0.4307**	**0.0031**
2007 and 2008	Cutthroat Trout	Adult	18	**0.5066**	**0.0009**
2007 and 2008	Cutthroat Trout	Juvenile	18	**0.4699**	**0.0017**
2007 and 2008	Cutthroat Trout	Fry	18	**0.3032**	**0.0179**
2007 and 2008	Cutthroat Trout	Other	18	0.0846	0.2417

Values in bold indicate significance at p = 0.10.

Table 32

Results of Wilcoxon Rank Sum Tests Comparing Trout Standing Crop (kg/Ha) and Habitat Metrics for Spring and Fall 2007 and 2008 Sampling Periods between Background and Downstream Locations

Comparison	Background Locations		Downstream Locations		Two-tailed p
	N	Mean Rank	N	Mean Rank	
Total Trout - All Seasons	20	16.2	16	21.3	0.1519
Total Trout - Fall 2007 and 2008	10	8.0	8	11.4	0.2592
Total Trout - Spring 2007 and 2008	10	8.6	8	10.6	0.4873
Brown Trout - All Seasons	20	13.8	16	24.4	**0.0028**
Cutthroat Trout - All Seasons	20	19.9	16	16.8	0.3900
HQI Score - Fall 2007 and 2008	10	9.6	8	9.4	0.9310
SRI/SCE Score - Fall 2007 and 2008	10	9.5	8	9.6	0.9846
SHI Score - Fall 2007 and 2008	10	11.3	8	7.3	**0.0894**
HSI Score - Brown Trout	5	6.1	4	3.6	0.1587
HSI Score - Cutthroat Trout	5	7.0	4	2.5	**0.0079**

Values in bold indicate significance at p = 0.10.

FIGURES

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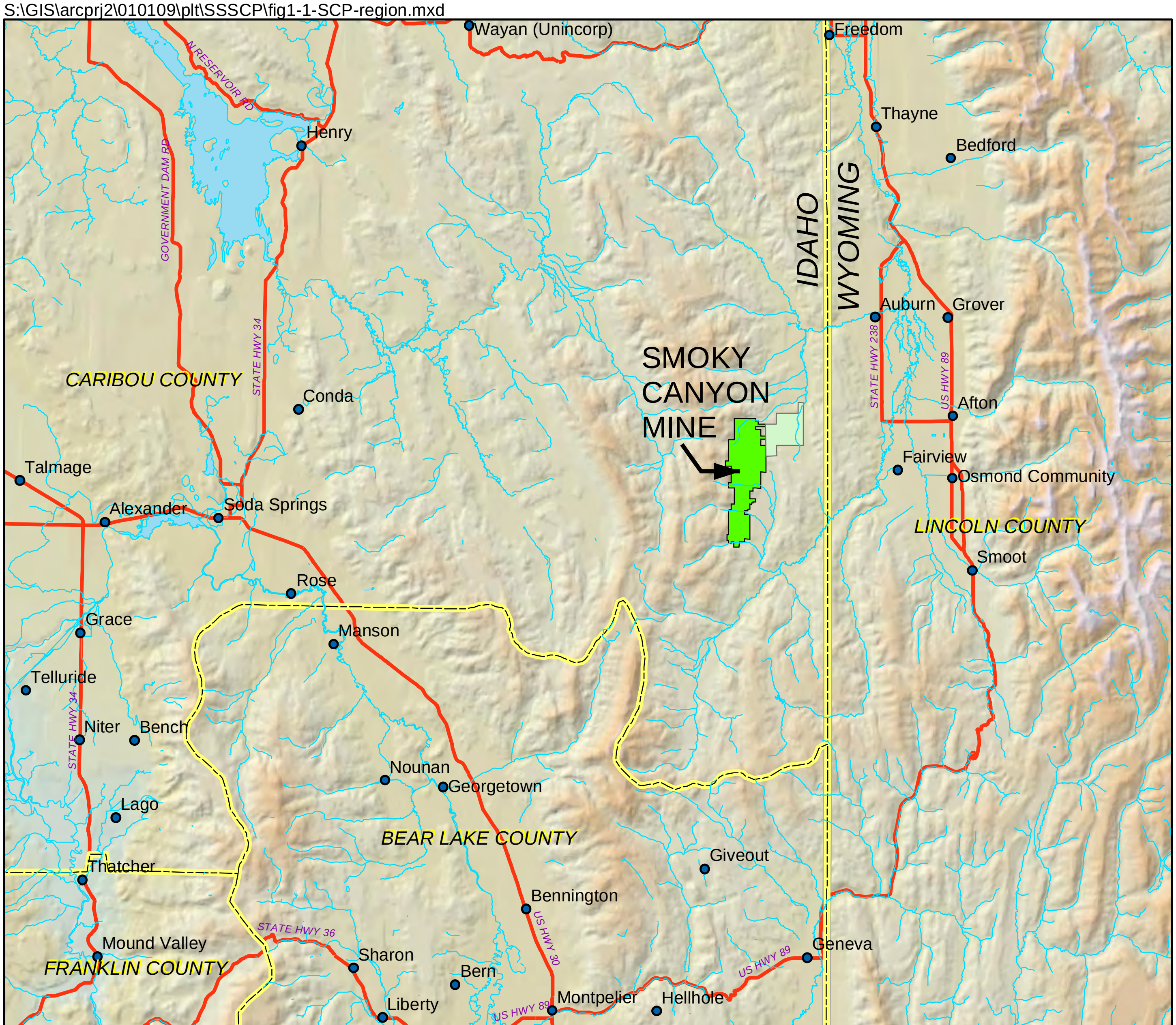

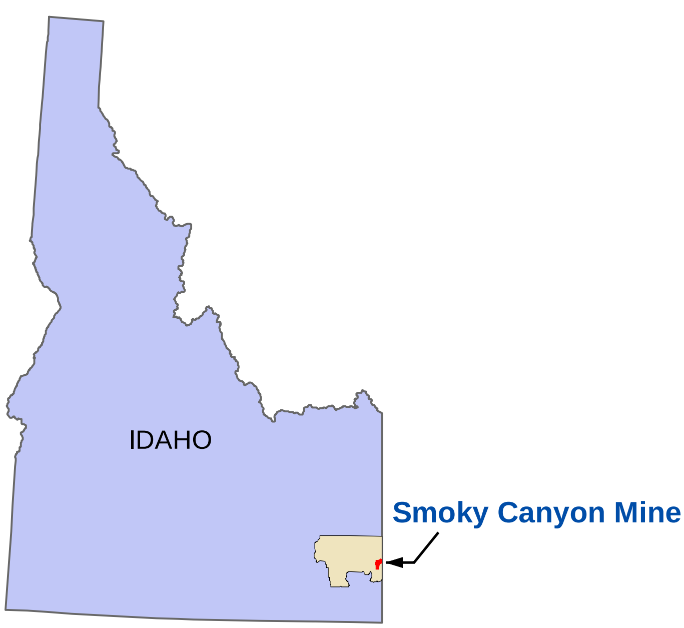

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0 5 10
Miles

J.R. SIMPLOT COMPANY

SMOKY CANYON MINE

FIGURE 1

LOCATION OF THE SMOKY CANYON MINE

PRJ: 0442-004-900.70	DATE: MAY. 05, 2011
REV: 0	BY: RCR CHK: SMC

FORMATION ENVIRONMENTAL

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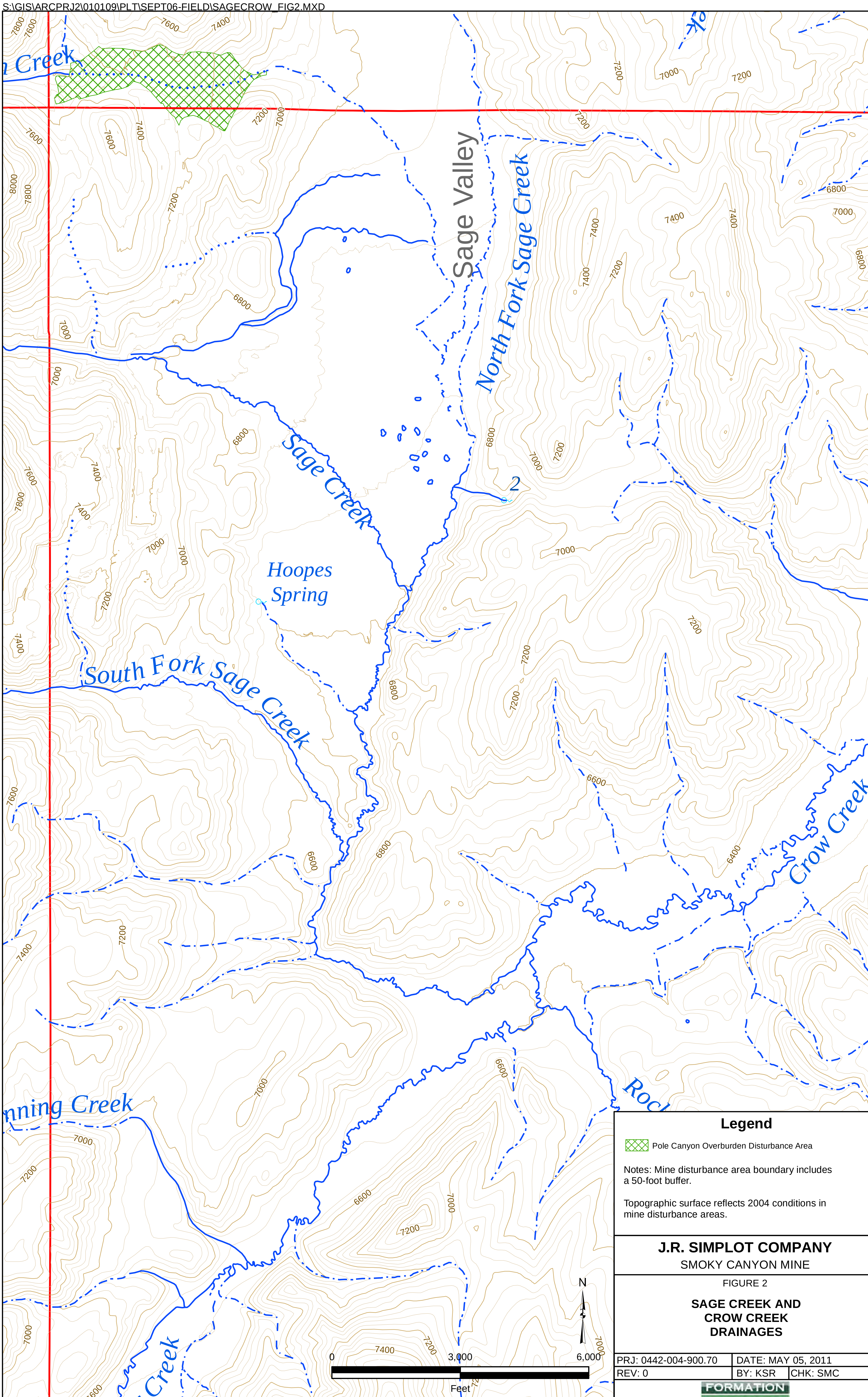

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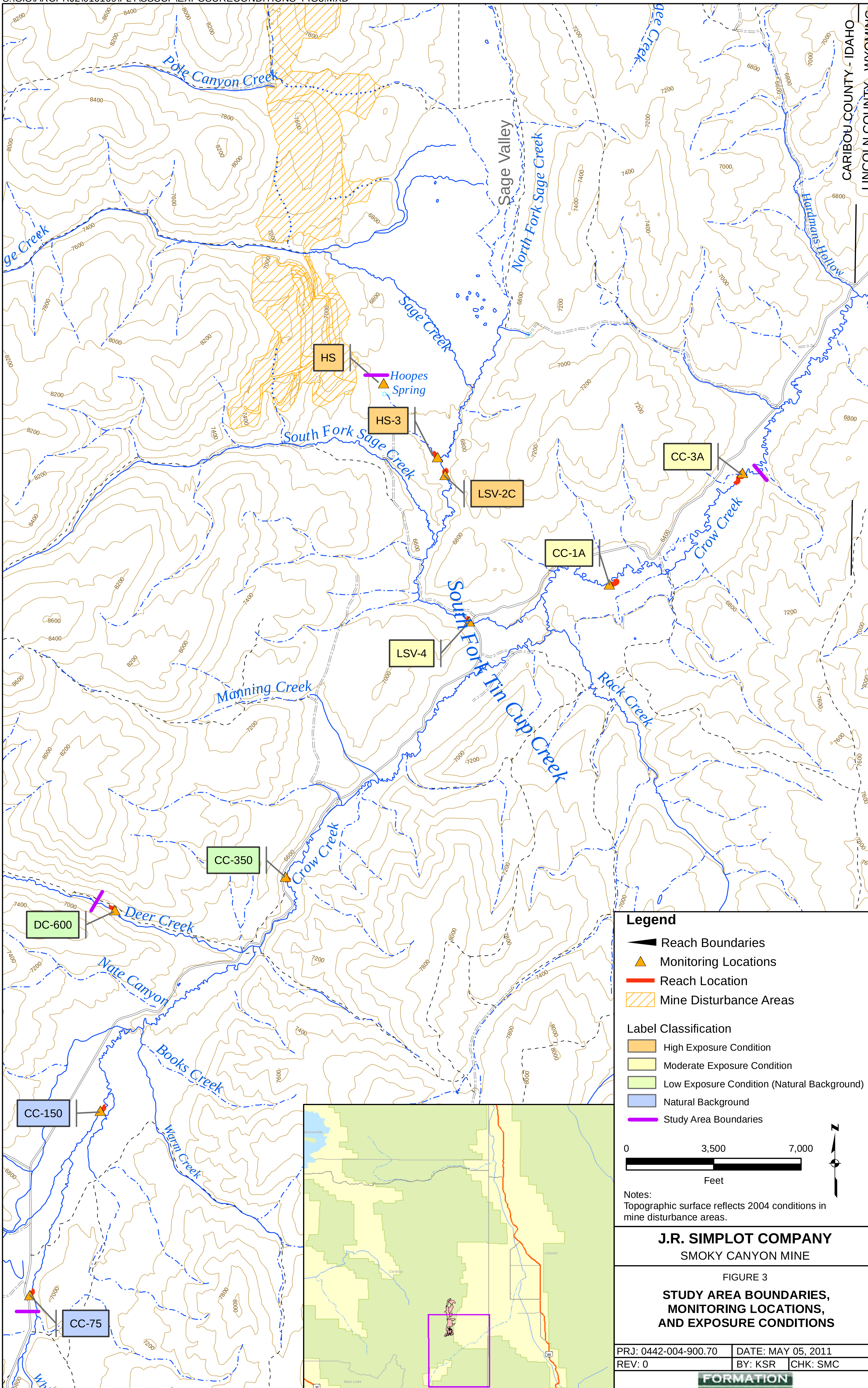

Notes:
Topographic surface reflects 2004 conditions in mine disturbance areas.

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE

FIGURE 3

STUDY AREA BOUNDARIES, MONITORING LOCATIONS, AND EXPOSURE CONDITIONS

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REV: 0	BY: KSR CHK: SMC

FORMATION ENVIRONMENTAL

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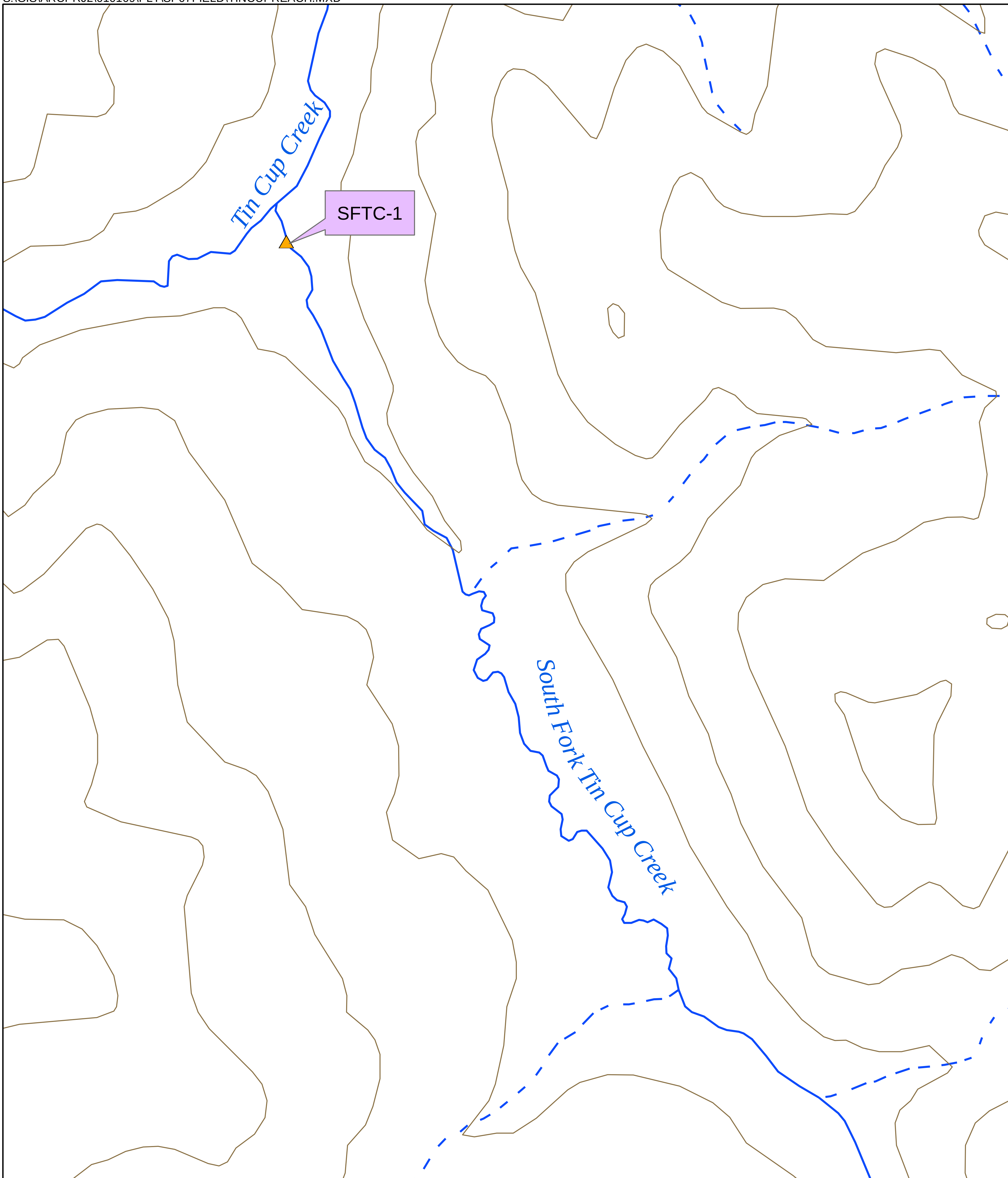

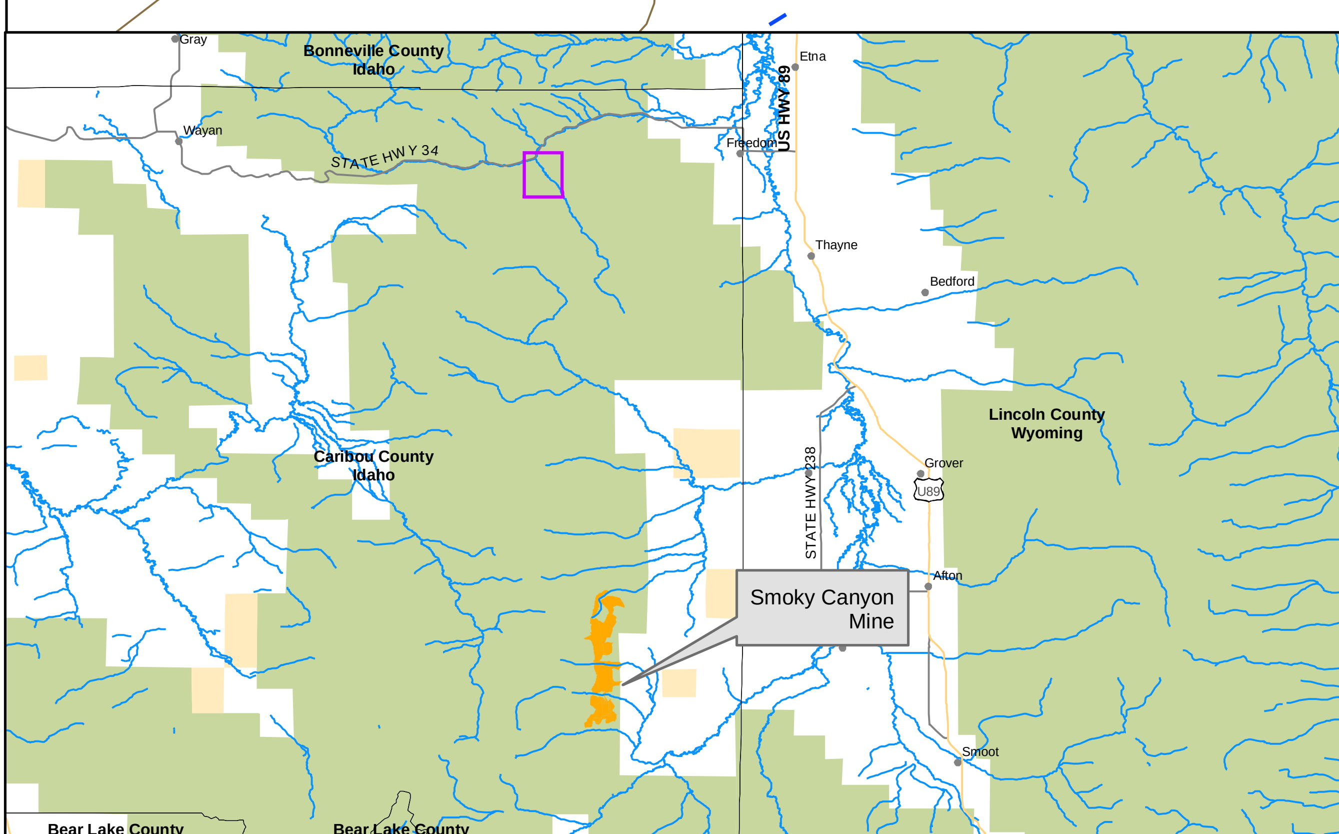

Legend

- Monitoring Locations
- Reach Location
- Reference Condition

Feet

0 600 1,200

N

J.R. SIMPLOT COMPANY

SMOKY CANYON MINE

FIGURE 4

SOUTH FORK TINCUP CREEK MONITORING LOCATION AND EXPOSURE CONDITION

PRJ: 0442-004-900.70	DATE: MAY 05, 2011	
REV: 0	BY: KSR	CHECKED: SMC

FORMATION ENVIRONMENTAL

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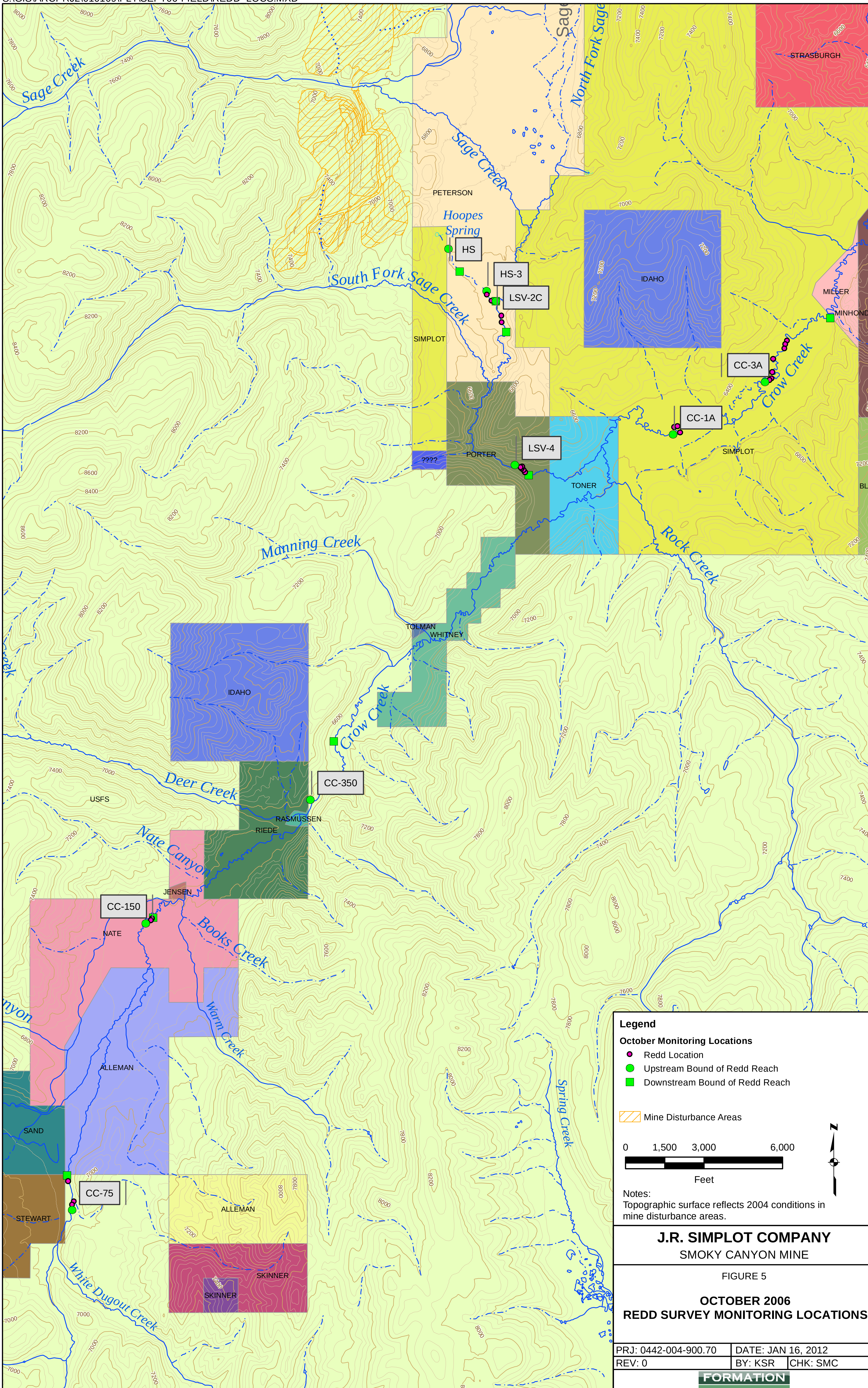

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J.R. SIMPLOT COMPANY
SMOKY CANYON MINE

FIGURE 6
MAY 2007
REDD SURVEY LOCATIONS
CROW CREEK BELOW
SAGE CREEK CONFLUENCE

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FORMATION ENVIRONMENTAL

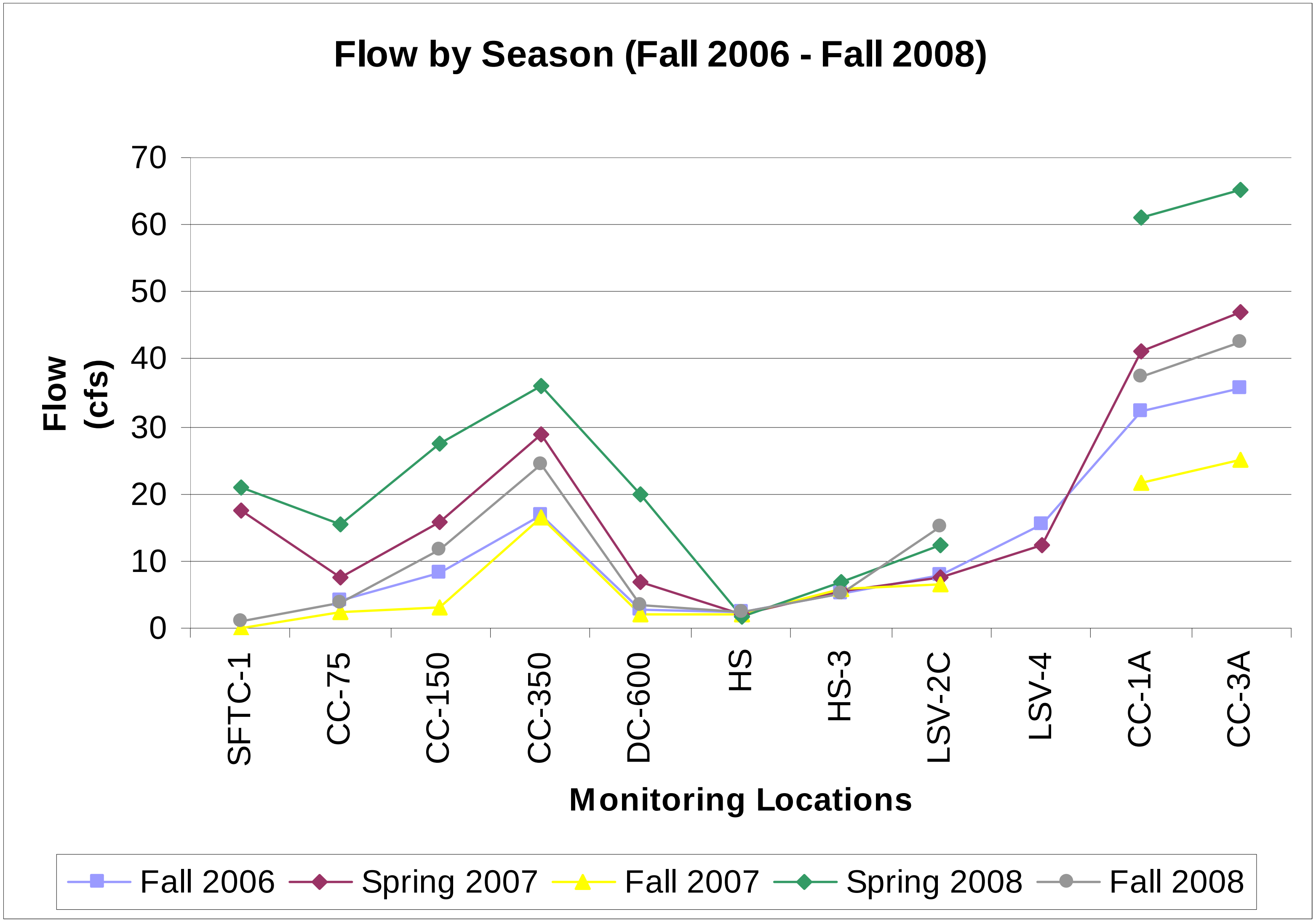

Figure 7
Flow by Season, Fall 2006 – Fall 2008

J.R. Simplot Company
Site-Specific Selenium Criterion

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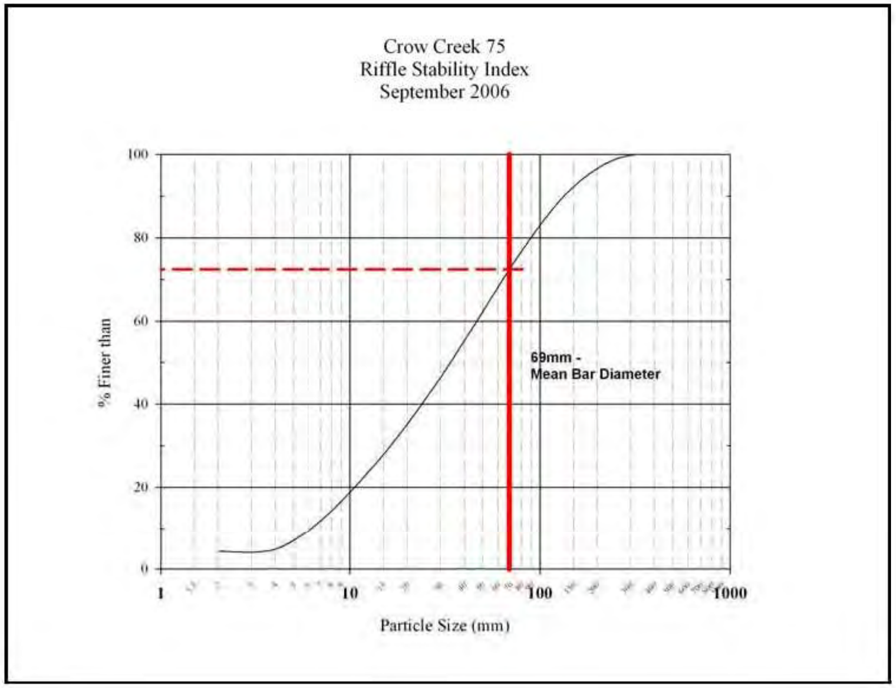


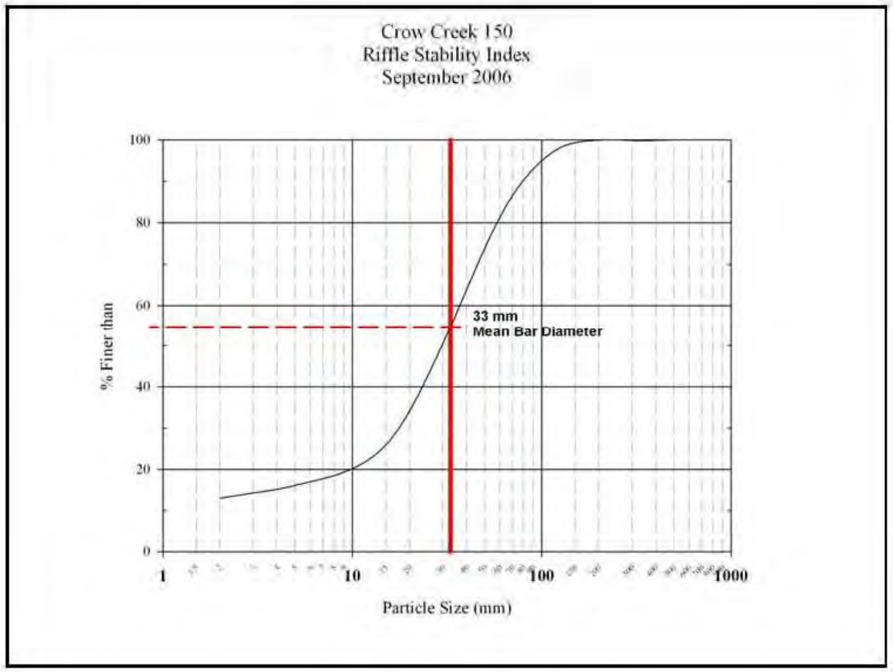
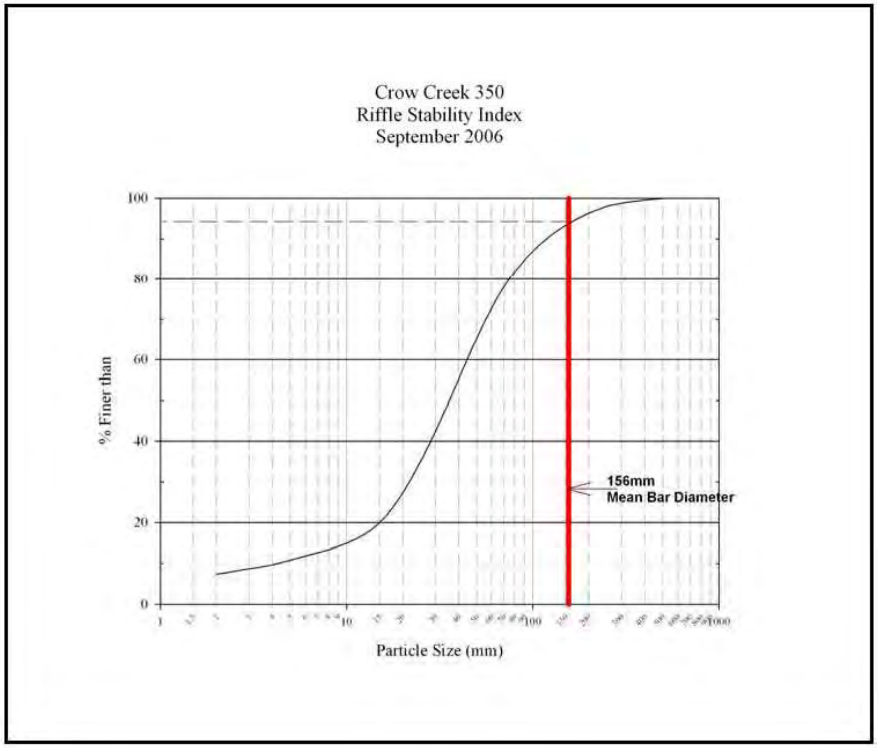


Figure 8
Substrate Particle Size Distribution Curves and Mean Bar Particle Diameters Used to Determine Riffle Stability Index Scores (Dashed Line) at Six Locations Sampled in August-September, 2006 (CC-75 and CC-150)

J.R. Simplot Company Site-Specific Selenium Criterion		
PRJ: 0442-004-900.70	DATE: January 2012	
REV: 0	BY: SMC	CHK: SMC
FORMATION ENVIRONMENTAL		



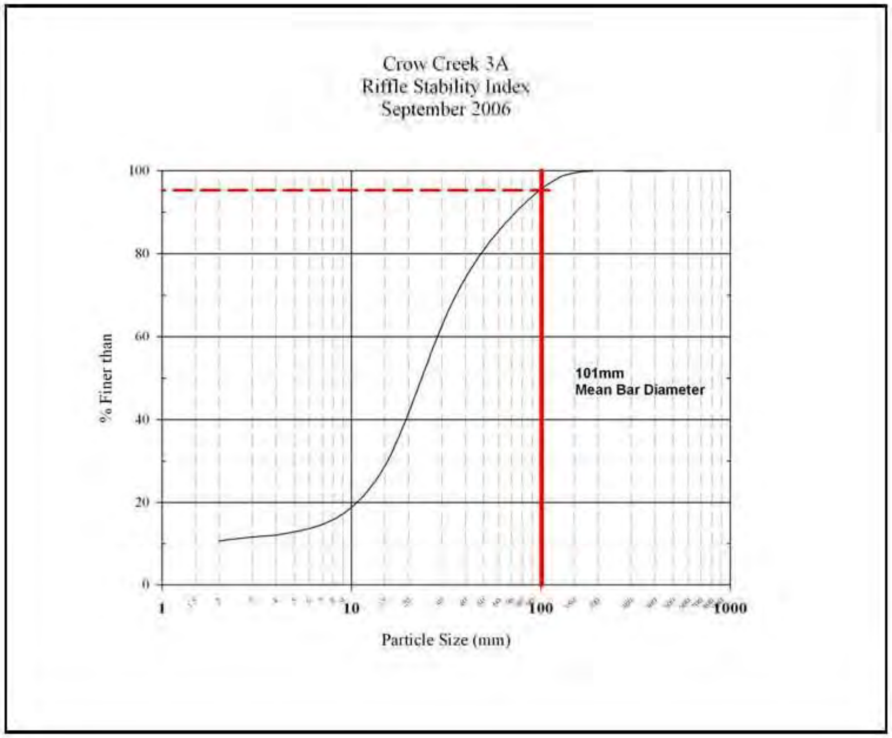
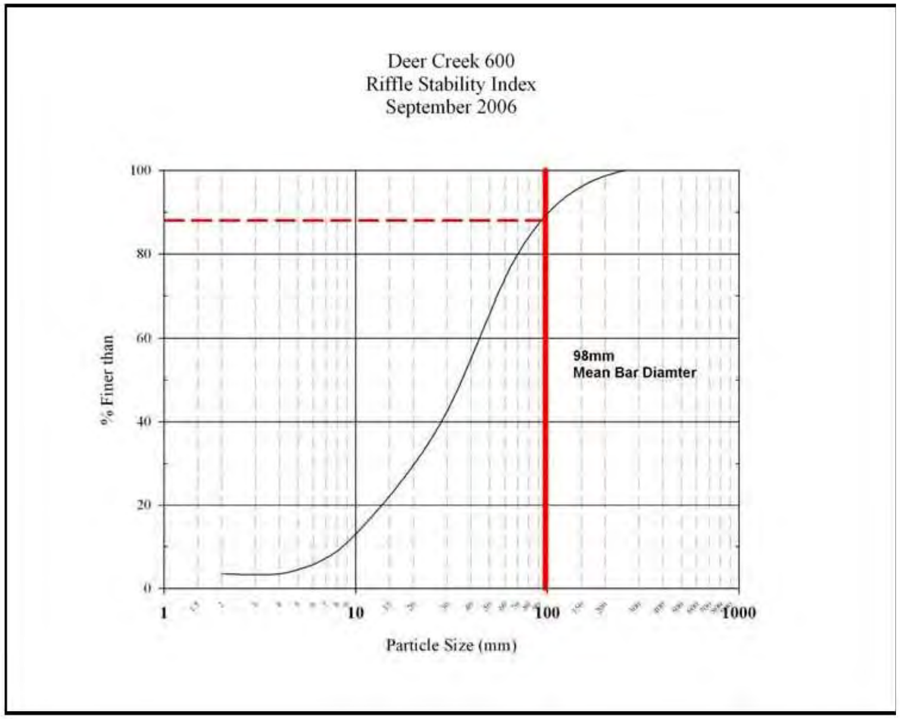


Figure 9
Substrate Particle Size Distribution Curves and Mean Bar Particle Diameters Used to Determine Riffle Stability Index Scores (Dashed Line) at Six Locations Sampled in August-September, 2006 (CC-350 and CC-3A)

J.R. Simplot Company
Site-Specific Selenium Criterion

PRJ: 0442-004-900.70	DATE: January 2012	
REV: 0	BY: SMC	CHK: SMC



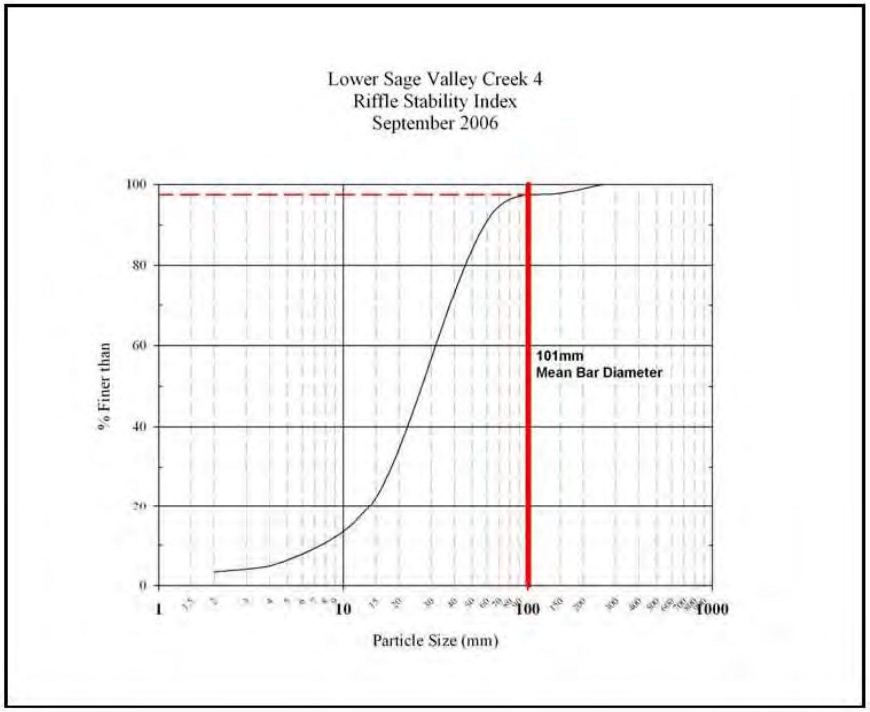


Figure 10
Substrate Particle Size Distribution Curves and Mean Bar Particle Diameters Used to Determine Riffle Stability Index Scores (Dashed Line) at Six Locations Sampled in August-September, 2006 (DC-600 and LSV-4)

J.R. Simplot Company
Site-Specific Selenium Criterion

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FORMATION ENVIRONMENTAL

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Legend

October Monitoring Locations

- Redd Location
- Upstream Boundary of Redd Reach
- Downstream Boundary of Redd Reach
- Redd Survey Reach

0 500 1,000 2,000

Feet

N

Notes:
Topographic surface reflects 2004 conditions in mine disturbance areas.

J.R. SIMPLOT COMPANY

SMOKY CANYON MINE

FIGURE 11

OCTOBER 2006
REDD SURVEY LOCATIONS
CROW CREEK BELOW
SAGE CREEK CONFLUENCE

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FORMATION ENVIRONMENTAL

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Notes:
Topographic surface reflects 2004 conditions in mine disturbance areas.

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE

FIGURE 12

OCTOBER 2006
REDD SURVEY LOCATIONS
SAGE CREEK

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REV: 0	BY: KSR	CHK: SMC

FORMATION ENVIRONMENTAL

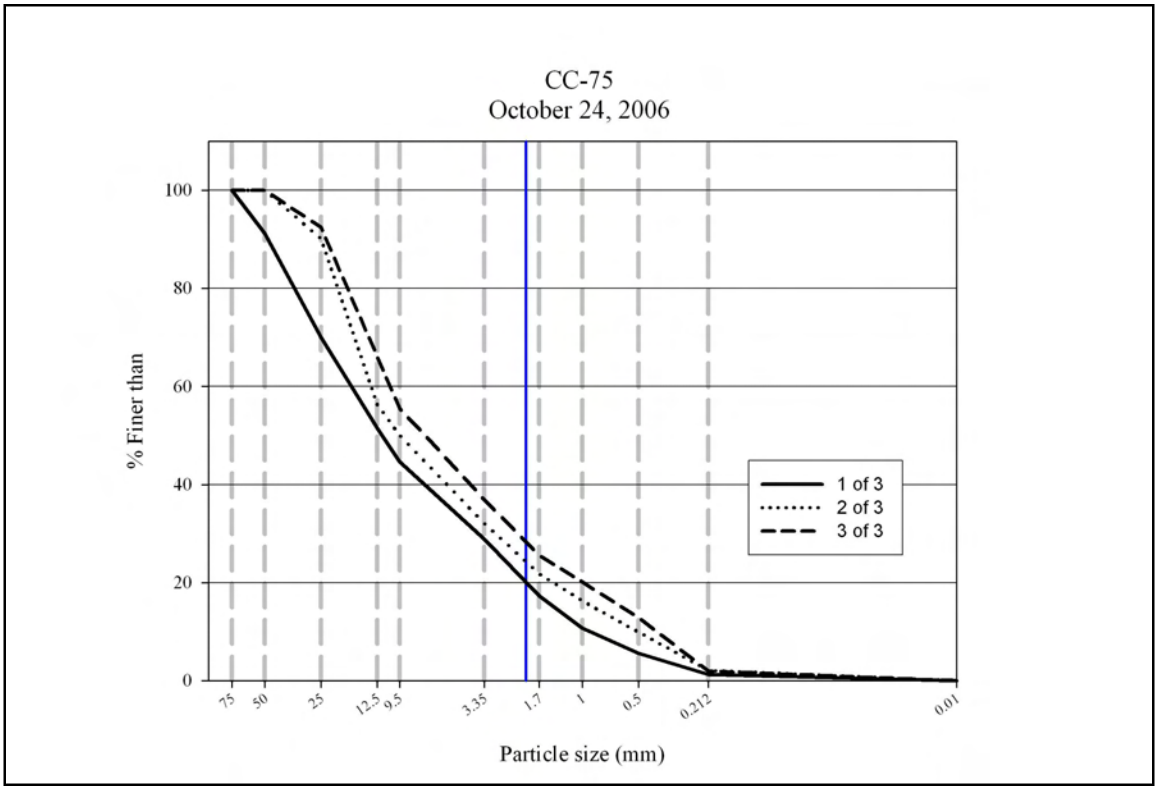
S:\GIS\ARCPRJ2\010109\PLT\SEPT06-FIELD\REDD_LOCS_UPPERCC.MXD

J.R. SIMPLOT COMPANY
SMOKY CANYON MINE

FIGURE 13
OCTOBER 2006
REDD SURVEY LOCATIONS
CROW CREEK ABOVE
SAGE CREEK CONFLUENCE

PRJ: 0442-004-900.70	DATE: JAN 16, 2012
REV: 0	BY: KSR CHK: SMC

FORMATION ENVIRONMENTAL



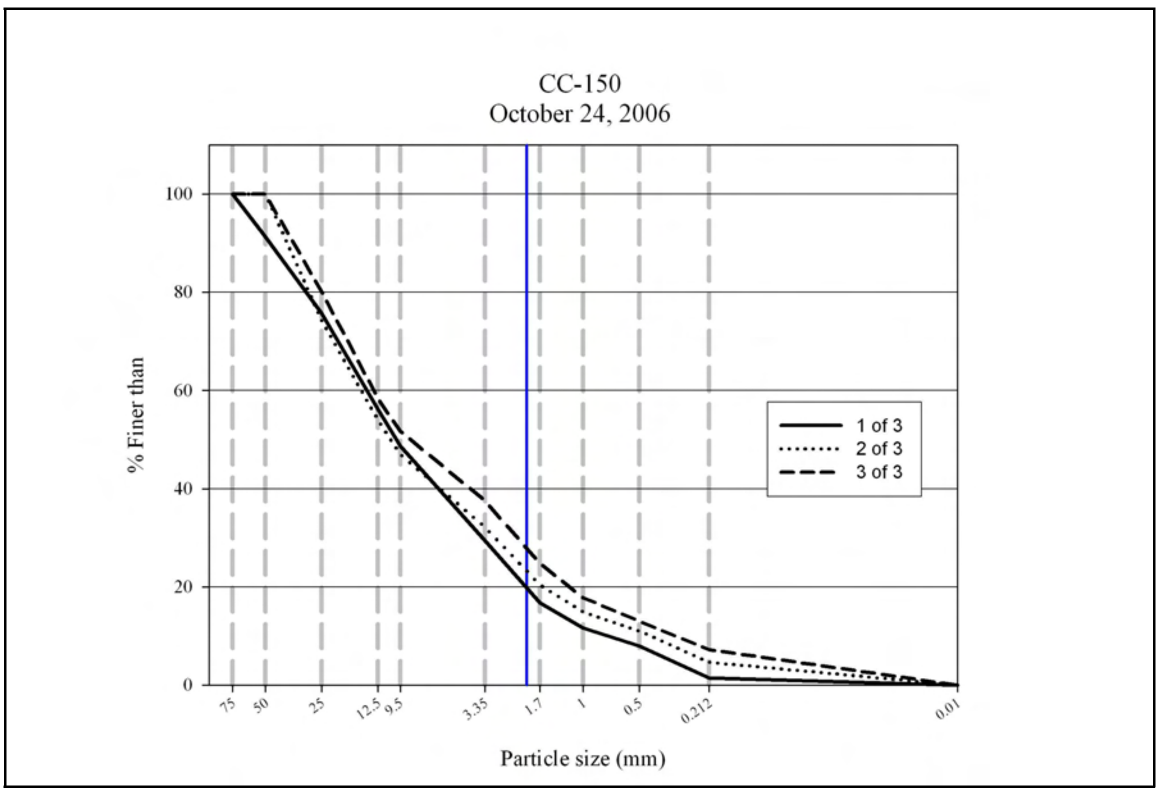
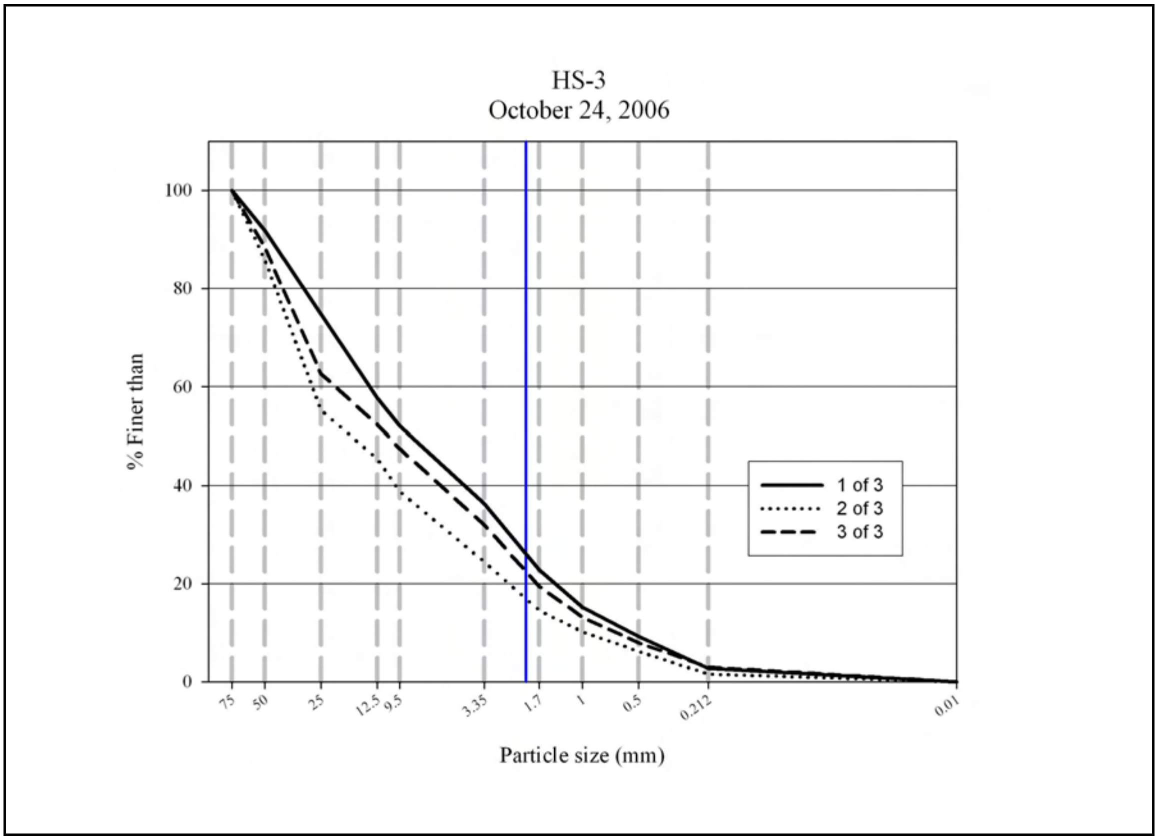


Figure 14 Particle size distribution of stream bed substrate collected by core sampling near suspected brown trout redds at seven study locations, October 2006.



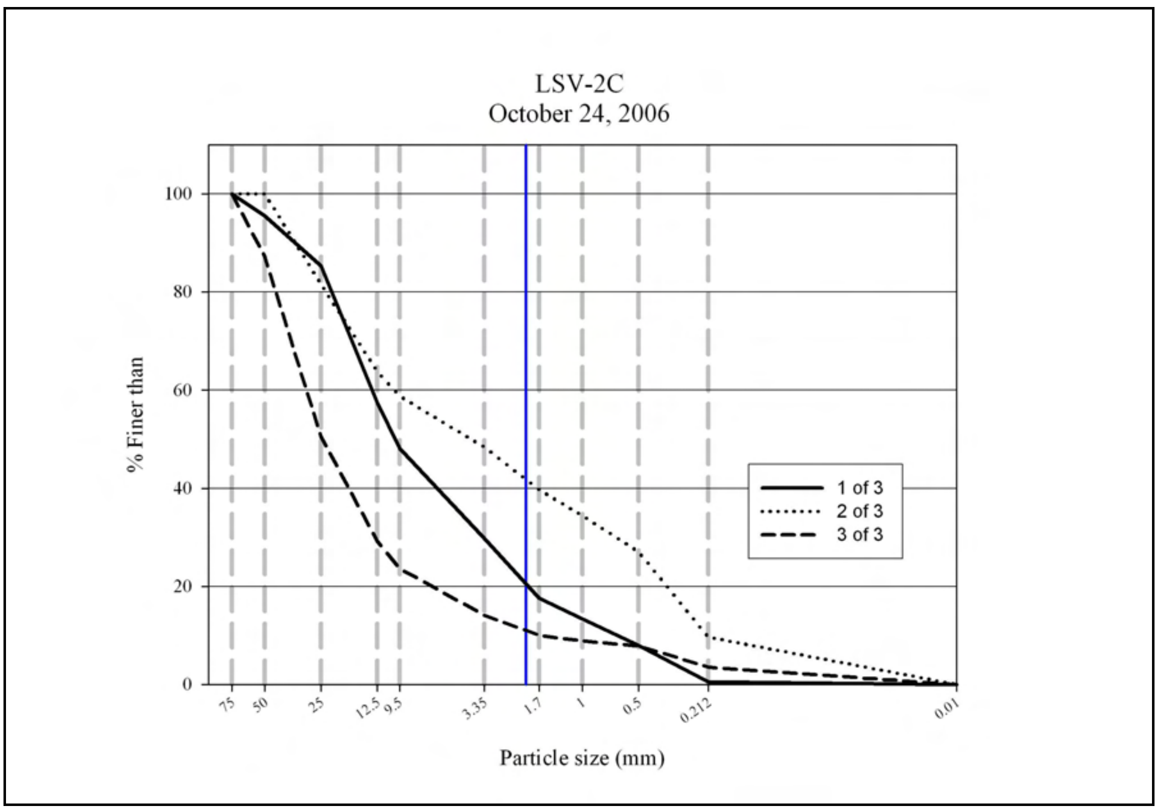
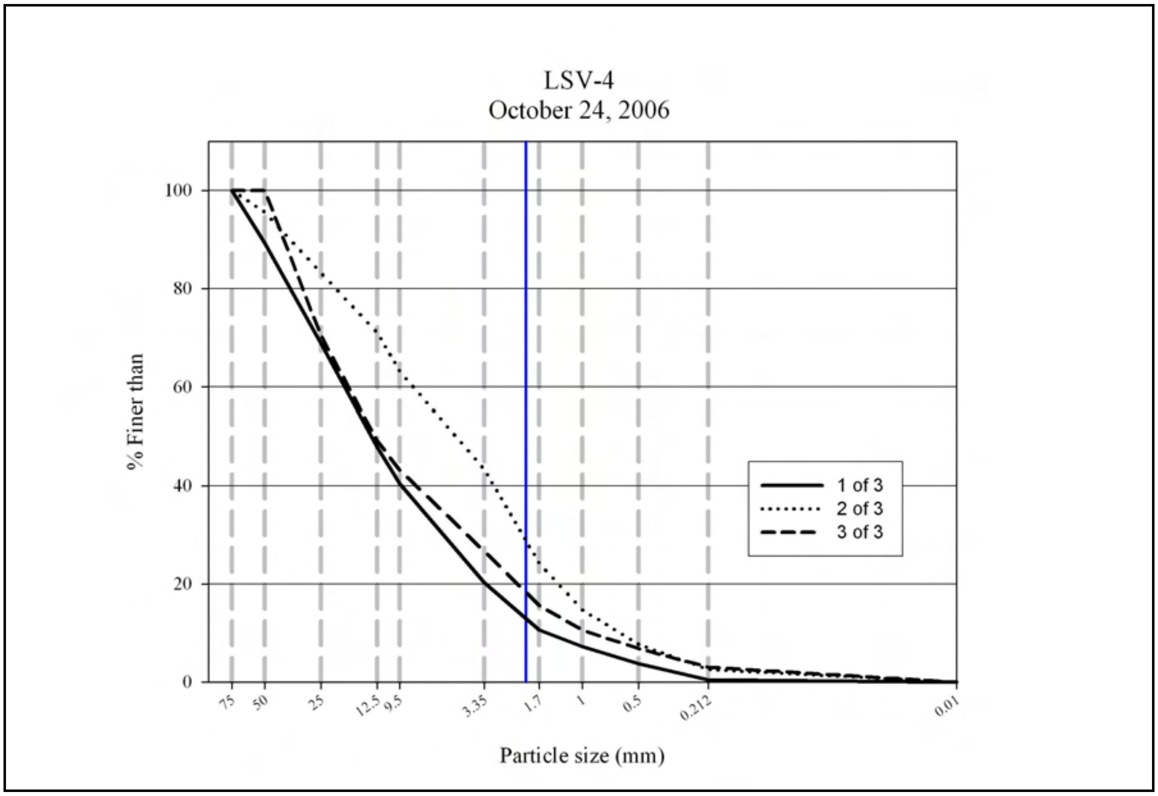


Figure 14(cont) Particle size distribution of stream bed substrate collected by core sampling near suspected brown trout redds at seven study locations, October 2006.



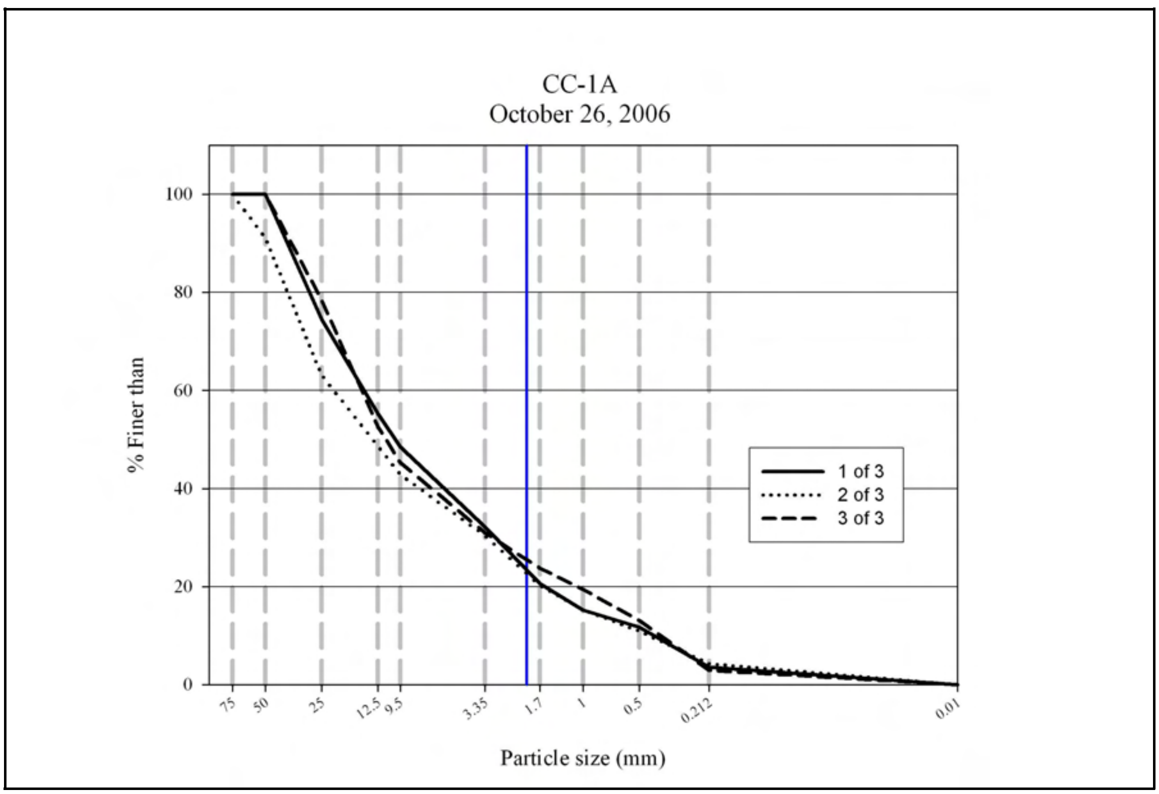


Figure 14(cont) Particle size distribution of stream bed substrate collected by core sampling near suspected brown trout redds at seven study locations, October 2006.

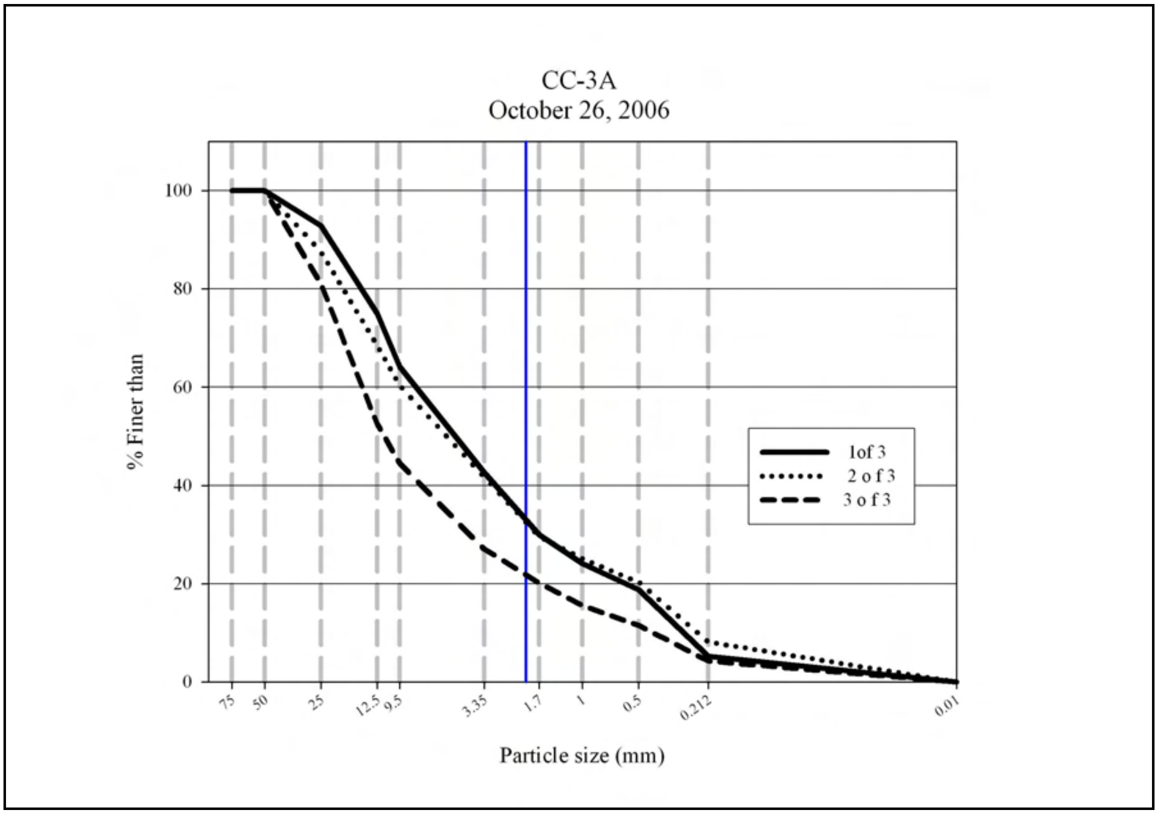
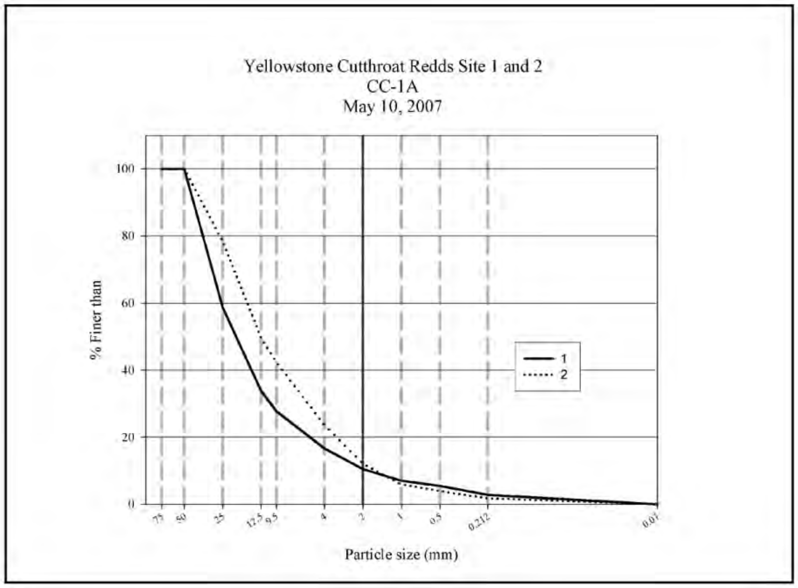
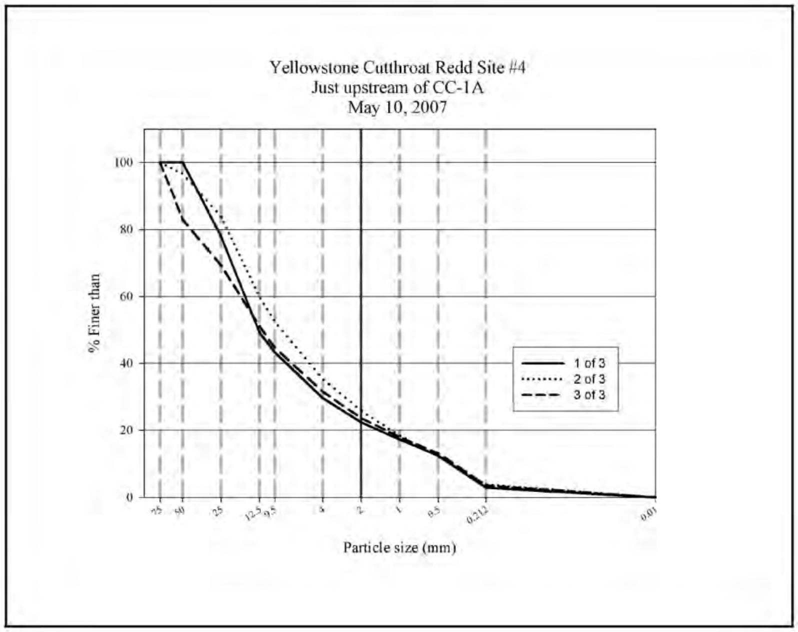
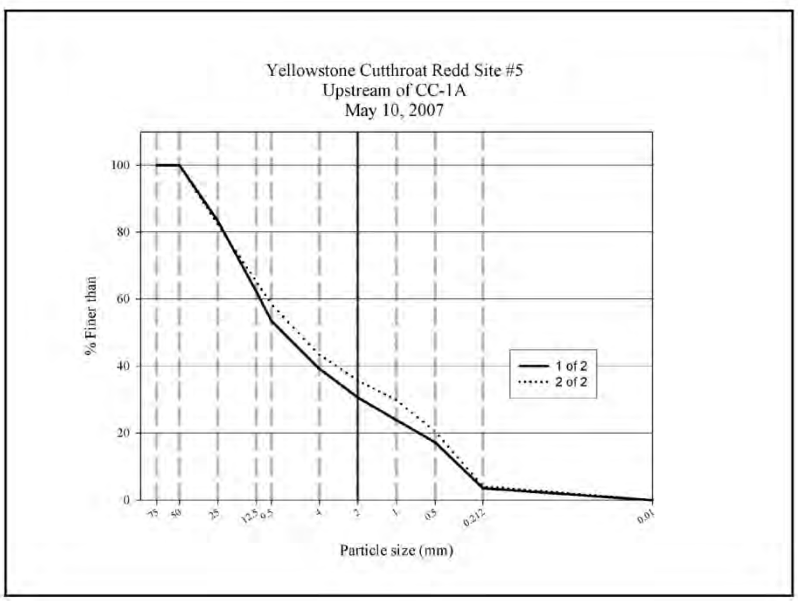


Figure 14(cont) Particle size distribution of stream bed substrate collected by core sampling near suspected brown trout redds at seven study locations, October 2006.







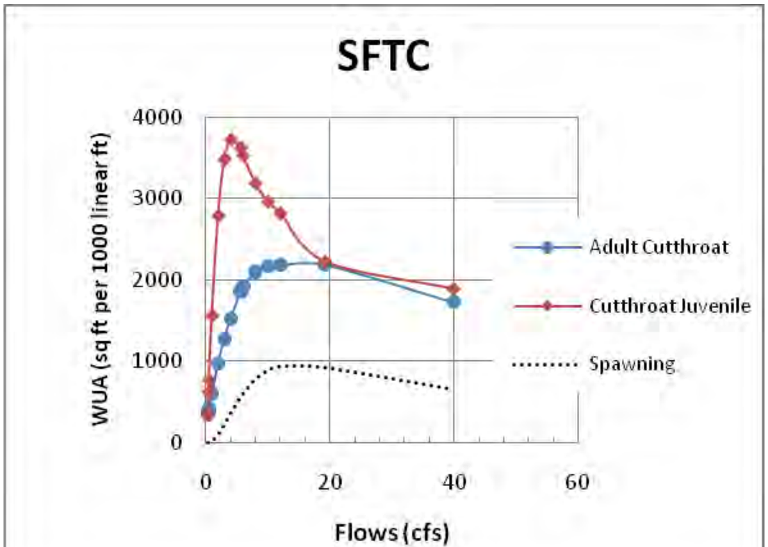
J.R. Simplot Company
Smoky Canyon Mine

FIGURE 15

Particle Size Distribution of Stream Bed Substrate Collected by Core Sampling Near Suspected Yellowstone Cutthroat Redds on Crow Creek near CC-1A, May 10, 2007

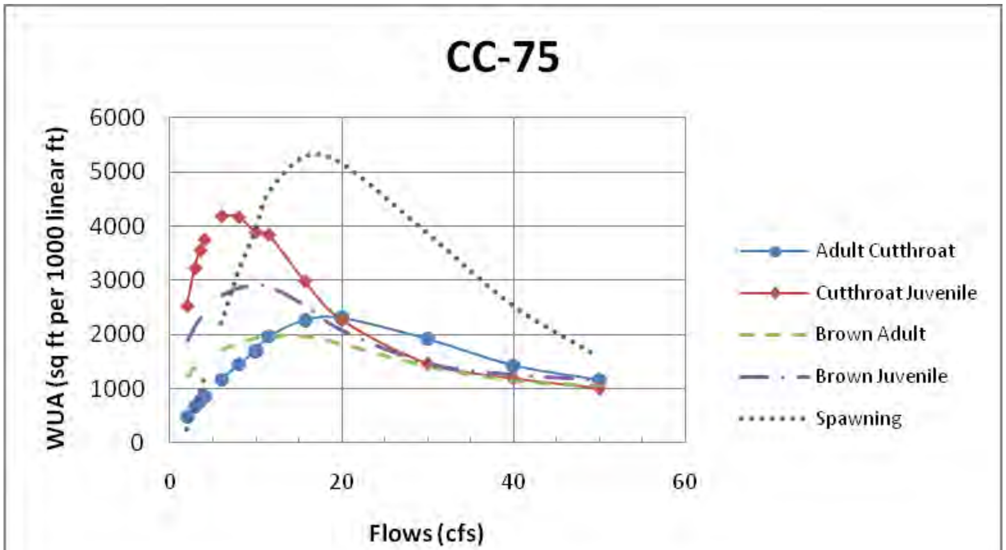
PRJ: 009-004	DATE: January 2012	
REV: 0	BY: SMC	CHK: SMC

FORMATION ENVIRONMENTAL



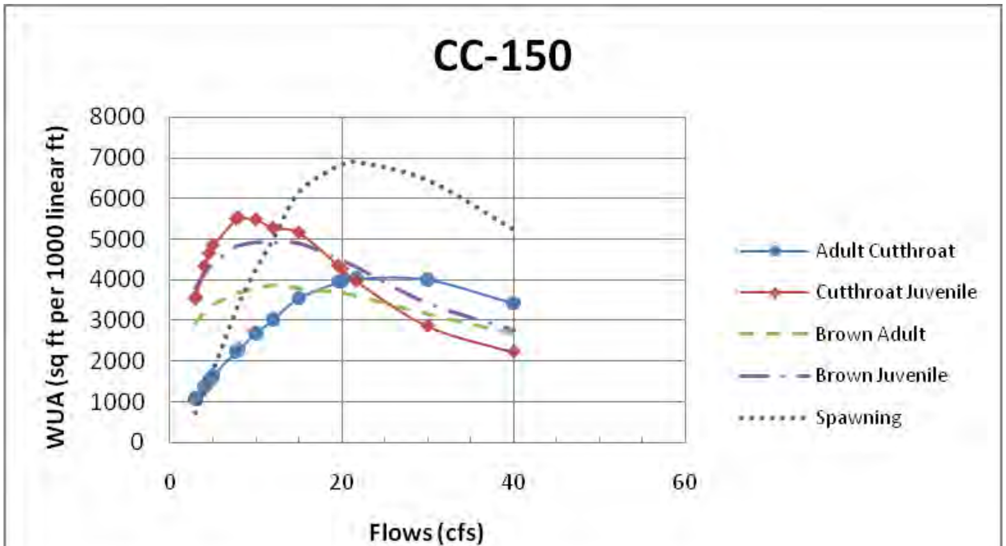
Flow	Adult Cutthroat	Cutthroat Juvenile	Spawning
0.3	338	347	0
0.43	384	625	0
0.5	410	766	0
1	600	1561	23
2	972	2792	106
3	1273	3485	230
4	1528	3730	366
5.6	1851	3629	564
6	1914	3535	604
8	2099	3192	780
10	2166	2966	886
12	2183	2823	933
19.2	2190	2226	918
40	1726	1889	651

Figure 16 Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the South Fork Tincup Creek monitoring location.



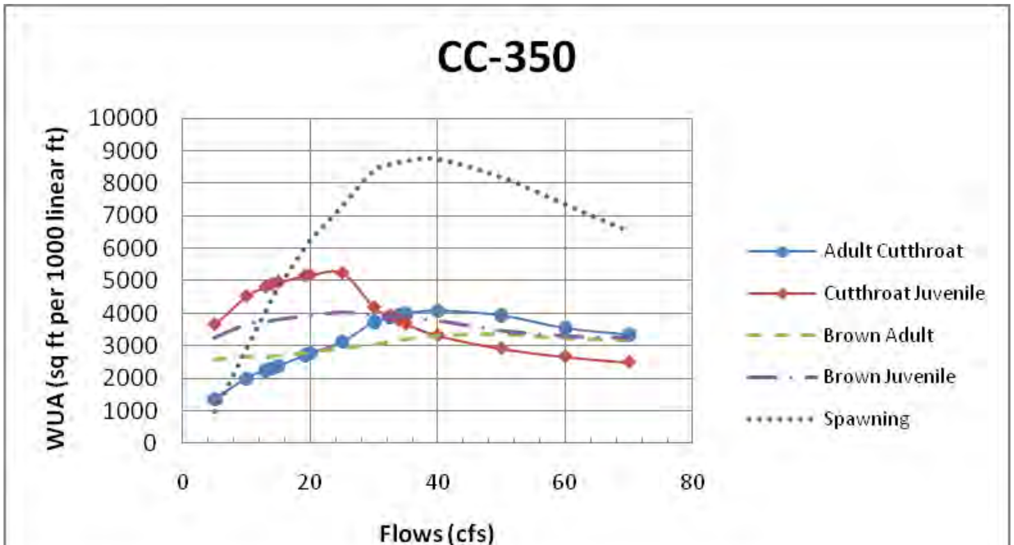
Flow	Adult Cutthroat	Cutthroat Juvenile	Brown Adult	Brown Juvenile	Spawning
2	482	2529	1223	1887	263
2.9	667	3229	1399	2151	625
3.5	771	3556	1482	2293	920
4	855	3757	1544	2401	1179
5	1018	4037	1645	2585	1703
6	1166	4191	1719	2715	2218
8	1447	4171	1838	2854	3164
10	1693	3892	1931	2887	3936
11.5	1962	3845	1963	2885	4621
15.7	2266	2989	1962	2529	5287
20	2307	2269	1820	2077	5167
30	1920	1462	1411	1467	3872
40	1429	1184	1156	1260	2533
50	1161	1005	1049	1169	1595

Figure 17. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Crow Creek-75 monitoring location.



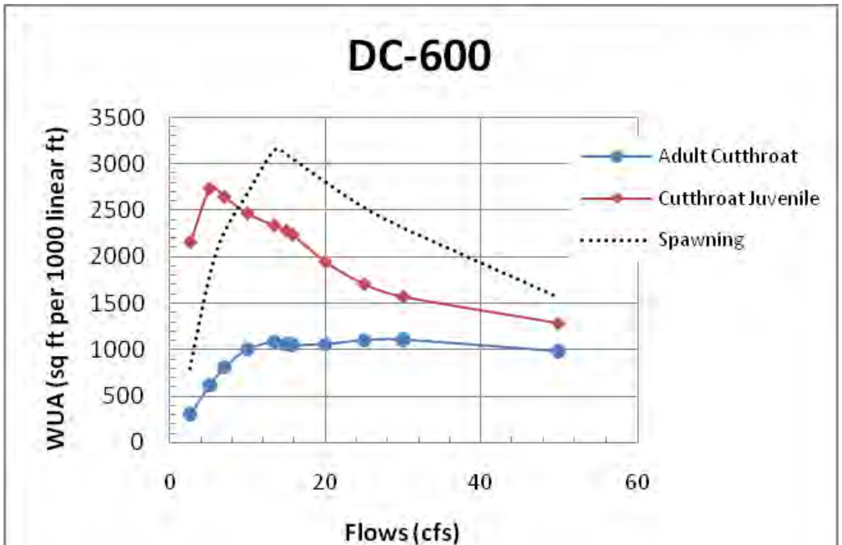
Flow	Adult Cutthroat	Cutthroat Juvenile	Brown Adult	Brown Juvenile	Spawning
2.96	1073	3531	2945	3794	742
3	1085	3575	2956	3809	759
4	1375	4332	3205	4133	1257
4.56	1531	4652	3319	4289	1548
5	1645	4854	3393	4394	1787
7.7	2240	5500	3665	4827	3277
8	2298	5523	3684	4849	3420
10	2678	5487	3793	4923	4270
12	3024	5275	3866	4915	4996
15	3551	5165	3798	4903	6153
19.6	3954	4347	3703	4517	6805
20	3976	4273	3686	4479	6832
21.7	4043	3972	3608	4312	6889
30	4013	2865	3169	3421	6439
40	3428	2225	2684	2757	5237

Figure 18. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Crow Creek-150 monitoring location.



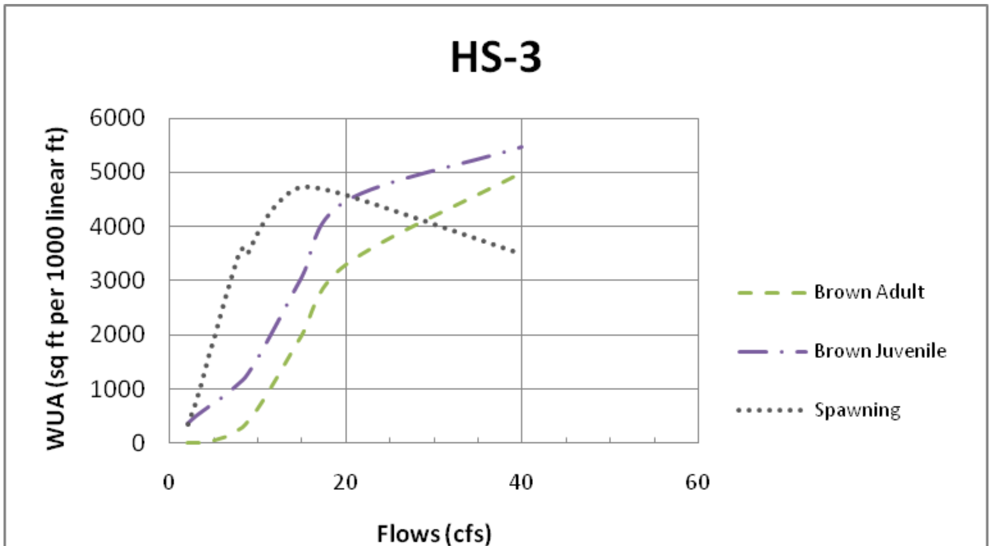
Flow	Adult Cutthroat	Cutthroat Juvenile	Brown Adult	Brown Juvenile	Spawning
5	1361	3654	2561	3228	986
10	1996	4530	2658	3645	2939
13	2249	4810	2633	3729	4076
14	2299	4890	2670	3766	4471
15	2377	4961	2684	3800	4796
19.2	2711	5158	2766	3900	6036
20	2773	5179	2787	3916	6250
25	3124	5241	2930	4020	7290
30	3735	4184	3048	3938	8382
32.5	3873	3928	3131	3897	8555
34	3945	3777	3178	3870	8630
35	3990	3679	3209	3854	8662
40	4081	3317	3331	3762	8719
50	3934	2914	3366	3452	8165
60	3543	2661	3241	3283	7333
70	3340	2488	3180	3239	6509

Figure 19. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Crow Creek-350 monitoring location.



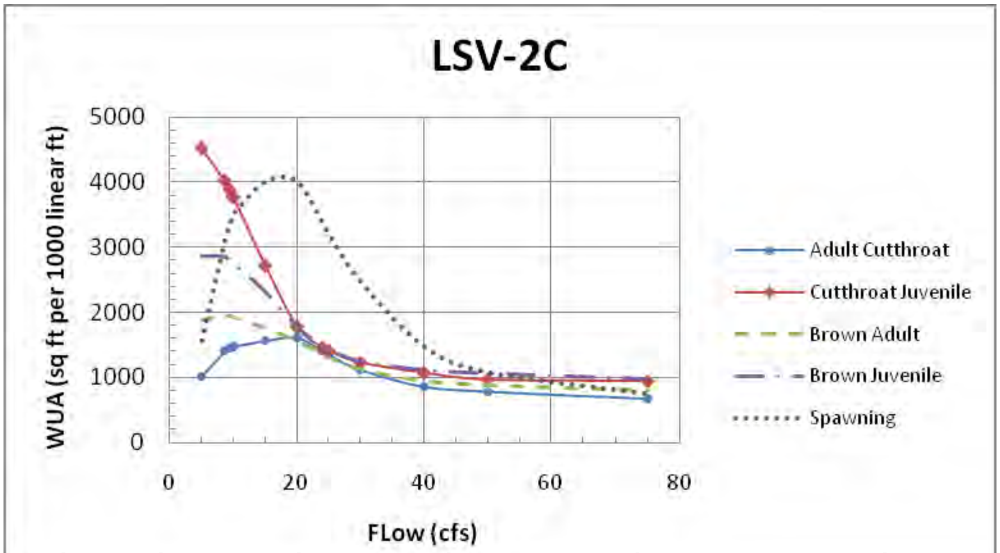
Flow	Total Area	Adult Cutthroat	Cutthroat Juvenile	Spawning
2.6	8886	307	2157	792
5.1	9654	617	2732	1783
7	10193	810	2640	2258
10	10836	1005	2466	2680
13.4	11426	1085	2335	3140
15	11712	1061	2278	3095
15.8	11907	1050	2236	3049
20	12380	1061	1948	2799
25	12714	1102	1707	2524
30	12862	1108	1571	2306
50	13235	984	1287	1555

Figure 20. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Deer Creek-600 monitoring location.



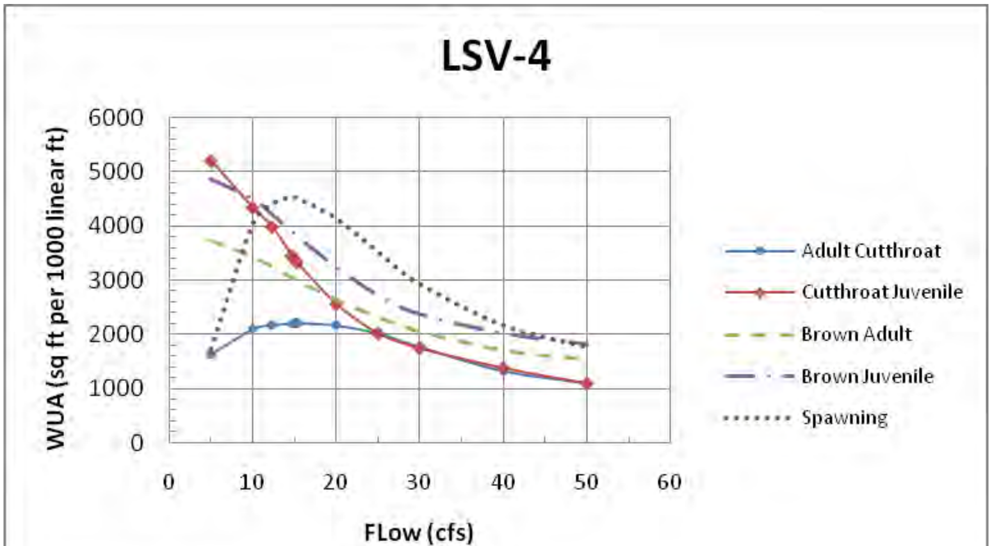
Flow	Total Area	Brown Adult	Brown Juvenile	Spawning
2	12367	0	372	343
3	13395	0	517	804
4	13683	8	635	1383
4.4	13797	22	685	1631
5	13914	45	748	1947
5.4	14032	64	795	2185
6.1	14203	99	875	2594
6.3	14239	111	898	2707
8	14517	260	1136	3575
8.7	14675	363	1255	3486
10	15151	638	1583	3899
12	15594	1160	2168	4392
15	16302	1995	3074	4726
20	17179	3299	4476	4574
40	19464	5005	5475	3484

Figure 21. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Hoopes Springs-3 monitoring location.



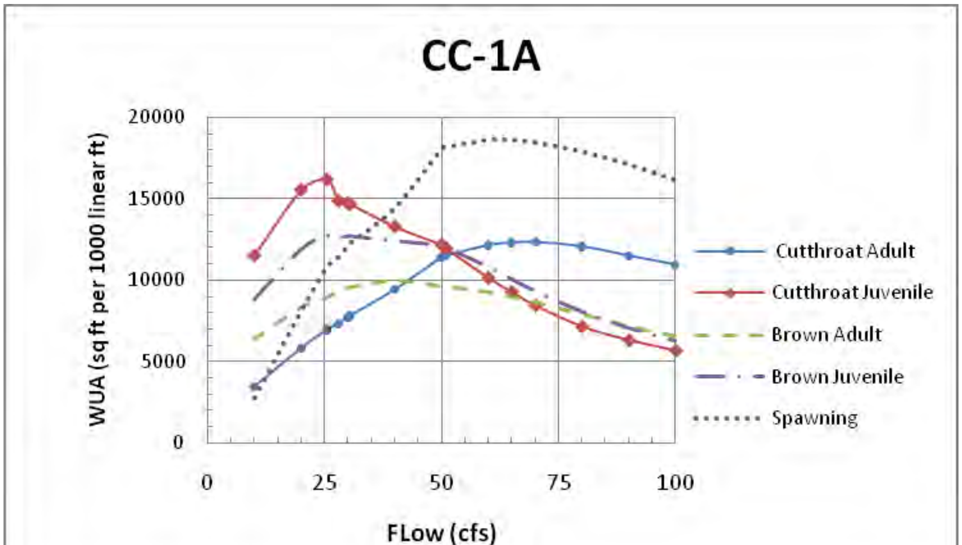
Flow	Adult Cutthroat	Cutthroat Juvenile	Brown Adult	Brown Juvenile	Spawning
5	1013	4519	1885	2867	1564
8.6	1405	4028	1960	2858	3106
9.4	1450	3885	1948	2808	3357
9.9	1473	3788	1940	2774	3498
10	1478	3769	1938	2766	3525
15	1569	2723	1765	2324	4019
20	1618	1782	1562	1782	4020
24	1407	1459	1354	1482	3388
25	1353	1409	1307	1429	3211
30	1119	1231	1122	1250	2477
40	857	1072	939	1117	1476
50	783	966	877	1064	1080
75	671	944	791	977	747

Figure 22. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Lower Sage Valley-2C monitoring location.



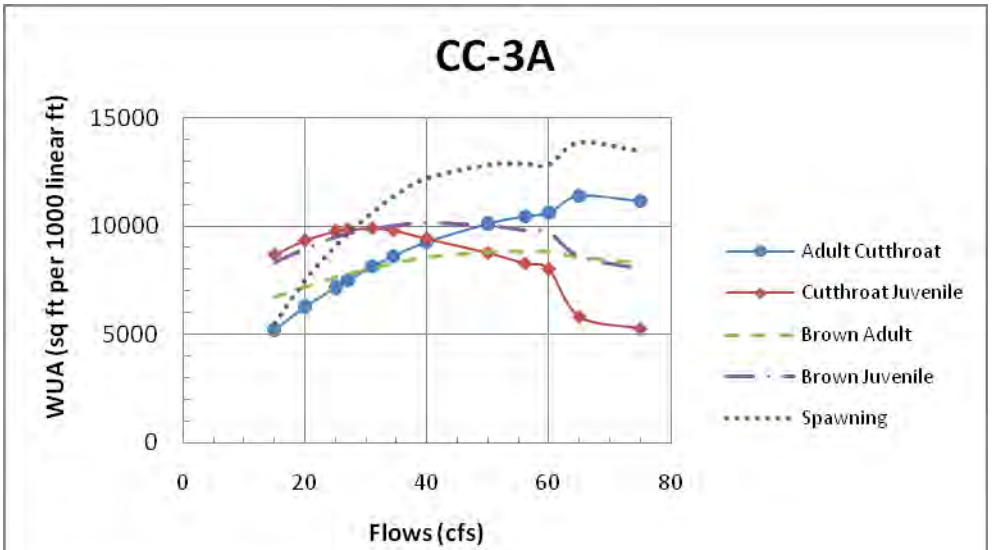
Flow	Adult Cutthroat	Cutthroat Juvenile	Brown Adult	Brown Juvenile	Spawning
5	1627	5201	3736	4856	1738
10	2094	4339	3441	4495	4055
12.3	2169	3988	3253	4211	4417
14.7	2201	3452	3046	3888	4549
15	2205	3390	3022	3851	4539
15.3	2208	3325	2998	3812	4525
20	2163	2564	2641	3236	4145
25	2015	2019	2312	2721	3527
30	1764	1745	2049	2373	2937
40	1319	1378	1696	2020	2173
50	1089	1093	1524	1817	1771

Figure 23. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Lower Sage Valley-4 monitoring location.



Flow	Cutthroat Adult	Cutthroat Juvenile	Brown Adult	Brown Juvenile	Spawning
10	3465	11508	6349	8808	2763
20	5820	15524	8340	11879	8106
25.5	6963	16161	8940	12712	10796
28	7328	14855	9388	12624	11421
30	7733	14706	9566	12705	12130
30.5	7833	14654	9605	12717	12294
40	9430	13278	10017	12424	14432
50	11412	12158	9664	12163	18101
51	11520	11923	9642	12037	18189
60	12152	10130	9303	10830	18621
65	12308	9261	9015	10087	18621
70	12337	8436	8669	9357	18464
80	12079	7133	7930	8094	17900
90	11508	6296	7193	7087	17115
100	10960	5666	6543	6297	16144

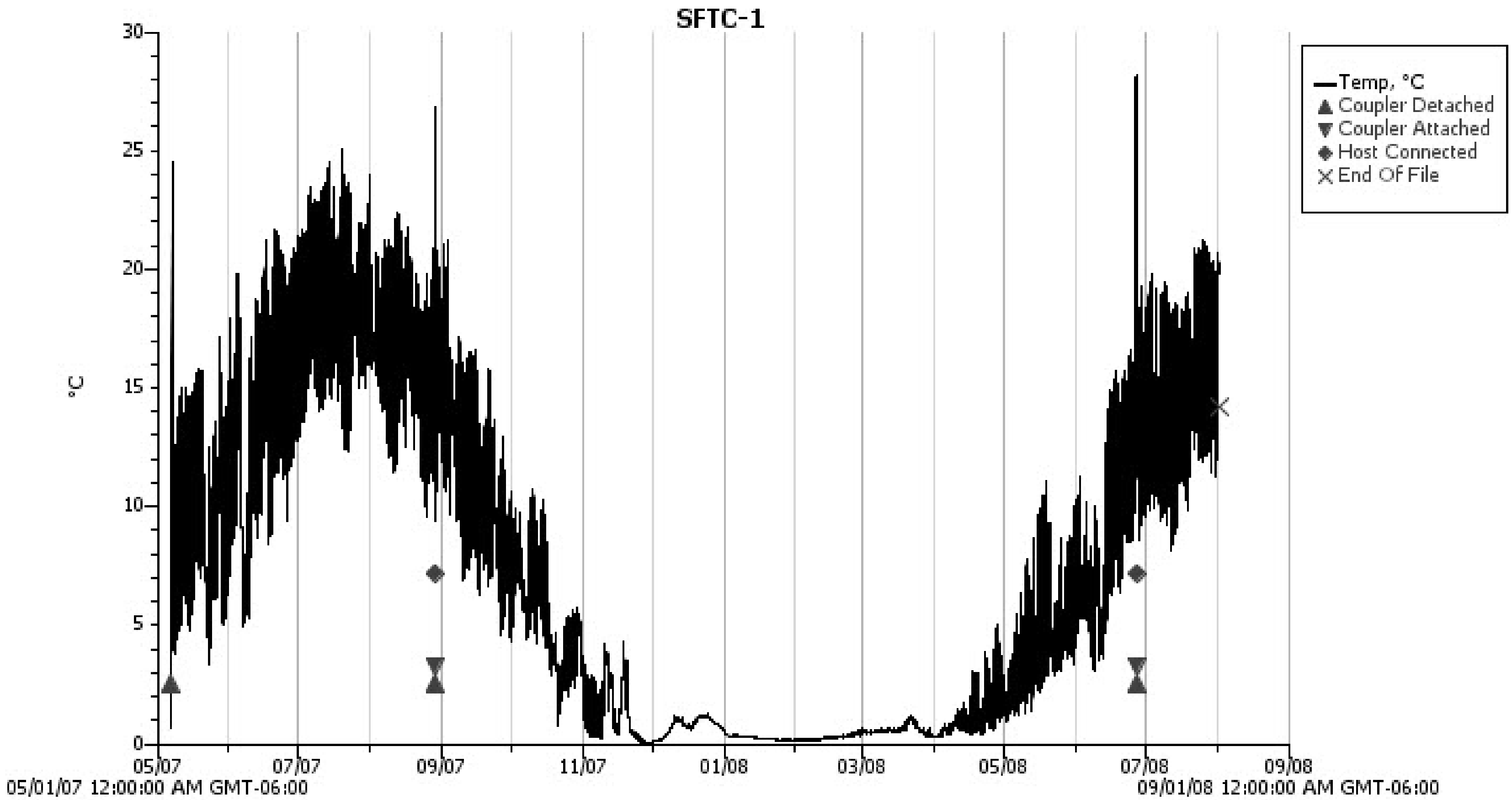
Figure 24. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Crow Creek- 1A monitoring location.



Flow	Adult Cutthroat	Cutthroat Juvenile	Brown Adult	Brown Juvenile	Spawning
15	5212	8703	6700	8327	5518
20	6271	9356	7176	8973	7519
25	7167	9782	7623	9508	9093
27	7499	9853	7784	9666	9654
31	8125	9907	8053	9887	10607
34.5	8624	9814	8281	10044	11350
40	9265	9438	8566	10174	12195
50	10111	8781	8810	10036	12800
56.1	10458	8291	8833	9827	12855
60	10611	8035	8822	9712	12806
65	11398	5845	8577	8619	13838
75	11163	5286	8309	8033	13448

Figure 25. Relationship between streamflow (cfs) and weighted usable area (sq ft per 1000 ft) for the target species and life stages at the Crow Creek- 3A monitoring location.

ATTACHMENT 1
Temperature Data Logs



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25
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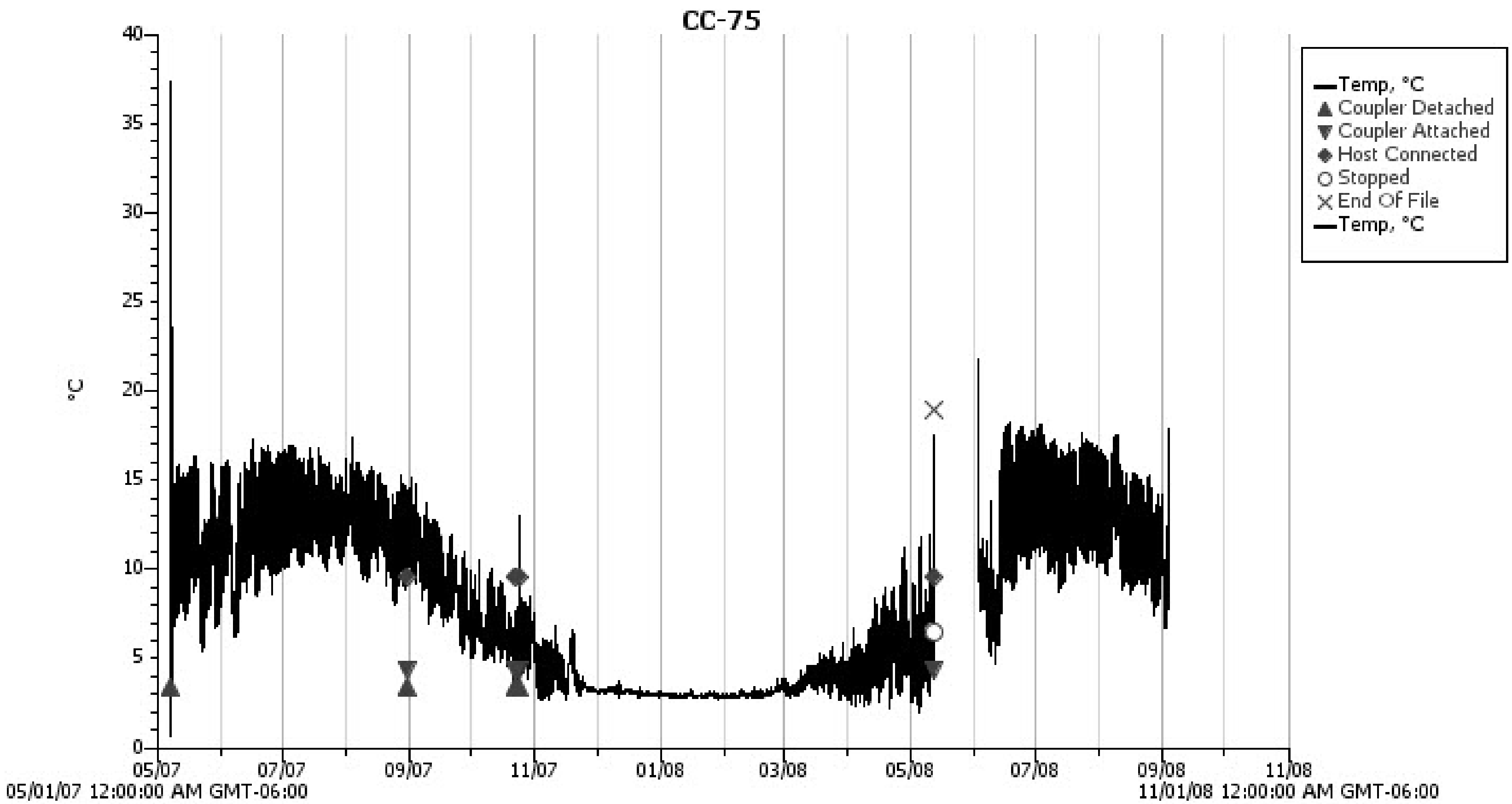
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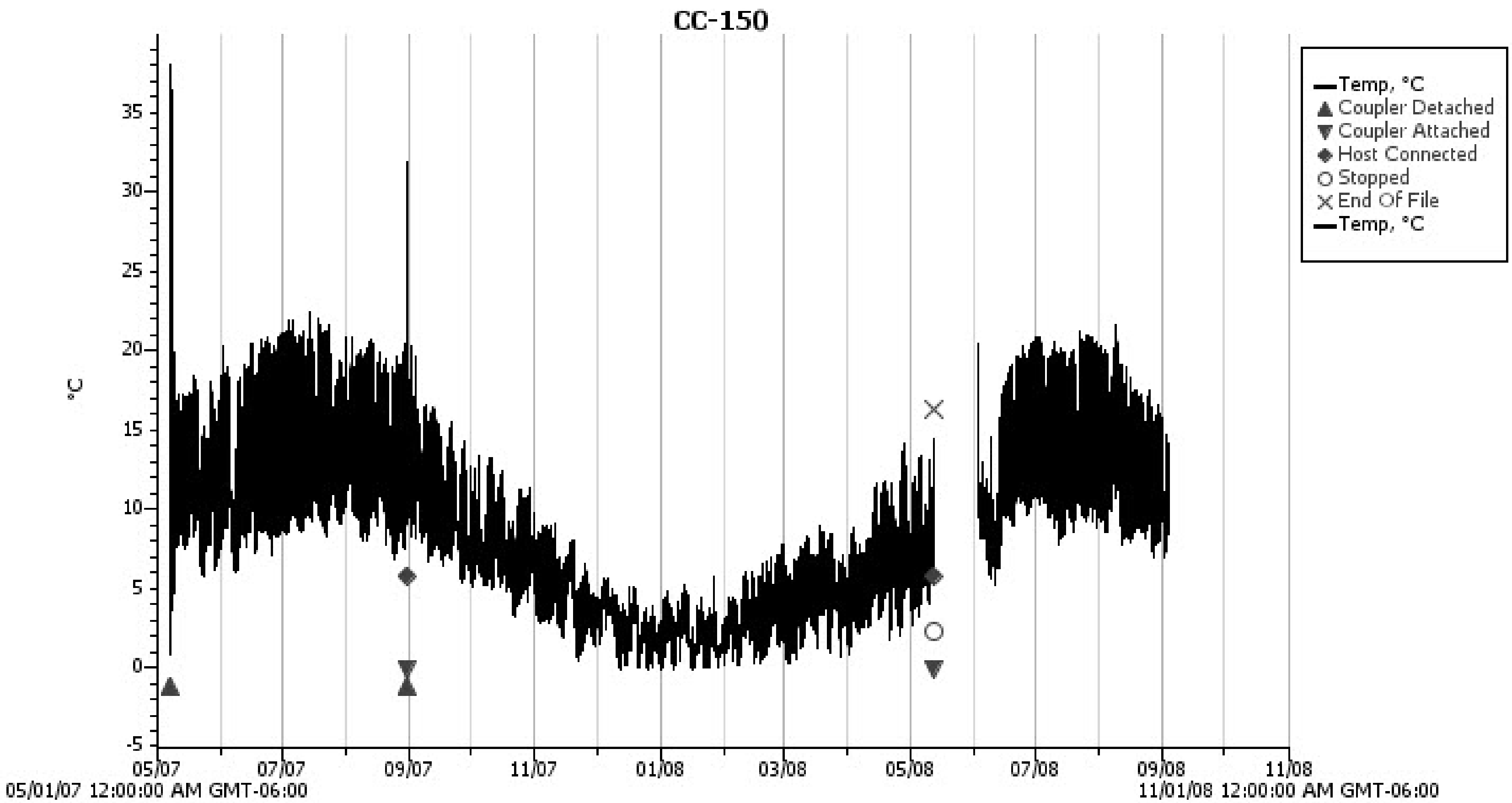
Temp, °C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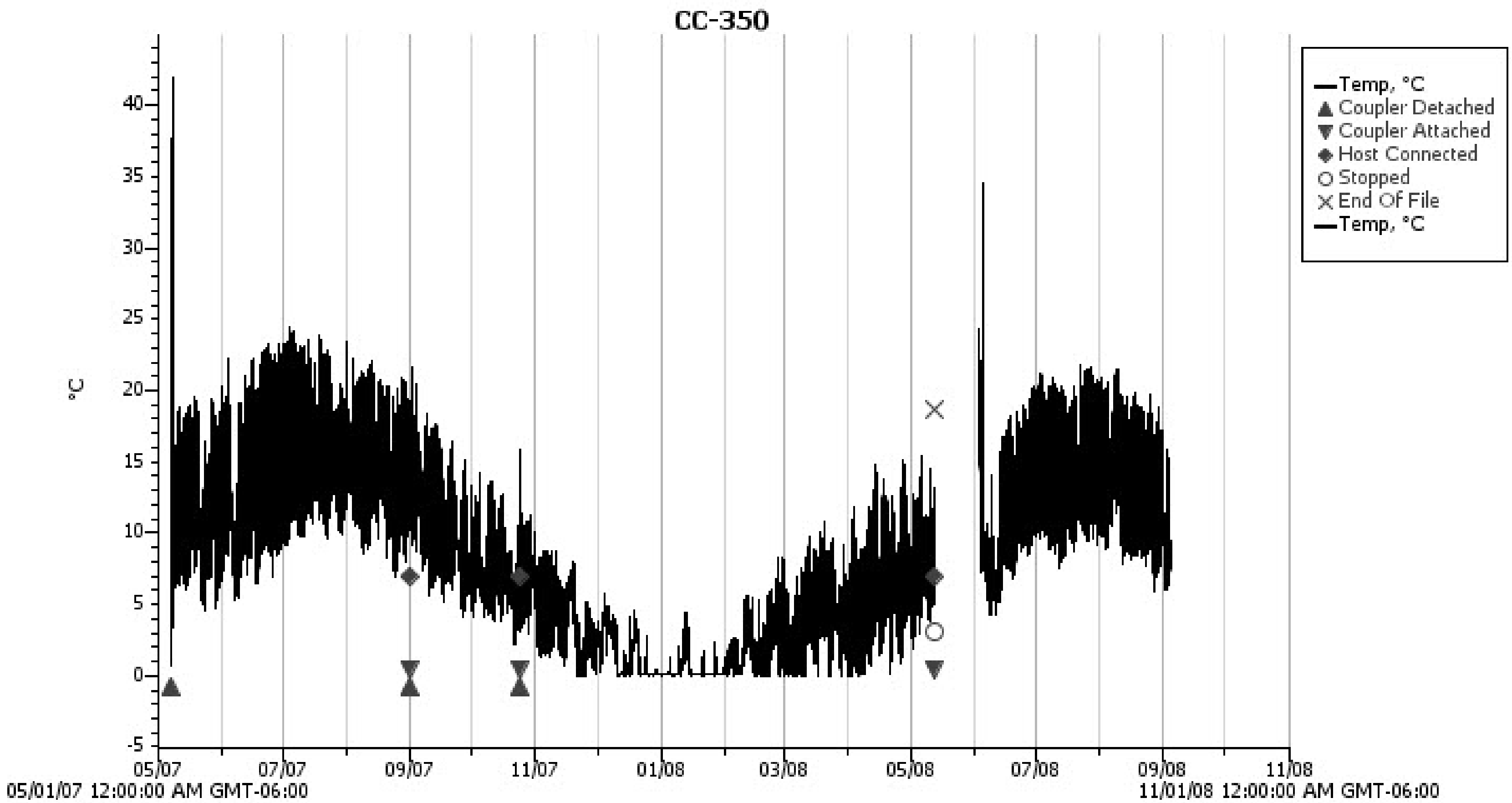
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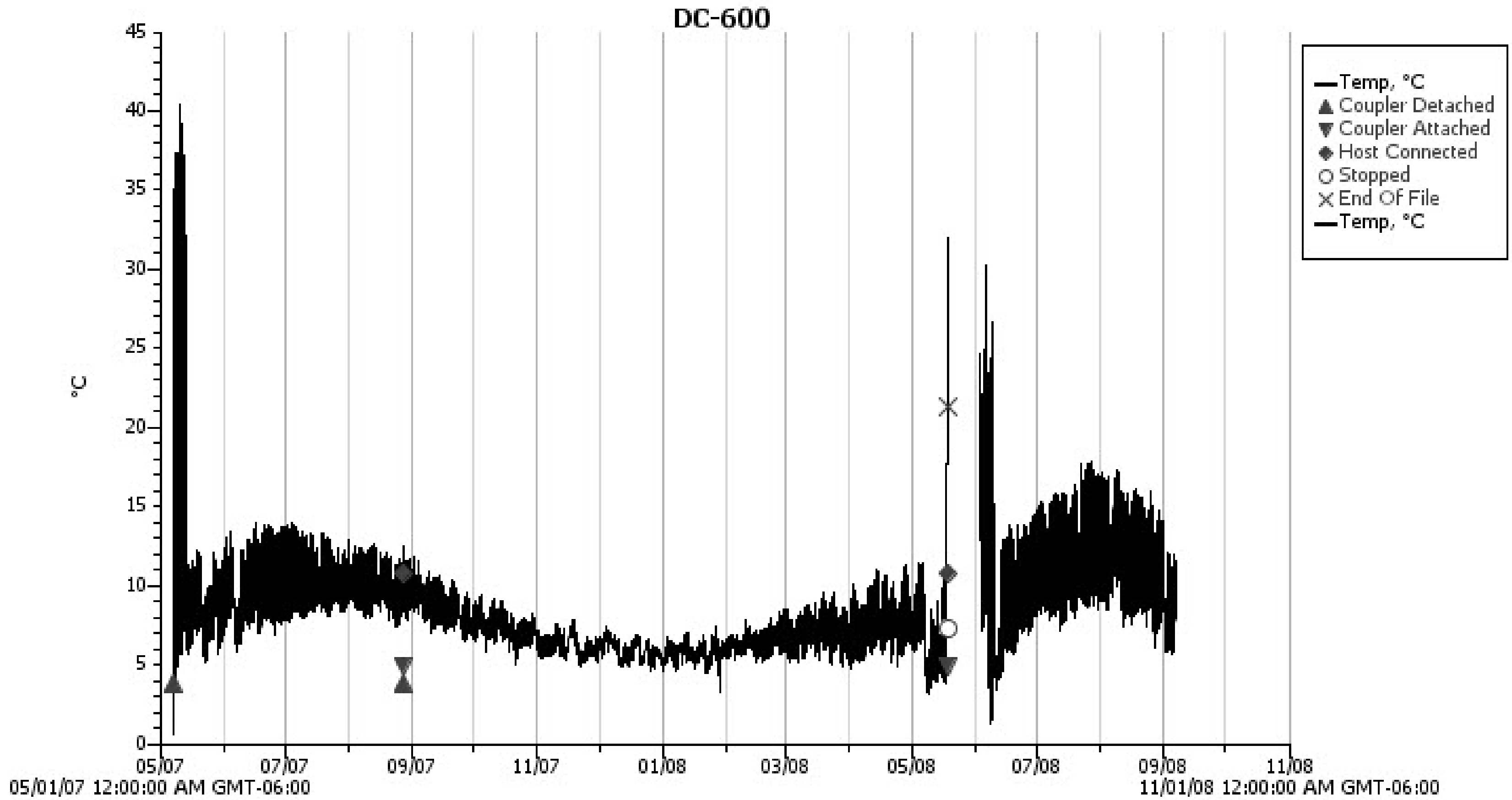
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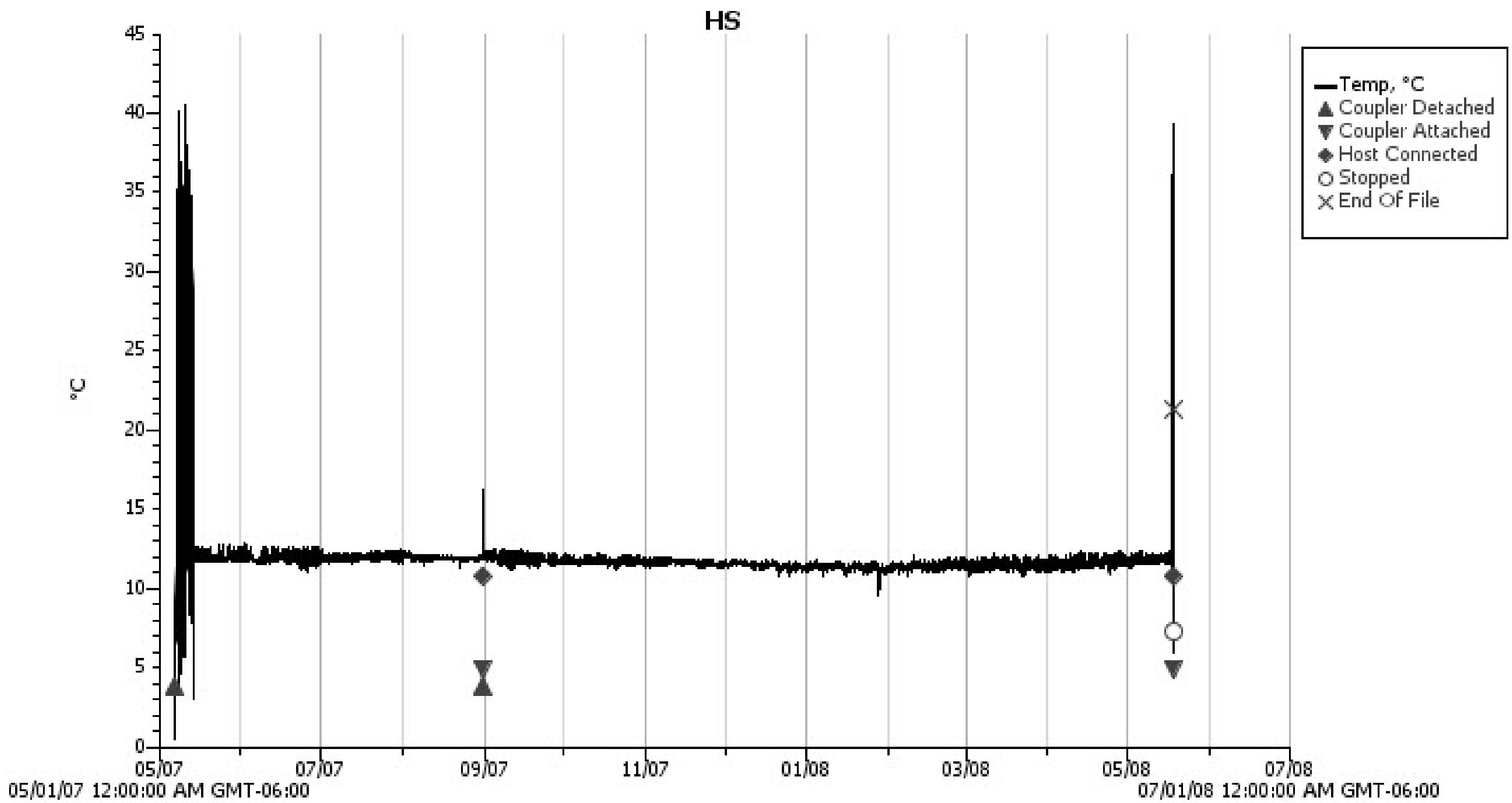
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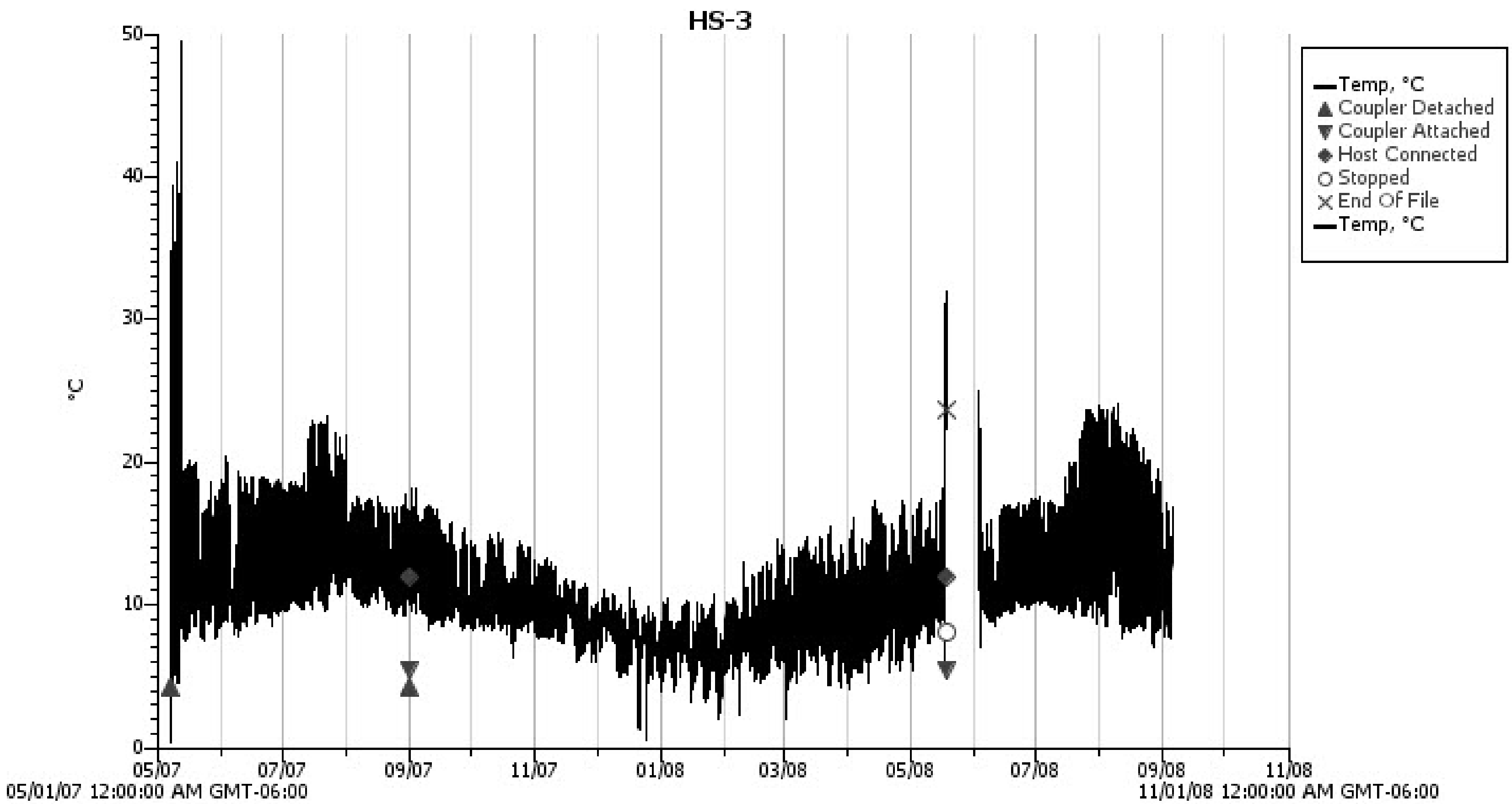

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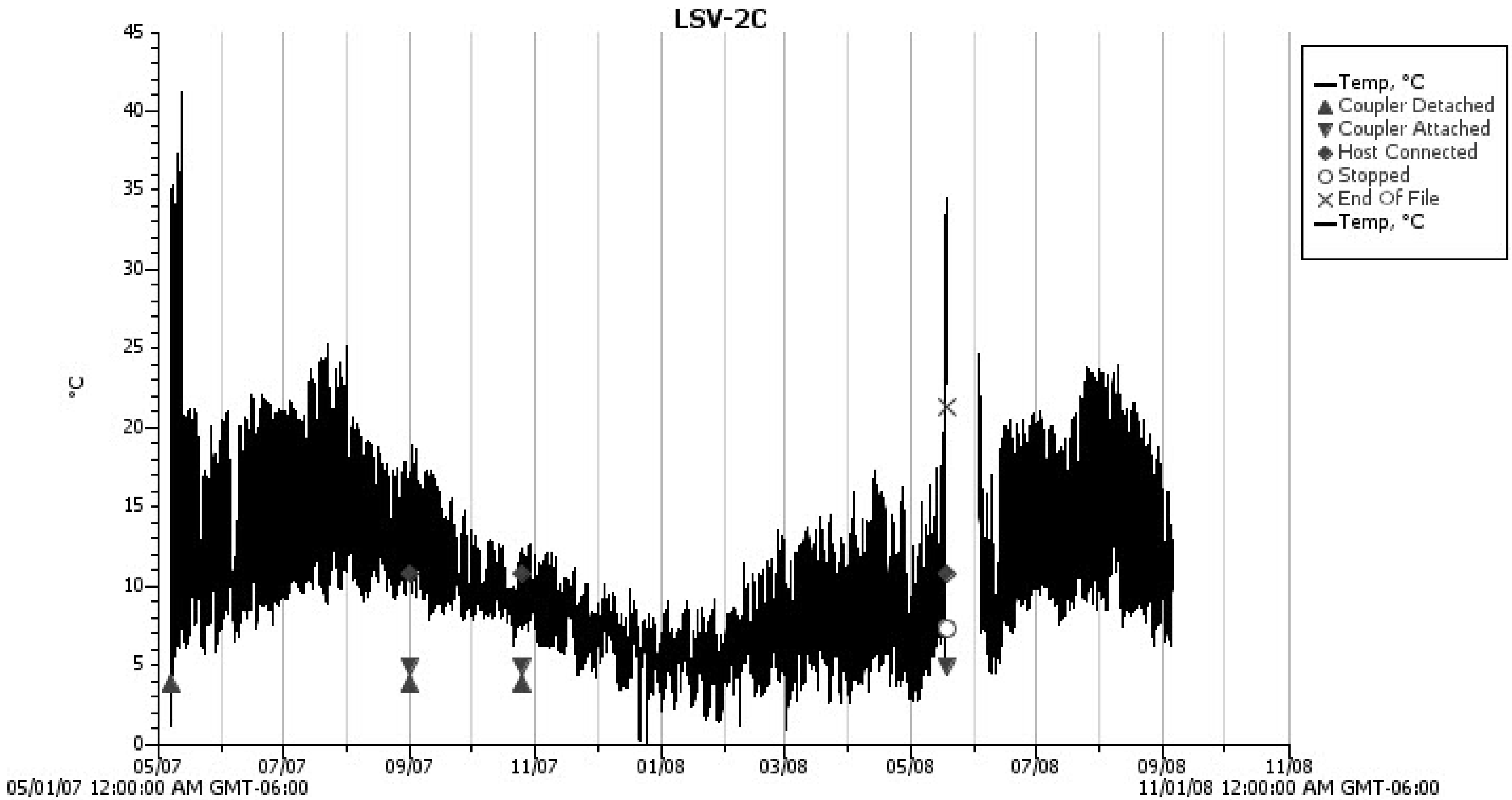
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°C
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05/01/07 12:00:00 AM GMT-06:00
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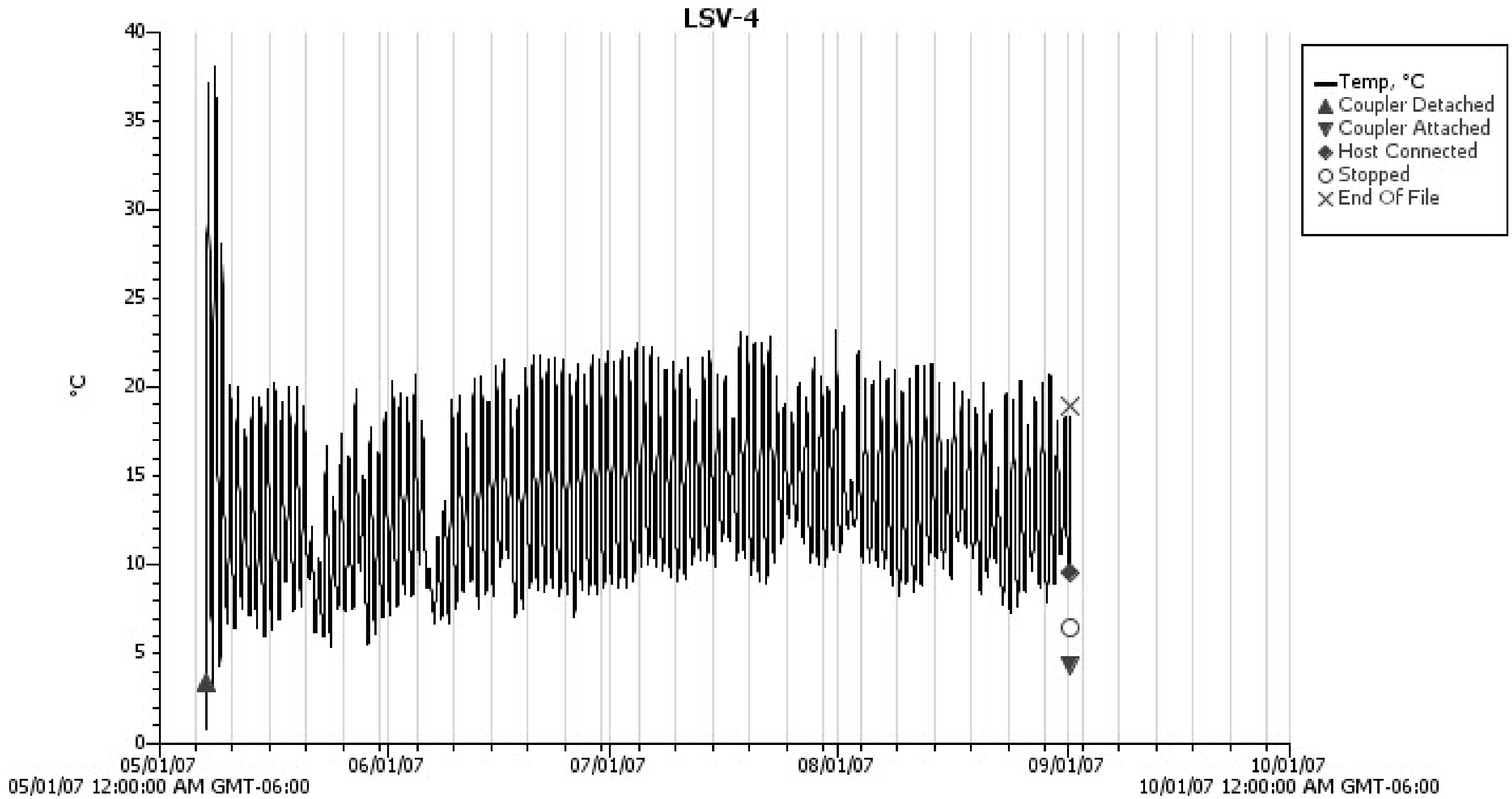
Temp, °C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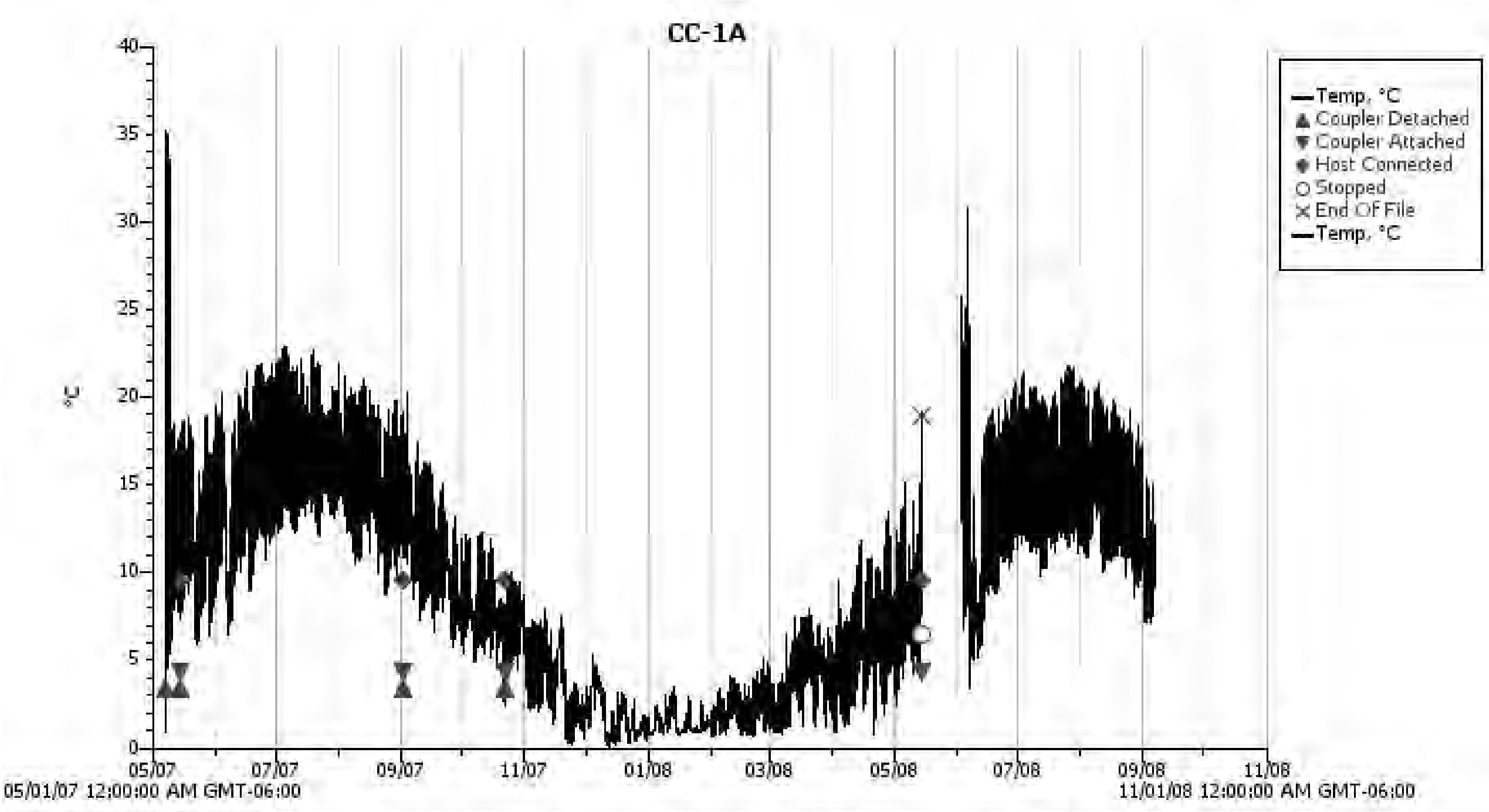
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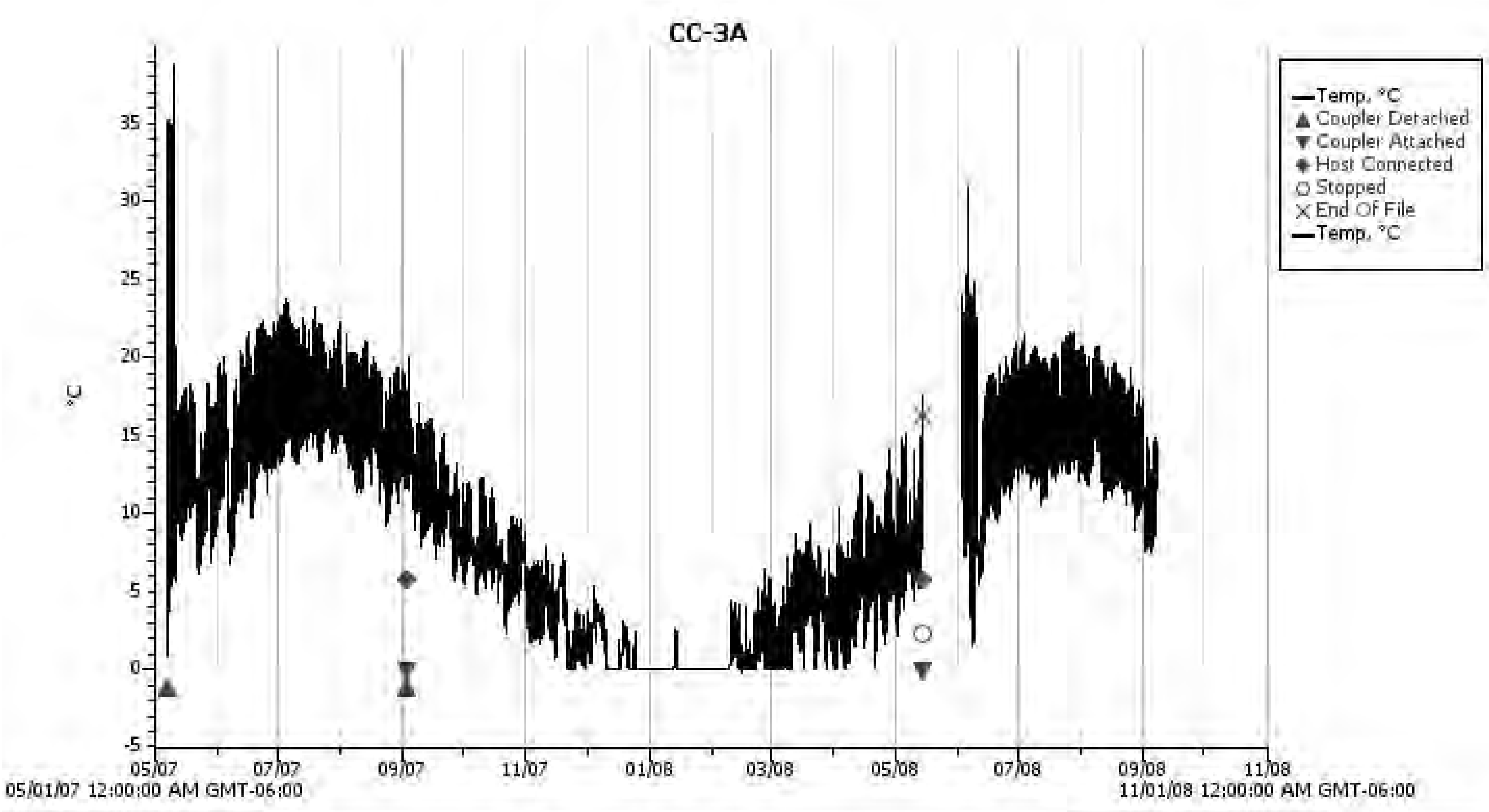
Temp, °C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11/01/08 12:00:00 AM GMT-06:00

ATTACHMENT 2
Redd Survey Data

Table 1
Locations of Brown Trout Redds, Numbers Observed and Measured, and Reach Lengths Surveyed during the October 2006 Redd Survey

Reach	Description	# Redds observed	Date Time	Reach Length Feet (meters)	Northing	Easting	UTM Zone	Altitude
CC-3A	Begin Reach d/s end				4720411	495176		
	Redds 1 - 4	4	23-OCT-06 9:49:32AM	7600	4720149	494676	12	6359 ft
	Redd 5	1	23-OCT-06 10:26:36AM	(2316)	4720106	494653	12	6346 ft
	Redds 6 - 10	5	23-OCT-06 10:54:59AM		4720057	494643	12	6363 ft
	Redd 11	1	23-OCT-06 11:18:26AM		4719934	494513	12	6374 ft
	Redds 12-14	3	23-OCT-06 11:34:47AM		4719782	494502	12	6371 ft
	Redd 15	1	23-OCT-06 12:05:31PM		4719707	494492	12	6374 ft
	Redds 16 -17	2	23-OCT-06 12:09:19PM		4719691	494471	12	6379 ft
	End Reach u/s end		23-OCT-06 1:07:10PM		4719668	494413	12	6394 ft
CC-1A	Begin Reach u/s end			2329	4719057	493345		
	Redd 18	1	23-OCT-06 1:31:10PM	(710)	4719077	493429	12	6420 ft
	Redds 19 and 20	2	23-OCT-06 1:53:12PM		4719142	493362	12	6415 ft
	Redds 21 -26	6	23-OCT-06 2:05:49PM		4719153	493397	12	6404 ft
	Redds 27-31	5	23-OCT-06 2:33:37PM		4719268	493538	12	6402 ft
	Redd 32	1	23-OCT-06 3:02:19PM		4719297	493569	12	6403 ft
	Redds 33-43; d/s end of reach	11	23-OCT-06 3:09:06PM		4719289	493588	12	6400 ft
CC-350	d/s end reach	0		4525	4715486	489397		
	u/s end of reach		23-OCT-06 5:01:48PM	(1379)	4714805	489122	12	6579 ft
HS-3	u/s end of reach		24-OCT-06 9:12:05AM	696	4720728	491174	12	6587 ft
	Redds 1 -2	2	24-OCT-06 9:27:51AM	(212)	4720683	491181	12	6599 ft
	Redds 3 -4	2	24-OCT-06 9:36:49AM		4720613	491233	12	6587 ft
	d/s end reach		24-OCT-06 9:48:47AM		4720609	491281	12	6591 ft
LSV-2C	u/s end of reach		24-OCT-06 9:48:47AM	1813	4720609	491281	12	6591 ft
	Redds 1-2	2	24-OCT-06 10:04:49AM	(552)	4720439	491349	12	6587 ft
	Redd 3	1	24-OCT-06 10:19:30AM		4720360	491352	12	6585 ft
	d/s end reach		24-OCT-06 10:26:37AM		4720250	491403	12	6580 ft
HS	u/s end of reach		24-OCT-06 11:45:45AM	1065	4721217	490728	12	6645 ft
	d/s end reach		24-OCT-06 11:53:53AM	(325)	4720954	490863	12	6633 ft
LSV-4	d/s end reach			1124	4718584	491663		
	Redd 1	1	24-OCT-06 1:01:09PM	(324)	4718616	491623	12	6460 ft
	Redd 2	1	24-OCT-06 1:08:15PM		4718641	491607	12	6462 ft
	Redd 3-5	3	24-OCT-06 1:23:43PM		4718657	491587	12	6471 ft
	Redd 6	1	24-OCT-06 1:29:29PM		4718680	491588	12	6467 ft
	Redd 7-8	2	24-OCT-06 1:34:44PM		4718676	491574	12	6468 ft
	u/s end of reach		24-OCT-06 1:47:09PM		4718702	491502	12	6466 ft
CC-75	d/s end reach			2130	4710432	486291		
	Redd 1	1	24-OCT-06 2:48:48PM	(649)	4710363	486303	12	6741 ft
	Redd 2	1	24-OCT-06 3:03:35PM		4710126	486370	12	6757 ft
	Redd 3 -4	2	24-OCT-06 3:13:42PM		4710089	486352	12	6762 ft
	u/s end of reach		24-OCT-06 3:22:20PM		4710029	486348	12	6769 ft
CC-150	d/s end reach		24-OCT-06 4:03:18PM	598	4713432	487291	12	6644 ft
	Redds 1-3	3	24-OCT-06 4:08:08PM	(182)	4713423	487281	12	6646 ft
	Redd 4	1	24-OCT-06 4:20:55PM		4713403	487268	12	6644 ft
	Redd 5-12	8	24-OCT-06 4:41:48PM		4713372	487223	12	6650 ft
	u/s end of reach		24-OCT-06 4:51:42PM		4713365	487205	12	6651 ft
Deer Creek	lower dam of area evalauted		25-OCT-06 10:49:49AM		4714801	488074	12	6650 ft
	upper dam of area evaluated		25-OCT-06 11:20:59AM		4714857	487846	12	6677 ft
	Crow Creek Culvert		26-OCT-06 8:13:54AM		4718592	491679	12	6462 ft
	Deer Creek Culvert		26-OCT-06 12:25:51PM		4714574	488847	12	6551 ft

Grid UTM
Datum NAD83

Table 2
Summary of Habitat Characteristics Measured at Suspected Brown Trout Redds, October 2006

Site	Number of redds	Mean Depth (ft)	Depth Range (ft)	1Mean V.6 (fps)	Mean V.6 Range (fps)	2Mean V.2 (fps)	Mean V.2 Range (fps)	3Mean V.8 (fps)	Mean V.8 Range (fps)	Average Substrate (mm)
CC-75	4	0.40	0.32 - 0.45	1.55	1.3 - 1.78	1.81	1.3 - 2.35	1.36	0.96 - 1.78	26.33
CC-150	12	0.90	0.65 - 1.16	2.25	1.93 - 2.38	2.30	1.82 - 2.75	2.05	1.53 - 2.32	34.57
HS3	4	0.38	0.34 - 0.40	1.30	1.07 - 1.62	1.74	1.24 - 2.38	0.97	0.64 - 1.25	29.28
LSV-2C	3	0.59	0.26 - 0.92	1.11	0.36 - 1.79	1.44	1.20 - 1.85	0.90	0.08 - 1.64	28.13
LSV-4	8	0.72	0.48 - 1.00	2.11	0.56 - 3.00	2.55	1.95 - 3.36	2.04	1.60 - 2.72	32.86
CC-1A	26	0.73	0.56 - 1.10	1.56	0.78 - 2.17	1.69	0.83 - 2.58	1.39	0.66 - 2.04	23.36
CC-3A	17	0.76	0.53 - 1.02	2.01	0.89 - 2.75	2.18	1.03 - 3.02	1.79	0.74 - 2.64	27.16
Total	74									
All Sites		0.64	0.26 - 1.16	1.70	0.36 - 2.75	1.96	1.03 - 3.36	1.50	0.64 - 2.72	28.81

1V.6 is velocity measured at 0.6 depth

2V.2 is velocity measured at 0.2 depth

3V.8 is velocity measured at 0.8 depth

Table 3
Redd Data CC-75

Redds		Depth (ft)	Range	V.6 (fps)	Range	V.2 (fps)	Range	V.8 (fps)	Range	Sub (mm)
1		0.32		1.3		1.3		1.23		33.3
2		0.45		1.78		2.05		1.78		26.9
3		0.44		1.46		1.52		0.96		22.1
4		0.37		1.64		2.35		1.46		23
Summary data	4.00	0.40	0.32 - 0.45	1.55	1.3 - 1.78	1.81	1.3 - 2.35	1.36	0.96 - 1.78	26.33

V.6 is velocity measured at 0.6 depth

V.2 is velocity measured at 0.2 depth

V.8 is velocity measured at 0.8 depth

sub is mean substrate particel size in tailspill (n=10) for each redd

Table 4
Redd Data CC-150

Redds		Depth (ft)	Range	V.6 (fps)	Range	V.2 (fps)	Range	V.8 (fps)	Range	Sub (mm)
1		0.95		2.36		2.26		2.16		40.1
2		0.82		2.4		2.42		2.32		32.9
3		0.88		2.52		2.75		2.28		36.1
4		0.8		2.22		2.25		1.75		37.7
5		0.8		2.35		2.49		2.4		34.9
6		0.95		2.7		2.62		1.9		32.2
7		0.65		1.98		1.82		2.01		26.8
8		0.75		2.27		2.5		2.2		28.4
9		0.95		2.22		2.26		2.05		30.9
10		1.15		1.94		2.14		1.53		36
11		0.96		2.07		2.13		2		39.3
12		1.16		1.93		1.99		2.02		39.5
Summary data	12.00	0.90	0.65 - 1.16	2.25	1.93 - 2.38	2.30	1.82 - 2.75	2.05	1.53 - 2.32	34.57

V.6 is velocity measured at 0.6 depth

V.2 is velocity measured at 0.2 depth

V.8 is velocity measured at 0.8 depth

sub is mean substrate particel size in tailspill (n=10) for each redd

Table 5
Redd Data HS-3

Redds		Depth (ft)	Range	V.6 (fps)	Range	V.2 (fps)	Range	V.8 (fps)	Range	Sub (mm)
1		0.4		1.62		1.99		0.64		34.3
2		0.4		1.34		2.38		1.25		32.2
3		0.36		1.07		1.34		0.95		30.9
4		0.34		1.17		1.24		1.03		19.7
Summary data	0	0.375	0.34 - 0.4	1.3	1.07 - 1.62	1.74	1.24 - 2.38	0.97	0.64 - 1.25	29.28

V.6 is velocity measured at 0.6 depth

V.2 is velocity measured at 0.2 depth

V.8 is velocity measured at 0.8 depth

sub is mean substrate particel size in tailspill (n=10) for each redd

Table 6
Redd Data LSV-2c

Redds		Depth (ft)	Range	V.6 (fps)	Range	V.2 (fps)	Range	V.8 (fps)	Range	Sub (mm)
1		0.26		1.18		1.2		0.97		23.6
2		0.92		0.36		1.28		0.08		28
3		0.6		1.79		1.85		1.64		32.8
Summary data	3	0.593333	0.26 - 0.92	1.11	0.36 - 1.79	1.44	1.20 - 1.85	0.90	0.08 - 1.64	28.13

V.6 is velocity measured at 0.6 depth

V.2 is velocity measured at 0.2 depth

V.8 is velocity measured at 0.8 depth

sub is mean substrate particel size in tailspill (n=10) for each redd

Table 7
Redd Data LSV-4

Redds		Depth (ft)	Range	V.6 (fps)	Range	V.2 (fps)	Range	V.8 (fps)	Range	Sub (mm)
1		0.82		2.55		2.72		2.17		31.4
2		1		1.82		1.95		1.6		29.6
3		0.85		2.55		2.68		1.9		27.7
4		0.5		2.15		2.19		1.85		29.2
5		0.82		1.9		1.97		1.79		33.6
6		0.48		0.56		3.36		2.28		42.2
7		0.65		3		2.99		2.72		35
8		0.6		2.34		2.52		1.98		34.2
Summary data	8.00	0.72	0.48 - 1.0	2.11	0.56 - 3.0	2.55	1.95 - 3.36	2.04	1.6 - 2.72	32.86

V.6 is velocity measured at 0.6 depth

V.2 is velocity measured at 0.2 depth

V.8 is velocity measured at 0.8 depth

sub is mean substrate particel size in tailspill (n=10) for each redd

Table 8
Redd Data CC-1A

Redds	Depth (ft)	Range	V.6 (fps)	Range	V.2 (fps)	Range	V.8 (fps)	Range	Sub (mm)
18	1		1.52		1.49		1.37		33.7
19	0.6		1.84		1.74		1.61		20.3
20	0.72		1.25		1.36		1.08		22.2
21	0.62		2		2.15		1.75		19.7
22	0.77		1.87		2.07		1.65		27.6
23	0.75		1.75		1.87		1.41		27.7
24	0.92		2.06		2.34		2.04		31.7
25	0.8		2.02		2.22		1.98		31.5
26	0.8		1.86		2.11		1.81		30.8
27	0.82		1.32		1.92		1.06		25.4
28	0.64		2.05		2.09		1.89		25.2
29	0.72		2.11		2.13		1.77		26.2
30	0.8		2.17		2.25		1.98		27.7
31	1.1		2.12		2.58		1.84		24.1
32	0.62		2.14		2.24		1.82		30.2
33	0.62		1.65		1.72		1.55		26.7
34	0.56		1.32		1.48		1.1		20.9
35	0.56		1.36		1.40		1.17		23.10
36	0.78		1.24		1.32		1.13		21.3
37	0.77		0.82		0.83		0.81		13.5
38	0.66		0.78		0.91		0.68		13.7
39	0.6		0.78		0.96		0.66		13.9
40	0.62		1.38		1.42		1.1		16.1
41	0.66		1.02		1.09		0.9		19.6
42	0.8		1.27		1.32		1.25		25.5
43	0.6		0.87		0.89		0.72		9
Summary Data 0.00	0.73	0.56 - 1.1	1.56	0.78 - 2.17	1.69	0.83 - 2.58	1.39	0.66 - 2.04	23.36

V.6 is velocity measured at 0.6 depth

V.2 is velocity measured at 0.2 depth

V.8 is velocity measured at 0.8 depth

sub is mean substrate particel size in tailspill (n=10) for each redd

Table 9
Redd Data - CC-3A

Redds		Depth (ft)	Range	V.6 (fps)	Range	V.2 (fps)	Range	V.8 (fps)	Range	Sub (mm)
1		0.97		1.57		1.7		1.44		19.5
2		1.02		1.8		1.85		1.62		24.9
3		0.7		2.22		2.47		1.62		22.3
4		0.93		2.18		2.33		1.95		27.1
5		0.53		2.36		2.1		2.19		19.7
6		0.9		1.92		1.76		1.64		32.7
7		0.9		2.48		2.64		2.34		21.8
8		0.92		1.85		2.02		1.65		25.5
9		0.73		2.48		2.68		1.94		28.4
10		0.72		2.72		3.02		2.64		32.5
11		0.64		2.05		2.28		1.92		36.9
12		0.6		2.36		2.9		2.6		34.8
13		0.78		1.52		1.69		1.32		21.9
14		0.52		1.42		1.9		1.18		24.7
15		0.3		0.89		1.03		0.74		24.6
16		0.95		2.75		2.78		2.38		33
17		0.85		1.59		1.95		1.22		31.4
Average and Count	17	0.76	0.53 - 1.02	2.01	0.89 - 2.75	2.18	1.03 - 3.02	1.79	0.74 - 2.64	27.16

V.6 is velocity measured at 0.6 depth

V.2 is velocity measured at 0.2 depth

V.8 is velocity measured at 0.8 depth

sub is mean substrate particel size in tailspill (n=10) for each redd

Table 10
Frequency Analysis

Depths	Bin		Velocity	Bin		Substrate	Bin	
0.97	0	0	1.57	0	0	19.5	5	0
1.02	0.1	0	1.8	0.25	0	24.9	10	1
0.7	0.2	0	2.22	0.5	11	22.3	15	3
0.93	0.3	2	2.18	0.75	5	27.1	20	6
0.53	0.4	6	2.36	1	18	19.7	25	15
0.9	0.5	4	1.92	1.25	5	32.7	30	18
0.9	0.6	10	2.48	1.5	6	21.8	35	23
0.92	0.7	10	1.85	1.75	6	25.5	40	6
0.73	0.8	17	2.48	2	7	28.4	45	2
0.72	0.9	9	2.72	2.25	10	32.5	50	0
0.64	1	12	2.05	2.5	4	36.9		0
0.6	1.1	2	2.36	2.75	2	34.8		
0.78	1.2	2	1.52	3	0	21.9		
0.52	1.3	0	1.42		0	24.7		
0.3	1.4	0	0.89			24.6		
0.95		0	2.75			33		
0.85			1.59			31.4		
1			1.52			33.7		
0.6			1.84			20.3		
0.72			1.25			22.2		
0.62			2			19.7		
0.77			1.87			27.6		
0.75			1.75			27.7		
0.92			2.06			31.7		
0.8			2.02			31.5		
0.8			1.86			30.8		
0.82			1.32			25.4		
0.64			2.05			25.2		
0.72			2.11			26.2		
0.8			2.17			27.7		
1.1			2.12			24.1		
0.62			2.14			30.2		
0.62			1.65			26.7		
0.56			1.32			20.9		
0.56			1.36			23.10		
0.78			1.24			21.3		
0.77			0.82			13.5		
0.66			0.78			13.7		
0.6			0.78			13.9		
0.62			1.38			16.1		
0.66			1.02			19.6		
0.8			1.27			25.5		
0.6			0.87			9		
0.4			0.4			34.3		
0.4			0.4			32.2		
0.36			0.36			30.9		
0.34			0.34			19.7		
0.26			0.26			23.6		
0.92			0.92			28		
0.6			0.6			32.8		
0.82			0.82			31.4		
1			1			29.6		
0.85			0.85			27.7		
0.5			0.5			29.2		
0.82			0.82			33.6		
0.48			0.48			42.2		
0.65			0.65			35		
0.6			0.6			34.2		
0.95			0.32			40.1		
0.82			0.45			32.9		
0.88			0.44			36.1		
0.8			0.37			37.7		
0.8			0.95			34.9		
0.95			0.82			32.2		
0.65			0.88			26.8		
0.75			0.8			28.4		
0.95			0.8			30.9		
1.15			0.95			36		
0.96			0.65			39.3		
1.16			0.75			39.5		
0.32			0.95			33.3		
0.45			1.15			26.9		
0.44			0.96			22.1		
0.37			1.16			23		

ATTACHMENT 3
HSI Data Sheets

HSI Component and Overall Scores for Cutthroat Trout at the Ten Simplot Study Locations Where Fish Populations Were Sampled

HSI Component Score	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	CC-1A	CC-3A
C_{Adult}	0.90	0.89	0.90	0.83	0.78	0.67	0.30	0.87	0.91	0.91
$C_{Juvenile}$	0.83	0.86	0.87	0.85	0.75	0.72	0.30	0.77	0.86	0.87
C_{Fry}	0.95	0.94	0.80	0.94	0.81	0.60	0.30	0.74	0.63	0.66
C_{Embryo}	-	-	-	-	-	-	-	-	0.60	0.58
C_{Other}	0.75	0.91	0.76	0.70	0.88	0.77	0.58	0.74	0.65	0.62
HSI (4 Equal Components)	0.85	0.90	0.83	0.83	0.80	0.69	0.35	0.78	0.75	0.75
HSI (5 Equal Components)	-	-	-	-	-	-	-	-	0.72	0.72

HSI Habitat Variables for Cutthroat Trout at the Ten Simplot Study Locations Where Fish Populations Were Sampled

HSI Habitat Variable	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	CC-1A	CC-3A
V_1 - Average maximum temperature °C	21 ***0.22***	17 ***0.88***	20 ***0.46***	20 ***0.46***	16 ***0.97***	12 ***1.0***	21 ***0.22***	20 ***0.46***	20 ***0.46***	20 ***0.46***
V_2 - Average maximum temperature for embryos - °C	11.5 ***1.0***	13.0 ***0.95***	15.3 ***0.6***	17.0 ***0.3***	11.3 ***1.0***	13 ***0.95***	17.3 ***0.28***	17.0 ***0.3***	15.3 ***0.6***	14.3 ***0.76***
V_3 - Average minimum DO - mg/l	9.6 ***1.0***	8.2 ***0.95***	9.3 ***1.0***	9.0 ***1.0***	8.3 ***0.95***	5.2 ***0.1***	7.2 ***0.77***	6.7 ***0.64***	9.1 ***1.0***	8.9 ***0.99***
V_4 - Average thalweg depth - cm	29.9 ***1.0***	23.6 ***0.93***	24.1 ***0.94***	40.1 ***0.96***	22.6 ***0.88***	15.0 ***0.52***	16.9 ***0.65***	34.8 ***1.0***	48.9 ***1.0***	56.3 ***1.0***
V_5 - Average velocity at redds - cm/s	ND	ND	ND	ND	ND	ND	ND	ND	59.1 ***1.0***	59.1 ***1.0***
V_6 - % Cover	23.5 ***1.0 A & J***	25.1 ***1.0 A & J***	26.5 ***1.0 A & J***	12.2 ***0.77A*** ***0.97J***	15.0 ***0.84A*** ***1.0 J***	74.2 ***1.0 A & J***	6.6 ***0.53A*** ***0.73J***	47.4 ***1.0 A & J***	29.6 ***1.0 A & J***	20.9 ***0.97A*** ***1.0 J***
V_7 - Average spawning substrate size - cm	ND	ND	ND	ND	ND	ND	ND	ND	3.0 ***1.0***	3.0 ***1.0***
V_8 - % substrate 10-40cm	40 ***1.0***	8 ***0.83***	4 ***0.4***	8 ***0.83***	14 ***1.0***	4 ***0.4***	8 ***0.83***	6 ***0.6***	2 ***0.2***	2 ***0.2***
V_9 - Dominant riffle substrate type	A ***1.0***	B ***0.6***	B ***0.6***	B ***0.6***	B ***0.6***	A ***1.0***	C ***0.3***	B ***0.6***	C ***0.3***	C ***0.3***
V_{10} - % Pools	25 ***0.9***	32 ***0.97***	45 ***1.0***	33 ***0.98***	13 ***0.66***	10 ***0.57***	0 ***0.3***	15 ***0.7***	32 ***0.97***	69 ***1.0***
V_{11} - Average % Vegetation	183.0 ***1.0***	145.5 ***1.0***	147.9 ***1.0***	126.0 ***0.93***	170.0 ***1.0***	150.0 ***1.0***	135.9 ***1.0***	143.8 ***1.0***	153.1 ***1.0***	125.5 ***0.93***
V_{12} - Average % stable bank	90.1 ***1.0***	82.2 ***1.0***	94.7 ***1.0***	65.0 ***0.95***	99.9 ***1.0***	97.7 ***1.0***	61.8 ***0.93***	79.1 ***1.0***	89.5 ***1.0***	59.7 ***0.90***
V_{13} - Max or Min pH	8.52 ***0.84***	8.29 ***0.92***	8.58 ***0.81***	8.89 ***0.52***	8.24 ***0.94***	7.60 ***1.0***	8.46 ***0.88***	8.56 ***0.82***	8.44 ***0.89***	8.47 ***0.87***
V_{14} - Base Flow Regime % ADF	20 ***0.4***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***
V_{15} - Pool Class Rating	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.3***	***0.6***	***0.6***	***0.6***
V_{16A} - % Fines in redds	ND	ND	ND	ND	ND	ND	ND	ND	27 ***0.25***	35 ***0.19***
V_{16B} - % Fines in riffles	4.7 ***1.0***	12.5 ***0.99***	12.2 ***1.0***	12.9 ***0.98***	4.3 ***1.0***	8.9 ***1.0***	28.8 ***0.72***	5.9 ***1.0***	22.6 ***0.85***	13.8 ***0.97***
V_{17} - % Shaded	60 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	50 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***

Bold and italized are HSI scores

HSI Component and Overall Scores for Brown Trout at the Ten Simplot Study Locations Where Fish Populations Were Sampled

HSI Component Score	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	CC-1A	CC-3A
C_{Adult}	0.74	0.68	0.72	0.77	0.55	0.26	0.10	0.79	0.82	0.88
$C_{Juvenile}$	0.73	0.77	0.83	0.71	0.36	0.30	0.10	0.67	0.77	0.87
C_{Fry}	0.77	0.80	0.75	0.81	0.36	0.30	0.10	0.56	0.54	0.66
C_{Embryo}	-	0.60	0.60	-	-	-	0.62	0.48	0.61	0.58
C_{Other}	0.79	0.75	0.72	0.66	0.79	0.77	0.57	0.69	0.62	0.62
HSI (4 Equal Components)	0.76	0.75	0.76	0.74	0.36	0.26	0.10	0.67	0.68	0.75
HSI (5 Equal Components)	-	0.72	0.72	-	-	-	0.10	0.63	0.66	0.71

HSI Habitat Variables for Brown Trout at the Ten Simplot Study Locations Where Fish Populations Were Sampled

HSI Habitat Variable	SFTC-1	CC-75	CC-150	CC-350	DC-600	HS	HS-3	LSV-2C	CC-1A	CC-3A
V_1 - Average maximum temperature °C	22 ***0.63***	17 ***1.0***	20 ***0.9***	20 ***0.9***	16 ***1.0***	12 ***1.0***	21 ***0.75***	20 ***0.9***	20 ***0.9***	20 ***0.9***
V_2 - Average maximum temperature for embryos - °C	3.6 ***0.52***	7.5 ***1.0***	9.4 ***1.0***	9.4 ***1.0***	8.4 ***1.0***	12.4 ***1.0***	13.6 ***0.64***	12.5 ***1.0***	8.2 ***1.0***	7.6 ***1.0***
V_3 - Average minimum DO - mg/l	9.6 ***1.0***	8.2 ***1.0***	9.3 ***1.0***	9.0 ***1.0***	8.3 ***1.0***	5.2 ***0.1***	7.2 ***0.65***	6.7 ***0.48***	9.1 ***1.0***	8.9 ***1.0***
V_4 - Average thalweg depth - cm	29.9 ***1.0***	23.6 ***0.68***	24.1 ***0.7***	40.1 ***0.91***	22.6 ***0.64***	15.0 ***0.26***	16.9 ***0.32***	34.8 ***1.0***	48.9 ***1.0***	56.3 ***1.0***
V_5 - Average velocity at redds - cm/s	ND	47.2 ***1.0***	68.6 ***1.0***	ND	ND	ND	39.6 ***0.99***	33.8 ***0.76***	47.5 ***1.0***	61.3 ***1.0***
V_6 - % Cover	23.5 ***0.68 A*** ***1.0 J***	25.1 ***0.7 A*** ***1.0 J***	26.5 ***0.72 A*** ***1.0 J***	12.2 ***0.34 A*** ***0.82 J***	15.0 ***0.41 A*** ***1.0 J***	74.2 ***1.0 A & J***	6.6 ***0.18 A*** ***0.47 J***	47.4 ***1.0 A & J***	29.6 ***0.84 A*** ***1.0 J***	20.9 ***0.59 A*** ***1.0 J***
V_7 - Average spawning substrate size - cm	ND	2.6 ***1.0***	3.5 ***1.0***	ND	ND	ND	29.3 ***1.0***	2.8 ***1.0***	2.3 ***1.0***	2.7 ***1.0***
V_8 - % substrate 10-40cm	40 ***1.0***	8 ***0.83***	4 ***0.4***	8 ***0.83***	14 ***1.0***	4 ***0.4***	8 ***0.83***	6 ***0.6***	2 ***0.2***	2 ***0.2***
V_9 - Dominant riffle substrate type	A ***1.0***	B ***0.6***	B ***0.6***	B ***0.6***	B ***0.6***	A ***1.0***	C ***0.3***	B ***0.6***	C ***0.3***	C ***0.3***
V_{10} - % Pools	25 ***0.6***	32 ***0.7***	45 ***0.9***	33 ***0.72***	13 ***0.36***	10 ***0.3***	0 ***0.1***	15 ***0.4***	32 ***0.7***	69 ***1.0***
V_{11} - Average % Vegetation	183.0 ***1.0***	145.5 ***1.0***	147.9 ***1.0***	126.0 ***0.93***	170.0 ***1.0***	150.0 ***1.0***	135.9 ***1.0***	143.8 ***1.0***	153.1 ***1.0***	125.5 ***0.93***
V_{12} - Average % stable bank	90.1 ***1.0***	82.2 ***1.0***	94.7 ***1.0***	65.0 ***0.95***	99.9 ***1.0***	97.7 ***1.0***	61.8 ***0.93***	79.1 ***1.0***	89.5 ***1.0***	59.7 ***0.90***
V_{13} - Max or Min pH	8.52 ***0.58***	8.29 ***0.7***	8.58 ***0.51***	8.89 ***0.32***	8.24 ***0.72***	7.60 ***1.0***	8.46 ***0.60***	8.56 ***0.52***	8.44 ***0.61***	8.47 ***0.59***
V_{14} - Base Flow Regime % ADF	20 ***0.4***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***	55 ***1.0***
V_{15} - Pool Class Rating	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.6***	***0.3***	***0.6***	***0.6***	***0.6***
V_{16A} - % Fines in redds	ND	31.0 ***0.22***	31.0 ***0.22***	ND	ND	ND	28.3 ***0.24***	28.7 ***0.24***	29.7 ***0.23***	35.7 ***0.19***
V_{16B} - % Fines in riffles	4.7 ***1.0***	12.5 ***0.99***	12.2 ***1.0***	12.9 ***0.98***	4.3 ***1.0***	8.9 ***1.0***	28.8 ***0.72***	5.9 ***1.0***	22.6 ***0.85***	13.8 ***0.97***
V_{17} - % Shaded	60 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	50 ***1.0***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***	10 ***0.45***
V_{18} - NO_3N mg/l	0.015 ***0.25***	0.033 ***0.25***	0.037 ***0.25***	0.01 ***0.25***	0.013 ***0.25***	0.057 ***0.50***	0.027 ***0.25***	0.023 ***0.25***	0.017 ***0.25***	0.01 ***0.25***

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