C/015/032 Incoming

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Snell & Wilmer
L.L.P.
LAW OFFICES

Gateway Tower West
15 West South Temple
Suite 1200
Salt Lake City, Utah 84101-1531
801.257.1900
801.257.1800 (Fax)
www.swlaw.com

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TUCSON

Denise A. Dragoo, Esq.
(801) 257-1998
ddragoo@swlaw.com

May 30, 2012
Hand Delivered

Mr. Daron Haddock
Coal Program Manager
Utah Division of Oil, Gas and Mining
1594 West North Temple
Salt Lake City, Utah

RE: Revised Probable Hydrologic Consequences Update, Genwal Resources, Inc., C/015/0032, Task ID #3983

Dear Daron:

In response to your letter dated April 27, 2012, enclosed on behalf of Genwal Resources, Inc. ("Genwal"), is their response to Division Task ID #3983 – Revised Probable Hydrologic Consequences Update, Crandall Canyon Mine, C/015/0032. The executed Form C-1 and C-2 are enclosed with this application for coal permit processing. Included with this submittal are the following:

Appendix 7-15
Probable Hydrologic Consequences determination – this is a redline-strikeout version that will completely replace the existing PHC text in Appendix 7-15

Appendix 7-67
Petersen Hydrologic, LLC report dated 7 November 2011 entitled *Investigation of Iron Concentrations in the Genwal Resources, Inc. Crandall Canyon Mine Discharge Water.* This is a new appendix to the MRP that is being added at this time.

Appendix 7-68
Phase 1 and Phase 2 Toxicity Identification Evaluations for the Crandall Canyon Mine, performed by Water & Environmental Testing, Inc. This is a new appendix to the MRP that is being added at this time.

File in:
☐ Confidential
☐ Shelf
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Appendix 7-69
Crandall Canyon Mine Macroinvertebrate Study, prepared by JBR Environmental Consultants, Inc. This is a new appendix to the MRP that is being added at this time.

Appendix 7-70
Crandall Canyon Mine iron treatment facility, description of chemicals currently used and laboratory analytical methods for analysis of residual chemicals in pond effluent waters.

Appendix 7-71
Petersen Hydrologic, LLC letter report to David Hibbs dated 11 May 2012 which summarizes the results of recent stable and unstable isotopic analyses of the Crandall Canyon Mine discharge water.

Table 1 from the 2011 Work Plan

Annual Hydrologic Monitoring Report for the Crandall Canyon Mine for 2011.

Four copies of the submittal package have been prepared to accompany this letter.

Please feel free to contact Erik Petersen or me should you have any questions.

Very truly yours,

Denise A. Dragoo

DD:jmc
Enclosures
cc: David Hibbs, Genwal
Erik C. Petersen, P.G.

APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

Permittee: Genwal Resources, Inc.
Mine: Crandall Canyon Mine — **Permit Number:** 015/032
Title: Response to Division Order 10-A

Description, Include reason for application and timing required to implement:

Instructions: If you answer yes to any of the first eight questions, this application may require Public Notice publication.

☐ Yes ☒ No 1. Change in the size of the Permit Area? Acres: ______ Disturbed Area: ______ ☐ increase ☐ decrease.
☒ Yes ☐ No 2. Is the application submitted as a result of a Division Order? DO# 10-A
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # ______
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: ______
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☐ Yes ☒ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes ☒ No 15. Does the application require or include soil removal, storage or placement?
☐ Yes ☒ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☐ Yes ☒ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☐ Yes ☒ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☐ Yes ☒ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?
☐ Yes ☒ No 24. Does the application include confidential information and is it clearly marked and separated in the plan?

Please attach three (3) review copies of the application. If the mine is on or adjacent to Forest Service land please submit four (4) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

David W. Hibbs	President	5/30/12	David W. Hibbs
Print Name	Position	Date	Signature (Right-click above choose certify then have notary sign below)

Subscribed and sworn to before me this 30TH day of May, 2012

Notary Public: Linda Kerns, state of Utah.

My commission Expires: 03.27-13
Commission Number: 578211
Address: 794 No. "C" Canyon Road, PO Box 910
City: East Carbon, State: ut Zip: 84520 } ss:

LINDA KERNS
NOTARY PUBLIC • STATE of UTAH
COMMISSION # 578211
COMM. EXP. 03-27-2013

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining

Form DOGM- C1 (Revised December 10, 2007)

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

Permittee: Genwal Resources, Inc.
Mine: Crandall Canyon Mine
Permit Number: 015/032
Title: Response to Division Order 10-A

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

Add	Replace	Remove	DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐	☒	☐	Chapter 7, Apendix 7-15, Probable Hydrologic Consequences Determination
☒	☐	☐	Chapter 7, Appendices 7-67, 7-68, 7-69, 7-70, 7-71, 7-72
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining

Form DOGM - C2 (Revised December 10, 2007)

APPENDIX 7-15

PROBABLE HYDROLOGIC

CONSEQUENCES DETERMINATION

R645-301-728 Probable Hydrologic Consequences Determination

This document has been prepared in accordance with requirements of the State of Utah R645 Coal Mining Rules. The format follows the regulations R645-301-718.100 through R645-301-728.400. This Probable Hydrologic Consequences evaluation of the coal mining and reclamation operations has been prepared by Genwal Resources, Inc. to provide a description of the potential impacts of the mining operation on the hydrologic systems and the means to prevent or mitigate those identified impacts.

R645-301-728.100 Determination

This determination section presents a brief summary of the surface water, groundwater, and geologic resource descriptions of the permit area and the South Crandall Lease area and the U-68082 lease mod area and a description of the possible impacts of the coal mine on the hydrologic resources.

The geologic and hydrologic data and their associated appendices are contained in Chapter 6 and Chapter 7, respectively. The potential sources of contamination to the hydrologic resources in the area of the mine were identified through site visits, knowledge of the working operations of the mine and discussions with Genwal Resources personnel. These potential contamination sources and impacts include:

Water Quantity

- Interception of groundwater and surface water
- Water consumption within the mine
- Seepage from mine sumps
- Pumping from Crandall Creek

Water Quality

- Additional sediment contribution
- Fugitive dust
- Oil and grease
- Mine water discharge
- Acid-toxic materials
- Flooding or Streamflow Alteration

Each of these potential sources of contamination or impact and their associated mitigating measures or circumstances are discussed in the following sections.

Water Quantity Impacts

Possible impacts to the surface and groundwater systems from the mining operation could affect the quantity of water in the mine area. Interception, consumption, and seepage of surface or groundwater are possible mechanisms which could affect the water systems.

Groundwater Interception.

Groundwater was commonly intercepted in the Crandall Canyon Mine workings when the mine openings intercepted sequences of water-bearing sandstone paleochannel deposits in the mine roof. In some locations, groundwater also upwelled from the Star Point Sandstone through the mine floor (this occurrence was visible in the westernmost portion of the mine near where the underlying Star Point Sandstone is truncated by the Joes Valley Fault). As described by Mayo and others (2003) a limited potential exists for interception of shallow, active-zone groundwater systems or surface waters due to subsidence which may affect the perched aquifers (springs and seeps), and stream flows in Crandall Canyon, Blind Canyon, Horse Creek, the upper headwaters of the Indian Creek drainage (Upper Joes Valley), and the streams and springs of the South Crandall Lease area and the U-68082 lease mod area. This is because of the heterogeneous nature of the interbedded bedrock lithologies comprising the overburden above mined areas. Within the Blackhawk Formation, permeable sandstone paleochannels are usually encased both vertically and horizontally in a matrix of low-permeability shales, claystones, and mudstones. Because the permeable rocks of the sandstone paleochannels are not continuous vertically or horizontally over substantial distanches, the potential for both vertical and horizontal flow through the bedrock is greatly limited. The Blackhawk Formation is also known to contain hydrophyllic clays, which swell when wetted to seal mining-related cracking which may form during mining operations. Because of the hydraulic disconnect between the deep, inactive-zone groundwaters that are commonly intercepted by the mine workings, and the overlying shallow, active-zone groundwater systems that support most springs in the area and provide baseflow to streams (Mayo and others, 2003), the likelihood that mining operations could cause impacts to groundwater flow in the overlying perched aquifers, the interruption or lessening of flow to springs, or the interception of surface water flow from ephemeral streams is small. This conclusion is strongly supported by the very large existing database of hydrologic monitoring data collected at springs and streams in and around the Crandall Canyon Mine permit area, which to date have not shown any quantifiable diminution of flow rates from monitored springs and streams that could be attributed to mining and reclamation activities at the Crandall Canyon Mine. Continued monitoring of streams and springs will occur to verify that no impacts occur.

A notable exception to the hydrologic isolation that typically exists between the deep, active-zone groundwaters encountered in the mine workings and the overlying shallow, active-zone groundwater systems was found to be present in the northwest portion of the Crandall Canyon Mine workings (herein defined as longwall panels 7, 8, 9, 10, 11, and 12 and the associated development entries for these panels). The northwest portion of the mine was sealed on June 17, 1999. While some water was encountered in the main Joes Valley Fault, the most significant quantities of water encountered in this area were associated with damaged zone fracturing and synthetic faulting associated with the Joes Valley Fault. When this area was first mined in the late 1990s, groundwaters of mixed source were identified (i.e containing appreciable tritium but also having radiocarbon ages on the order of hundreds to thousands of years) (Mayo and Associates, 1997, provided in Appendix 7-53). As described by Mayo and others (2003) the presence of appreciable tritium indicates hydraulic communication with surface water in that location. Mayo concluded that the communication with the surface exists where the stress field associated with the outward expansion of cliff faces creates aperture in the damage zone associated with the fault. It is noteworthy that a sample of groundwater collected from the main Joes Valley Fault underground (Main West Fault) contained no tritium and had a carbon-14 mean residence time exceeding 2,000 years. It should be noted that, as stated above, although hydraulic communication between the mine workings and overlying active-zone groundwater systems was present in that location, there is no indication that impacts to spring or stream discharge rates has occurred (based on water monitoring data collected to date). Continued monitoring of streams and streams overlying and surrounding the synthetic faulting and associated damage zone continues to be performed to verify that the interception of active-zone waters does not detrimenetally impact spring and stream discharge rates.

To better understand this occurrence, it is useful to provide additional information regarding the geologic and hydrogeologic character of the Joes Valley Fault Zone. The Joes Valley Fault Zone (East Fault) is a normal fault bounding the east side of the Joes Valley graben. The fault zone shows evidence of Holocene movement with an estimated slip rate of 0.2 to 1 mm/year (Utah Geologic Survey, 1999). The trace of the fault trends approximately N2°E. The Joes Valley Fault Zone has previously been described by Doelling (1972). Doelling describes the Joes Valley Fault Zone as the most extensive of the fault zones of the Wasatch Plateau, with a total length of 75 miles. The fault zone's northern limit is somewhere not far north of Cleveland Reservoir, while the fault is visible to the south at Quitchupah Creek. Doelling indicates that the offset on the fault is from 1,500 to 2,500 feet and that the dropped graben block is everywhere "much shattered". Rather than an individual fault plane, the system is described as a "fault zone", reflecting the complexity of the internal faults of the zone. Where the fault was initially encountered along the western edge of the Crandall Canyon Mine there was found to be considerable clayey gouge associated with the structure. A seal constructed of concrete, timbers, and bentonite was emplaced at the fault location to minimize the potential for groundwater inflow from the fault into the mine workings. When the Joes Valley Fault location was visited in February 1997 for isotopic sampling, it was observed that only minor amounts of groundwater were weeping from the fault area at that time (0.1 gpm).

Stokes (1963) shows that an alignment of faults along the Joes Valley Fault Zone extends from McGrath Lake south of Boulder Mountain in Garfield County northward, west of Thousand Lake Mountain and past Cleveland Lake, northward toward Strawberry Reservoir. At the north end, it fuses with the Pleasant Valley Fault Zone. The total length of this zone may be as much as 160 miles.

As discussed previously, copious amounts of discharge were not observed emanating from the main Joes Valley Fault where it was intersected in the Main West entries at the Crandall Canyon Mine. When the exposed segment of the Joes Valley Fault was visited for isotopic sampling in 1997, the total discharge was estimated to be less than 5 gpm in total. The vast majority of the total water intercepted within the Crandall Canyon Mine originated from fracture systems or exposed saturated sandstone paleochannels intersected in the mine roof. Lesser quantities of groundwater welled-up from the underlying Spring Canyon member of the Star Point Formation in the mine entries in the western portion of the mine. It should be noted that an unknown quantity of groundwater may possibly have upwelled from the mine floor in inaccessible longwall-mined gob areas after mining in the area was completed. It is not possible to quantify the amount of groundwater that may have originated from the Star Point Sandstone in the mine floor in these areas.

Synthetic faults that likely have a genetic origin associated with the stress field of the adjacent Joes Valley Fault Zone are present in the western portions of Sections 26 and 35, Township 15 South, Range 6 East. It is noteworthy that in some locations, the synthetic faults intercepted underground contained clayey fault gouge and did not transmit any water, but rather were likely barriers to groundwater flow. In other locations, the faults discharged some groundwater, although generally at rates of a few gallons per minute or less. More appreciable quantities of water were encountered in damage zones associated with the fault system where fractured sandstone rocks in the mine roof drained into the mine openings. When the land surface in the synthetic fault area was visited, no indication of pronounced brecciation of the exposed bedrock was observed, nor were there indications of groundwater discharge associated with these features at the surface.

As part of the Division-requested Work Plan activities performed during 2011, the surface trace of the Joes Valley Fault along the western escarpment of East Mountain was visited. During the site visits several springs which discharge from near the fault trace were monitored for flow and field water quality parameters. Additionally, the projected surface locations of the synthetic fault system associated with the Joes Valley Fault Zone in the northwest portion of the Crandall Canyon Mine were visited and monitored during 2011. Springs on East Mountain were also monitored as part of the 2011 work plan investigation. Almost without exception, the discharge rates measured at all of these springs during 2011 were similar to or in most cases greater than the discharge rates measured during pre-mining baseline monitoring activities. Several springs not identified during initial spring and seep surveys were identified during the 2011 Work Plan investigations. Based on these findings, there is no indication that any quantifiable or perceptible impacts to springs discharging near the Joes Valley Fault Zone have been impacted by mining operations at the Crandall Canyon Mine. It should also be noted that Genwal Resources, Inc. is not aware of any claim made by water rights holders regarding impacts to groundwater or surface-water resources in the Joes Valley Fault area near the Crandall Canyon Mine.

A plot of discharge rates measured at the Indian Creek monitoring station is presented in Figure PHC-6. Also included on Figure PHC-6 is a plot of the Palmer Hydrologic Drought Index (PHDI) for Utah Region 4. The PHDI is a monthly value generated by the National Climatic Data Center (NCDC) that indicates the severity of a wet or dry spell. The PHDI is computed from climatic and hydrologic parameters such as temperature, precipitation, evapotranspiration, soil water recharge, soil water loss, and runoff. Because the PHDI takes into account parameters that affect the balance between moisture supply and moisture demand, the index is a useful for evaluating the long-term relationship between climate and groundwater recharge and discharge. It is apparent in Figure PHC-6 that discharge rates measured at Indian Creek have been variable over the period of record. Generally, the baseflow discharge rates measured in the creek respond to long-term climatic variability. The measured peak discharge rates are less predictable, which is likely largely controlled by the date of the first monitoring event of the year (i.e., whether the monitoring event occurred prior to, during, or after the passage of the seasonal discharge peak. It is noteworthy that the 4th quarter baseflow discharge measurement recorded during October 2011 is the largest baseflow measured recorded in the past 14 years at the site. There is no indication of any diminution of flow in Indian Creek that could be attributable to any mining-related activities at the Crandall Canyon Mine. It should also be noted that Genwal Resources, Inc. is not aware of any claims made by water rights holders regarding impacts to surface-water resources in the Indian Creek drainage near the Crandall Canyon Mine.

Springs and streams in the upper Joes Valley drainage along the Joes Valley Fault Zone were visited and inspected on 9 August 2007, which was three days after the mine collapse event of 6 August 2007. The purpose of this supplementary site visit was to observe conditions in the region immediately west of the collapse event location to ascertain whether any notable impacts to groundwater or surface-water systems had occurred as a result of the event. Visual observation did not indicate any increases in groundwater or surface-water turbidity, nor any obvious increases or decreases in groundwater or surface-water discharger rates in the region investigated. Measured discharge rates and field and laboratory water quality parameters performed on water samples from these the three springs (SP1-47, SP2-1, and SP1-33) and one creek site (Indian Creek) were similar to those monitored at these sites previously. Additionally, similar observations were made at each of other the regular Crandall Canyon Mine water monitoring sites during monitoring activities in the third quarter of 2007. Anomalous conditions were not noted at the monitoring sites during the 3rd quarter.

Groundwater Interception.

Previously, researchers commonly referred to a regional aquifer existing in the Blackhawk Formation and the Star Point Sandstone. However, a new conceptual model of groundwater has been developed that describes two largely disconnected groundwater systems (Mayo and others, 2003). These two systems include 1) shallow, active-zone groundwater systems that generally support discharge at springs and seeps in the area and provide baseflow to surface waters, and 2) deep, inactive-zone groundwater systems that are commonly encountered in the coal mining environment away from cliff faces and in areas under shallow cover. Groundwater that occurs in the deep, inactive-zone groundwater systems in the Blackhawk Formation often occurs in discrete sandstone paleochannel deposits that may or may not be connected to adjacent channel sands. Inactive-zone groundwaters are also commonly intercepted in fault systems that have open apertures, both in the mine floor and in the mine roof. Rarely, the deep, inactive-zone groundwater systems come into hydraulic communication with overlying shallow, active-zone groundwater systems through interconnecting faults or associated damaged zones. It is believed that recharge to the deep, inactive-zone groundwater systems may occur where the sandstone members are exposed at the surface and horizontal movement of the recharge waters into the exposed rock may occur. There is also isotopic evidence that suggests that, regionally, recharge to the deep, inactive-zone groundwater systems occurred under paleoclimatic conditions, when climatic conditions in the region were considerably wetter and cooler than they are at present.

Petersen Hydrologic, LLC performed isotopic sampling of the Crandall Canyon Mine discharge water on 18 October 2011. The results of this investigation are presented in a letter report to Mr. David Hibbs. The Petersen Hydrologic, LLC letter report is included as Appendix 7-71.

~~Typically, groundwater interception and translocation of that water is the primary mechanism by which the groundwater system may be impacted. As indicated in Section 7.24.1 of this permit, the regional groundwater system, located in the Blackhawk-Starpoint aquifer at the Crandall Canyon Mine, is below the Hiawatha Coal in all but the western portion of the mine.~~ Sandstone paleochannels that are saturated with groundwater are present in the strata overlying the mine roof in many locations throughout the mine. Groundwater monitored in the Spring Canyon Member of the Star Point Sandstone at monitoring well MW-7 exists under flowing artesian conditions. The shut-in pressure measured at the well during November 1997 was 22 psi, which equates with a hydraulic head that is 50.8 feet above the top of the well casing at that location. It is considered likely that the artesian pressure at this location exists in large part as a result of the westward dip of the saturated sandstone beds of the Star Point Sandstone toward the Joes Valley Fault, which truncates the sandstone beds on the west. The flowing artesian discharge from MW-7 was meager, typically in the range of 0.1 to 0.2 gpm, which suggests a low permeability for the Spring Canyon Member in the vicinity of the well. A shut-in recovery test was performed on the well MW-7 which indicated a low hydraulic conductivity of 7.4×10^{-8} feet per second.

The fact that large quantities of groundwater were released from storage through the mine roof during longwall mining operations in the northwest and southwest portions of the Crandall Canyon Mine indicate that saturated sediments were obviously present in the mine roof in these areas. It is interesting to note, however, that the occurrence of groundwater from the mine roof was variable from location to location. This occurrence is attributable to 1) the fact that bedrock lithologies are spatially variable in the heterogeneous Blackhawk Formation (i.e., in some areas the mine roof consisted of aquifer-quality sandstsones, while in other areas siltstone or mudstones are present immediately above the mined coal seam), and 2 the presence or absence of fault or fracture systems, which have the effect of enhancing the secondary permeability of the rocks surrounding the mine openings.

Monitoring of in-mine and surface wells indicate that water levels in the underlying Spring Canyon Member of the Star Point Sandstone are typically about 50 to 60 feet below the top of the formation over much of the mine. In the western portion of the mine near the Joes Valley Fault systems, the Spring Canyon Member was found to be fully saturated with groundwater systems existing under flowing artesian conditions. A shut-in pressure of 22 psi was measured in monitoring well MW-7, which is completed in the Spring Canyon Member below the mine. In these areas, minor amounts of groundwater weep from the floor of the mine (particularly where the permeability of the tight sandstones is enhanced by fracturing or faulting).

~~the potentiometric surface of the regional Blackhawk-Star Point aquifer in the mine area lies approximately 50 to 60 feet below the top of the Star Point Sandstone over most of the mine. In the westernmost portion of the mine, near the Joes Valley Fault system, the potentiometric surface of the Star Point Sandstone is at or slightly above the elevation of the floor of the mine. In the remainder of the mining areas, because mining is being conducted in the Hiawatha seam of the Blackhawk~~

~~Formation, which overlies the Starpoint Sandstone, dewatering of the Blackhawk-Starpoint aquifer by the Crandall Canyon Mine is not possible.~~

Historically, the springs within the permit area which are monitored on a quarterly basis, in the perched aquifer of the Blackhawk Formation above the mine, have not been affected by operating the Crandall Canyon Mine. ~~Because of the tightness of the joints and the presence of aquicludes, significant mine in-flows from the overlying strata have not occurred and nor are they anticipated.~~ Locally, modest amounts of groundwater were initiallyintercepted during mining operations at the Crandall Canyon Mine. Prior to 1996, discharge from the Crandall Canyon Mine was minimal or did not occur. As mining occurred in the northwest portion of the mine in Sections 26 and 35, T15S, R6E, appreciable groundwater inflows were encountered. Most of this groundwater entered the mine workings from fracture zones in the mine roof. This groundwater discharge appeared to be associated with release of groundwater from storage in fractured paleochannel systems overlying the Hiawatha coal seam. The fracture systems from which the groundwater emanated are likely associated with synthetic faulting related to the Joes Valley Fault system. The Joes Valley Fault system, which extends considerable distances to both the north and south, is present immediately west of mined areas.

It is important to note that, although during the life of the Crandall Canyon Mine substantial quantities of groundwater were intercepted by the mine workings, more than 20 years of water monitoring data indicates that the interception of this water has not had any measurable impact on the discharge rates from springs or streams in the area (i.e., it did not impact the hydrologic balance). This observation supports the conclusion that the water being intercepted by the mine workings is largely derived from deep, inactive-zone groundwater systems that are hydraulically disconnected from shallow, active-zone groundwater systems that support springs and streams in the region. (with the exception noted here of the interconnection between the underground mine openings and overlying active-zone groundwater systems in the northwest portion of the mine).

The amount of groundwater flowing into the mine from Sections 26 and 35, T15S, R6E, together with groundwater originating from less significant sources located elsewhere in the mine, exceeded the amount of groundwater utilized in underground mining processes. Consequently, it became necessary to discharge the excess groundwater from the Crandall Canyon Mine. The mine water was pumped from underground sumps to the surface and then discharged into Crandall Canyon Creek at monitoring point UPDES 002. The northwest portion of the Crandall Canyon Mine was sealed on June 17, 1999 after mining in that area was complete. However, drainage of groundwater from the sealed northwest portion of the mine continued. Groundwater discharge from the Crandall Canyon Mine was essentially continuous throughout the remaining period of active mining (through August 2007).

In August 2007, a tragic mine collapse event occurred at the Crandall Canyon Mine. As a consequence of this event, the Crandall Canyon Mine was subsequently closed and sealed. Accordingly, as the mine pumps were removed, it was no longer possible to pump groundwater from the Crandall Canyon Mine workings and discharge from the mine ceased during September 2007.

Beginning in January 2008, groundwater began to discharge from the Crandall Canyon Mine portals via gravity drainage. It should be noted that, based on the geometry of the Crandall Canyon Mine workings (with the lowest elevation regions occurring in the southern part of the mine), large portions of the mine workings likely remain free of mine water.

A reconnaissance of field information and data available from the old Huntington #4 permit indicates that Little Bear Spring located in T16S-R7E-Sec9 (see Plates 7-12, 7-13, and 7-14) emanates from the Panther (lowest member) of the Star Point Formation. Previous drilling within the mine area has shown that the three members of the Starpoint Sandstone are vertically isolated from one another. The Spring Canyon member is located within the upper 100 feet of the Starpoint Sandstone. This member has been found to contain water in some areas of the mine. The Storrs member was isolated from the Spring Canyon member by interbedded shale and siltstone. It did not appear to contain any appreciable water. The Panther member was found to be about 36 feet thick at a depth of 315 to 351 feet. Flow from this bed varied from about 2.1-7.0 gallons per minute. Although Little Bear spring emanates out of the Panther member, age dating showed the water to be of recent age (<50 years old). Age dating of water from the Starpoint Sandstone shows it to be of an age greater than 10,000 years old. It appears that Little Bear Spring emanates from a fault zone which may be serving as a conduit for diversion of recent water intercepted in some of the larger drainages in the area. It is doubtful that mining activities would have any affect on flow from Little Bear Spring due to the large age difference between the water encountered underground and the water flowing out of Little Bear Spring.

Meetings with the Castle Valley Special Service District officials and their representatives, as well as the other water user districts of the area, were held on 10 June 1993. The concern of the Castle Valley Special Service District regarding diminution and mitigation of the Little Bear Spring flow that could result from future mining were discussed. Given the elevations of the Starpoint potentiometric surface, in relation to that of the Hiawatha Coal Seam, it was shown that the present and future mine workings would not interfere with the Starpoint aquifer.

Little Bear Spring is a developed spring that provides municipal water to nearby municipalities. It emanates from a fracture system in the Panther Member of the Star Point Sandstone that trends in an approximate northeast-southwest direction.

Because of its importance as a municipal water supply source and its proximity to proposed mining areas, Little Bear Spring has been extensively studied. Several hydrologic studies have been performed since 1977 to investigate the recharge source for Little Bear Spring (Forest Service Project File). These studies have agreed that the spring flow is supported by a fault/fracture system. Since Little Bear Spring lies more than 300 feet below the level of the mineable coal seams and past mining encountered the fault/fracture system without significant inflow of water, there is general consensus among the Castle Valley Special Service District (CVSSD), mine operators, scientific community, and the regulatory agencies that adverse effects to the spring are unlikely.

Several studies have been done that suggest a northerly component of flow feeding Little Bear Spring. These studies include:

X Vaughn Hansen Associated, *Water Quality and Hydrologic Study in Vicinity of Huntington Creek Mine No. 4 and Little Bear Spring*, Prepared for Swisher Coal Company, August1977.

X Hydro-Sciences, Inc., *Ground Water Hydrology in the Vicinity of the Huntington No. 4 Mine,* Prepared for ARCO Coal Company, December 19, 1980.

X Beaver Creek Coal Company, *Huntington Canyon No. 4 Mining and Reclamation Plan,* Prepared for UDOGM, 1983.

X Utah Geological and Mineral Survey, *Effects of Coal Mining at Huntington Canyon No. 4 Mine on Little Bear Spring, Emery County,* Prepared for Castle Valley Special Services District, Job No. 84-005, January 21, 1984.

X Vaughn Hansen Associated, *Hydrologic Conditions in Huntington Canyon No. 4 Mine,* 1984.

These referenced studies are available for review at the Division=s Public Information Center.

Other studies indicate that the Little Bear Spring may possibly be fed by a fault/fracture system which intercepts surface water in Mill Fork Canyon southwest of the South Crandall Lease area. These scientific investigations include an investigation of the Little Bear Spring groundwater system and the groundwater systems encountered in the Crandall Canyon Mine (Appendix 7-52), a solute and isotopic investigation of groundwater from Little Bear Spring and the Star Point Sandstone and Blackhawk Formation groundwater systems the Crandall Canyon Mine (Appendix 7-53), an investigation of the hydraulic conductivity of the Star Point Sandstone in the vicinity of the Crandall Canyon Mine (Appendix 7-54), an investigation of the alluvial groundwater system in Mill Fork Canyon with implications for recharge to Little Bear Spring (Appendix 7-55), an investigation of the potential for Little Bear Spring recharge in Mill Fork Canyon (Appendix 7-56), and a fluorescent dye-tracing study that conclusively demonstrates the hydraulic connection between the stream/alluvial groundwater system in Mill Fork Canyon and Little Bear Spring (Appendix 7-57). Sunrise Engineering also performed a series of investigations using a proprietary geophysical technique that demonstrated a hydraulic connection between Little Bear Spring and the surface drainage in Mill Fork Canyon. These investigations are included as Appendix 7-59, Appendix 7-60, Appendix 7-61, and Appendix 7-62.

These studies, taken as a whole, have indicated that Little Bear Spring is possibly recharged through surface water and alluvial groundwater losses in Mill Fork Canyon, located well beyond the boundary of the South Crandall Lease area, approximately 1.5 miles southwest of the spring. The basis for this assumption is discussed briefly below. The reader is referred to the above mentioned appendices for a more rigorous discussion of the recharge of Little Bear Spring.

The assumption that Little Bear Spring may possibly be recharged from surface-water and alluvial groundwater losses in Mill Fork Canyon is based on several findings. These include:

1) the finding that, from a water budged standpoint, there is sufficient water available in Mill Fork Canyon to account for the recharge to Little Bear Spring and any surface water drainage that leaves the Mill Fork drainage and flows into Huntington Creek,

2) the finding that there is a chemical and isotopic match (or a plausible chemical evolutionary pathway) between surface waters and alluvial groundwaters in Mill Fork Canyon and groundwater at Little Bear Spring, and

3) the finding that there is a demonstrated hydraulic connection between Mill Fork Canyon and Little Bear Spring and the hydraulic gradient and flow volume through the connection is sufficient to provide Mill Fork water to the spring.

These findings are discussed below.

An investigation was performed in 2001 to determine the quantity of water available in Mill Fork Canyon to recharge Little Bear Spring (Appendix 7-56). It is the finding of this investigation that there is an excess of approximately 300 gpm in the Mill Fork drainage that is available for recharge to the spring. Indeed, it is difficult to explain the loss of approximately 300 gpm from the drainage basin without taking the recharge to Little Bear Spring into account. This finding is based on a comparative analysis of baseflow in the Crandall Creek drainage, which is very similar in geology, topography, aspect, and elevation to the Mill Fork Creek drainage. The baseflow in Crandall Canyon Creek during most years is approximately 300 gpm greater than that in Mill Fork.

Another investigation examined the capacity of the alluvial groundwater system in Mill Fork Canyon to transmit sufficient groundwater to sustain the baseflow of Little Bear Creek during periods when there is not surface flow in the Mill Fork drainage (Appendix 7-55). This investigation was based on a quantitative determination of the flow of groundwater migrating through the alluvial groundwater system above the spring recharge location compared to that flowing through the alluvial deposits below the spring recharge location in Mill Fork Canyon. It is the conclusion of this investigation that there is appreciably more groundwater flowing through the alluvial deposits above the spring recharge location as compared to that flowing in the alluvial deposits below the spring recharge location (approximately 300 gpm more).

Investigations regarding the solute and isotopic compositions of groundwater at Little Bear Spring and other shallow groundwater systems in the vicinity have been performed. These investigations have also examined the solute and isotopic compositions of Star Point Sandstone groundwater systems encountered in the Crandall Canyon Mine. These studies are included as Appendix 7-52 and Appendix 7-53. It is the findings of these investigations that groundwater discharging from Little Bear Spring is modern in origin (<50 years old), while groundwater from deep Star Point Sandstone groundwater systems in the Crandall Canyon Mine have a mean groundwater age of many thousands of years. Shallow Groundwater systems (that provide baseflow to upper Mill Fork Creek) are modern in origin. The solute composition of groundwater in Little Bear Spring and that of surface water and shallow alluvial groundwater in Mill Fork Canyon are similar.

The fact that the discharge in Little Bear Spring shows rapid seasonal variations in discharge rate suggests that the recharge is related to a shallow recharge source that is closely tied to seasonal recharge. The ancient groundwater systems encountered in the Star Point Sandstone in area coal mines do not exhibit seasonal variability.

Finally, in order to explore the assumption that Little Bear Spring may possibly be recharged from Mill Fork Canyon, a fluorescent dye tracing study was performed in 2001 (Appendix 7-57). In this investigation, fluorescent dye was placed in the upper Mill Fork drainage immediately above the spring recharge location. A positive dye recovery occurred at Little Bear Spring within 40 days of the dye placement. Thus, a hydraulic connection between the alluvial system in upper Mill Fork Canyon was positively confirmed.

The elevation of the spring recharge location in upper Mill Fork Canyon is approximately 7710 to 7790 feet, while the elevation of Little Bear Spring is approximately 7475 feet. Thus, there is a substantial hydraulic gradient between the possible Mill Fork recharge location and Little Bear Spring. It is important to note that the possible recharge location for Little Bear Spring in Mill Fork Canyon is outside the boundaries of the South Crandall Lease area. Likewise, the groundwater flowpath connecting Mill Fork Canyon and Little Bear Spring is outside of the area of potential coal mining by Genwal Resources.

While the flow mechanisms conveying water to Little Bear Spring are not completely understood, additional hydrologic studies performed since the Mill Fork EA was written have indicated that adverse impacts to the spring are not expected due to the vertical separation between the coal seams and flow. (Forest Service, BLM Joint Decision Notice/Finding of No Significant Impact, Coal Lease Application UTU-78953)

In conclusion, because mining occurs above the Panther Member of the Star Point Formation, the source of water of the Little Bear Spring; because the mine is relatively dry; and because age dating has shown that the water sampled underground from the Starpoint Sandstone and from Little Bear Springs are not the same age (: there is little, if any chance, that current or proposed future mine workings of the Crandall Canyon Mine could affect the Little Bear Spring. Operation of the mine should not adversely impact the Star Point aquifer or Little Bear Spring.

Mitigation for potential disruption to the Little Bear Spring was accomplished though the construction of a water treatment plant which can provide replacement water for the spring should the need arise. Construction of this water treatment plant will be done under the provisions of a water replacement agreement between Genwal Resources, Inc. and the Castle Valley Special Service District who maintain culinary water rights to Little Bear springs. A copy of this water replacement agreement is included in Appendix 7-51. With construction of this water treatment plant an uninterrupted supply of culinary water is assured irrespectively of whether mining can be conclusively shown to have affected Little Bear Spring. This is in compliance with special stipulation #17 of federal lease UTU-78953 (see Appendix 1-13).

Spring and Seep Interception.

There is a potential for impact to overlying seeps and springs through interception of the perched aquifers as a result of subsidence. Seeps and springs throughout the mine area and the South Crandall Lease area and the U-68082 lease mod area have been identified through intensive field and aerial surveys. These survey results are presented in Chapter 7, Section 7.24.1, associated appendices, and are shown on Plate 7-12. Water rights have also been researched and are provided in Chapter 7, Table 7-6.

Genwal is currently monitoring the water flow rates and quality of representative springs and seeps as indicated in section 7.31 within and adjacent to the current mine permit area (including LBA No. 9 and the South Crandall Lease area). The springs which are monitored cover both the proposed aerial extent of the mine and also are located within each of the major lithologic units from the Blackhawk (above the regional aquifer) to the North Horn Formation (which caps the highest portions of the top of East Mountain).

As stated in Section 7.24.1, the water emitting from seeps and springs which overlie the coal seam originates from perched aquifers. These perched aquifers appear to have no direct communication with the Star Point Sandstone, or with the mine. Isotopic sampling has shown the chemistry of these springs to be substantially different than water from underground sources or the Starpoint Sandstone. These springs do not appear to have any vertical communication with the Blackhawk or Star Point Sandstone formations even when subsidence has occurred. This is due to the extensive interbedded shale in the intervening strata. Also, during the drilling conducted for the LBA No. 9 only one hole, DH-7, intercepted any groundwater. These data indicate that a significant zone of non-saturated, low-permeability strata (aquitard or aquiclude) are present between the Star Point Sandstone and the overlying perched aquifers.

~~Natural groundwater inflow to the Crandall Canyon Mine is limited. Inflows~~ Prior to the 1996, inflows into the Crandall Canyon Mine were usually modest in magnitude and of short duration ~~to be of short and limited duration~~. Beginning around 1996, most of the natural inflows originated from mined-out, subsided portions of the mine. Less frequently, natural inflows occurred from bolt holes in the roof and from very limited sections at the active mining face. As mining occurred in the northwest portion of the mine in Sections 26 and 35, T15S, R6E, appreciable groundwater inflows were encountered. By late 1998, the total discharge from the northwest portion of the mine was approximately 600 gpm. Most of this groundwater entered the mine workings from fracture zones in the mine roof. This groundwater discharge appeared to be associated with release of groundwater from storage in fractured paleochannel systems overlying the Hiawatha coal seam. The fracture systems from which the groundwater emanated are likely associated with synthetic faulting related to the Joes Valley Fault system. While discharge from the northwest portion of the mine continued, it is noteworthy that discharge rates from individual groundwater inflow sources where encountered in mine entryways almost without exception gradually declined over time. This suggests that the intercepted water sources existed as isolated partitions which were not in strong hydraulic communication with a continuous, actively flowing groundwater system. Discharge from the northwest portion of the mine continued after the mine was sealed in 1999, although at a much diminished rate, on the order of 50 to 100 gpm (personal communication, Gary Gray, 2012).

Longwall mining in the southwest portion of the mine (longwall panels 13-18) occurred between mid-1999 and early 2003. Appreciable groundwater was encounted during mining of the southwest portion of the mine (personal communication, Gary Gray, 2012). Discharge from the 9th west entries on November 29, 1999 was estimated at 300 gpm. By December 7, 1999, the flow had decreased to an estimated 150 gpm. When mining operations advanced in longwall panel 14 in mid-2000 a large surge of groundwater from the mine roof was encountere. However, within a matter of just a few days, the discharge rate from the system had declined dramatically. Occurrences of this nature (intermittent periods of high flow followed by a period of declining discharge rates) were common during mining of the southwest portion of the mine (personal communication, Gary Gray, 2012).

Genwal has an operational monitoring plan which includes monitoring surface flows from Crandall, Blind Canyon and Indian Creeks using flumes and continuous recorders. In addition, Genwal has committed to monitor Horse Canyon at station H-1 on a quarterly basis. Genwal is currently monitoring 24 springs on a quarterly basis across their potential area of influence (see Chapter 7 for additional details).

Prior to about 1996, due to the dryness of the mine, water from Crandall Creek had been pumped into the mine to provide dust control water and water for the mining equipment. A water supply well provided shower water for the bathhouse. This well (MW-1) is no longer operative in the now closed Crandall Canyon Mine. Based on the 1992 mine water records, approximately 6.9 million gallons of water were used in the mining operation. Of this volume, it is estimated that approximately 6.2 million gallons of water were pumped into the mine from either the water supply well MW-1 or from Crandall Creek. These volumes indicate that the water collected from natural inflow underground was approximately 700,000 gallons, which is about 10 percent of the 1992 water usage. This amounts to a 1.3 gpm inflow rate. Much of the natural inflow water is used in the mining operation. Discharge from the mine had occurred only 3 times prior to 1990. Beginning in January 1996, relatively continuous discharge of mine water began to occur. A plot of Crandall Canyon Mine discharge as monitored at UPDES 002 is presented in Figure PHC-1. It is apparent in Figure PHC-1 that mine-water discharge rates increased gradually from 1996 to 2001. The northwest portion of the mine, where considerable groundwater inflows were first encountered, was sealed on June 17, 1999. By the early 2000s, discharge from the sealed northwest portion of the mine had declined to approximately 50 to 100 gpm (personal communication, Gary Gray, 2012). Beginning in mid-1999, mining of longwall panels in the southwest portion of the mine commenced. Intermittent zones of groundwater were intercepted primarily in the mine roof during the mining of these longwall panels. Discharge from the mine peaked during the period from 2001 through 2004, with discharges commonly exceeding 1,000 gpm. After 2004, discharge data from the mine show a gradual decreasing trend. During the first three quarters of 2010, the reported discharge has averaged about 500 gpm.

In the event that a subsidence fracture did reach the surface or intercept one of the overlying perched aquifers, it is likely that the affect would be temporary in nature. As indicated in Appendix 7-41, the clays within the Blackhawk Formation have a tendency to swell when exposed to water. Therefore, if the fracturing from subsidence did intersect a saturated, perched aquifer and conveyed water, the clays within the formation would swell and seal the fracture. This self-healing condition has been identified within the headwaters of the Huntington Creek drainage (DeGraff, 1978) and at other mines in the area.

An alternative water source plan has been developed in the event any water rights or springs/seeps impacted in a long-term manner by the mining operation or reclamation activities. This plan is detailed in Chapter 7, Section 7.27.

The Division of Oil, Gas and Mining has requested that this PHC be revised with respect to:

1. The magnitude and potential source of the groundwater inflows currently occurring at the Crandall Canyon Mine

2. The nature of the groundwater system currently being intercepted in the mine

3. The potential impacts of intercepting groundwater in the mine including the potential for impact to State appropriated water rights, and

4. The potential impacts to the Crandall Creek stream channel resulting from sustained discharge, including potential impacts to stream channel morphology and aquatic habitat.

In conjunction with this request, a written work plan was prepared that outlined the specific work tasks that would be performed in conjunction with the Division's request. The work plan was discussed in detail with Division personnel and representatives of Genwal Resources in a meeting held at the Division's offices on 4 April 2011. Petersen Hydrologic, LLC was commissioned to perform the requested hydrologic investigations and other work tasks in accordance with the plans outlined in the 4 April 2011 meeting.

2011 Investigative Tasks

- Monitoring of supplemental Spring and Seep locations

During the 2011 field season, Petersen Hydrologic performed a field investigation of selected springs and seeps in the permit and surrounding areas. The purpose of this investigation was to collect supplemental discharge and water quality data from springs in the study area to which baseline hydrologic data could be compared. The purpose of this analysis was to determine whether there has been any measureable interception or diversion of groundwater resources into the subsurface as a result of mining operations at the Crandall Canyon Mine. For this investigation, hydrologic monitoring was performed by Petersen Hydrologic at 36 spring locations distributed over the study area during the 4th quarter of 2011 (an additional spring site was monitoring during July 2011 and a general observation of conditions in the Joes Valley alluvium was performed during October 2011). Additionally, as part of the routine quarterly water monitoring activities at the Crandall Canyon Mine, an additional 12 monitoring sites in and adjacent to the study area were monitored during the 4th quarter of 2011. Additionally, laboratory water quality analysis for four additional springs was performed as part of this investigation. These springs include SP1-3, SP1-19, SP1-24, SP1-22, which are part of the approved monitoring plan, but for which laboratory water chemistry analysis is not generally performed. The results of the laboratory water quality measurements will be submitted electronically to the Division's on-line hydrology database together with the other 4th quarter 2011 monitoring information when the results from the analytical laboratory become available.

Additionally, as part of their water monitoring activities at the adjacent Deer Creek Mine, PacifiCorp previously performed monitoring at 10 spring sites situated near the Crandall Canyon Mine permit area (See Appendix 7-66, Figure 1 and Table 1). Monitoring information collected by PacifiCorp (including discharge and field water quality data) was obtained for these sites from the Division's publically available on-line hydrology database. Information from the Deer Creek Mine monitoring activities for the 4th quarter 2010 was utilized for this investigation (which was the most recent 4th quarter monitoring data available).

A summary of the comparison between the 2011 monitoring data and the historic monitoring data previously provided to the Division (Work Plan Table 1) for the comparison is presented in Appendix 7-66, Table 1. From the data presented in Appendix 7-66, Table 1 it is apparent that groundwater discharge rates measured during 4th quarter of 2011(and during 2010 for the PacifiCorp monitoring) generally equal or exceed those measured during the period of baseline monitoring (in some instances by a considerable amount). There is no indication that groundwater discharge rates from springs in any portion of the study area have been adversely impacted by mining operations at the Crandall Canyon Mine. Similarly, there is no indication that appreciable changes to water quality have occurred relative to conditions observed during the baseline monitoring activities (with the possible exception of some marginally elevated specific conductance values at a few monitoring sites). What this suggests is that the groundwater systems that support springs and seeps and provides baseflow to streams in the mine permit and surrounding area are apparently not in good hydraulic communication with the groundwater systems which have previously been intercepted in the Crandall Canyon Mine workings.

- Monitoring of Surface Water

As part of this investigation, surface water flow rates and stream water quality from the mine permit area have been measured in the Indian Creek drainage, Horse Canyon drainage, Blind Canyon drainage, Shingle Canyon drainage, Crandall Canyon drainage, Little Bear Canyon drainage, the Section 4 Creek drainage, and the Section 5 Creek drainage. These surface water drainages together drain essentially the entirety of the land surface in the Crandall Canyon Mine permit area.

The results of regular quarterly monitoring activities on streams are reported to the Division quarterly through the Division's on-line coal water quality database. The results of previous year's surface water monitoring activities have been summarized in annual reports of water monitoring at the Crandall Canyon Mine. These reports include graphs of discharge rates and important water quality parameters for each stream monitoring site. An analysis of the current year's surface-water monitoring data together with data from previous years is provided in the annual report to the Division.

To date, other than the effects of the permitted discharge of mine water to Crandall Creek, no detrimental impacts to water quantity or water quality in streams that could be attributed to mining and reclamation activities at the Crandall Canyon Mine have been identified.

The UPDES permit for the Crandall Canyon Mine specifies the maximum allowable total iron concentration

- Hydrogeologic field investigation

During the 2011 field season, the land surface overlying mining areas were traversed and geologic and hydrogeologic conditions were observed. The locations of identified features of potential hydrogeologic significance are shown in Appendix 7-66, Figure 1.

The land surface area overlying the synthetic faulting encountered in the underground mine workings (in Section 35 and in the southern portion of Section 26, T15S, R6E) was traversed and inspected. Lineaments were observed in this area on high-resolution aerial imagery. However, the presence of a relatively thick soil mantle in the area and the unusually dense vegetative cover present during the 2011 field season made field identification of these structures difficult. As a result of these factors, together with the fact that these faults apparently have only relatively small offsets, positive identification of the surface traces of these faults in the field was not made during the 2011 field investigation (i.e. the previously mapped fault locations have not been changed). It was notable that when the fault area was surveyed, groundwater discharge was observed at several springs and seeps in the area. The presence of the springs and seeps in the area suggests that the land surface overlying the synthetic fault system is a groundwater discharge area and not an area where recharge to fractures would potentially be occurring. The fact that these springs (numbers 20, 21, 22, 23, and 25) discharge along the approximate trend of the westernmost of the mapped synthetic faults suggests the possibility that the discharge mechanisms for these springs could be associated with a damaged zone associated with the fault.

The surface trace of the Joes Valley Fault system was observed in several locations. It is readily apparent that groundwater discharge along the surface expression of the fault trace is not significant. While there are a few springs that discharge along the length of the Joes Valley Fault zone within the study area, the discharges from these few springs are generally meager (See Work Plan Table 1). These observations suggest that groundwater discharge as upwelling from the Joes Valley Fault along the steep, fault-related escarpment is either not appreciable or does not occur. It should be noted that appreciable groundwater discharge does occur in Joes Valley west of the East Mountain escarpment. Earthfax Engineering previously performed an isotopic investigation of groundwaters discharging from selected springs in Joes Valley. The results of their investigation demonstrated that each of these springs (SP1-1A, SP1-47, SP1-42A, and SP1-37A) had elevated tritium concentrations ranging from 19.2 to 38.2 TU (See Mayo and Associates, 1997). These elevated tritium contents clearly indicate that recharge to these springs occurred within the past approximately 50 years. In contrast, tritium and radiocarbon analysis on the Joes Valley Fault water intercepted underground contained no tritium and had old radiocarbon ages.

The land surface overlying the Blackhawk Formation sandstone channel scour that was encountered in the underground Crandall Canyon Mine working was inspected as part of this investigation (primarily in Sections 25 and 26, T15S, R6E, and also the southern portions of Sections 23 and 24, T15S, R6E). Where encountered underground, the southern extent of the channel scour area is situated along the northern margins of the mined area. No unusual or hydrogeologically significant features were observed at the land surface in these regions, although a few springs with appreciable groundwater discharge were identified (Refer to springs 26, and 29-33 in Appendix 7-66, Table 1). The significance of the presence of these springs is that it indicates that these areas are groundwater discharge locations. Accordingly, there is no indication that large quantities of groundwater are being diverted from these areas into the subsurface. Because of the thickness of the overburden in these areas, the lower Blackhawk Formation scour is not exposed at the surface in the study area. Where the lower Blackhawk Formation is exposed in Horse Canyon east of the study area, no unusual hydrogeologic characteristics were observed.

Other than the considerable and spatially extensive erosion of near-surface soils and colluvium along the steeper slopes below the ridge line of East Mountain, no particularly anomalous geologic or hydrologic conditions were observed during the 2011 field geologic inventory.

- Analysis of historic discharge data from Crandall Creek

Prior to the temporary cessation of mining in 2007, flow measurements were generally performed using an in-line totalizing flow meter and are believed to be accurate. Gary Gray, the Genwal Resources engineer primarily responsible for the collection of mine discharge rate data indicates that the totalizing flow meter utilized through September 2007 was believed to be reasonably accurate. Mr. Gray indicates that he periodically checked the accuracy of the discharge meter by comparing the discharge measured at the upper flume on Crandall Creek (UPF-1) with that measured below in Crandall Creek below the mine discharge point (LOF-1). He generally found the readings to be in good agreement. The measured discharges were also generally in good agreement with information regarding the levels of activity at pumping stations at various locations in the mine. Mr. Gray indicates that in his opinion, the reported discharge measurements are likely within a 10% margin of error. Accordingly, it is the Genwal's belief that the mine water discharge rate data provided to the Division measured using the in-line totalizing flow meter is reasonably accurate.

From the time that gravity discharge from the mine portal commenced in early 2008 until October 2011, various methods were utilized to measure the mine-water discharge rates. Several factors complicated the performance of the mine water discharge flow measurements subsequent to the commencement of gravity discharge (including the necessity of correcting flow meter readings for the rate of pumped water recirculation associated with the water treatment facility). Accordingly, the flow measurements performed during this time period may be less accurate than those measured prior to September 2007. A new flow meter was installed at the Crandall

Canyon Mine discharge location on 3/19/2010. However, personnel responsible for operating the meter indicated that corrosion associated with the ferric chloride coagulant utilized in the treatment system eventually damaged the flow meter. The time at which the meter became significantly damaged is not known. Commencing in October 2011, an improved flow metering system was installed and flow measurements being performed currently are believed to be accurate. On 18 October 2011 a manual measurement of the discharge from the mine was performed using a current-velocity meter and a wading rod. The result of this manual flow measurement (427 gpm) was in good agreement with that reported by the automated flow meter at that time.

The mine water discharge rates measured at the Crandall Canyon Mine are graphed in Appendix 7-66, Figure 2. Also included in Appendix 7-66 is a plot of the 6-month running average for the mine discharge (Figure 3). The 6-month running average plot is useful for analyzing long-term trends. The running average data analysis technique typically results in a smoothed data plot which simplifies the identification of long-term trends while minimizing the noise and clutter of short-term data anomalies (such as potential measurement errors). The period during which there was no discharge from the mine during late 2007 was omitted from the running average flow rate calculation. A bar graph summarizing the average yearly mine water discharge rates are presented in Appendix 7-66, Figure 4.

It is apparent from Appendix 7-66, Figures 2, 3, and 4, that after peaking in the early 2000s, the mine discharge rate plot indicates a downward trend beginning around 2004. This trend is more readily discernable in the 6-month running average plot for mine discharge shown in Figure 3. Additionally, the yearly-average mine discharge rates plotted in Figure 4 show an obvious generally declining trend, and do not correlate with recent climatic trends (i.e. extremely wet years in 2005 and 2011). It is notable from Figure 4 that the average yearly discharge rate for 2011 (first 6 months) is less than half the average rate for 2001, demonstrating the declining trend in mine water discharge rates. The observed declines are likely the result of two main factors. These include 1) with a decrease in the mining rate or a cessation of mining activities, the potential for the underground interception and exposure of water-bearing features in the subsurface is minimized or ceases, and 2) over time it is common for discharge rates from intercepted underground water-bearing features in the Wasatch Plateau coal district to decline as the contained water is gradually drained from storage.

It has been suggested that it is inappropriate to compare trends in mine water discharge rates that occurred prior to the start of gravity discharge with the current trends for the rates of gravity discharge. An analysis of the overall trend in discharge rate data prior to the cessation of pumping is reflected in a very similar trend observed during the period of gravity discharge (See Appendix 7-67). It is important to note that because of the geometry of the mine workings, during the period of active pumping of mine discharge from the mine (pre September 2007) mine water naturally flowed by gravity along the western and southern margins of the mine workings where it was collected in sumps before being pumped to the surface. Under the current non-pumping conditions, similar patterns of mine water flow along the western and southern portions of the mine (with some likely increased pool sizes) are likely present (Personal communication, Dave Shaver, 2011).

While some additional areas of the mine are now flooded (particularly in the southeast portion of the mine), the additional surface area that is now flooded is not believed to be extraordinarily large. While it is possible that the impounding of additional mine water in the mine workings could conceivably have some influence on the rate of groundwater flow into the mine (i.e. related to head/discharge relationships), the fact that most of the groundwater encountered in the mine originated from the northwest and southwest longwall mining areas essentially contradicts that possibility. Based on the topography of the mine, it is considered likely that groundwaters that may be currently flowing into the mine in these areas readily drain down gradient toward the southern portion of the mine, leaving the mine voids in these areas non-flooded. Accordingly, groundwater inflows to these areas, whether free-falling from the mine roof to the floor, or upwelling unobstructed from the mine floor into a non-flooded mine area would likely continue uninterrupted under the non-flooded condition. Assuming that these conditions are present (i.e. a hydraulic break existing between the inflow locations and the elevations of any down-gradient pooled mine waters), groundwater inflow rates would not be expected to change appreciably relative to those occurring prior to the onset of gravity discharge.

It is has also been suggested that to evaluate yearly total mine discharge rates from the mine is an inappropriate method to determine whether the mine discharge rate responds to long-term climatic trends. As indicated previously, it is Genwal's belief that the mine discharge rates reported prior to the decommissioning of the mine pumps are reasonably accurate (within about 10%). A definite declining trend is evident in the mine discharge plots presented in Appendix 7-67. A similar trend is apparent in the post gravity discharge data (See Figures 5 and 6 in Appendix 7-67). It seems incorrect to suggest that the recent range of discharge occurring from the mine (400-500 gpm) which is substantially lower than the typical range of mine discharge that occurred in the early 2000s (which exceeded 1,000 gpm) is not indicative of a significant downward trend in mine water discharge rates (i.e. a 50% decrease in the discharge rate in about 10 years). Genwal Resources, Inc. will continue to monitor discharge rates from the Crandall Canyon Mine using the recently installed flow meter (which is believed to be accurate). As additional flow rate data are collected from the mine discharge, these data will be evaluated on an on-going basis in an attempt to identify trends in the recent discharge rate data and to determine whether seasonal and climatic variability is evident in recent mine discharge rates.

Prior to the onset of gravity discharge, seasonal and/or climatic variability was not observed in the groundwater systems encountered in the Crandall Canyon Mine (personal communication, Gary Gray, 2012). This conclusion is supported by an inspection of mine water discharge data as shown in Figure PHC-1. Similarly, indications of seasonal and/or climatic variability are not readily apparent in the discharge hydrograph for the period subsequent to the onset of gravity discharge (Figure PHC-1). Utilizing a technique whereby a graphical analysis of the yearly discharge totals from the mine is performed, the task of evaluating long-term climatic trends is greatly simplified because the "noise" of short term (monthly discharge) anomalies in the data (see Figure PHC-1) are removed from the analysis.

It has been observed by Genwal Resources personnel that recent increases in the mine discharge rate seem to correlate with the passage of weather fronts or the onset of cold weather. It is important to note that these flow rate changes occur even in the absence of any associated precipitation. The observation that the discharge rate surges occur even in the absence of precipitation events indicates that this phenomenon is apparently not in any way related to groundwater recharge. Rather, this suggests the possibility that the temporary increases in mine water discharge rate may possibly be related to other influences (such as possibly a relationship between local barometric pressure effects acting on the underground mine pool). Because some of these events are not associated with any precipitation, those surges in discharge rates cannot be attributed to infiltration of precipitation. Currently, barometric data have not been located for the Crandall Canyon Mine area which could be used for a reasonable comparison between the local barometric pressure and the occurrence of mine water discharge surges at the mine. Genwal Resources, Inc. will continue to attempt to location suitable barometric pressure data and will provide the requested graph when the suitable barometric pressure

- Crandall Creek stream channel morphology field investigation

During November 2011, a field investigation of the stream channel morphology in Crandall Creek was performed. The purpose of this investigation is to characterize the physical properties of the stream channel to assist in determining whether the addition of mine discharge water to creek could have detrimental impacts to the stream channel. Measurements were performed at 13 stations on the creek between the mine water discharge location and the confluence with Huntington Creek. The stream channel morphology evaluation points are shown in Appendix 7-66, Figure 1.

At each creek station, measurements of the channel geomorphology were made. These measurements were made using a field laser transit, a tape measure, and a stream wading rod. The widths of the surveyed cross sections at each location were made of sufficient length such that the inner channel, bank full level, and flood plains were included in the measured sections.

It should be noted that where the water was deep in ponded areas associated with beaver dams, and the substrate consisted of relatively uniform fine-grained sediments (which could not reasonably be waded), the water depths in the ponds was approximated. Also, in some locations where the hillside rises precipitously above the lateral extents of the highest flood plain level, the slope of the adjacent hillside was estimated.

At each station, the measured section included the inner channel geometry (width and depth), the bank full channel geometry, and the geometry of any associated flood plains. These measurements are presented herein graphically as a series of cross-section profiles that are presented in Appendix 7-66, Attachment 1. These cross-sections were generated electronically using SigmaPlot™ version 9.01 scientific graphing software.

In most locations, the stable inner channel, which was accommodating the entirety of the stream flow at the time of the stream survey in November 2011, is well vegetated and does not appear to be easily erodible. The abundant presence of cobbles and boulders in the stream bed and stream banks minimizes the potential for appreciable erosion during increased flow events. In many locations, the stream bed is stabilized by the presence of deposited carbonates.

It was noteworthy that there were many beaver ponds in the surveyed portion of Crandall Creek. The presence of these beaver ponds has resulted in a stepped stream channel geometry, with areas of impounded, quiescent water behind the beaver dams in which fine-grained sediments are deposited. The intervening reaches between the ponds have steeper stream gradients and swifter water currents. As expected, little fine-grained material is present in the steeper gradient reaches of the stream.

It is evident in the discharge record for Crandall Creek that peak seasonal flows exceeding 6,000 gpm are common. The potential for erosion in the stream channel during these high-flow periods likely exceeds the erosion potential associated with baseflow conditions, which, although persistent for longer periods of time, are an order of magnitude lower in flow rate.

It is of significance to this investigation to note that the existing Crandall Canyon stream channel has accommodated the addition of mine discharge flows near to or exceeding the current mine water discharge rate for at least 10 years (see Appendix 7-66, Figures 2 and 3). In its current state, the stream channel appears to be in a fairly stable condition. Given the general downward trajectory of the mine water discharge rate in recent years, it follows that the potential impact associated with the inclusion of mine water should generally decrease rather than increase over time.

It should be noted here that in some locations, slumpage of the soils and colluvium situated on the steep hillsides adjacent to the active stream channel has occurred. However, inspection of the Crandall Creek stream channel in locations above the mine discharge location shows similar mass movement occurrences throughout the upper reaches of the Crandall Creek drainage. This phenomenon is likely largely attributable to entrenchment and downcutting of stream channels into their associated unconsolidated sediments – a phenomenon that is currently being observed regionally throughout the Wasatch Plateau and adjacent regions of Utah.

- <u>State appropriated water rights inventory</u>

As part of this investigation, an inventory of State appropriated water rights in the study area was performed. Specific water rights have been filed with the Utah Division of Water Rights on some specific springs and stream reaches in the Crandall Canyon Mine permit and surrounding areas (see Table 7-22 and Plate 7-14).

State appropriated water rights for springs in and near the study area include 93-1176 (SP1-3), 93-1404 (SP2-9), 93-1403 (SP2-14), 93-624 (SP2-23), 93-1406 (SP2-24), 93-1410 (SP1-26), and 93-1409 (probably SP-58). Each of these springs was inspected and monitored as part of the 2011 field investigation (with the exception of SP2-14). Based on comparisons with baseline water quantity and water quality data, there is no indication that there have been impacts to water quantity or water quality in these springs.

As part of this investigation, an inventory of State appropriated water rights on streams in and around the study area was also performed. Each of the major stream drainages was visited and inspected as part of the 2011 field investigation. Based on an analysis of water monitoring data for the surface water drainages in the study and surrounding areas, there is no indication that water quantity or water quality has been impacted at these drainages.

- Whole effluent toxicity (WET) testing

Whole effluent toxicity testing was performed during the 2011 field season as required. Reports summarizing the findings of the Phase 1 and Phase 2 TIE investigations are provided in Appendix 7-68.

- Macroinvertebrate studies

Macroinvertebrate field studies were performed in 2011 during the early and late season time periods as required. The results of the macro invertebrate studies are provided in Appendix 7-69. Genwal Resources, Inc. will continue to perform macroinvertebrate studies in Crandall Creek on a yearly basis to evaluate the potential impacts to fish and wildlife resources and potential impacts to aquatic communities and aquatic habitat. These investigations will be performed by individuals and organizations qualified to perform the required investigations.

Conclusions

The magnitude and potential source of the groundwater inflows currently occurring at the Crandall Canyon Mine and The nature of the groundwater system currently being intercepted in the mine

While the storage volume of the source(s) of water contributing to the Crandall Canyon Mine discharge is unknown, it is readily apparent that the rate of discharge is gradually declining (See Appendix 7-66, Figures 2, 3, and 4). Additionally, there is no correlation evident between mine water discharge rates and climatic variability. During mining operations, seasonal variability in discharge rates from water sources intercepted underground were not observed. These observations support the conclusion that at least some of the source(s) of the mine inflow waters are not in good hydraulic communication with appreciable recharge sources (i.e., the groundwater is primarily being removed from storage). These considerations also suggest that the observed declining trend in the mine water discharge rate will continue into the future.

Mayo and Associates, LC (1997), and Mayo et al. (2003) have previously conducted a series of investigations regarding groundwater systems in the Crandall Canyon Mine and surrounding mines in the Wasatch Plateau coal district.

Mayo and Associates (1997) concluded that 1) the groundwater in the Joes Valley Fault system within the Crandall Canyon Mine is thousands of years old, with no component of modern water, 2) the fault system groundwater has a stable isotopic affinity for other groundwaters encountered within the mine, suggesting that the recharge source for the fault waters is different from the recharge source for modern, shallow groundwaters and surface waters, 3) no expression of groundwater discharge from the fault system into springs and creeks at the surface in the vicinity of the Genwal lease area was identified, suggesting that groundwater discharge to the surface is either minimal or non-existent, and 4) groundwaters are upwelling from beneath the mine along the fault system, and do not appear to be under great confining pressure.

Mayo et al. (2003) concluded that damage-zone groundwater at the Crandall Canyon Mine is compartmentalized and does not readily recharge adjacent aquifer-quality rock. They indicate that water issuing from a fractured sandstone channel in the mine roof, located 100 meters from the Joes Valley Fault, contained 0.95 TU, indicating hydraulic communication with surface water. This water (5th West fault) had a ^{14}C age of approximately 3,000 to 4,000 years (Mayo and Associates, 1997), indicating a mixed source. Mayo and others (2003) further concluded that elsewhere, water in the roof channel sandstone, located near the fault, had 0 TU and older ^{14}C ages. Water issuing from the mining face, located ~ 60 meters from the fault, had 0 TU and had a ^{14}C age of 2,500 years. Additionally, modern water in the damage zone did not impact the deeper Star Point Sandstone where a sample from a well located ~ 60 meters from the fault contained 0 TU and had a ^{14}C age of 5,000 years.

Water sampled in a sandstone channel in the mine roof in the southwest portion of the mine (8th East roof drips), where longwall mining occurred from about 1999 to 2004, contained 0 TU and had a mean radiocarbon age of approximately 14,000 years (Mayo and Associates, 1997).

While much is known about the groundwater systems encountered in the Crandall Canyon Mine, a determination of precisely where the water in the various systems is ultimately recharged is probably not possible. However, potential source(s) include:

- Drainage of old, perched groundwater from fractured Blackhawk Formation paleochannels in the mine roof into the mine openings
- Upwelling of old Star Point Sandstone groundwater through fractures in the mine floor in the western portion of the mine
- Discharge of old groundwater leaking from the Joes Valley Fault along the western edge of the mine
- Drainage of groundwater with a mixed origin (with components of both old and modern water) from other sources.

All of these sources have in varying degrees contributed groundwater to the Crandall Canyon Mine workings in the past.

However, it is important to stress that the results of our 2011 investigation of groundwater and surface-water resources overlying and adjacent to the Crandall Canyon Mine workings *do not* indicate that quantifiable decreases in rates of discharge from groundwater systems that support springs and seeps and provide baseflow to streams in the area have occurred.

The potential impacts of intercepting groundwater in the mine including the potential for impact to State appropriated water rights

During the 2011 field season, Petersen Hydrologic, LLC conducted an inventory of selected springs and seeps in the region overlying areas where groundwater inflows into the Crandall Canyon Mine were observed. The details of this investigation are provided in Appendix 7-66. The purpose of this investigation was to determine whether shallow groundwater systems that support springs and seeps at the surface are a potential source of the water intercepted in the underground mine workings. The findings of this investigation indicate that after more than 14 years of inflow of groundwater into the Crandall Canyon Mine, no quantifiable impacts have occurred to spring or stream flow rates. This conclusion is based on 1) the results of the performance of the rigorous Division approved hydrologic monitoring plan for springs and streams (which show no impacts), and 2) the results of the 2011 supplemental monitoring of more than 36 different spring and seep locations, which showed no discernable impacts to water quantity or quality when compared to baseline, pre-mining hydrologic conditions. Accordingly, as the magnitude of the groundwater inflows is declining over time (Appendix 7-66, Figures 2, 3, and 4), there seems to be little basis to conclude that future impacts would be likely.

An analysis of the groundwater and surface-water resources associated with the specifically delineated State appropriated water rights indicates that no detrimental impacts to flow rates have occurred at these sources. Similarly, there is no indication that any regional or systematic impacts to water resources has occurred.

Potential impacts to the Crandall Creek stream channel resulting from sustained discharge, including potential impacts to stream channel morphology and aquatic habitat

A stream morphology survey was conducted on Crandall Creek below the mine discharge location in November 2011. This information includes channel widths and depths, the character of the materials in the bed and bank deposits, and measured stream gradients. This information was gathered to assist in the determination of whether erosion would be anticipated at varying creek discharge rates. However, based on the geometry and non-erosion prone materials present in the relatively stable inner stream channel, and the fact that the flow from the mine has been gradually decreasing over time, it seems probable that ongoing discharge of water in the stream under baseflow conditions similar to those existing currently, will not result in significant erosional changes to the stream channel morphology.

Information regarding the aquatic habitat in Crandall Creek has been collected and analyzed. This information is provided to as Appendix 7-69.

Surface Water Interception.

The possible surface water interception impacts may affect stream flows in Crandall Canyon, Blind Canyon, Horse Creek, the headwaters of Indian Creek, and drainages in the South Crandall Lease area and in the U-68082 lease mod area. These impacts would likely be the result of subsidence fractures intersecting the ground surface. If these fractures occur within or across a surface drainage channel, then a potential is created for the surface flow within the drainage to be temporarily intercepted. For the drainages within and adjacent to the Crandall Canyon Mine, all sections of the streams that are perennial will be protected from subsidence by limiting retreat mining activities within the area of the stream buffer zones as discussed in Section 5.25 of this permit.

The potential for significant water loss for these drainages is minimal. This conclusion is based on the existing hydrologic and geologic information presented in Section 7.24 and Appendices 7-2 and 7-23 and past mining experience within the Huntington Creek drainage. In addition, the streams in the majority of the surface area which overlies the current or proposed mine workings are ephemeral. However, due to the concerns raised by the U.S. Forest Service, regarding their uncertainty in supporting this conclusion, Genwal Resources Inc. has initiated extensive studies of within Blind and portion of Crandall Canyon to determine if mining through these drainages have an adverse affect on the surface or groundwater resources within the drainage. Until the results of these studies are determined, Genwal will continue to protect those portions of the streams that have been proven to be perennial.

It is important to note that the geologic units located in the formations stratigraphically above the Blackhawk Formation and the Hiawatha coal seam at the Crandall Canyon mine are hydrologically isolated from the contiguous area. East Mountain is bounded on the north by the South (Left) Fork of Huntington Creek; on the west by Upper Joes Valley; on the south by Cottonwood Canyon; and on the east by Huntington Canyon. Data show that the regional aquifer is located below the Hiawatha Coal. Field data indicate that Blind Canyon is ephemeral and that Horse Canyon is perennial only in that area where it intersects or is below the regional aquifer. Based on the baseline data (Appendix 7-58), it is apparent that all of the surface-water drainages in the South Crandall Lease area are likely ephemeral or intermittent in nature. The drainages in the U-68082 lease mod area are all ephemeral or intermittent.

The perennial portion of Crandall Canyon extends above the regional aquifer. This occurs because the perched Price River and North Horn Formation cover a broader area of this watershed and because Crandall Canyon has a larger drainage area (and thus, more potential for recharge and increased runoff) than the other two canyons.

Consumption.

The consumption of water by the mining operation is a combination of moisture added to the mined coal through the mining process and that which is extracted with the coal as well as evaporation due to ventilation of the mine workings. It is estimated that mining extraction and the mining process utilize approximately 200 gpm during the two 8-hour mining shifts per day. The volume of water extracted by ventilation is estimated to be approximately 50 gpm.

Seepage from Mine Sumps.

Underground sumps are utilized to store water pumped underground or collected from groundwater inflows until the water is used as mine process water. During the period that water is stored in these sumps it is probable for some seepage to occur to the underlying formation (Spring Canyon member). For the Crandall Canyon Mine, the potential volume of such seepage is expected to be quite low because of the presence of a fine-grained mudstone strata underlying the Hiawatha seam within the Blackhawk Formation. This layer limits the downward movement of seepage to a very slow rate.

Pumping from Crandall Creek.

Due to the past need for supplemental water underground, there is also potential for decreased surface flows in Crandall Canyon due to pumping from Crandall Creek. Surface water availability could only be impacted by excessive pumping of water from Crandall Creek for the operation. This is not expected to occur since Genwal has committed to not pump from Crandall Creek at a rate that will dewater the stream. (Chapter 7, Section 7.24.2). (Genwal will have determined the baseline water flow which needs to remain within Crandall Creek to sustain the existing flora and fauna by August 31, 1995) Essentially continuous groundwater inflows into the mine occurred beginning in 1996 and continuing through the cessation of active mining operations in 2007. Consequently, it was no longer necessary to pump surface water from the creek to the mine workings and accordingly, pumping of groundwater from Crandall Creek ceased. Accordingly, the potential for decrease in flow volume in Crandall Creek as a result of pumping of water from the stream is low. Under the current operational condition at the mine, pumping from Crandall Creek does not occur. Therefore, the in-stream water present at UPF-1 represents the minimum flow that would be present in the creek below the mine (since water is no longer pumped from the creek above the mining location).

Water Quality Impacts.

There is the potential for an increase in TSS due to fugitive coal fines and dust entering the adjacent surface water system at the mine surface facilities area. To minimize the potential for this impact, sweeping of the access roads and pads is performed as necessary. Water is misted onto the coal to minimize the potential for mobilization of fugitive dust.

The quality of the surface and groundwater in the mine area may potentially be affected by increased sediment loading, dust from the operations, mine water discharges, hydrocarbons used in the mining operations, and seepage losses from within the mine. The following sections discuss these potential impacts and mitigating measures.

With the installation of the main diversion culvert during the expansion of the mine yard facility area it is possible that additional sedimentation could occur. Genwal will install a pair of silt fences downstream in Crandall Canyon to collect any suspended material that may occur as a result of the installation of the 18" drain pipe bedded in drain rock or the 72" culvert. The silt fences will be checked periodically and cleaned out as needed to maintain maximum efficiency.

Once the culvert is in place and operable, the creek will be diverted through the culvert thus bypassing the disturbed area and minimizing the potential for runoff from the disturbed area accidentally flowing directly into the creek. The sediment pond may experience an increase in sediment loading during the construction process and until the construction has been completed. This would be a short term effect. The sediment pond will also be enlarged during the construction process to accommodate the increase in disturbed area. The net result will be that the pond will be better suited to handle runoff from the disturbed area once it has been reconstructed and enlarged. Drainage from the Forest Service parking area will now report directly to the sediment pond. All drainage from the disturbed area will report directly to the sediment pond and the potential for drainage to bypass the sediment pond and flow into the creek untreated will be virtually eliminated.

Flow in Crandall Creek will be temporarily (during the remainder of the life of the mine) diverted through the 72" culvert. However, when reclamation occurs, the channel will be replaced exactly in the same location as it existed prior to the culvert placement. Genwal will lay a geotextile over the existing channel to preserve the channel morphology prior to installation of the drain rock and 18" drain pipe. The drain rock and drain pipe will serve to allow any drainage from the channel bed or adjacent seepage from colluvial materials to flow downstream. Then, the 72" diversion pipe will be placed over this drain. The drain will preserve the integrity of the fill, thus minimizing the potential for problems from settling of the 72" pipe and ensuring the successful operation of the bypass culvert.

The Crandall Canyon Mine discharge water is routinely tested for toxicity through whole effluent toxicity (WET) testing. After failing several WET tests during 2011, a Phase 1 and a Phase 2 Toxic Identification Evaluation was performed by Water and Environmental Testing, Inc. Subsequently, because the mine discharge water passed the routine fourth quarter 2011 WET test (likely in response to an earlier change in the type of treatment chemicals utilized at the iron treatment facility), Water and Environmental Testing suggested that a Phase 3 TIE test was not recommended (see Appendix 7-68). It was their conclusion that "activities taken at the mine have got the situation under control". However, the fact that the mine discharge water has periodically failed the WET testing indicates that there is the potential for adverse impacts to water quality in Crandall Creek resulting from the use of chemical treatments in the mine discharge water. However, by carefully managing the use of chemicals at the mine treatment facility and by carrying out routine monitoring of residual treatment chemicals at the UPDES 002 discharge monitoring station, the possibility that adverse impacts to water quality in the creek may occur in the future can be minimized.

Increased Sediment Loading.

As discussed in Section 7.24.2, the permit area is drained by ephemeral, intermittent, and perennial watersheds. These watersheds are steep (with average slopes 50 percent) and well vegetated (with vegetative cover also often exceeding 50 percent). The primary potential for impact to surface water is in the form of increased sedimentation from the operations.

Sediment yield will naturally increase (on a temporary basis during construction and revegetation) from areas disturbed for the operation. A runoff control plan, required by the Division of Oil, Gas, and Mining, provides for the containment or treatment of all runoff and sediment produced from the disturbed areas. Based on this plan, described in Chapter 7, Section 7.42.22, the majority of the disturbed area runoff is directed to the sediment pond. The designed sediment storage for the pond is 1.02 acre feet, including 0.084 acre feet from disturbed areas and 0.018 acre feet from undisturbed and reclaimed areas, over a 10 year period. Storm runoff was determined to be 1.98 acre feet. The pond is designed with a total storage volume of 3.27 acre feet, which allows for complete containment of sediment.

There are 7 small areas (ASCA 2, 5, 6, 7, 8, 9, & 10) which do not drain to the sediment pond, as shown on Plate 7-5, and described in Chapter 7, Section 7.42.21. Sediment yield from these areas is minimized through the use of sediment traps, straw bale dikes, silt fences, and vegetation as described in Section 7.42.21. Sediment yield from the facility and the disturbed areas is minimized through the installation and maintenance of the above described controls.

A secondary potential source may exist due to subsidence creating surface irregularities which would be more susceptible to erosion. Calculations presented in Appendices 7-27 to 7-40 indicate a very small potential for increased sedimentation reaching a perennial stream. A study has been conducted by Genwal and the U.S. Forest Service in Blind Canyon to measure the amount of subsidence, erosion, and the associated sediment yield which may be produced as a result of current mining operations. (Refer to Appendices 7-38 and 7-39).

Fugitive dust.

The potential impacts of fugitive dust from the Crandall Canyon Mine include reduced air quality in the facilities area and a small decrease in the surface water quality of Crandall Creek. The air quality degradation result from particulate emissions from the paved road and pad, reclamation activities, and from coal loading operations. The water quality degradation and sediment loading increase would result from the settlement of dust within the waters of Crandall Creek. Placement of the stream within the culvert under the expanded mine yard will serve to minimize the possibility of coal dust settling in Crandall Creek.

These impacts are mitigated by sweeping the paved access roads and portions of the pad, water sprays in the coal handling process, and contemporaneous reclamation. These actions minimize the dust production from the facilities area.

Oil and grease.

The use of oil, grease, and flammable hydrocarbon-based products in the mine facilities area creates the possibility of contamination within and adjacent to the facilities area. Contamination could result from spillage of these products during maintenance of the mine equipment, accidental spillage during filling of fuel tanks, or leakage from equipment during operations. Such contamination could impact the soils, groundwater, and possibly surface waters downstream of the facility.

The impacts from spillage during maintenance activities and during filling of tanks will be mitigated by the implementation of the SPCC plan. Additionally, the runoff from all areas of the site where equipment will be operating is drained to the sedimentation pond. The pond is equipped with an oil and grease skimmer to prevent the release of hydrocarbons.

Mine water discharge.

A potential impact to water quality would be from mine water discharges. ~~Currently there is~~ Prior to early 1996 there was no appreciable discharge from the Crandall Canyon Mine. ~~However, when the underground sumps are full and mining consumption is minimal, such as during a longwall move or vacation, discharges may occur.~~ Prior to 1990, there were only three discharges from the mine and these discharges were of a limited nature in both duration and quantity. The mine has an UPDES discharge permit.

Petersen Hydrologic, LLC performed an investigation of Crandall Canyon Mine discharge water chemistry entitled "*Investigation of iron concentrations in the Genwal Resources, Inc. Crandall Canyon Mine discharge water*" dated 7 November 2011. This report is included as Appendix 7-67. The information provided in the Petersen Hydrologic, LLC report provides much of the basis for the following discussion.

From early 1996 until the mine was sealed in September 2007, mine water was routinely discharged from the Crandall Canyon Mine to Crandall Canyon Creek. The quality of the mine discharge water was good, and almost always met the requirements of the UPDES discharge permit. Information on water quality and water discharge rates from the Crandall Canyon Mine (and also from all other monitoring sites) has been submitted quarterly to the Utah Division of Oil, Gas and Mining and is available for inspection at http://ogm.utah.gov/coal/edi/wqdb.htm (UDOGM, 2011). The total dissolved solids (TDS) concentrations of mine discharge waters are plotted in Figure PHC-2. It is apparent in Figure PHC-2 that the TDS concentrations of mine discharge waters prior to the cessation of pumping in 2007 were (with a single anomalous exception in 2004) less than about 625 mg/L (see monitoring site UPDES 002, UDOGM, 2011). Total iron concentrations in the mine discharge water during this period were almost always substantially less than the UPDES discharge permit limit of 1 mg/L.

Beginning in January 2008, after a period of several months with no discharge subsequent to the cessation of pumping of mine discharge water, groundwater began to discharge from the Crandall Canyon Mine portals via gravity drainage. It should be noted that, based on the geometry of the Crandall Canyon Mine workings (with the lowest elevation regions occurring in the southern part of the mine), large portions of the mine workings likely remain free of mine water.

The TDS concentrations of the mine discharge waters that initially flowed from the Crandall Canyon Mine portals in early 2008 were somewhat elevated relative to that pumped prior to the mine's closure (see Figure PHC-2 and monitoring data for site UPDES 002 in the UDOGM online coal hydrology database, 2011). The elevated TDS concentrations were likely attributable to the initial flushing and dissolution of soluble minerals or other materials present in portions of the mine that had not previously been inundated with water. TDS concentrations of the mine water subsequent to its first discharge from the mine portals lowered precipitously during the first several months of discharge (Figure PHC-2). After a period of approximately 30 months, TDS concentrations in mine discharge waters had completely returned to the levels observed prior to the mine collapse event and the subsequent cessation of pumping of mine water in 2007. Total dissolved solids concentrations in the Crandall Canyon Mine pre-treatment water during the 21-month period from April 2010 to December 2011 (since the beginning of the period of record for monitoring site UPDES 002 pre-treatment) averaged 615 mg/L. This average concentration is entirely consistent with the TDS levels that were observed in the mine discharge water prior to the 2007 mine collapse event. It is noteworthy that this TDS concentration represents an increase of only about 11 percent relative to the average TDS concentration of the receiving Crandall Creek water during 2010 and 2011 (average TDS at UPF-1 of 552 mg/L).

Since gravity discharge from the Crandall Canyon Mine commenced in early 2008, total iron concentrations in the mine discharge waters have been elevated relative to the total iron concentrations of mine waters discharging prior to mine closure (See Figures PHC-2 and PHC-3; UDOGM, 2011). The likely source of increased total iron concentrations in the mine discharge water is the oxidation of sulfide minerals (such as pyrite) that have come into contact with oxygenated water in the newly flooded portions of the Crandall Canyon Mine.

It is apparent from the data plotted in Figure PHC-4 that total iron concentrations in the Crandall Canyon Mine discharge water peaked at a concentration of 8.03 mg/L in October 2009. It is apparent in Figure PHC-4 that since that time, total iron concentrations in the pre-treatment mine discharge water have been declining gradually. During the fourth quarter of 2010, total iron concentrations in the mine pre-treatment water were 2.81, 3.19, and 3.29 mg/L in October, November, and December, respectively, averaging 3.1 mg/L. Thus, the fourth quarter 2010 average total iron concentration in mine discharge water (untreated) represents a decrease of more than 60% relative to the October 2009 peak concentration over this approximately 12 to 14 month period.

In response to the increased total iron concentrations in the Crandall Canyon Mine discharge water, Genwal Resources, Inc. has constructed and operates a treatment facility that removes iron from the water prior to its discharge into Crandall Canyon Creek. Details of the treatment facility are provided in Appendix 7-65. Subsequent to the installation and successful operation of the treatment facility, total iron concentrations in the mine discharge water (UPDES

002) are now routinely in compliance with the 1 mg/L discharge limit established in the UPDES discharge permit (See Figure PHC-4; UDOGM, 2011).

A well oxygenated surface stream with near-neutral pH will rarely contain more than a few micrograms per liter of dissolved iron (Hem, 1985). Dissolved iron species in such streams are readily precipitated as solid precipitates (commonly iron hydroxides) which will settle to the bottom of the stream bed or may be incorporated as co-precipitates with other mineral precipitation processes. Accordingly, because elevated dissolved iron concentrations are not likely to persist in the well-oxygenated creek, the potential for significantly impacting iron concentrations in Huntington Creek into which Crandall Canyon Creek flows (more than a mile below the mine water discharge point) is considered minimal. Concentrations of total iron in Crandall Creek water above the mine water discharge point (at UPF-1), and immediately below the mine water discharge point (at LOF-1) are shown on Figure PHC-5.

Prior to the installation and operation of the iron treatment facility, some discoloration of the Crandall Canyon Creek stream substrate near and below the mine-water discharge point was observed. The discoloration of the creek likely resulted from the presence of iron hydroxide precipitates.

Whole effluent toxicity (WET) testing of Crandall Canyon Mine discharge water has occurred routinely subsequent to the onset of gravity discharge from the mine portals. WET testing of the chemically treated mine discharge water has been performed subsequent to the operation of the mine's iron treatment facility (second and third quarters of 2010). The results of Phase 1 and Phase 2 Toxicity Identification Evaluations performed by Water and Environmental Testing are included as Appendix 7-68.

The aquatic habitat of Crandall Canyon Creek has also been evaluated previously by JBR Environmental Consultants, Inc. In a report entitled *Crandall Canyon Mine Macroinvertebrate Study September 2009*, JBR evaluated the aquatic habitat by sampling the creek's benthic macroinvertibrates and assessed the resultant data to determine whether or not the mine discharge is affecting Crandall Creek's aquatic community. JBR found that overall, while both the upper and lower monitoring sites continue to support a variety of macroinvertebrates, the Crandall Creek macroinvertebrate community downstream of the mine's discharge was negatively impacted relative to the sampling site upstream of the mine discharge. However, they considered attributing the degradation directly to iron in Genwal's mine water discharge to be problematic. It should also be noted that this represents a potential impact that occurred prior to the onset of chemical mine-water treatment. Impacts to aquatic communities and aquatic habitat resulting from the increased flow in the creek resulting from the addition of mine discharge waters during 2011 are described in a Crandall Canyon macroinvertebrate study dated December 5, 2011 performed by JBR Environmental Consultants, Inc. which is included as Appendix 7-69. Genwal Resources, Inc. has committed to performing ongoing routine monitoring of the macroinvertebrate community in Crandall Canyon Creek in the future. The future sampling will provide additional data, which will be used to assess continued impact or recovery as the mine discharge water is now treated.

Based on the results of the 2011macroinvertebrate study (see Appendix 7-69), it is apparent "that the Crandall Creek macroinvertebrate community immediately downstream of the mine discharge continues to show negative impacts of the mine water discharge." Also, "although the furthest downstream reach of Crandall Creek (CRANDLWR-03) also has a degraded macroinvertebrate community, its poor substrate condition (embedded and cemented) is likely a contributing (if not dominating) factor affecting macroinvertebrate community health at that site". Based on these findings, it is evident that future impacts to the invertebrate community in Crandall Creek below the mine discharge location may continue to occur in the future. Genwal Resources, Inc. is committed to performing the macroinvertebrate study in Crandall Creek on an ongoing annual basis to further characterize and monitor for potential impacts to the creek.

Subsequent to the construction and operation of the iron-treatment facility for the Crandall Canyon Mine discharge, the treated mine discharge water is currently being discharged in compliance with all relevant regulations and guidelines. Impacts to the hydrologic balance resulting from the discharge of mine water are being minimized. To summarize current mine water discharge conditions:

1) The iron treatment facility (which uses both chemical and physical treatment processes) is successfully reducing total iron concentrations in the mine discharge water to levels in compliance with the UPDES permit (continuously for the last 10 months).
2) Aluminum concentrations in the treated mine discharge water are in compliance with the UPDES permit stipulations.
3) The use of polyacrylamide chemicals in the iron treatment facility at the Crandall Canyon Mine is in compliance with relevant NSF 60 standards for drinking water treatment chemicals.
4) Whole effluent toxicity testing of the treated mine discharge water indicates a lack of toxicity.
5) All applicable regulations and guidelines for the mine water discharge are currently and consistently being met, demonstrating the capability of Genwal Resources, Inc. to remain in compliance with the stipulations of the mine water discharge permit.

While the precise length of time during which elevated iron concentrations will persist in the untreated Crandall Canyon Mine discharge is difficult to determine with certainty, it is considered very likely that iron concentrations will gradually decline over time. This is because the system is reactant-limited. Crandall Canyon Mine waters that were pumped to the surface prior to the closure and sealing of the mine were consistently low in iron content (Figure PHC-3; UDOGM, 2011). These waters flowed over the mine floor and were held in underground sumps prior to being discharged to the surface via pumping. Subsequent to the mine closure and the cessation of mine water pumping, groundwaters within the mine likely came into contact with portions of the mine that had not previously been inundated with water prior to reaching the surface. This may include areas where coal debris resulting from the mine collapse event was emplaced in mine entries. Over time, the sulfide minerals exposed in the newly flooded portions of the mine will either 1) become depleted due to removal of the iron by oxidation processes (i.e. become consumed and flushed from the system as iron and sulfate in the mine discharge water), or 2) become non-reactive as the necessary chemical reactants facilitating the sulfide mineral oxidation processes become unavailable (i.e. depletion of dissolved oxygen levels in the mine water for example). Because there is not an unlimited supply of exposed and available sulfide mineral in the newly flooded portions of the mine, it can be stated with confidence that the discharge of iron from sulfide mineral oxidation cannot continue in perpetuity.

It should also be noted that, while damage occurred to pillars in some portions of the mine in conjunction with the August 2007 mine collapse event, such damage likely did not occur over widespread portions of the mine. In their July 2008 report of the August 2007 mine collapse incident, the Mine Safety and Health Administration (MSHA) provide a delineation of the likely spatial extent of collapse damage in the mine. This report includes a delineation of the approximate extent of "extensively damaged pillars" as well as a delineation of the approximate extent of "damaged pillars" (see Figure 33 on page 61 of the MSHA report). It is significant to note that the total acreage of "damaged" and "extensively damaged" pillars is on the general order of the size of one of the typical longwall panels in the Crandall Canyon Mine adjacent to the collapsed area.

Inasmuch as more than three years have transpired since the August 2007 mine collapse event (and the performance of any underground mining activities in the area), it seems unlikely that seismic activity in the mine area of significant magnitude to rubbleize currently in-tact coal and expose appreciable amounts of sulfide minerals to oxygenated mine water will occur in the future.

~~Based on these considerations and the recent trends in total iron concentrations observed in the mine discharge water, together with previous experiences at the Crandall Canyon Mine and other coal mining operations in the Wasatch Plateau, it seems reasonable to conclude that the elevated iron concentrations in the Crandall Canyon Mine discharge water likely will not persist more than about 10 years.~~

Petersen Hydrologic, LLC (Appendix 7-67) projects that total iron concentrations in untreated Crandall Canyon Mine discharge water will likely decline to below the UPDES discharge limit of 1.2 mg/L within a time frame on the order of approximately 3 years. This projection was based on a graphical analysis of the recent total iron concentration trends in the mine water. The approximately three year time frame was derived by extrapolating the graphed historical concentration trend line to the intersection with the 1.2 mg/L concentration level.

It should be noted that, while continuous discharge of untreated Crandall Canyon Mine discharge water to the creek at levels above the UPDES permit limit of 1.24 mg/L would constitute a negative impact to the biota in the creek, this impact is currently mitigated through the operation of the Crandall Canyon Mine iron treatment facility. The iron treatment facility effectively removes total iron from the discharge water such that the treated mine water discharged to the creek at UPDES 002 is consistently in compliance with the maximum allowable total iron concentrations as specified in the mine's UPDES permit. Accordingly, the potential for impacts to biota in the creek as a result of the discharge of mine water with elevated total iron concentrations is minimized.

It should be noted that Genwal's previous statement that elevated iron concentrations in the Crandall Canyon Mine discharge water likely would not persist for more than about 10 years was a very conservative, general estimate of the likely window of time during which the iron concentrations would likely abate (i.e. at some point within the 10 year window of time the concentrations would abate). It was provided to the Division as a conservative order-of-magnitude projection (i.e. it would be a few years, not decades or centuries). It was not meant to indicate that the concentration would decline to 1.2 mg/L after a period of10 years had elapsed.

The quantity of water in Crandall Creek increases substantially when Crandall Canyon Mine discharge waters are discharged into the creek. Typically, during mid-summer and low-flow conditions, the amount of water in the creek more than doubles as a consequence of the inclusion of the mine discharge water (UDOGM, 2011). ~~The additional modest quantity of flow in the creek, particularly during the low-flow season, is likely beneficial to aquatic habitat rather than being detrimental to the overall aquatic habitat.~~

Impacts to aquatic communities and aquatic habitat resulting from the increased flow in the creek resulting from the addition of mine discharge waters are described in a Crandall Canyon macroinvertebrate study performed by JBR (Appendix 7-69) and in Phase 1 and Phase 2 Toxicity Identification Evaluations performed by Water and Environmental Testing (Appendix 7-68). The names of professional persons or organizations that collected and analyzed the data, dates of collection and analysis of the data, and descriptions of the methodology used to collect and analyze the data are provided in Appendix 7-69 and Appendix 7-68.

The JBR Envonmental Consultants report provided in Appendix 7-69 provides an analysis that incorporates the results of macroinvertebrate studies from 2009 and 2010.

The proposed monitoring plan for the Crandall Canyon Mine discharge water (prior to any treatments) is presented below:

Water monitoring protocols for Crandall Canyon Mine discharge water (untreated mine discharge)		
Parameter	**Reported as**	**Frequency**
Field Parameters		
Mine discharge	gpm	Daily
Temperature	°C	Monthly
pH	S.U.	Monthly
Specific conductance	µS/cm	Monthly
Dissolved oxygen	mg/L	Monthly
Ferrous Iron (field)	mg/L	Monthly

Laboratory analyses		
Calcium (dissolved)	mg/L	Monthly
Magnesium (dissolved)	mg/L	Monthly
Sodium (dissolved)	mg/L	Monthly
Potassium (dissolved)	mg/L	Monthly
Bicarbonate	mg/L as CaCO3	Monthly
Carbonate	mg/L as CaCO3	Monthly
Sulfate	mg/L	Monthly
Chloride	mg/L	Monthly
Aluminum (total)	mg/L	Monthly
Aluminum (dissolved)	mg/L	Monthly
Iron (total)	mg/L	Monthly
Iron (dissolved)	mg/L	Monthly
Manganese (total)	mg/L	Monthly
Silica	mg/L	Monthly
TDS	mg/L	Monthly
TSS	mg/L	Monthly
Alkalinity (total)	mg/L as CaCO3	Monthly
Hot acidity (by SM 2310B 4(a))	mg/L	Monthly

The specific chemicals currently being used at the iron treatment facility include NALCO ULTRION 8187 and NALCO NALCLEAR 7763. Further information on the chemical properties and the manufacturer's safety data sheets for these chemicals are provided in Appendix 7-70.

Laboratory analytical methods for the determination of polymer concentrations in a sampled solution are provided in Appendix 7-70.

Monitoring of residual polymer treatment chemical and aluminum (total and dissolved) will be carried out according to the protocols specified in the table below. Samples will be collected from the mine water treatment facility effluent at monitoring site UPDES 002 using appropriate, careful sample collection and handling procedures. Samples will be placed in sample containers as directed by the analytical laboratory performing the laboratory analyses.

Whenever chemicals are used in the vicinity of surface waters, there is always a possibility that the utilized chemicals could potentially impact water quality in surface waters as a result of chemical spills or leakage from storage containers. In order to minimize the potential for impacts to water quality resulting from the use of treatment chemicals at the iron treatment facility, the following protocol will be implemented when using treatment chemicals. The chemicals will be stored in well-maintained storage containers and handled carefully to minimize the potential for spillage and uncontrolled release of the chemicals into the environment. Emergency equipment for fires, spills, leaks, etc. will be kept available for use at the site. When spillage of any appreciable or hazardous quantity of a utilized chemical occurs, the spill will be promptly cleaned up and the recovered chemical will either be used in the treatment process or disposed of properly. The quantities and concentrations of chemicals used in the treatment process will be regulated and monitored such that conditions that would result in unacceptable impacts to water quality or health and safety do not occur.

Supplemental water monitoring protocols for Crandall Canyon Mine discharge water UPDES 002 (supplemental to existing UPDES monitoring requirements)		
Parameter	**Reported as**	**Frequency**
Laboratory analyses		
Residual polymer treatment chemical	Mg/L	Monthly while a polymer treatment chemical is being used.
Aluminum (total)	Mg/L	Monthly while a potentially aluminum releasing treatment chemical is being used.
Aluminum (dissolved)	Mg/L	Monthly while a potentially aluminum releasing treatment chemical is being used.

The water monitoring data for the untreated mine discharge water outlined above will be submitted to the Division monthly. The water chemistry and measurement data will be submitted electronically using the Division's water monitoring database EDI system. Mine-water discharge rate data will be provided in a spreadsheet format or other format acceptable to the Division. The monitoring of the untreated mine discharge water will be conducted for the life of the permit or until the Division deems it no longer necessary.

The monitoring data will be used to detect and characterize any potential changes in the quantity or quality of Crandall Canyon Mine discharge water. Although unanticipated, if changes to the chemical quality of the discharge water were to occur, the monitoring data would allow the detection of any such changes and appropriate responses to any such changes could be designed and implemented. This may be accomplished by evaluating changes or significant trends in individual monitored parameters over time (i.e. comparing previous chemical compositions or discharge rates with current chemical compositions or discharge rates). This information may then be used to determine whether adverse impacts to the quality or quantity of the receiving water (Crandall Canyon Creek) are occurring or are likely to occur. The monitoring data may also be used in future geochemical evaluations of groundwater regimes associated with the Crandall Canyon Mine.

It should be noted that during the period of active mining, some groundwater was removed with the coal during the mining operations or evaporated as a result of exposing the coal to circulating air, which represented a decrease in the quantity of groundwater present. The relatively small overall magnitude of these impacts during the period of active mining was moderate, largely because groundwater in the coal is generally part of the inactive-zone groundwater system that does not contribute groundwater to springs or streams in the area under non-mining conditions. Under the current condition with the mine in suspension and the ventilation fans turned off, this impact is currently negligible.

<u>Acid-toxic materials</u>.

As discussed in Section 5.28.30, waste rock is not normally produced during mining operations. When incidental quantities of rock are encountered, the rock is left in the mine and will not be removed in the future~~.; thus, the strata which overlie and underlie the Hiawatha seam are not expected to cause any negative effects or create acid-forming potential. Additionally, the mine is currently considered to be a "dry mine" and the minimal volume of water that is encountered underground does not exhibit any acid or toxic characteristics.~~ All waters encountered have had a near neutral to slightly alkaline chemistry~~. Laboratory data have shown that the amounts of no materials are present within the coal, underburden, overburden, etc. which are of an acid or toxic nature.~~

As is common with essentially all coal mines in Utah's Wasatch Plateau and Book Cliffs coal fields, sulfide minerals such as pyrite (FeS_2) are known to be present in varying quantities in mined coal seams When exposed to air and water, pyrite is oxidized according to:

$$FeS_{2\,(S)} + 7/2\ O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+$$

The products of this reaction include aqueous dissolved iron, sulfate, and hydrogen ions (acid). In some coal mines in the eastern United States where appreciable quantities of pyrite are present , this reaction continues for prolonged periods of time and acid mine drainage occurs which results in an iron-rich low-pH water. However, in coal mines in the western United States, where carbonate minerals are pervasive in the mine environment, the acidity produced through pyrite oxidation is rapidly consumed through carbonate mineral dissolution reactions and the pH of the solution raises correspondingly. For this reason, acid mine drainage generally does not occur in Utah's Wasatch Plateau and Book Cliffs coal fields.

As described by Petersen Hydrologic (Appendix 7-67) total iron has been present in the Crandall Canyon Mine discharge water at concentrations of a few milligrams per liter since 2008. As described in Appendix 7-67, "it is considered very likely that iron concentrations will gradually decline over time", "because there is not an unlimited supply of exposed and available sulfide mineral in the newly flooded portion of the mine, it can be stated with confidence that the discharge of iron from sulfide mineral oxidation cannot continue in perpetuity. Accordingly, although pyrite oxidation is occurring in the flooded mine workings and somewhat elevated total iron concentrations are currently present in the mine discharge water, this impact is considered to likely be temporary in nature. Because the currently occurring total iron concentrations in the Crandall Canyon Mine discharge water remain somewhat elevated, Genwal Resources, Inc. has constructed and operates an iron treatment facility at the mine discharge location. After being treated at the facility, iron concentrations in the treated mine discharge water are consistently below the UPDES permit levels. Based on the fact that the concentrations are projected to naturally decline within a few years to levels below the UPDES permit limit, the potential for on-going elevated total iron concentrations in mine discharge waters is considered low.

Total dissolved solids concentrations of the mine discharge water over the past year have averaged approximately 616 mg/L (see UDOGM's on-line coal water quality database), which is only about 11 percent greater than that of the receiving water (Crandall Creek). While this impact to water quality in Crandall Creek is currently occurring (as permitted in the mine's UPDES permit), the magnitude of this impact is minor.

Further, handling plans have been implemented for earth, refuse, and acid-toxic forming materials (if encountered), which, if needed, will prevent or control discharge of pollutants to the hydrologic system (Section 7.31.3). This will be accomplished using the best technology currently available.

However, to further characterize the acid-forming potential of strata immediately above and below the Hiawatha seam, the applicant has collected roof-, floor-rock, and coal samples from locations within the current mine workings. Analytical results from these sets of samples, Appendix 6-2, indicate that high levels of acid and toxic forming materials are not present within the overburden or underburden.

Flooding or Streamflow Alteration.

The potential for flooding is minimized by the design and installation of adequately sized diversions, sediment pond and velocity control structures as described in Chapter 7, Section 7.40. All diversions are sized for a 25 year - 24 hour storm event. Ditches, culverts and sediment pond are designed for a 10 year - 24 hour storm event. Ditches, culverts and sediment pond are designed for a 10 year - 24 hour storm event.

Currently, the potential for streamflow alteration as a result of subsidence is minimal because active mining (which could generate subsidence) is not presently occurring at the Crandall Canyon Mine.

Crandall Creek will be culverted for a distance of about 1,100 feet through the expanded mine yard area. While a minimal short term impact will occur as the culvert is being installed, the long term affect will be to reduce the potential for sediment to flow from the disturbed area into the creek. It will also reduce the potential for flow within Crandall Creek to impinge upon the sediment pond embankment due to their close proximity. The slopes of the sediment pond will be 2:1 on the outslope. The toe of the sediment pond has been fortified with an additional 2 feet of 12.5 inch D-50 rip-rap for protection and stabilization. The culvert outlet downstream from the pond will minimize the potential for impact from running water to damage the sediment pond embankment. An analysis of the Crandall Creek flow and pond protection measures indicates that these measures are adequate for a return period in excess of 10,000 years (Section 7.42.22). A slope stability analysis has also been performed on the pond embankment, indicating it meets the required slope-stability safety factors (Chapter 7, Table 7-7).

R645-301-728.200 Basis for Determination

The PHC Determination for this operation is based on baseline hydrologic, geologic, and other information gathered specifically for this site and the surrounding area by the permittee. This includes information from the South Crandall Lease area and from the U-68082 lease mod area. Additionally, regional information has been provided through various published reports as noted in the plan.

Specific groundwater information is provided in Section 7.24.1 and Appendices 7-16, 7-17, 7-18, 7-19, 7-21, 7-24, 7-40, 7-41, 7-43, 7-46, 7-47, and 7-48 of Chapter 7. Surface water data is presented in Section 7.24.2 and Appendices 7-14, 7-23, 7-25, 7-26, 7-27 through 7-39, 7-43, 7-44, 7-45, and 7-48 of Chapter 7. Geologic information is provided in Chapter 6 and Section 7.24.3, while climatic information is provided in Section 7.24.4.

R645-301-728.300 Findings

728.310

Chapter 7, Sections 7.24.1 and 7.24.2, indicate the potential for adverse impacts to the hydrologic balance to be minimal in both the existing permit area and in the South Crandall Lease area, and in the U-68082 lease mod area. The basis for this determination is through extensive studies, past and on-going groundwater and surface water monitoring, past history, and performance of the on-going operation, and various protection plans for operations and reclamation. ~~A summary of potential impacts is provided in Table 1 of this PHC.~~

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Waste rock is produced in limited quantities on a very infrequent basis during mining operations. When incidental quantities of rock are encountered, the rock is left in the mine and will not be removed in the future. ~~These conditions, coupled with the fact that the waste rock does not have acid or toxic characteristics indicate that little potential exists for any impacts from toxic- or acid-forming materials.~~

Further, handling plans have been implemented for earth, refuse, and acid-toxic forming materials, which, if needed, will prevent or control discharge of pollutants to the hydrologic system (Section 7.31.1). This will be accomplished using the best technology currently available.

As is common with coal mines in Utah's Wasatch Plateau coal district, sulfide minerals including pyrite (FeS_2) are known to be present in the mined coal seam at the Crandall Canyon Mine. When exposed to air and water, pyrite oxidizes according to:

$$FeS_{2\,(S)} + 7/2\ O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+ \quad \text{(pyrite oxidation)}$$

This reaction, which may be facilitated and enhanced by the presence of certain bacteria, yields free, reduced iron (Fe^{2+}), sulfate, and H^+ (acid), and removes oxygen from the water. The liberation of H^+ in this reaction results in a temporary lowering of the pH and facilitates the dissolution of carbonate minerals according to:

$$H^+ + CaCO_3 = Ca^{2+} + HCO_3^- \quad \text{(calcite dissolution)}$$
$$2H^+ + CaMg(CO_3)_2 = Ca^{2+} + Mg^{2+} + 2HCO_3 \quad \text{(dolomite dissolution)}$$

These two reactions result in an increase in the calcium, magnesium, and bicarbonate concentrations of the water and consume H^+, resulting in a rising of the pH. Because of the abundance of carbonate minerals in the coal fields of the western United States, the acid produced from pyrite oxidation is readily consumed in the reactions described above and acid-mine-drainage does not occur.

Water flowing in a surface stream that is fully aerated with near neutral pH generally will generally not contain more than a few micrograms per liter of dissolved iron (Hem, 1985). This is because oxygen is continuously present in an actively flowing stream and the Fe^{2+} is rapidly oxidized to Fe^{3+} according to:

$$Fe^{2+} + 1/4\ O_2 + H^+ = Fe^{3+} + 1/2\ H_2O \quad \text{(iron oxidation)}$$

The oxidized iron is subsequently precipitated as a solid (commonly as an amorphous iron hydroxide) which eventually settles to the bottom of the water body. This simplified reaction may be expressed as:

$$Fe^{3+} + 3H_2O = Fe(OH)_{3\ (s)} + 3H^+ \quad \text{(iron hydroxide precipitation)}$$

The H^+ produced in the reaction is consumed in the carbonate mineral dissolution reactions described above.

The iron hydroxide sometimes co-precipitates with carbonate minerals such where supersaturation with respect to the carbonate minerals exists in the receiving water.

As a result of these chemical reactions,

Petersen Hydrologic (2011) indicate that total iron concentrations will likely decline to below the UPDES discharge limit of 1.24 mg/L within a time frame of approximately 3 years (Appendix7-67).

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The following are expected impacts from the coal mining and reclamation operation:

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Sediment yield does naturally increase on a temporary basis from areas disturbed for the operation. However, the majority of the disturbed area runoff is directed to the sediment pond. The pond is designed with a total storage volume of 1.061 acre feet, which allows for complete containment of sediment. The 7 small areas which do not drain to the sediment pond, as shown on Plate 7-5, are treated through the use of sediment traps, straw bale dikes, silt fences, and vegetation.

Genwal, in cooperation with the U.S. Forest Service, is conducting detailed sedimentation and erosion studies in the Blind Canyon watershed to determine the exact impact of mining and subsidence. To date, negative impacts to intermittent and perennial streams by sediment loading and increased turbidity has not been observed in the permit area.

The potential for increases in sediment yield in the permit area is minimized through the use of the sediment pond, diversions, and other sediment controls. The effectiveness of these techniques is monitored through implementation of the mine's water monitoring plan and UPDES monitoring.

728.332

Water quality parameters, including acidity, total suspended solids and total dissolved solids, are not expected to be impacted by the mining or reclamation operations. This determination is based on information provided in Chapter 7, Sections 7.24.1 and 7.24.2, and by results of the on-going water monitoring program detailed in Section 7.31.2.

It is unlikely that groundwater quality or quantity will be affected by the underground mining operations (as discussed in Section 7.24.1 and associated appendices, and Section 7.28.100). This is primarily because groundwater systems that support spring discharges and provide baseflow to streams in the mine area are predominantly from shallow, active-zone groundwater systems (Mayo and others, 2003). Over almost all locations in the Crandall Canyon Mine (with the exception of the fractured zones in the northwest portion of the mine), the groundwaters encountered in the underground mine workings are from deep, inactive-zone groundwater systems. The active zone and inactive zone groundwater systems are isolated by a thick sequence of heterogeneous bedrock strata which are known to have poor vertical and horizontal water transmitting potential. The potential for physical interaction between in-mine groundwaters and overlying active-zone groundwaters to result in chemical contamination of shallow, active-zone groundwaters seems remote. Accordingly, the potential for impacting overlying shallow groundwater systems as a result of mining within the deep, inactive zone is considered low. As discussed elsewhere in this PHC, hydraulic communication between the mine openings and active-zone groundwater systems was indicated in a fractured zone in the northwest portion of the Crandall Canyon Mine. However, in the 15 years that have elapsed since the active-zone groundwater system was first encountered in the mine workings, there is no indication that quantifiable or perceptible impacts to the water quantity or water quality of surrounding surface waters or groundwaters have occurred. This seems to suggest that the active zone system encountered in the northwest portion of the mine is apparently not in good hydraulic communication with a groundwater system that supports appreciable discharge to the surface. It is also evident that the total discharge from the northwest portion of the mine declined appreciably after that area was sealed in June 1999. Genwal mine personnel indicate that the estimated quantity of discharge reporting from the northwest portion of the mine in the early 2000s was on the order of 50 to 100 gpm (personal communication, Gary Gray, 2012).

In general, the conclusion that it is unlikely that groundwater quality or quantity will be impacted by mining activities is strongly supported by the fact that 1) active mining operations in the Crandall Canyon Mine have ceased, and 2) in the more than 25 years since mining activities commenced at the Crandall Canyon Mine, there is no indication that the mining activities have resulted in any perceptible or quantifiable impacts to groundwater quantity or groundwater quality that could be attributed to mining-related activities.

There does exist a potential for impacts to the surface water. However, any potential impacts that may occur are expected to be minimal for the following reasons:

(1) Sediment controls are in place and maintained to minimize sediment loading to drainages;

(2) All discharges from the sediment pond (or mine) are conducted in accordance with requirements of a U.P.D.E.S. Permit; Where elevated total iron concentrations (above UPDES discharge permit limits) in mine discharge waters may occur, the water will be treated to remove excess iron prior to discharge to receiving waters;

(3) Historical data from this site (which is summarized in the Annual Report and Appendices 7-16, 7-17, 7-18, 7-19, 7-21, 7-24, 7-40, 7-41, 7-43, 7-46, 7-47, and 7-48) show no indication of mine related impacts on the hydrology of the area, other than the permitted discharges of mine water to Crandall Creek regulated under the mine's UPDES permit; (Note that the UPDES permit for the Crandall Canyon Mine UT0024368 allows for discharge of water with TDS concentrations not to exceed 1,200 mg/L or one ton of TDS per day, total iron concentrations not to exceed 1.24 mg/L. Currently, the average TDS of the mine discharge water – pre-treatment is approximately 615 mg/L (April 2010-December 2011) which is only approximately 11% greater than the average TDS of the average Crandall Creek receiving water (552 mg/L). The total iron concentrations in the pre-treatment mine discharge water currently exceed the 1.24 mg/L UPDES limit. However, the mine operates an iron treatment facility that is effective at removing total iron from the discharge water. Petersen Hydrologic has projected that the total iron concentration in the pre-treatment water will likely fall below the UPDES limit of 1.24 mg/L within a few years).

(4) The water monitoring program will continue to be followed as described in Chapter 7, Section 7.31.2. Results will continue to be analyzed and any problem areas noted will be corrected to prevent further impacts to the hydrology. ~~As requested by the Division, recent water monitoring data (through the third quarter of 2010)~~

The potential for detrimental impacts to groundwater or surface-water quality as a result of the spillage of hydrocarbons is minimized through the implementation of the mine's SPCC plan.

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The potential for flooding of the surface facilities is minimized by the design and installation of adequately sized diversions, sediment pond and velocity control structures as described in Chapter 7, Section 7.40.

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The Crandall Canyon Mine is expected to have little impact on groundwater. ~~As mentioned earlier, the mine does not appear to have any hydrologic connection to surface water above the mine nor any connection to groundwater in the Star Point Sandstone below.~~

Monitoring of in-mine and surface monitoring wells drilled within and adjacent to the Crandall Canyon Mine and completed in the regional Blackhawk-Starpoint aquifer indicate the potentiometric surface of this aquifer generally lies 50 to 60 feet below the top of the Star Point Formation in all but the westernmost portion of the mine. Thus, mining of the Hiawatha Coal Seam at the base of the Blackhawk Formation, overlying the Star Point Formation, will not intersect and drain any water from the regional aquifer. Nor would water from underground mining enter the Star Point Sandstone due to the relatively impermeable shale zone that lies between the Hiawatha seam and the sandstone below.

There may be some potential for impact to seeps and springs through subsidence. Genwal is currently monitoring the water flow rates and quality of the water rights associated with seeps and springs within and adjacent to the current mine permit area. No evidence of impacts has been identified; however, an alternative water source plan has been developed in the event any water rights or springs/seeps are adversely affected by the mining operation or reclamation activities.

At the request of the Division, an analysis of water-monitoring data at the Crandall Canyon Mine through the third quarter of 2010 has been performed. All related water-monitoring information has been submitted electronically to the Division's on-line hydrology database located at http://ogm.utah.gov/coal/edi/wqdb.htm.

As part of the requested analysis of water-monitoring data, graphs of discharge, specific conductance, and pH are provided together with plots of the Palmer Hydrologic Drought Index (PHDI) for Crandall Canyon Mine monitoring sites in PHC-Attachment 1. The PHDI is a monthly parameter that is generated by the National Climatic Data Center (NCDC) that indicates the severity of wet or dry spells. The PHDI is useful in evaluating spring or stream discharge data to determine whether variability in spring or stream discharge rates is related to climatic variability or attributable other factors.

Based on the analysis of all monitoring information performed in this investigation, it is concluded that, other than the permitted discharge of mine discharge water to Crandall Creek (which may include increased TDS concentrations of the mine discharge water relative to receiving waters), which is regulated under a UPDES discharge permit, there are no indications of mining-related impacts to water quality or water quantity that could be attributed to mining-related activities. It is apparent that effects of both seasonal and climatic variability influence conditions at monitored springs and streams in the mine area. Other than the permitted discharge of mine water to Crandall Creek with likely temporarily increased total iron concentrations as discussed previously, there is no indication that the events associated with the August 2007 mine collapse event have had any perceptible or quantifiable impacts on water quality or water quantity in surrounding streams or springs. Similarly, no perceptible or quantifiable impacts to water quality or water quantity in streams or springs overlying mine areas that could be attributed to the current discharge of mine water from the Crandall Canyon Mine portals have been identified.

Similar comprehensive analyses of water-monitoring data from the Crandall Canyon Mine have previously been provided yearly in annual reports of water monitoring activities submitted to the Division. An analysis of all monitoring data collected during 2010 will be provided to the Division with the submittal of the 2010 annual report of water monitoring activities.

Three springs which are monitored as part of the regular Crandall Canyon Mine monitoring plan have previously been directly undermined with longwall panels and subsided. These include the following:

SP1-22	Undermined by longwall Panel 12 (May 1999)
SP1-24	Undermined by longwall Panel 13 (September 1999)
SP2-24	Undermined by longwall Panel 11 (December 1998)

Long-term water monitoring information from these springs (which has been submitted electronically to the Division's Hydrology Database) does not indicate any perceptible or quantifiable impacts to discharge rates from these springs (see 2011 annual report of water monitoring for further analysis). Groundwater discharge currently continues uninterrupted at each of these spring locations.

Monitored springs which have experienced longwall subsidence in nearby surrounding areas but not directly at the spring discharge location include the following:

SP-58	Nearby undermining with Panels 4 and 5 (1996-1997)
SP2-9	Nearby undermining with Panels 7, 8, and 9 (1997-1998)
SP-47A	Nearby undermining with Panels 2 and 22 (1996, 2005)
SP1-19	Nearby undermining with Panel 12 (1999)

Long-term water monitoring information from these springs (which has been submitted electronically to the Division's Hydrology Database) does not indicate any perceptible or quantifiable impacts to discharge rates from these springs (see 2011 annual report of water monitoring for further analysis). Groundwater discharge currently continues uninterrupted at these spring locations.

Two monitored springs are located within the region delineated by MSHA as encompassing the likely 2007 mine collapse area. These include:

SP1-22	(August 2007)
SP1-24	(August 2007)

There is no indication that spring discharge rates at these two springs were impacted in any perceptible or quantifiable way as a result of the August 2007 mine collapse event though the event was centered not far from these two springs. Groundwater discharge currently continues uninterrupted at both of these spring locations.

What this indicates is that, in spite of extensive coal mining and subsidence of the land surface in the mine permit area, there is no indication that the groundwater systems that support discharge to overlying springs have experienced any quantifiable loss of flow. Likewise, as discussed previously, there is no indication that any quantifiable loss of flow has occurred at the springs and streams investigated as part of the 2011 work plan investigations. As described elsewhere, most of the groundwater historically intercepted at the Crandall Canyon Mine has been from fracture zones in strata overlying the mine openings. As described by Mayo and others (2003) the deep, inactive-zone groundwater systems commonly encountered in coal mines in the Wasatch Plateau are in most locations hydrodynamically disconnected from shallow, active-zone groundwater systems which typically support discharges to springs and seeps in the region. The fact that through the years appreciable quantities of groundwater have been intercepted in the Crandall Canyon Mine, while diminution of shallow groundwater discharge rates at overlying springs has not been identified, suggests that the groundwater intercepted by the mine is primarily derived from storage in the rock strata surrounding the underground mine workings.

At the request of the Division, we have performed a conceptual analysis of the quantity of groundwater that could be drained from storage from the rock strata surrounding the mine openings at the Crandall Canyon Mine. In presenting this analysis, it is important to note that the analysis provided is meant to determine whether it is reasonable to conclude that sufficient water could be produced from storage in the surrounding groundwater systems to account for the volume of water that has historically discharged from the mine. Because the detailed hydrogeologic conditions present in the overburden and underburden strata are not known, it is not possible to determine with certainty where the groundwaters intercepted in the mine originated.

The Blackhawk Formation is approximately 600 to 700 feet thick in the Crandall Canyon Mine permit area. Employing a commonly utilized assumption that bedrock fracturing above areas subsided by coal extraction may extend upward from the mined horizon for a distance of approximately 80 times the mined height, assuming an extraction height of 8 feet it would be projected that the zone of cracking above subsided areas could extend upward for a distance of about 640 feet. Based on the known lithologic characteristics of the Blackhawk Formation regionally, it seem reasonable to conclude that in the aggregate, 100 feet of saturated sandstone bedrock would be present (which conservatively estimates that about 16% of the total encountered Blackhawk Formation lithology would consist of sandstone). Assuming an effective porosity of 14 percent for fine-grained Blackhawk Formation sandstones (Slaughter and others, 1995) it is possible to calculate a volume of groundwater held in storage within a hypothetical square mile of saturated sandstone. This calculation is presented below:

<u>Blackhawk Formation (gallons drained from storage per unit square mile)</u>

- Saturated sandstone thickness within cracked zone = 100 feet
- Effective porosity = 14 percent
- Cubic feet of rock = 5280 feet * 5280 feet * 100 feet thickness = 2,787,840,000
- Cubic feet of porosity volume = 2,787,840,000 cubic feet * 0.14 = 390,297,600
- Gallons of water = 390,297,600 cubic feet * 7.48 gallons/cubic foot = **2,919,426,048**

It is apparent from these calculations that approximately 2.9 billion gallons of water could be drained from storage per square mile of Blackhawk Formation overlying mined areas at the Crandall Canyon Mine hypothetically (and somewhat arbitrarily) assuming a 100 foot thickness of saturated sandstone. Considering the total land area contained within the Crandall Canyon Mine permit area beneath which all or most of the Blackhawk Formation is present (within Sections 1, 2, 25, 26, 31, 35 and 36) it is estimated that these lands encompass roughly 5.5 square miles. Accordingly, it is calculated that for 2,919,426,048 gallons per square mile x 5.5 square miles, a total storage capacity in excess of approximately 16,000,000,000 gallons of groundwater would exist. Assuming that approximately 5,950,000,000 gallons of water has drained from the mine since 1996, it is readily apparent from these calculations that it would hypothetically be possible to produce the approximately 5,950,000,000 gallons of water from storage release in such a Blackhawk Formation groundwater system. Under this hypothetical scenario, approximately 37 percent of the total storage would be drained currently, with approximately 63% remaining in storage.

Assuming an arbitrary discharge rate of 400 gpm, the remaining volume of water would be depleted in approximately 48 years.

A similar series of calculations is presented below for the storage potential of the underlying Star Point Sandstone. The Spring Canyon Member of the Star Point Sandstone is present stratigraphically immediately or a short distance below the mined Hiawatha coal seam at the Crandall Canyon Mine. The thickness of the Spring Canyon Member locally is approximately 100 feet. For this hypothetical calculation, it is somewhat arbitrarily assumed that on average the Spring Canyon is only 50% saturated. Assuming an average effective matrix porosity of 15.5 percent for the Star Point Sandstone (Bills, 2000) it is possible to calculate the groundwater storage volume of such a hypothetical groundwater system.

Star Point Sandstone Formation – Spring Canyon Member (gallons of storage per square mile)

- Saturated sandstone thickness = 50 feet
- Effective porosity = 15.5 percent
- Cubic feet of rock = 5280 feet * 5280 feet * 50 feet thickness = 1,393,920,000
- Cubic feet of porosity volume = 1,393,920,000 cubic feet * 0.155 = 216,057,600
- Gallons of water = 216,057,600 cubic feet * 7.48 gallons/cubic foot = **1,616,110,848**

Conservatively assuming a 5.5 square mile land surface area beneath which the Star Point Sandstone is present within Sections 1, 2, 25, 26, 31, 35 and 36 in the permit area, it is calculated that such a hypothetical Star Point Sandstone groundwater system could contain approximately 8,889,000,000 gallons of groundwater physically in storage. This quantity of water alone could account for the total approximately 5,950,000,000 gallons of water discharged from the Crandall Canyon Mine since 1996. Using this hypothetical estimate, approximately 67 percent of the water held in storage would have now been drained. This calculation is considered highly conservative because the Star Point Sandstone is known regionally to be present well beyond the extents of the Crandall Canyon Mine permit area.

Assuming an arbitrary discharge rate of 400 gpm, the remaining volume of water would be depleted in approximately 14 years.

It is important to emphasis that these calculations have been provided at the request of the division and are intended for the purpose of determining whether there could be adequate groundwater residing in storage in a specified hypothetical groundwater system to account for the approximate volume of groundwater that has been discharged from the mine since 1996. Genwal Resources, Inc. makes no inferences from these calculations as to actual groundwater conditions that may exist in the permit and adjacent areas.

These calculations demonstrate that it is indeed possible for the observed volume of water that has discharged from the Crandall Canyon Mine since 1996 to be accounted for through removal of groundwater entirely from storage in either the Blackhawk Formation overlying the mine, or from the Star Point Sandstone underlying the mine workings, or through a combination of these sources. This finding is consistent with the fact that no quantifiable impacts to discharge rates in springs or to baseflow components of streams that could be attributable to mining-related activities have been observed (i.e., no appreciable impact to the hydrologic balance). As discussed above, a component of the groundwater intercepted in the northwestern portion of the mine workings is known to have likely been in communication with shallow active-zone groundwater systems or surface waters. The specific location of the active-zone groundwater system(s) that contributed water to the composite mine discharge water is not known. However, rigorous monitoring of springs and streams in the mine permit and adjacent areas has not shown any quantifiable or perceptible impact to discharge rates at the monitoring sites. The source of the modern, active-zone component of the mine discharge water remains problematic. Monitoring of springs and streams in the permit and adjacent areas will continue to be performed to verify that impacts to shallow groundwater systems or surface-water systems do not occur.

The groundwater system that supports discharge at Little Bear Spring will not be subsided. As discussed above, the groundwater discharging from the spring is NOT derived from a regional Star Point aquifer. Rather, it is recharged from surface-water and alluvial groundwater losses in Mill Fork Canyon outside of the permit area. The significant fracture in the Star Point Sandstone from which the spring discharges serves primarily as a conduit for the conveyance of the Mill Fork water to the spring. Groundwater in the Star Point Sandstone that is not within the fracture system does not contribute appreciable quantities of groundwater to the spring. For these reasons, the potential for impacts to Little Bear Spring resulting from mining operations in Genwal=s permit area is considered extremely unlikely.

Impacts to the surface water quality and quantity are minimized through the installation and maintenance of surface runoff and sediment control structures, and a commitment (Section 7.24.2) to not pump from Crandall Creek at a rate that will cause the in-stream flow to decrease below the minimum required rate.

In addition, groundwater and surface water quantity and quality are monitored on a quarterly basis to determine seasonal flow conditions for the permit and adjacent areas. Further, handling plans have been implemented for earth, refuse, and acid-toxic forming materials, which will prevent or control discharge of pollutants to the hydrologic system. Implementation of these plans will be accomplished using the best technology currently available.

Based on the above, there is some potential for the operation to have an impact on the groundwater and surface water resources of the area; however, the impacts are expected to be minimal due to natural geologic and hydrologic conditions, and the implementation of control and protection systems. Therefore, the "Probable Hydrologic Consequences" of this operation are expected to be minimal, if not negligible.

7.28.335

Additional information will be provided if deemed necessary by the Division.

R645-301-728.340 N/A

This is an underground operation.

R645-301-728-400 Updated PHC

This document is provided as an up-dated PHC for the permit renewal in accordance with the State of Utah R645-Coal Mining Rules.

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TABLE 1

POTENTIAL HYDROLOGIC IMPACTS

MPACT	POTENTIAL EFFECT	POTENTIAL MAGNITUDE OF IMPACT	PROBABILITY OF OCCURRENCE	MITIGATION
-toxic	Degradation of surface and groundwater quality	Low (no such materials present)	Low	Monitoring material: approved methods
ability	Decrease in spring flow due to subsidence	Low to moderate depending on location	Low (No history of impact)	Monitoring
ability	Interception of groundwater by mine workings	Low	Low (on-going)	Monitoring
ability	Removal of water with coal	Low	Moderate (on-going)	Monitoring
ty	Decrease in quality due to hydrocarbons	Low	Low	SPCC Plan, monitor maintenance
	Increase in TSS	Moderate	Low	Sediment pond, dive control, monitoring
	Damage to downstream area	Low	Low	Sediment ponds, div monitoring
ion	Damage to streams due to subsidence	Low	Low	Protection of perenn monitoring
lity	Decrease in quality due to hydrocarbons	Low	Low	SPCC plan, inspecti maintenance
lity	Increase in TSS due to coal fines and dust	Low	Low	Sweeping of access r misting of coal
lity	Increase in iron concentrations in Crandall Canyon Creek as a result of mine water discharge	Moderate	Low (mine discharge is being treated)	Monitoring, Mine di treated
ntity	Decrease in flow in Crandall Creek below mine	Moderate	Low	Monitoring, maintai
ntity	Increase in flow rates in Crandall Creek below the mine discharge	Low potential for negative impact; additional water of acceptable quality would likely benefit the overall aquatic habitat	Moderate	Monitoring, mine di: treated

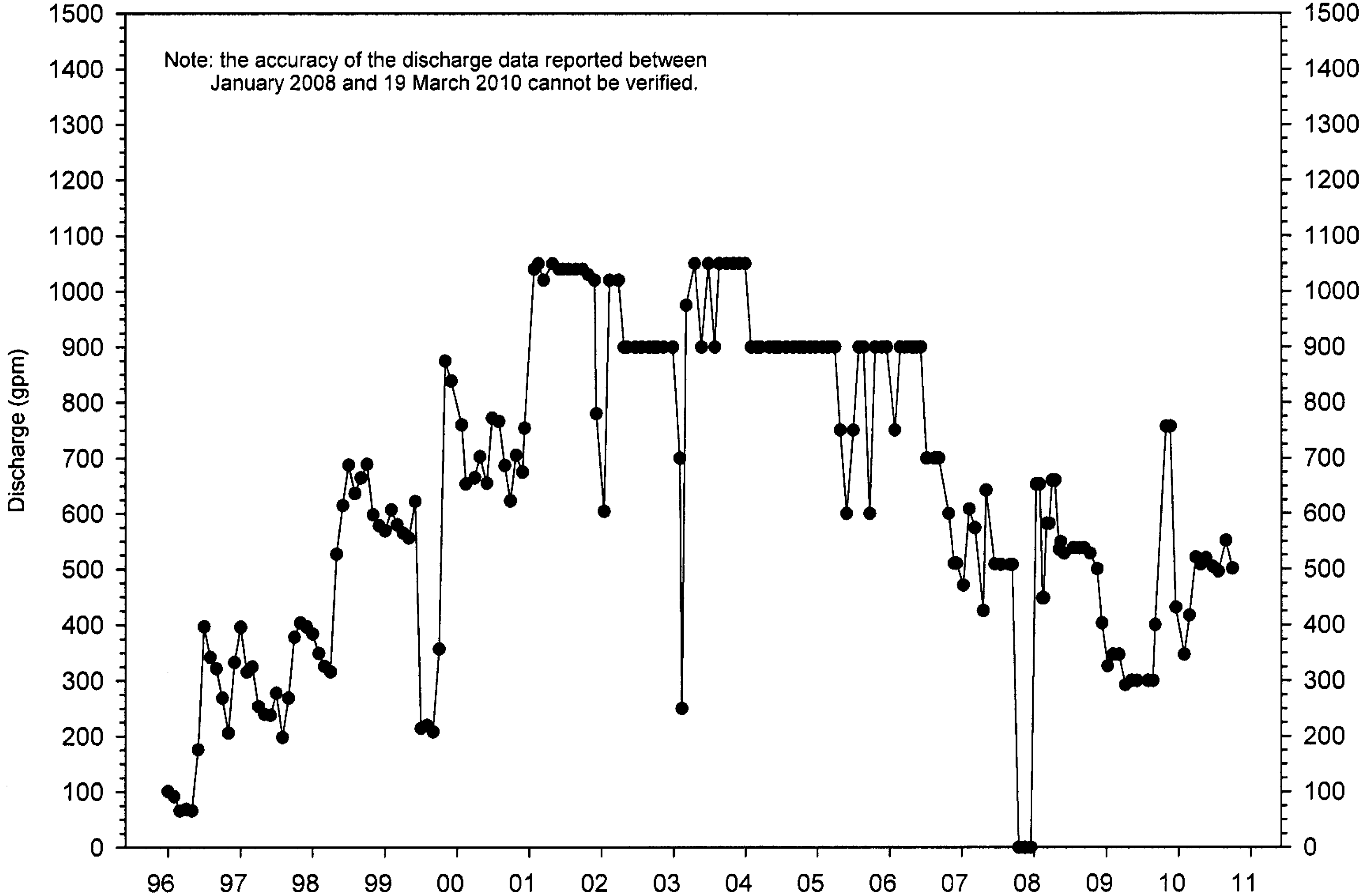


Figure PHC-1 Reported discharge for Crandall Canyon Mine (UPDES 002).

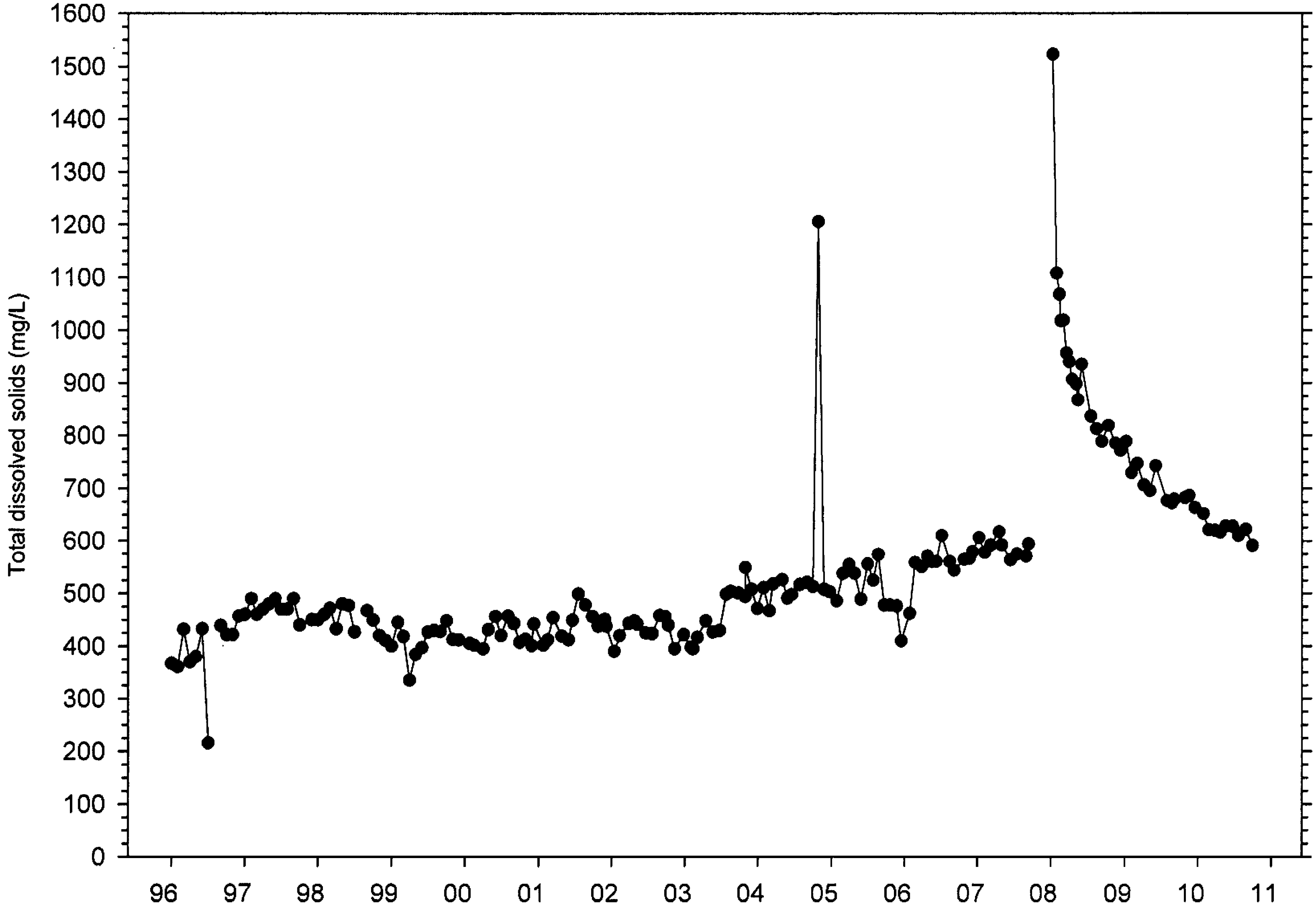


Figure PHC-2 Total dissolved solids (TDS) concentrations of Crandall Canyon Mine discharge waters.

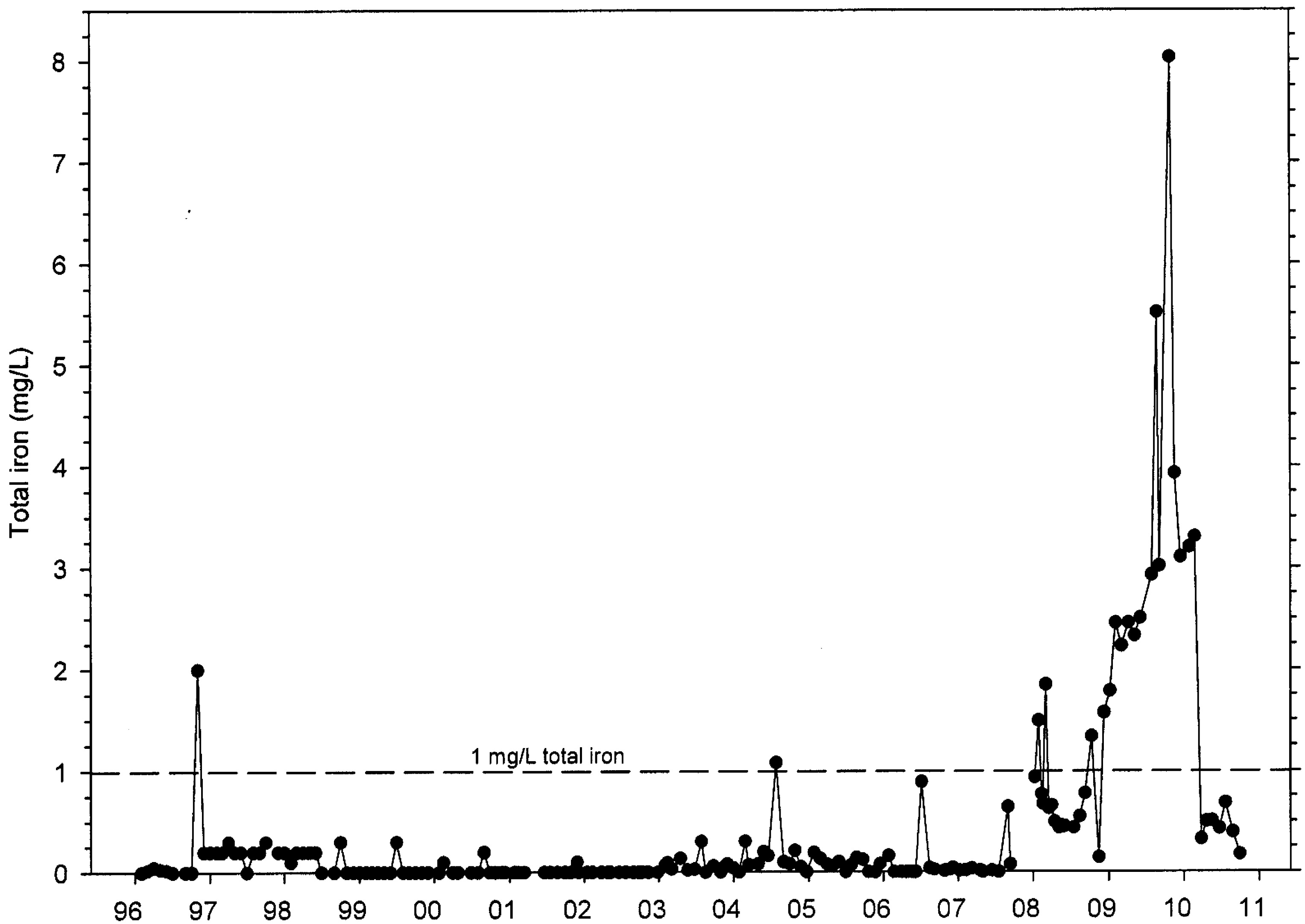


Figure PHC-3 Total iron concentrations of Crandall Canyon Mine discharge waters.

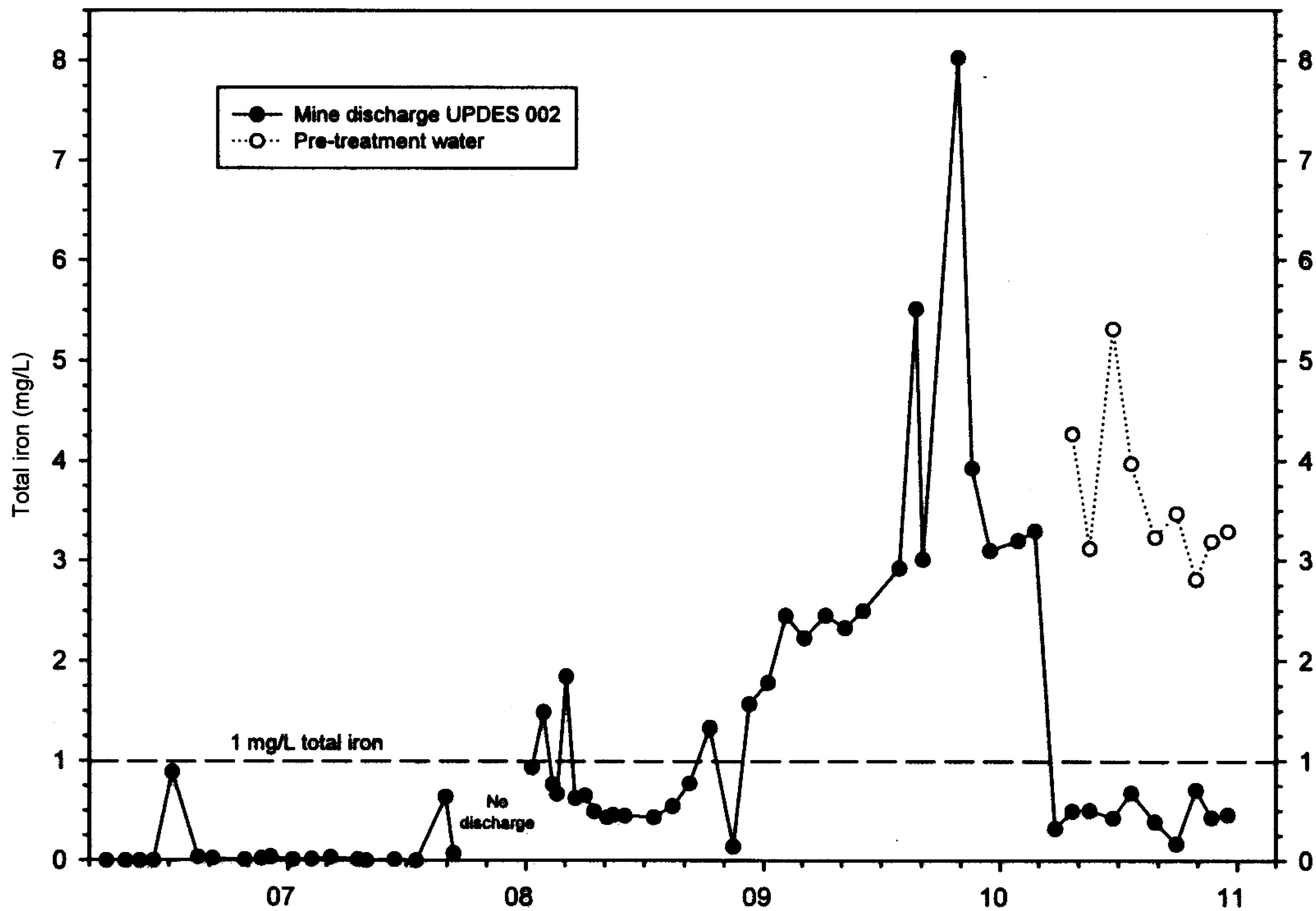
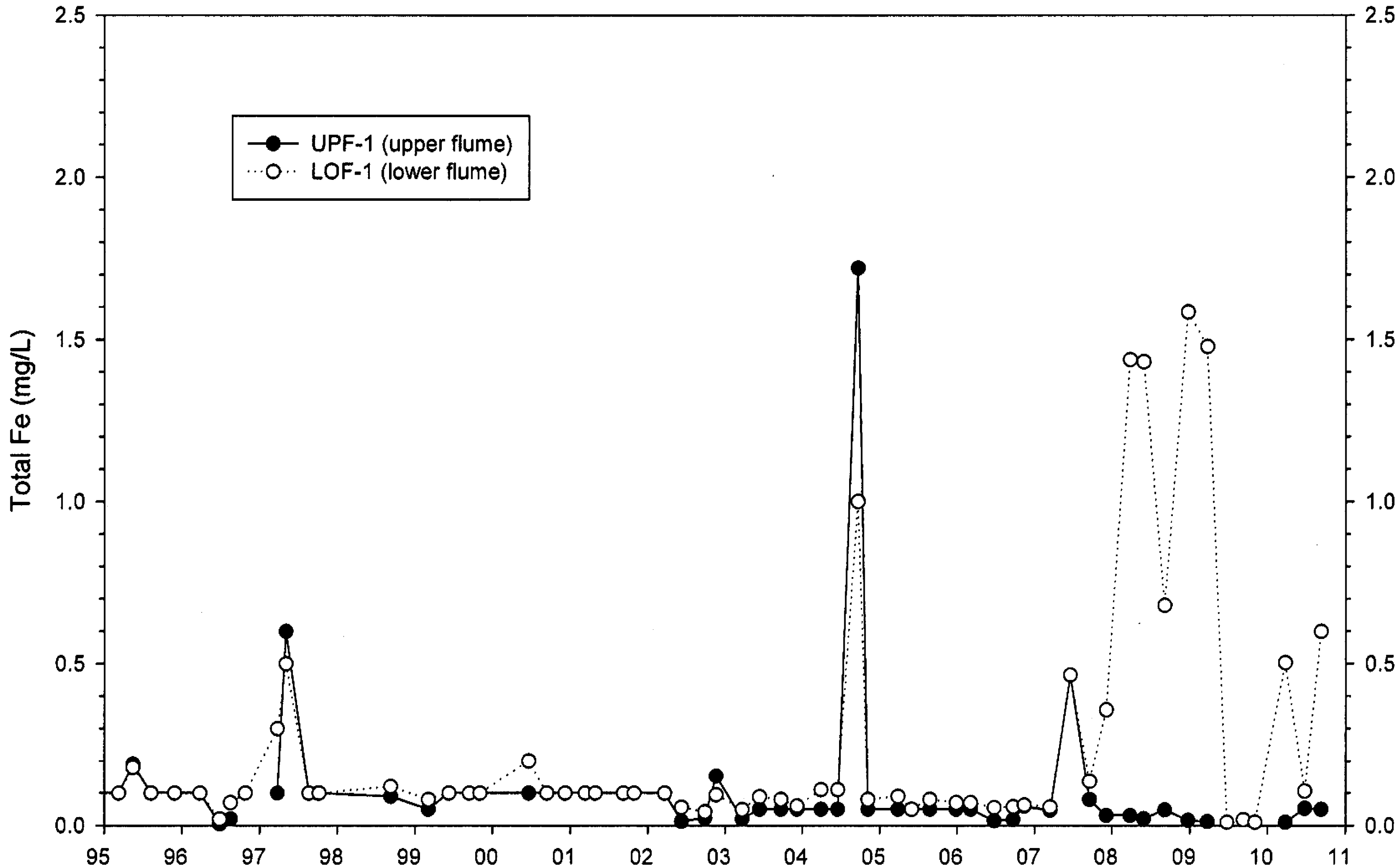


Figure PHC-4 Total iron concentrations of Crandall Canyon Mine discharge and pre-treatment water.



Note: for samples with non-detect laboratory results, the minimum laboratory detection limit value is plotted.

Figure PHC-5 Total iron concentrations in Crandall Creek water as measured at the upper and lower flumes.

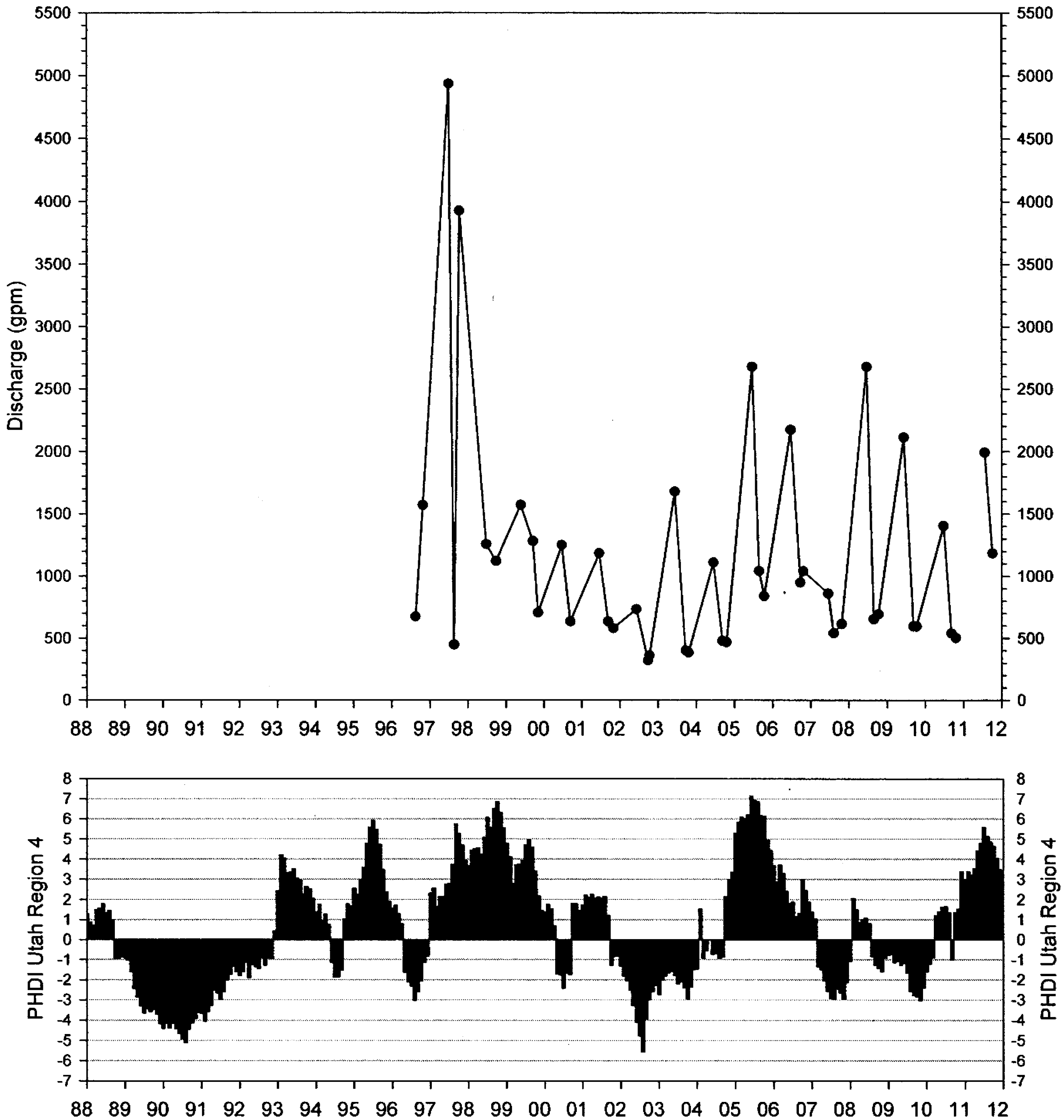


Figure PHC-6 Discharge hydrograph for Indian Creek and plot of the Palmer Hydrologic Drought Index (PHDI) for Utah Region 4.

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Investigation of Iron Concentrations in the Genwal Resources, Inc. Crandall Canyon Mine Discharge Water

7 November 2011

Genwal Resources, Inc.
Crandall Canyon Mine
East Carbon, Utah

PH

PETERSEN HYDROLOGIC, LLC
CONSULTANTS IN HYDROGEOLOGY

Investigation of Iron Concentrations in the Genwal Resources, Inc. Crandall Canyon Mine Discharge Water

7 November 2011

Genwal Resources, Inc.
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East Carbon, Utah

Prepared by:

LICENSED PROFESSIONAL GEOLOGIST
ERIK CARL PETERSEN
No. 5373615-2250
10 Nov 11
STATE OF UTAH

Erik C. Petersen, P.G.
Senior Hydrogeologist
Utah P.G. No. 5373615-2250

PETERSEN HYDROLOGIC
CONSULTANTS IN HYDROGEOLOGY

2695 N. 600 E.
LEHI, UTAH 84043
(801) 766-4006
PETERSEN@RELIA.NET

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Photo 2 Raw Crandall Canyon Mine discharge water collected from sampling port on 18 October 2011 (containers 1, and 3).

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1.0 Introduction

The Genwal Resources Inc. Crandall Canyon Mine is located in the Wasatch Plateau coal field approximately 15 miles northwest of the town of Huntington, Utah (Figure 1). On August 6, 2007, a major event occurred near the Main West pillar section of the Crandall Canyon Mine. The Crandall Canyon Mine is in a period of approved temporary cessation. Because of the obvious unplanned nature of this event, the routing of mine waters in some portions of the mine could no longer be controlled as these areas were rendered inaccessible. On 12 September 2007 the mine pumps were shut-off and discharge of mine water to the surface ceased. During October, November, and December 2007, no mine water discharged from the Crandall Canyon Mine. Commencing in early 2008, mine water began to spill from the mine portals as portions of the sealed mine workings became filled to a topographic level that allowed gravity discharge of the mine water to the surface through the mine portals.

In early 2010, Petersen Hydrologic, LLC performed an initial investigation of iron concentrations in water discharging from the Crandall Canyon Mine. The results of our initial investigation were summarized in a letter report submitted to Mr. Dave Shaver of Genwal Resources Inc.

At the time this initial investigation was performed, iron concentrations in the mine discharge water had recently been increasing. The conclusions of our 25 February 2010 investigation are summarized as follows:

- The initial spike in TDS concentrations observed in the gravity discharge from the Crandall Canyon Mine in early 2008 was believed to be attributable to the dissolution of soluble minerals or other matter in inundated portions of the mine. Upon flushing of these materials from the flooded mine areas over time, the TDS concentrations of mine discharge water were at that time gradually returning to near-previous levels.

- It was our opinion that the elevated iron concentrations observed in Crandall Canyon Mine discharge waters subsequent to the commencement of gravity drainage from the mine were likely attributable to the oxidation of pyrite or other sulfide minerals in newly inundated mining areas. We believe that the Division is now in agreement with this conclusion. It should be noted that at that time of our initial consultations with the Division, it had been their opinion that the primary source of the iron in the Crandall Canyon Mine discharge water was likely from the rusting of mining machinery and other metals left underground.

- It was considered unlikely that substantially elevated iron concentrations (> 1 mg/L) [1] would persist over long periods of time in the mine discharge water. This conclusion was based on the assumption that either 1) the available pyrite in the flooded mine workings would eventually be consumed through oxidation reactions, and/or 2) the underground environment would eventually become oxygen depleted, minimizing the chemical potential for future pyrite oxidation. Consequently, prolonged discharges of mine waters with concentrations exceeding about 1 mg/L were considered unlikely. This conclusion was also based largely on 1) the fact that sustained, elevated concentrations of iron were not observed in Crandall Canyon Mine discharge water in the roughly 10 years of mine discharge prior to the mine flooding event, and 2) the concept that there is no reason to believe that any substantial change to the fundamental geochemical regime of the rocks and coals in the mine environment occurred during the August 2007 mine collapse event – other than the subsequent

[1] At the time of the previous report production, the Crandall Canyon Mine UPDES limit for total iron was 1.0 mg/L. The Utah Division of Water Quality has now assigned a total iron UPDES limit of 1.2 mg/L.

flooding of some mine areas that had not previously been flooded with mine groundwaters when the mine pumps ceased their operation, and the emplacement of rubblized coal in mine openings in the mine collapse area.

2.0 New Hydrologic Data

Subsequent to the time of the production of our initial report, continuing routine collection of hydrologic data, including mine discharge water chemical compositions and mine discharge rate data, has occurred.

Genwal Resources, Inc. (Genwal) has continued to perform routine monitoring of mine water discharge rates and mine discharge water quality at the Crandall Canyon Mine (including sites UPDES 002 and the mine discharge water pre-treatment site. The requirements of the UPDES discharge permit specify a monthly monitoring frequency (12 per year) for the mine discharge water. Additionally, personnel from the Division collected 11 supplemental samples on a near-weekly basis during the period 10 March 2011 to 17 May 2011. During the last eight sampling events carried out by Division personnel, Genwal Resources, Inc. and Division personnel collected contemporaneous replicate samples. The mine discharge water samples (pre-treatment) were collected from a sampling manifold that is connected to the bottom of a raw mine water feed pipe at the iron treatment facility.

The Division-collected samples were analyzed by the Utah Unified State Laboratory. The Genwal samples were analyzed by an independent certified laboratory (SGS Mineral Services of Huntington, Utah). The total iron concentrations reported for the samples collected by Genwal and DOGM were generally in good agreement (although the results reported for the DOGM collected samples were always slightly lower than were the Genwal collected samples).

Samples of untreated mine discharge water were collected for laboratory analysis from a sampling port installed on a raw mine discharge water supply line at the Crandall Canyon

Mine iron treatment facility. The sampling port is plumbed into the raw mine water discharge line such that it 'tees" from the bottom of the pipe. The port is constructed with a vertical length of pipe (projecting downward) with two gate valves installed to control the flow of water through the port. Water samples are collected from a length of flexible plastic tubing attached to the lower gate valve. While raw mine water flows continuously through the mine water discharge pipe, the attached gate valves are almost always left in the "off" position, being opened only immediately prior to the collection of water samples. A written sampling protocol was not incorporated into the sampling program.

As a part of this investigation, samples of groundwater discharging by gravity drainage from three nearby abandoned coal mines in the Wasatch Plateau coal district were collected and analyzed for iron content. The purpose of this investigation was to gain insight into whether the coal seams of the Blackhawk Formation locally support sustained, long-term discharge of groundwaters with elevated iron concentrations. The three mine sites sampled included the following:

1. Mohrland Portal (King Mine No. 2) located in Cedar Creek Canyon approximately 7 miles east of the Crandall Canyon Mine. The King Mine No. 2 was active from 1896 to 1938. Together with the King Mine, Hiawatha Mine, Blackhawk Mine, and the Miller Canyon prospects, this mining complex produced more than 51 million tons of coal.

2. Winter Quarters Mine, located in Winter Quarters Canyon approximately 16 miles north of the Crandall Canyon Mine. The Winter Quarters Mines were active from 1878 to 1940s. The total coal production has been estimated at 10.8 million tons.

3. Unnamed mine near the Joes Valley Fault in the upper Left Fork of Huntington Creek drainage approximately 4 miles north of the Crandall Canyon Mine (the period of operation and the total coal production amount is unknown).

The nearby Huntington No. 4 Mine, located in Mill Fork Canyon approximately 2 miles south of the Crandall Canyon Mine was also inspected. The Huntington No. 4 Mine was reclaimed in the early 1980s. However, while gravity drainage of water from the reclaimed mine portal area had been observed by the author during the late 1990s, when the site was visited during late 2010, the discharge was no longer occurring.

3.0 Presentation of Data

The recent and historic discharge and water quality data from the Genwal Resources, Inc. monitoring activities at the Crandall Canyon Mine have been submitted electronically to the Division's coal water quality database. These data, which are utilized in this investigation, are freely available on the Division's internet site at: http://ogm.utah.gov/coal/edi/wqdb.htm.

A time-series plot of total iron concentration data for the Crandall Canyon Mine discharge waters are plotted on Figure 2 (For UPDES 002, Pre-Treatment Water, and Division-collected samples). A plot of the 6-month running average total iron concentrations in untreated Crandall Canyon Mine discharge water is presented in Figure 3. The 6-month running average data analysis technique for total iron concentrations in Figure 3 was implemented to simplify the analysis of longer term trends in the iron data. A 6-month running average value for a given month is obtained by calculating the average of the current month's laboratory result and the five preceding month's laboratory results. (It should be noted that during the second quarter of 2011, during which time a more frequent sampling interval was performed, the running average was calculated using the current and the five most recent data points). The running average data analysis technique typically results in a smoothed data plot which simplifies the identification of long-term trends while minimizing the noise and clutter of short-term data anomalies (such as potential sampling errors).

A plot of the monthly mine water discharge rates at the Crandall Canyon Mine is presented in Figure 4. A plot of the 6-month running average values for the mine discharge is presented in Figure 5 (the period during which there was no discharge from the mine during late 2007 was omitted from the running average flow rate calculation). A bar graph summarizing the average yearly mine water discharge rates are presented in Figure 6.

As mentioned by the Division in their 2 June 2011 Hydrologic Evaluation Update, several factors have complicated the performance of the mine water discharge flow measurements subsequent to the commencement of gravity mine water discharge at the Crandall Canyon Mine. (Prior to the temporary cessation of mining in 2007, flow measurements were generally performed using an in-line totalizing flow meter and are believed to be accurate). Accordingly, to independently determine the current discharge rate, an instantaneous discharge rate measurement was performed by Petersen Hydrologic, LLC on 18 October 2011. This measurement was performed at the outflow from the treatment facility to the UPDES 002 outflow point using a Marsh McBirney brand electromagnetic current velocity meter and wading rod. The result of that measurement (427 gpm) is similar to values recently reported to the Division by Genwal.

The results of the sampling of gravity mine water discharges from nearby abandoned coal mines is summarized in Table 1.

Laboratory reporting sheets are provided in the Appendix.

4.0 Discussion

As shown on Figure 2, after peaking in late 2009 and 2010, total iron concentrations in the mine discharge water have shown a gradual declining trend (see also 6-month running average plot in Figure 3). It remains our opinion that the iron in the discharge water is primarily derived from pyrite oxidation reactions in the flooded portions of the now sealed Crandall Canyon Mine. The Division is in agreement with this determination of the source of the iron (see the Division's Crandall Canyon Mine Hydrologic Evaluation Update, June 2, 2011). The observed general downward trend of the iron concentration data are consistent with our initial conclusion regarding the source of the iron and the conclusion that iron concentrations would decline over time. This decline is likely attributable to the combined affects of 1) chemical reactant depletion and reactant product flushing, and 2) the effects of preferential groundwater flow pathways.

The establishment of preferential groundwater flow pathways in an underground mining environment tends to enhance the effective flushing capacity of a given flow of groundwater as water is flushed continuously along the established pathways. Because of the relatively low rock/water ratio in an actively flushing preferential pathway area, there is an increased flushing potential in the actively flowing areas relative to the more stagnant, portions of the underground mine environment. In contrast, in the more stagnant portions of the underground flow regime (the "dead-end" mine entries for example) there is appreciably less movement of water passing the area, resulting in increased contact time of the stagnant water with surrounding rocks and coals and a greatly diminished potential for the transport of chemical reaction products away from the area.

In the professional experience of the author, it is not uncommon in Utah coal mines for waters gravity flowing from sealed mining areas to have appreciably better water quality characteristics (including lower iron concentrations) than do waters produced from relatively stagnant sealed areas by aggressive pumping and drawing down of pool levels. This effect is likely attributable primarily to the large differences in the rock/water ratios (See Mayo, Petersen, and Kravits, 2000) and increased residence times that exist between relatively stagnant, back-water portions of flooded mine workings and those portions of the flooded mine workings where water flow is actively occurring. In a similar way, it is likely that groundwater quality in those portions of the flooded Crandall Canyon Mine workings where preferential flow pathways to the surface have been established and active water flow conditions exist likely have improved water quality characteristics relative to the more stagnant, isolated portions of the mine.

The Division is wrong to conclude that somewhat elevated sulfate concentrations in the mine discharge water necessarily indicate that the rate of pyrite oxidation is not slowing. It is true that in some coal-mine geochemical regimes, the oxidation of pyrite is a dominant source of sulfate in associated mine discharge waters (and indeed, such may be the case in the Crandall Canyon Mine). However, it is not uncommon in coal mining environments that the dissolution of the evaporate minerals such as gypsum ($CaSO_4 \cdot 2H_2O$) or anhydrite ($CaSO_4$) can also be a major or principal source of sulfate in mine discharge waters. Locally in the Wasatch Plateau and adjacent areas, dissolution of other mineral species including thenardite (Na_2SO_4), mirabilite ($Na_2SO_4 \cdot 10H_2O$), and epsomite ($MgSO_4 \cdot 7H_2O$) may also be important sources of sulfate in groundwater. In the Division's analysis they incorrectly interpret Mayo, Petersen, and Kravits (2000) as stating that "*most sulfate in minewater discharge results from pyrite oxidation*". The findings of that investigation were from a case study of the Sufco Mine. In that study, while sulfide mineral oxidation was the primary source of sulfate in some portions of that mine, in other locations it was probably less significant than from the dissolution of gypsum or from other sources. The relative contribution of pyrite dissolution to sulfate concentrations described in the Journal of Hydrology paper was determined using site-specific solute and isotopic geochemical modeling (including $\delta^{34}S$ isotopic analysis). Indeed, as cited in the journal article, "Dissolution of gypsum, both native and gypsum dust previously used as rock dust, is also a significant contributor of SO_4^{2-}." Accordingly, it would not be correct to assume, as the Division did, that the modest increases in the sulfate concentrations in the Crandall Canyon Mine discharge water relative to surrounding groundwaters is wholly derived from pyrite oxidation.

As indicated in our previous report (Petersen Hydrologic, 2010), groundwater that flooded a large, sealed portion of the Skyline Mine (located about 11 miles north of the Crandall Canyon Mine) did not result in sustained discharges of mine water with elevated iron concentrations (see Figure 6 in Petersen Hydrologic (2010)). At the Skyline Mine location, fault-related groundwater inflow sources flowed into the mine workings and subsequently filled the sealed mining area by gravity flow. Upon reaching the elevation of the pumping station by gravity flow, the mine water was then pumped to the surface. After peaking in mid-2006, the iron concentrations in the mine discharge water declined gradually until reaching non-detect levels in mid 2009 (a period of approximately 3 years). It is noteworthy that this time frame is not inconsistent with the current trends in declining total iron concentrations at the Crandall Canyon Mine. The fact that the peak total iron concentration in the Skyline CS-14 discharge water was lower than that at the Crandall Canyon Mine may be a result of the appreciably greater magnitude of the flows encountered at the Skyline Mine location (several thousand gallons per minute at Skyline as compared to several hundred gallons per minute at Genwal – which is reflective of a considerably different rock/water ratio).

It is noteworthy that sulfate concentrations in the Crandall Canyon Mine discharge water (which ranged from 156 to 185 mg/L during the first 6 months of 2011) are not elevated relative to mine discharge waters from other Utah coal mines. Based on public information available from surrounding coal mines (UDOGM, 2011), it is evident that sulfate concentrations in mine discharge waters from surrounding coal mines that appreciably exceed 200 mg/L with total iron concentrations well below 1.2 mg/L are common. Notably, the sulfate concentration of mine water discharging from the Mohrland Portal (as monitored by the Bear Canyon Mine from 1994 to 2010; UDOGM 2011) averaged 329 mg/L, while total iron concentrations were consistently low (averaging less than 0.06 mg/L and not exceeding 0.10 mg/L). Most importantly, it should be stressed that regardless of the geochemical evolutionary pathway by which some of the sulfate in the Crandall Canyon Mine is derived, it is readily apparent that the total iron concentrations in the mine discharge water have declined appreciably in recent months (Figures 1 and 2) which is consistent with our previous projections of future declining total iron concentrations. The Division is wrong to conclude that iron concentrations have not declined and that the observed sulfate levels confirm that conclusion.

The Division's emphasis on geochemical reactions to explain the total iron content of the mine discharge is misplaced. The concentration of iron hydroxide particles in the mine discharge water at the mine mouth is largely controlled by the fluid flow regime within the mine, and not by the availability of chemical reactants or rates of reaction throughout the mine. The emergence of most of the iron in the discharge as solid iron hydroxide, rather than as aqueous dissolved iron species, demonstrates that the sequence of geochemical reactions discussed has largely reached its (irreversible) endpoint within the mine prior to discharge to the mine mouth. While the chemical reactions discussed at length by the Division predict that pyrite will dissolve upon contact with oxygenated water, and that a corresponding amount of solid iron hydroxide will subsequently form, they cannot predict the concentration of solid iron hydroxide in the discharge water.

The iron hydroxide particles emerge in the discharge because they are flushed from the mine workings by flowing water. Accordingly, they are only flushed from those portions of the flooded mine workings where the current velocity exceeds the settling velocity of the solid particles. If oxygenated water has reached the remainder of the flooded workings, and if pyrite is present, any iron dissolved and subsequently precipitated simply settles to the floor and does not contribute to the amount of iron reaching the surface (assuming an ample availability of oxygen as the Division asserts).

The flushing mechanism is significant because it demonstrates that only those portions of the flooded mine workings where the water current is strong enough to suspend iron hydroxide particles will contribute to observed total iron levels in the discharge (assuming a complete precipitation to ferric hydroxide in the presence of oxygenated water). Even if a large supply of unreacted pyrite exists elsewhere in the flooded workings, any iron liberated by its oxidation will not contribute to the observed iron discharge. Therefore, the Division's (unsupported) assumption that large amounts of pyrite exist in the mine has little value in predicting the extent and duration of iron-containing discharge at the mine mouth. It is more reasonable to conclude that the discharge of iron will persist only until the available precipitated iron has been flushed out of that portion of the mine where the current is swift enough to keep the particles suspended in the flow.

The Division is wrong to conclude that the recent total iron data, and in particular the single data point associated with a spike in total iron concentration observed on 27 April 2011, provide a scientific basis for concluding that total iron concentrations are not declining in the Crandall Canyon Mine discharge water. It is noteworthy that sharp, short-lived upward spikes in the total iron concentrations in samples from the mine discharge water have occurred periodically in the sampling history (Figure 2). However, downward spikes (relative to a more constant lower base concentration) are only rarely observed. It is my professional opinion that these upward spikes are likely a result of the inclusion of solid iron-bearing particulates in the collected water samples which elevate the measured total iron concentration above the current base (non-spike) level. This conclusion is supported by a close examination of the iron concentration data associated with a total iron spike (6.68 mg/L) that occurred on 27 April 2011 (UDOGM, 2011). When the total iron concentration was monitored only six days later (on 3 May 2011), the concentration was only 2.05 mg/L. It seems exceedingly unlikely that the bulk chemical composition of the iron concentration of the large volume of water held in the mine varied by more than 325% during that six day period. Rather, it seems much more likely that the measured spike was attributable to the inclusion of suspended iron hydroxide particulate matter in the collected water sample, which could have originated from any of several possible sources. As shown on Figure 8, for the Division to conclude that data from an anomalous single sampling event, which is bracketed both prior to and after the anomalous event by relatively constant data with a much lower total iron concentration from at least 12 monitoring events (22 laboratory analyses) over a time period of just 82 days does not seem justified.

To understand this condition, it should be remembered that the iron measured in a total iron (or total recoverable iron) analysis includes two fractions. These include 1) the iron that is present in the dissolved (filterable) form in the water, and 2) any additional iron that may be included in the water sample, which can include solid, iron-bearing particulate matter. A laboratory dissolved iron analysis measures the dissolved iron (ferrous and/or ferric ionic species) in a water sample. The dissolved iron analysis is performed by first filtering the water sample through a 0.45μm filter which removes any particles larger than 0.45μm (which would include any suspended iron hydroxide particles present in the sample), leaving only the dissolved ionic iron species in the water sample (note that the average dissolved iron concentration in the Crandall Canyon Mine discharge water for the first six months of 2011 is only 0.36 mg/L).

By comparison, a total iron analysis is performed on a raw water sample that includes the dissolved fraction plus any particulate matter that may be present at the time of sampling. Such matter could include dirt, rust particles from metal pipes, or suspended iron-hydroxide precipitate which is pervasive throughout the Crandall Canyon Mine discharge piping, treatment system, and sampling ports and apparatus. Prior to the performance of the total iron analysis, the contents of the sample (water and any included particulate matter) are digested under heat using a strong acid to convert solid iron-containing matter into ionic iron species that are included in the analysis. Accordingly, any iron contained in the particulate matter at the time of sampling is included in the total iron laboratory result.

As part of this investigation, we have specifically evaluated the 27 April 2011 total iron spike in the Crandall Canyon Mine discharge pre-treatment water sample (Figure 2). On 18 October 2011 the mine discharge pre-treatment sampling site located at the Crandall Canyon Mine iron treatment facility was visited and inspected by the author. Information regarding previous sampling procedures followed by Genwal and Division personnel during the collection of pre-treatment water samples was reviewed with Genwal personnel (Personal communication, Dana Marrelli, 2011). During this visit, a sample of the raw mine water (pre-treatment) was collected. In order to assure that as much particulate matter was flushed from the sampling port as possible, an extended purging of the sampling port was performed during this sampling event. For visual inspection of the progression and completeness of the purge, new, unpreserved plastic bottles were filled with the purge water at approximately 15-minute intervals. Sample containers filled with water from the first approximately 45 minutes of the purge were subsequently photographed (See Photograph Section of this report). Upon visual inspection, it is immediately apparent that the bottle filled with water after a purge period of approximately 15 minutes contained appreciably more suspended iron hydroxide particulate matter than did the sample collected after 30 minutes of purging. After approximately 45 minutes of purging, the collected sample contained visibly less iron particulate matter than did the sample collected after approximately 30 minutes of purging, though the difference was less substantial than between the first two samples.

The significance of this observation is that it clearly suggests that iron hydroxide particulates were being flushed from the sampling apparatus for at least the first ½ hour subsequent to the opening of the sampling port valve. This condition is likely related to the design of the sampling port, with the apparatus (which likely contains lots of "nooks and crannies" associated with the valves and couplings) being suspended below the larger raw water feed line. In other words, iron hydroxide particles can accumulate in this "sump" during the extended periods of time the valve is left in the "off" position. Depending on the fluid velocities, the degree of solidification or compaction of the particulate matter within the port, and the amount of iron particulate that may have accumulated since the port was last purged, it may require an appreciable amount of time for the particulate matter to be completely flushed from the sampling system. Additionally, it is possible that iron hydroxide particulate matter may accumulate in some locations within the raw water feed pipes upstream of the sampling port. While some particles may adhere to the inside of a pipe under the constant, laminar flow conditions, when the fluid dynamics in the pipe are altered by the opening of the sampling port valve (e.g. inducing turbulence) some of these particles may become dislodged and flow into the sampling port. In the absence of any written protocol, Genwal personnel have routinely collected samples of the pre-treatment water after a purge of only a few to several minutes. It is apparent that in collecting their replicate samples of mine discharge pre-treatment water, Division personnel likewise may not have allowed a sufficient purge time before collecting their samples (Personal communication, Dana Marrelli, 2011). It is interesting to note that, as indicated by Genwal personnel, it was generally the case that when the replicate samples of the pre-treatment water were collected by Genwal and the Division, the Division samples were typically collected after the Genwal sampling had been completed. Whether the additional purge time that transpired between the collection of the Genwal samples and the later collection of the Division samples contributed to the observed uniformly lower total iron concentrations determined from the Division's samples is unknown. However, it seems likely that during the 27 April 2011 replicate monitoring event, the purge state of the sampling port at the time of sampling was likely not complete and this condition may have resulted in the iron spike determined at the laboratory. This conclusion is based on the fact that the total iron samples from that date were collected perhaps a few minutes apart. However, the total iron concentrations measured by Genwal and the Division (6.68 mg/L and 5.0 mg/L) vary by 1.68 mg/L. The analytical laboratory utilized by Genwal (SGS Minerals Services of Huntington, Utah) reports a detection limit of 0.05 mg/L for the total iron analysis. Assuming similar accuracy in the total iron determination performed by the Utah Unified State Laboratory, then it is follows that the total iron concentrations in the two sample containers at the time of collection were not the same, and that the sample collected by the Division after the collection of Genwal's sample contained less total iron. This observation suggests the possibility that the samples collected on 27 April 2011 were likely collected prior to the complete flushing of the sampling port apparatus. Accordingly, the elevated iron concentrations measured on that date were likely associated with the inclusion of an unrepresentative amount of iron hydroxide particulate matter flushing from the sampling port, and not as a result of a spike in the total iron concentration in the Crandall Canyon mine discharge water itself (in other words, this was likely a sampling error).

While we cannot determine with certainty the causes of all of the total iron spikes that have occurred in the past, it is my professional opinion that the lack of an adequate purging of the sampling port, raw mine water feed piping, or other portions of the sampling apparatus could likely have been largely responsible for the observed spikes that have occurred while the sampling apparatus has been operative in its current condition.

It should be noted that the since March 2010 total iron concentrations of the mine discharge waters monitored at UPDES 002, which have undergone chemical treatment at the mine's iron treatment facility, have been continuously below 1 mg/L and in compliance with the UPDES permit requirements.

While it seems to be the position of the Division that extreme, unprecedented changes to the groundwater regimes at the Crandall Canyon Mine occurred as a result of the August 2007 "catastrophic mine collapse", we do not see evidence that such is the case. This conclusion is based on the fact that:

1) The rate of discharge from the Crandall Canyon Mine at the commencement of mine water gravity discharge is essentially the same as it was just prior to the 2007 collapse event, and the gradual decline in discharge rates that began in the early 2000s (Figures 4, 5, and 6) continues, suggesting that interception of groundwater from any potential newly-fractured overlying horizons resulting from the collapse has not occurred. It is noteworthy that in down-hole videos of the emergency mine rescue drill holes in the collapse area that were reviewed by the author, it was apparent that the coal rubble present in the entryways likely originated primarily from rib bursts, while the mine roof rock appeared to be largely intact. Observations of video footage of the rock strata within the boreholes immediately overlying the coal seam likewise did not appear to have been catastrophically impacted.

2) The Division cites an MSHA report[2] indicating that the area of collapsed pillars associated with the 2007 event is on the order of 40 acres, which is not dissimilar in general scale to the size of a typical Crandall Canyon Mine longwall panel, and is much smaller than the adjacent mining areas situated immediately to both the north and south, which experienced years of longwall-related subsidence,

3) Four years of quarterly hydrologic monitoring data collected from springs and streams overlying and surrounding the area of the collapse event have not shown any pronounced changes in discharge rates, water quality characteristics, or any other observable conditions that could be attributed to the 2007 collapse event (UDOGM, 2011).

[2] Genwal Resources, Inc. does not endorse the accuracy or the conclusions in the MSHA report referenced by the Division.

The Division indicates in its 7 June 2010 report that in the future "the flow path of the mine-water could be easily altered and previously non-exposed areas of pyritic material could become inundated with mine water". Their conclusion is entirely speculative. While it is possible that some additional subsidence of the overburden overlying the Crandall Canyon Mine workings could occur in the future, the fact that now more than four years have transpired without the occurrence of any major ground movement seems to minimize the likelihood of such an occurrence in the future. Particularly, the potential for movement within the mine workings of a magnitude that would cause a substantial change to the topographic gradient of the mine floor, to the extent that previously dry mining areas would become flooded, seems highly unlikely.

In the findings section of their 2 June 2011 hydrologic evaluation update, the Division finds that "The Crandall Canyon Mine has been discharging for approximately 14 years. There has been no indication of diminution of flow, nor is there any indication that the flow will diminish in the foreseeable future". This conclusion is incorrect. As plotted in Figure 4, it is readily apparent that after peaking in the early 2000s, the mine discharge rate plot indicates a downward trend beginning around 2004. This trend is more readily discernable in the 6-month running average plot for mine discharge shown in Figure 5. Additionally, the yearly-average mine discharge rates plotted in Figure 6 show an obvious generally declining trend, and do not correlate with recent climatic trends. It is notable from Figure 6 that the average yearly discharge rate for 2011 (first 6 months) is less than half the average rate for 2001, clearly demonstrating the declining trend in mine water discharge rates. Although a detailed analysis of the reasons for the declining mine discharge water flow rates is beyond the scope of this investigation, the observed declines are likely the result of two main factors. These include 1) with a decrease in the mining rate or a cessation of mining activities, the potential for the underground interception and exposure of water-bearing features in the subsurface is minimized or ceases, and 2) over time it is common for discharge rates from intercepted underground water-bearing features in the Wasatch Plateau coal district to decline as the contained water is gradually drained.

Genwal Resources personnel indicate that recent increases in the mine discharge rate seem to correlate with the passage of weather fronts or the onset of cold weather (Personal communication, Dana Marrelli, 2011). It is important to note that these flow rate changes occur even in the absence of *any* associated precipitation. This seems to suggest the likelihood that the temporary increases in mine water discharge rate are associated with barometric pressure effects acting on the underground mine pool. There is no indication that the occasionally observed increases in flow are in any way tied to any potential nearly immediate infiltration of precipitation waters into the underground mine workings.

Long-term iron discharges from coal mines in the Blackhawk Formation in Utah's Wasatch Plateau mining district are not known to occur. In order to better understand whether the coal seams of the Blackhawk Formation locally support sustained, long-term discharge of groundwaters with elevated iron concentrations (as assumed by the Division), gravity discharges from three abandoned coal mines were inspected and sampled as part of this investigation. Gravity discharge of mine groundwater has occurred from each of the three visited mines for many years. The discharge rates for these mines range from a few gallons per minute at the Winter Quarters and Left Fork mines to several hundred gallons per minute at the Mohrland Portal. Neither total nor dissolved iron concentrations at any of the three mine discharges exceeded 0.05 mg/L (Table 1). In other words, the iron concentrations in these abandoned mine discharges are at least ***24 times*** below a 1.2 mg/L UPDES limit. While this information does not does not of itself indicate when discharge of groundwater with elevated iron concentrations at the Crandall Canyon Mine will abate, it does strongly support the conclusion that the geochemical regimes in these three surrounding lower Blackhawk Formation coal mines do not support long-term discharges with elevated iron concentrations.

5.0 Projections of Likely Future Iron Concentrations

Prior to a discussion of potential future iron concentration trends at the Crandall Canyon Mine, it is important to emphasize that because the mine workings are sealed, it is not possible to observe physical conditions within the Crandall Canyon Mine workings. Consequently, our capability to fully characterize the underground hydrogeochemical regime is limited. However, based on the existing data set and upon our previous professional experience relating to iron geochemical behavior in underground mining environments, as part of this investigation, we have provided projections of possible future trends in iron concentrations in the Crandall Canyon Mine discharge water. It should be emphasized that the projections provided here should not be considered to be absolute predictors of future iron concentrations over time in the mine. Rather the plotted trends are provided to show reasonably plausible future trends for future iron concentrations based on the existing data and professional experience. Importantly, these trends are provided to illustrate the likely magnitude of future trends (i.e., with concentrations likely declining to levels below 1.2 mg/L within in a few years, not decades). These trends are shown graphically on Figure 7.

The first projection shown on Figure 7 (in blue) shows a mathematically calculated statistical linear regression of the pre-treatment data for the period 21 April 2010 through 18 October 2011. The linear regression line (which essentially assumes that the recent total iron concentration trends will continue into the future) intercepts the 1.2 mg/L UPDES limit at approximately mid-2012. This projection appears visually consistent with the existing historical data assuming that the declining concentration limb of the recession curve is quasi-symmetrical with the increasing limb of the curve.

It is likely that the future trend in the total iron concentration will follow an exponential decay curve. Such a decay curve was observed previously in the Crandall Canyon Mine discharge data for the total dissolved solids concentration of mine discharge water subsequent to the onset of gravity drainage (See Figure 3 of the Petersen Hydrologic (2010) report). A reasonably plausible exponential decay curve trend for total iron concentrations in the Crandall Canyon Mine discharge water is shown in green on Figure 7. The plotted exponential decay curve trend intersects the 1.2 mg/L total iron concentration line at approximately the end of 2013. Again, it should be emphasized that this projection is intended for use as a reasonable predictor of the order of future decline rates and is not intended as an absolute prediction of future concentrations. However, it should be noted that because the most recent total iron concentration in the mine discharge water (2.15 mg/L) is only 0.95 mg/L above the UPDES discharge limit, it would be difficult to draw a reasonable hypothetical decay curve that would intersect the 1.2 mg/L line at a time significantly further in the future than that plotted on Figure 7.

6.0 Conclusions

- It remains our opinion that the elevated iron concentrations observed in Crandall Canyon Mine discharge waters are likely attributable to the oxidation of pyrite or other sulfide minerals in flooded portions of the mine. While the minor dissolved iron fraction of the total iron present in the mine discharge water is transported in the aqueous solution, the more substantial iron hydroxide particulate fraction is transported only where the water current is sufficient to flush the solid particles to the discharge location.

- We are not aware of any special geologic conditions at the Crandall Canyon Mine that would result in probable long-term elevated concentrations of total iron in the mine discharge water. The fact that historic (pre-2007) total iron concentrations in Crandall Canyon Mine discharge waters were consistently low, even though most of the mine discharge water was historically collected from the mine floor after running considerable distances through mine longwall gob areas and elsewhere over the mine floor, does not suggest that there is any unusual iron-generating potential in the Crandall Canyon Mine geochemical environment relative to other mines in the region.

- An investigation of gravity mine-water discharges from three surrounding abandoned coal mines suggests that long-term discharges with elevated iron concentrations from the coal seams of the lower Blackhawk Formation will not occur.

- It remains my professional opinion that the iron concentrations in the Crandall Canyon Mine discharge water will likely continue to decline over time as the necessary reactants are gradually consumed and flushed from actively flowing portions of the flooded underground mine workings. It is also my professional opinion that iron concentrations in the mine discharge water will likely not exceed the UPDES limit of 1.2 mg/L for a prolonged period of time.

- Based on the projections presented in Figure 7, it is apparent that the iron concentrations in the Crandall Canyon Mine discharge water will likely drop below 1.2 mg/L within a reasonable timeframe, likely on the order of a few years (not decades). Extrapolating a future exponential decay curve from recent trends, as shown on Figure 7, this condition could occur perhaps by the end of 2013. In my professional opinion, there is no reasonable potential for a "perpetual" discharge of mine water with elevated total iron concentrations.

- Elevated sulfate concentrations do not necessarily evidence high rates of continuing pyrite oxidation. In their 2 June 2011 findings, the Division indicates that "there is no indication that the rate of pyrite oxidation is slowing". In the general sense, this conclusion is not consistent with the total iron data that has been presented to the Division, which clearly shows a declining iron concentration in mine water since about early 2010. The Division apparently bases this conclusion largely on the sulfate concentrations of the mine discharge water (which conclusions are based at least in part on a flawed interpretation of the Mayo, Petersen, and Kravits (2000) Journal of Hydrology article). Regardless of the geochemical evolutionary pathway by which some of the sulfate in the Crandall Canyon Mine is derived, it is readily apparent that the total iron concentrations in the mine discharge water have declined appreciably in recent months, which is consistent with our previous projections of future declining total iron concentrations.

- Iron concentrations are declining toward compliance levels. We find no basis for the Division's assertion in their 2 June 2011 finding that "iron concentrations have not declined". This conclusion appears entirely inconsistent with the data plotted in Figures 2 and 3. We vigorously disagree with this finding.

- There are no data to support an expectation of perpetual iron-containing discharge from the Crandall Canyon Mine. The Division's 2 June 2011 finding that "the available data support the likelihood of a perpetual discharge of mine water containing elevated concentrations of iron which will require treatment into the foreseeable future" seems to ignore the current trends in total iron data as plotted in Figures 2 and 3. We vigorously disagree with this finding.

7.0 References Cited

Mayo, A.L., Petersen, E.C., Kravits, C., 2000, Chemical evolution of coal mine drainage in a non-acid producing environment, Wasatch Plateau, Ut., Journal of Hydrology 236: 1-16.

Petersen Hydrologic, LLC, 2010, Investigation of iron concentrations in mine discharge waters from the Genwal Resources, Inc. Crandall Canyon Mine, unpublished consulting letter report to Mr. Dave Shaver of Genwal Resources, Inc.

UDOGM, 2011, DOGM on-line water quality database, http://ogm.utah.gov/coal/edi/wqdb.htm

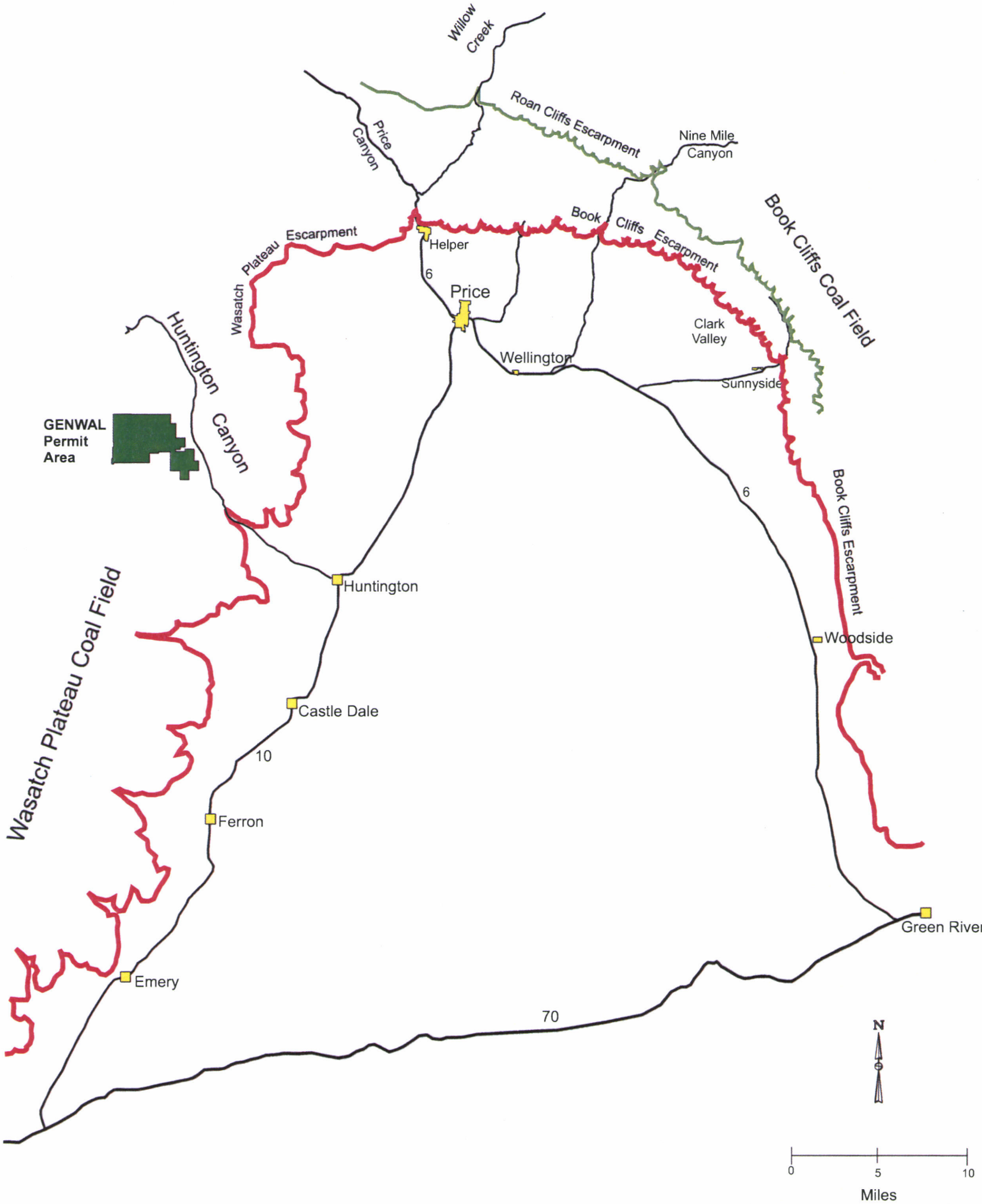


Figure 1 Location of the Genwal Resources, Inc. Crandall Canyon Mine.

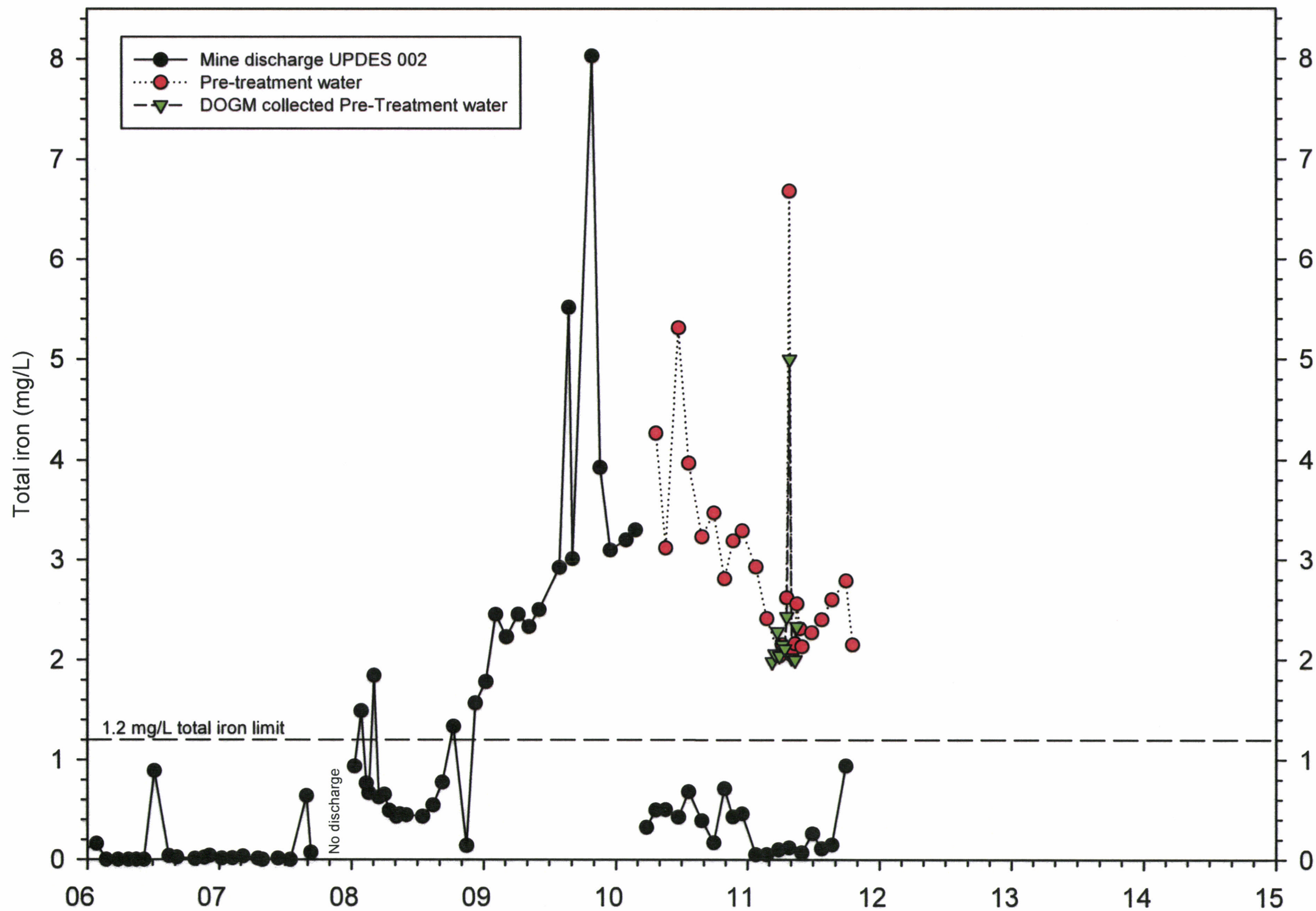


Figure 2 Plots of total iron concentrations in Crandall Canyon Mine discharge water and treated mine discharge water.

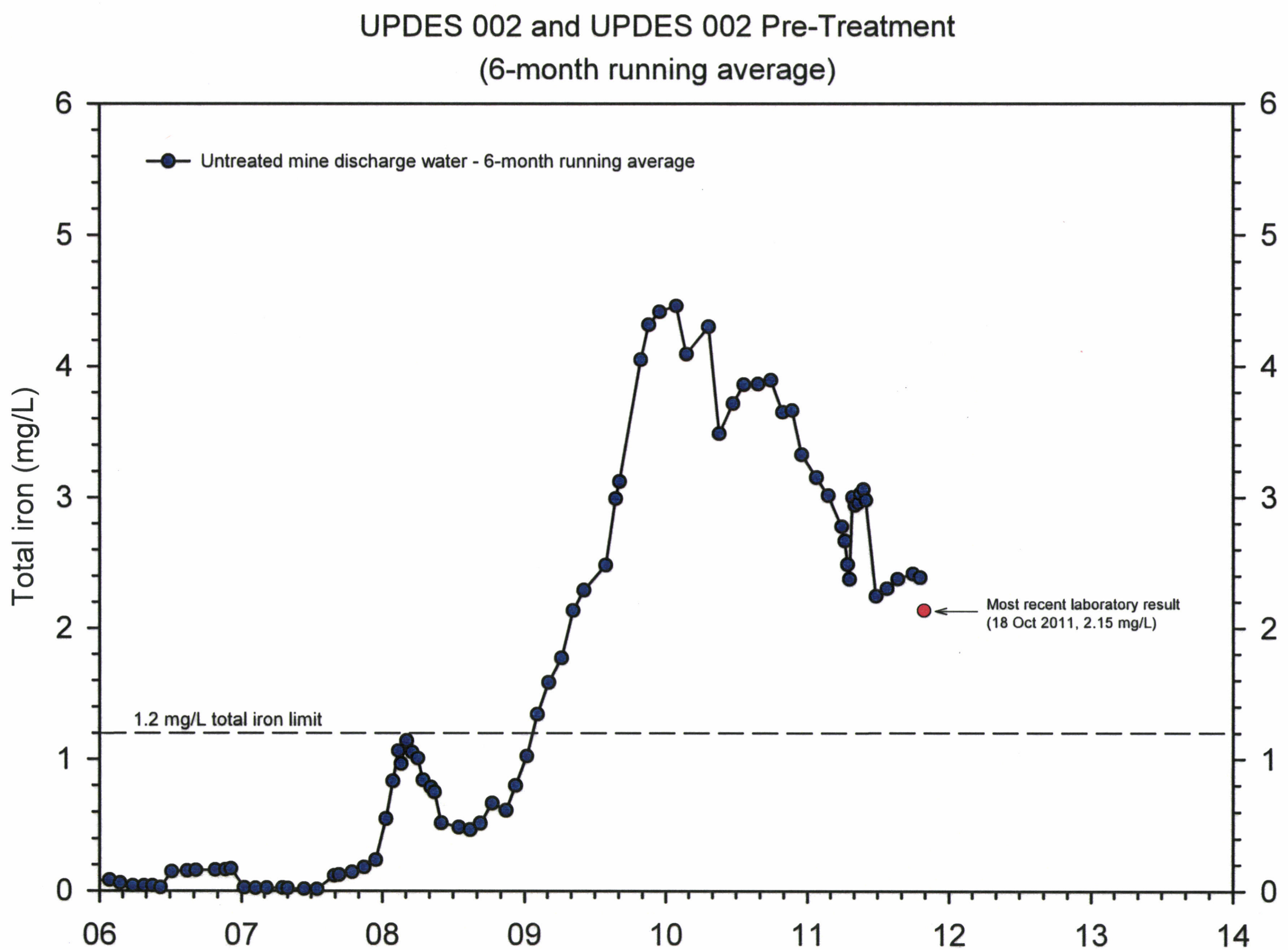


Figure 3 Plot of 6-month running average of total iron concentrations in untreated Crandall Canyon Mine discharge water.

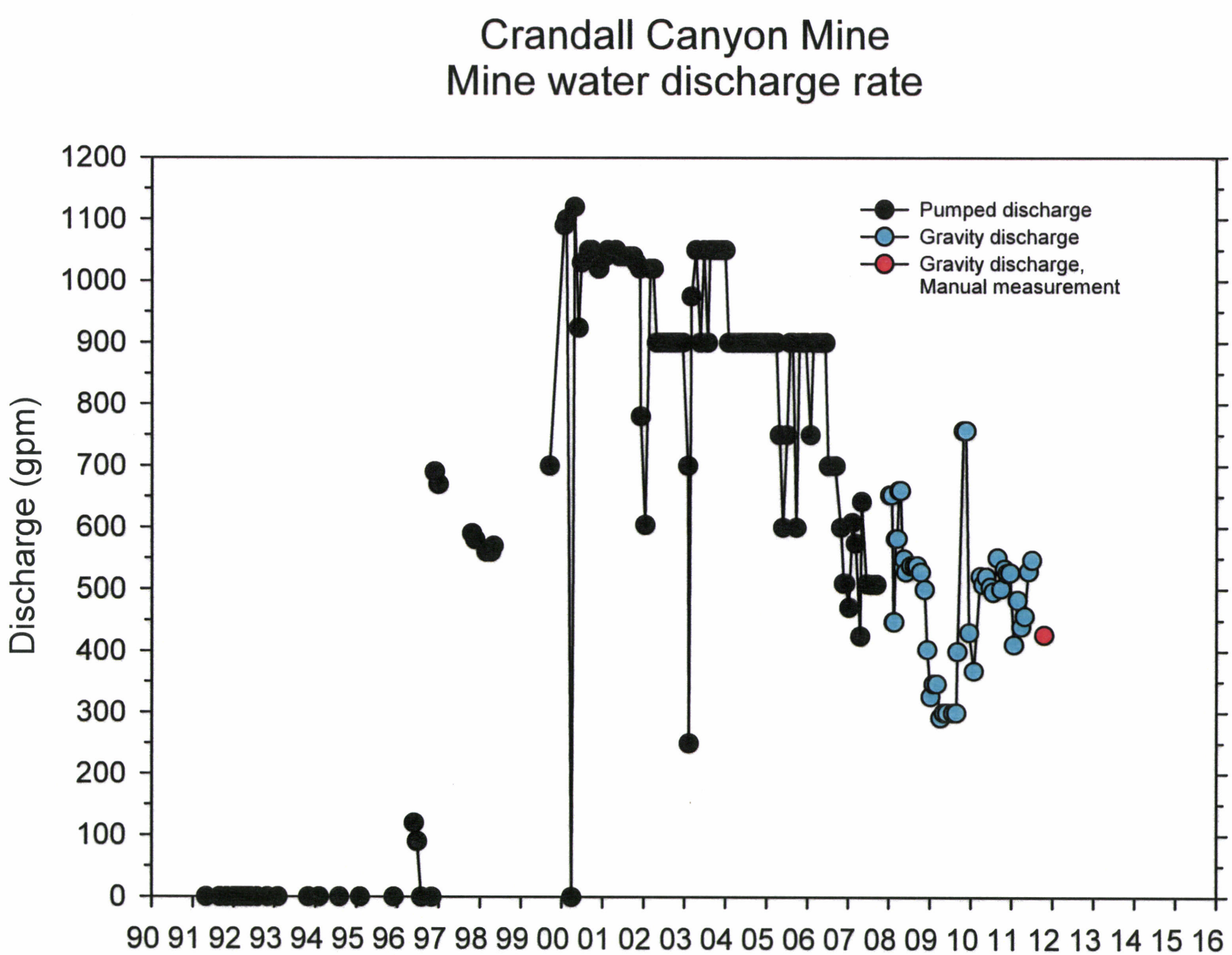


Figure 4 Plot of Crandall Canyon Mine discharge rates.

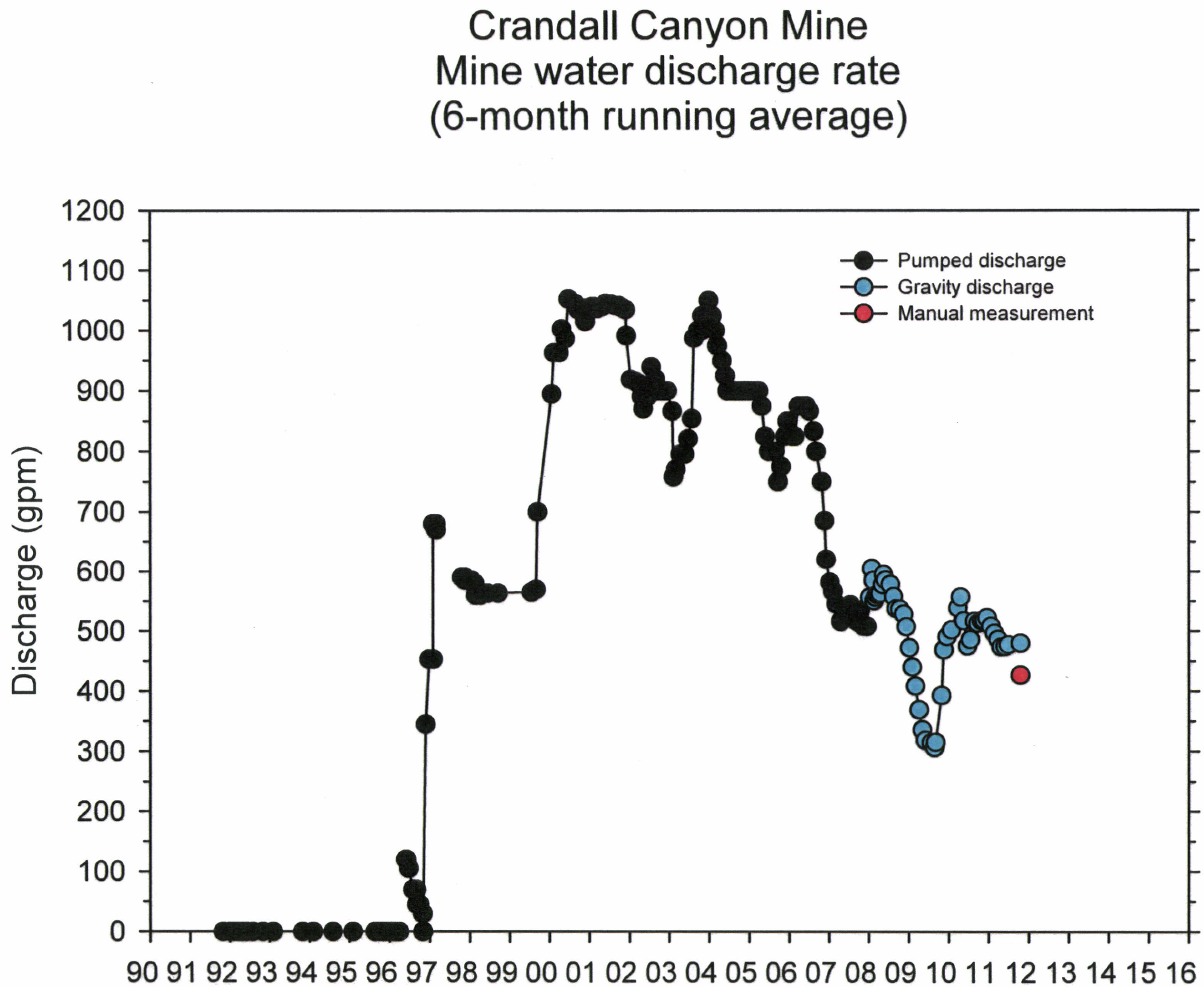


Figure 5 Plot of Crandall Canyon Mine discharge rates, 6-month running average.

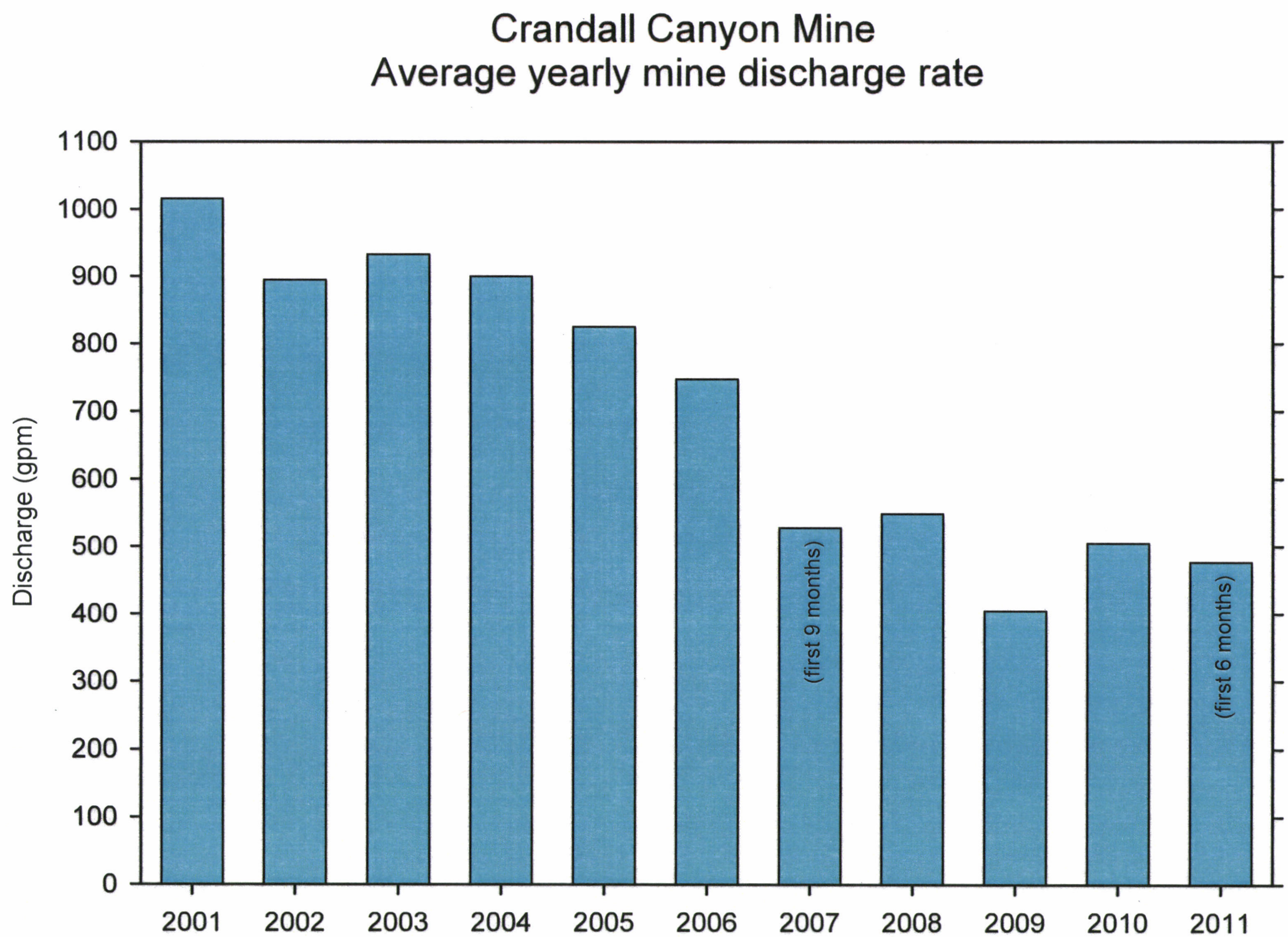


Figure 6 Average yearly mine water discharge rates for the Crandall Canyon Mine.

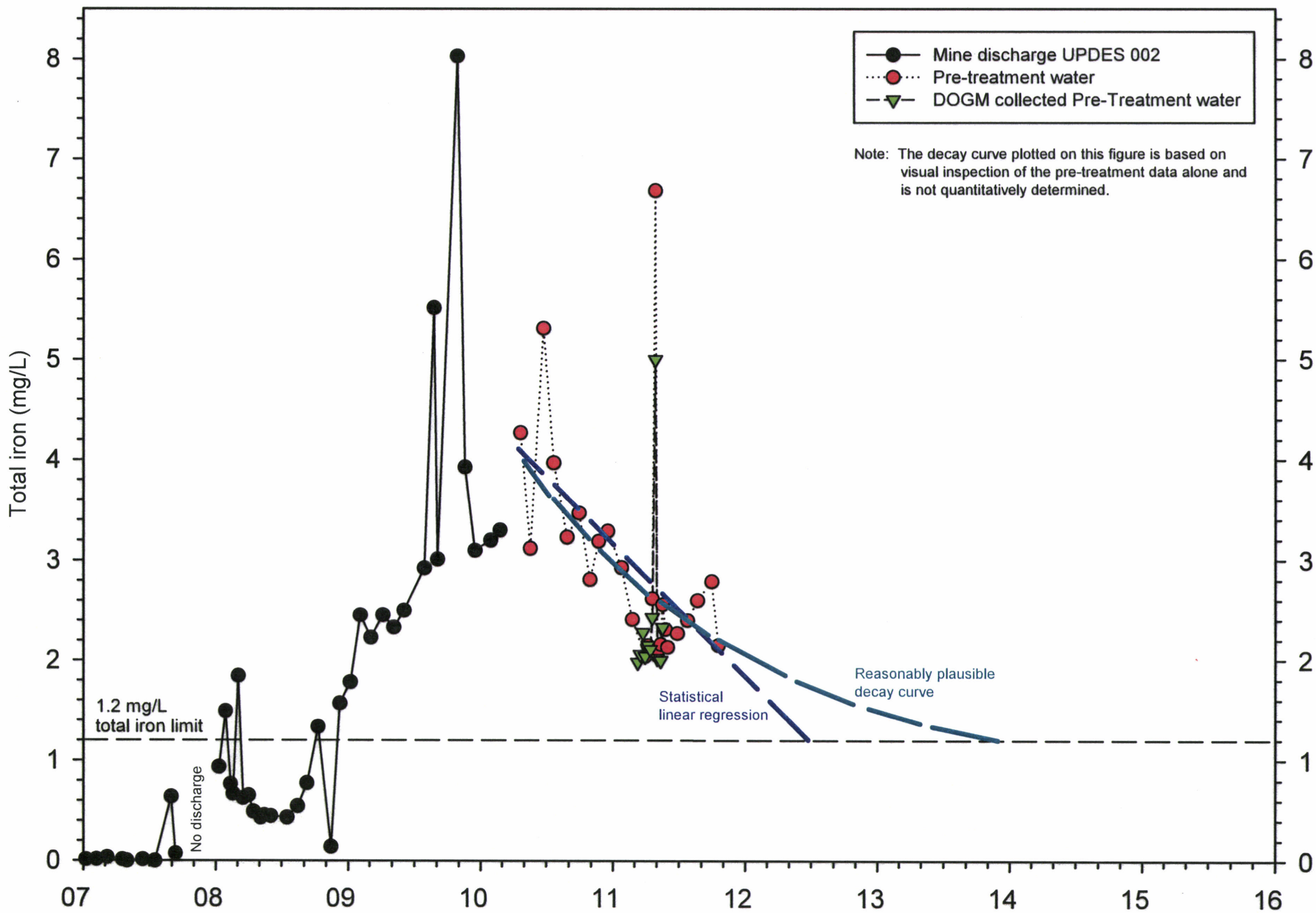


Figure 7 Possible future trends for iron concentrations in untreated mine discharge water (based on pre-treatment data).

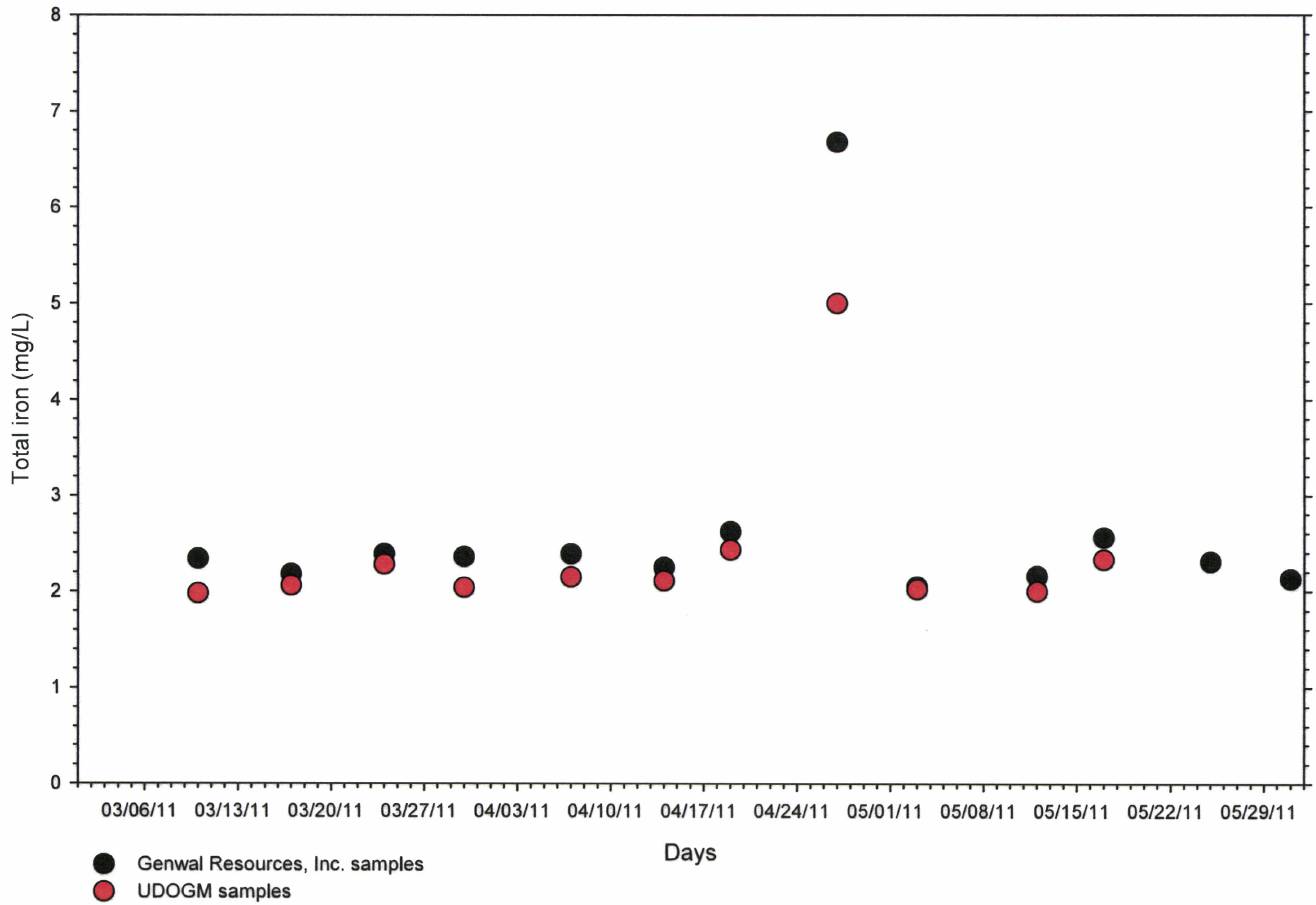


Figure 8 Measured total iron concentrations in mine discharge pre-treatment samples collected from 10 March 2011 to 31 May 2011.

Table 1 Water quality data for gravity groundwater discharges associated with abandoned coal mines in the Wasatch Plateau coal district.

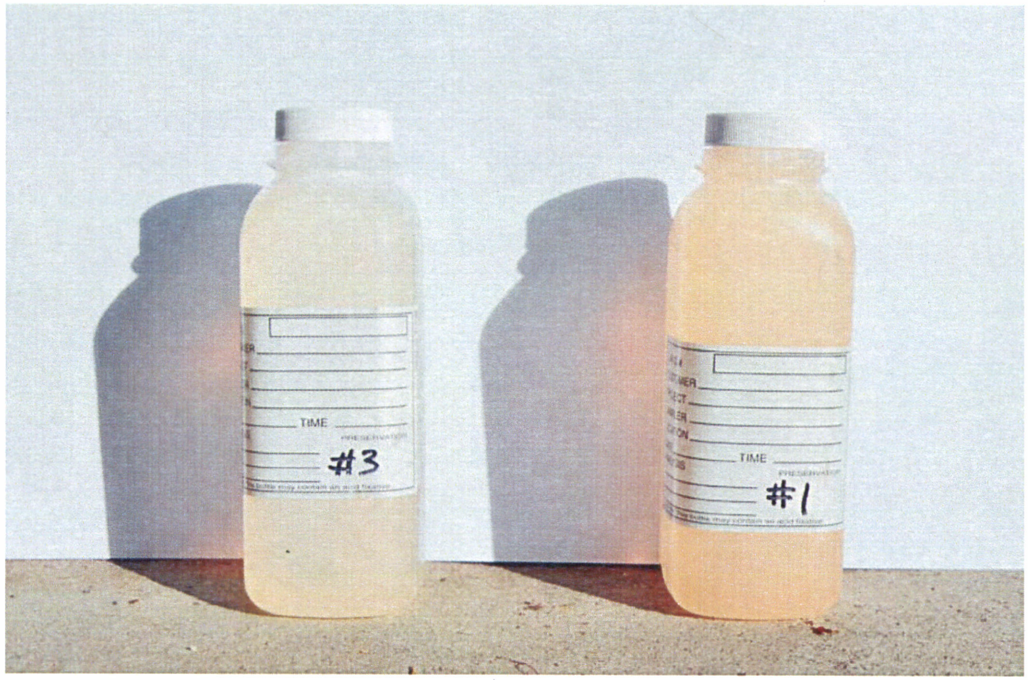
	Location	UTM, Nad 27		Sample date	T (°C)	pH S.U.	Cond. (µS/cm)	D.O. (mg/L)	Fe (d) (mg/L)	Fe (t) (mg/L)
Mohrland Portal	Sec. 8, T. 16 S., R. 8 E.	496623	4365707	23-Sep-10	12.0	7.02	1052	7.37	<0.03	0.05
Winter Quarters Mine portal	Sec. 6, T. 13 S., R. 7 E.	483785	4396466	17-Sep-10	8.5	6.65	1285	6.41	<0.03	<0.05
Joes Valley Mine spring (Left Fork Huntington)*	Sec. 2, T. 15 S., R. 6 E.	480985	4376891	20-Oct-10	10.7	8.25	528	7.75	<0.03	<0.05

* Note: The groundwater discharge observed at this location emanates near the reclaimed mine portal.
However, it is not certain that this water is directly sourced from the old mine workings.

Photographs Section

Sampling port purged Approx. 45 Minutes | Sampling port purged Approx. 30 Minutes | Sampling port purged Approx. 15 Minutes

Photograph 1 Raw Crandall Canyon Mine discharge water collected from sampling port on 18 October 2011.



Sampling port purged
Approx. 45 Minutes

Sampling port purged
Approx. 15 Minutes

Photograph 2 Raw Crandall Canyon Mine discharge water collected from sampling port on 18 October 2011.

Appendix

Laboratory reporting sheets

SGS

Analysis Report

March 07, 2011

PETERSEN HYDROLOGIC LLC
2695 NORTH 600 EAST
LEHI UT 84043

Client Sample ID:	Snell & Wilmer, LLP	Sample ID By:	Petesen Hydrologic LLC
Date Sampled:	Sep 23, 2010	Sample Taken At:	Mohrland Portal
Date Received:	Oct 4, 2010	Sample Taken By:	E. Petersen
Product Description:	WATER	Time Received:	0730
		Time Sampled:	1240

SGS Minerals Sample ID: 782-1106854-002

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
METALS BY ICP							
Iron, Fe - Dissolved	<0.03	mg/L	EPA 200.7	0.030	2010-10-12	14:18:00	CM
Iron, Fe - Total	0.05	mg/L	EPA 200.7	0.050	2010-10-08	10:47:00	CM

Lab Supervisor

Domenic Ibanez
Lab Supervisor

SGS

Analysis Report

March 07, 2011

PETERSEN HYDROLOGIC LLC
2695 NORTH 600 EAST
LEHI UT 84043

Client Sample ID:	Snell & Wilmer, LLP	Sample ID By:	Petesen Hydrologic LLC
Date Sampled:	Sep 17, 2010	Sample Taken At:	Winter Quarters Portal
Date Received:	Oct 4, 2010	Sample Taken By:	E. Petersen
Product Description:	WATER	Time Received:	0730
		Time Sampled:	1830

SGS Minerals Sample ID: 782-1106854-001

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
METALS BY ICP							
Iron, Fe - Dissolved	<0.03	mg/L	EPA 200.7	0.030	2010-10-12	14:18:00	CM
Iron, Fe - Total	<0.05	mg/L	EPA 200.7	0.050	2010-10-08	10:47:00	CM

Lab Supervisor

Domenic Ibanez
Lab Supervisor

SGS

Analysis Report

March 07, 2011

PETERSEN HYDROLOGIC LLC
2695 NORTH 600 EAST
LEHI UT 84043

Client Sample ID:	Joes Valley Mine Spring	Sample ID By:	Petesen Hydrologic LLC
Date Sampled:	Oct 20, 2010	Sample Taken At:	Joes Valley Mine Spring
Date Received:	Nov 18, 2010	Sample Taken By:	E. Petersen
Product Description:	WATER	Time Received:	1720
		Time Sampled:	1830

SGS Minerals Sample ID: 782-1106855-001

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
METALS BY ICP							
Iron, Fe - Dissolved	<0.03	mg/L	EPA 200.7	0.030	2010-11-23	15:45:00	CM
Iron, Fe - Total	<0.05	mg/L	EPA 200.7	0.050	2010-11-23	12:24:00	CM

Lab Supervisor

Domenic Ibanez
Lab Supervisor

SGS

Analysis Report

October 26, 2011

GENWAL RESOURCES INC
794 "C" CANYON ROAD
EAST CARBON UT 84520

Client Sample ID:	PRE 002	Sample ID By:	Genwal Resources Inc.
Date Sampled:	Oct 18, 2011	Sample Taken At:	PRE 002
Date Received:	Oct 19, 2011	Sample Taken By:	E.Peterson
Product Description:	WATER	Time Received:	1325
		Time Sampled:	1645
		Mine:	8

Comments: Dissolved Metals Field Filtered

SGS Minerals Sample ID: 782-1110378-001

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
Sulfate, SO4	157	mg/L	EPA 300.0	1	2011-10-25	16:03:00	AL
Total Dissolved Solids	606	mg/L	SM2540-C	30	2011-10-19	14:40:00	CM
Chloride, Cl	10	mg/L	EPA 300.0	1	2011-10-25	16:03:00	AL
Alkalinity, mg CaCO3/L (pH 4.5)	381	mg/L	SM2320-B	5	2011-10-20	09:00:00	AL
Carbonate Alkalinity as CaCO3	<5	mg/L	SM2320-B	5	2011-10-20	09:00:00	AL
Bicarbonate Alkalinity as CaCO3	381	mg/L	SM2320-B	5	2011-10-20	09:00:00	AL
METALS BY ICP							
Calcium, Ca - Dissolved	96.86	mg/L	EPA 200.7	0.03	2011-10-20	15:16:00	AL
Iron, Fe - Dissolved	0.29	mg/L	EPA 200.7	0.03	2011-10-20	15:16:00	AL
Iron, Fe - Total	2.15	mg/L	EPA 200.7	0.05	2011-10-26	15:20:00	AL
Magnesium, Mg - Dissolved	54.10	mg/L	EPA 200.7	0.01	2011-10-20	15:16:00	AL
Potassium, K - Dissolved	8.24	mg/L	EPA 200.7	0.14	2011-10-20	15:16:00	AL
Sodium, Na - Dissolved	33.44	mg/L	EPA 200.7	0.09	2011-10-20	15:16:00	AL

Lab Supervisor

Domenic Ibanez
Lab Supervisor

Appendix 7-68

Utah American

Crandall Canyon Mine

Toxicity Identification Evaluation- 10/03/2011

Phase I Toxicity Characterization

By: Water & Environmental Testing, Inc

November 26th, 2011

Table of Contents

TIE Phase I Summary Report

TIE Phase I Executive Summary
Table 1- Phase 1 Toxicity Characterization

Accelerated Test #3 10/3/2011

Chronic Fathead Minnow (1 dilution) Passed

Chronic Ceriodaphnia (5 dilution) Failed

Phase I Testing

Baseline Test
Filtration Test
Aeration Test
C-18 column
PH 6.0
PH 7.0
EDTA 3.0 mg/L
EDTA 8.0 mg/L
Thiosulfate 10 mg/L
Thiosulfate 25 mg/L

Sample Chemistries

Quality Control Charts

Fathead Minnow LC50
Fathead Minnow IC25

Ceriodaphnia dubia LC50
Ceriodaphnia dubia IC25

Chain of Custody

W.E.T. Inc.

Water Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801) 763-0660 FAX (801) 763 04440

November 20th, 2011

Dana Morrelli
Crandall Canyon Mine
194 North 100 West
Huntington, Utah 84528

Executive Summary

Included in the executive summary are the highlights of the Phase I testing completed on the samples collected starting 10/03/2011. Actual copies of each test and the associated data reduction have been included in the data section of this report.

Background Information

The initial failure for the Crandall Canyon Mine occurred during routine quarterly testing for the second quarter dated June 7, 2011. In this round of testing the Fathead Minnow test passed and the Ceriodaphnia test failed reproduction with an IC25 of 11.23%. The first accelerated test was conducted June 28, 2011, using Ceriodaphnia with an IC25 of 7.42% for the standard conditions and 14.67% for a CO_2 atmosphere test.

The water from the mine is treated after exiting the mine, before being discharged. To identity the source of the toxicity, a sample was collected prior to treatment and one post treatment and analyzed for chronic toxicity using Ceriodaphnia. The results of these two tests showed that the toxicity was being introduced in the treatment process. Ferric chloride was being added to help precipitate iron and solids to meet the discharge permit.

Following this round of testing the chemical used for treatment was changed to aluminum sulfate, which had been used previously. Accelerated test #2 was collected September 1, 2011 and again tested using both Fathead Minnows and Ceriodaphnia. Enough sample was collected at this time to complete a Toxicity Identification Evaluation (TIE) should measurable toxicity be found. The Fathead Minnow test passed and the Ceriodaphnia test failed with an IC25 of 28.09%. The increase in the IC25 from the previous tests suggested that the change in chemical was helping the situation. In preparation for the TIE the Ceriodaphnia test was repeated to ensure that the toxicity was still present in the sample. This retest conducted on September 10, 2011 showed no measurable toxicity and without toxicity it is impossible to get beneficial data from a TIE.

A second TIE sample was collected October 3, 2011. This time the sample was collected in bladders to minimize the sample's contact with oxygen and extend the "shelf life" of the sample. Again the initial testing for this sample included testing with both Fathead Minnows and Ceriodaphnia. The Fathead Minnow test passed and the Ceriodaphnia test failed with an IC25 of 34.0%. A TIE was initiated on October 11, 2011 using this sample but due to poor quality food did not produce useable results. A second TIE test, using the same sample, was initiated on October 26, 2011. This round of testing showed that while there was less toxicity than in the initial test for this sample, there was still enough to give some useable results.

Summary Phase I Testing

Results of the Phase I Toxicity Characterization are shown in Table 1. The dilution series for this phase of the testing was set at 25, 50, and 100% with the number of replicates reduced from 10 to 6 as directed in the TIE guidance documents to conserve sample.

Summary of Phase I Test Results 10/7/2011

Test ID	Result IC25	TUc
Initial Test	34.0%	2.94
Baseline	56.5%	1.77
Aerated	46.41%	2.15
Filtered	86.15%	1.16
C-18	18.8%	5.3
C-18 Eluate	*	
PH 6	61.76	1.62
PH 7	>100%	1
EDTA 3 mg/L	>100%	1
EDTA 8 mg/L	>100%	1
Thiosulfate 10 mg/L	43.31%	2.30
Thiosulfate 25 mg/L	68.15%	1.47

TUc- Toxicity Unit for chronic tests.
* Test was not run as no toxicity was removed from in the C-18 test.

Conclusions from Phase I Testing

When reviewing Phase I data, the guidance documents recommend starting with the strongest indicators but include all significant tests when characterizing the toxicant. The data in Table 1, show the strongest indicators to be both EDTA test, the ph7 test and to a lessor extent the filtered test. The EDTA test suggest the toxicant to be a metal. The pH 7 test suugests a metals which becomes less toxic at lower pH. The 100% concentration of the pH 7 test stayed a range between 7.3 and 8.2 while the range for the baseline test stayed between 8.0 and 8.4. A reduction of toxicity associated with a change in pH suggest a metal which is more toxic at higher pH such as nickel or zinc. The filtered test collected a small amount of fine light brown powder on the filter collected on the filter. Some of the toxicant could be contained in the solids collected.

Failure of the other tests to reduce toxicity suggest that the toxicant is not an oxidizer such as chlorine, bromine or ozone. Also most likely not a non-polar organic and a reduced suspicion that it results from a surfactant or other sublateable compound nor one that can be oxidized through aeration.

An observation made in several of the Phase I tests was that in higher dilutions there was some formation of visible solids on the surface of the solutions and formation of grit on the sides and bottom of the test chambers. This would suggest that the sample is still chemically active or "unstable"and the changing environment could be contributing stress to the organisms. Stress can cause reduced reproduction and if high enough can cause mortality.

Recommended Phase II Testing

Samples have been submitted to Chemtech-Ford for analysis of total (15) and dissolved metals (4). This data will be reviewed to see if any single metals is over the expected toxic limits. Combined concentrations will also be considered. These values will be used to create mock effluents in an effort to recreate the toxicity in the original sample. The dried solids remaining on the filtered could also be analyzed for metals to determine which are prevalent in the retained solids.

The potential for stability and formation of solids could be checked by measuring the TSS of the sample then passing the sample thought a finer filter than the one used in the original test to see if additional toxicity is removed. The potential for calcium carbonate solids to precipitate out of solution can be removed by raising the pH of the sample over pH 11 and letting the solids form and settle then pouring off the supernate. The pH of the supernate is then returned to the original pH before using organisms to test for toxicity. This procedure can also remove some metals from solution.

While we finish up the phase II testing I suggest we proceed with the routine test for the fourth quarter and continue to collect extra sample to have on-hand in the event of another failure.

If you have any questions or need any additional information please feel free to give me a call at 801-763-0660, or on my cell phone at 801-360-5438.

Sincerely,

Lee Rawlings

Lee Rawlings
Laboratory Director
Water & Environmental Testing, Inc

Crandall Canyon Mine

Reproduction average young/adult

Sample date 10/3/2011

Tests	Control	25%	50%	100%	IC25	TUc
Initial Test	16.1	16.0	9.1	0.5	34.0	2.94
Baseline #2	16.8	25	17.3	4.7	56.5	1.77
Aerated #2	16	18.8	12.2	12.5	46.41	2.15
Filtered #2	17	24.3	21.3	13.7	86.15	1.16
C-18 #2	21	13.2	14.8	6.8	18.8	5.3
PH 6 #2	27	32.2	24.5	14.7	61.76	1.62
PH 7 #2	25.3	28.2	25	21	>100	1
EDTA 3 #2	21.5	23.3	17.2	19.8	>100	1
EDTA 8 #2	18.2	23.78	24.5	17.7	>100	1
Thiosulfate 10 #2	15.7	15	10.8	3.3	43.31	2.3
Thiosulfate 25 #2	13.5	11.8	12.2	6.8	68.15	1.47

Eluate No Toxicity removed with C-18. Test not analyzed

TUc- Toxicity Unit for a chronic test.

Accelerated Test #3 10/3/2011

W.E.T. Inc.

Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Cover Letter

October 28, 2011

Utah American- Crandall Canyon Mine (Accelerated Test #3)
Attn: Dana Morrelli
194 North 100 West
Huntington, Utah 84528

Dear Dana,

Enclosed is the report for the sample dated 10/03/2011. The laboratory Id assigned to these sample(s) are #8490. The sample was tested for chronic toxicity using Fathead Minnows following the procedures listed in EPA 1000.0. This report is comprised of 11 pages which include;

Cover Letter,
Chronic Whole Effluent Toxicity Reports Fathead Minnows,
Chronic Whole Effluent Toxicity Testing Data Fathead Minnows,
Chronic Whole Effluent Toxicity Chemical Report,
Data Reduction Fathead Minnows (Toxis Analysis Summary, 2 pages survival and growth)
Reference Toxicant Charts, Fathead Minnows (2 pages Survival-LC50 and Growth-IC25)
Completed Copies of the Chain of Custodies (3).

Our reports have been designed to meet requirements of National Environmental Accreditation Program, (NELAP), section 5.13. All these pages ***together*** constitute the final report, individual pages should not be removed. If copied, the report must be reconstructed in full. If you have not received any of these pages, or if you have any questions please give us a call at 801-763-0660. We look forward to doing business with you in the future.

Sincerely,

Lee Rawlings
Lab Director

QA/QC Flags: None

Comments:

W.E.T. Inc.
Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Whole Effluent Toxicity Report
Fathead Minnows

DATE: October 28, 2011

PERMITTEE NAME: Utah American- Crandall Canyon Mine (Accelerated Test #3)

TEST *(Animal/Age)*: Fathead Minnows <24 hours **SAMPLE** *(Date/Type)*: 10/03/2011 Composite

DATE/TIME TEST BEGAN: 10/04/2011 3:00 p.m. **DATE/TIME TEST COMPLETED:** 10/11/2011 6:00 p.m.

TEST CONDITIONS

Fathead Minnow larvae were exposed to diluted effluent as specified by EPA 1000.0. At the end of the test period Survival and Growth were measured and compared statistically against a control to determine if Chronic Toxicity was present in the samples.

Animal Age at Test Start	24 hours.
Number of Organisms/Dilution Volume/Replicates	10 organisms/200 ml/6 replicates
Food	Fed twice daily 0.1 ml of newly hatched Brine Shrimp.
Aeration	None required.
Dissolved Oxygen	Measured Daily old/new.
Water Replacement	Renewed daily.
Temperature	25 ± 1 degree C.
Photo Period	16 hours light 8 hours dark.
pH	Measured initially and at 24 hours for each sample.
Dilution Water	Reconstituted lab water approx 200 mg/L.
Receiving Water	None Supplied
Sample Concentrations	Control, 100%.

SUMMARY

Results: X Pass Fail

There was NO significant effect on growth. (Results of Wilcoson Two-Sample Test)

There was NO significant effect of survival. (Results of Wilcoson Two-Sample Test)

Enclosed are data sheets and statistical reports.

Sincerely,

Lee Rawlings
Laboratory Director
Enclosure

Chronic Whole Effluent Toxicity Testing
Fathead Minnows

PERMITTEE NAME: Utah American- Crandall Canyon Mine (Accelerated Test #3)

Final Mean Weight: Control 0.57 Effluent 0.59 Pass X Fail __

Percent Lethality: Control 3.3% Effluent 0.0% Pass X Fail __

Sample Type / Times and Dates

No. 1 10/03/2011 9:30 p.m.
No. 2 ______
No. 3 ______

Analyses: Times and Dates

Beginning 10/03/2011 3:00 pm
Ending 10/11/2011 6:00 pm
Initial Organism Age <24 hours

Control = 0% Effluent **Effluent Sample** = 70% Effluent **Hardness:** Reconstituted Water (if used) 200 mg/L

FATHEAD MINNOWS
Replicates

Sample	Number of Organisms/Percent Survival						Mean Weight after 7 days (Milligrams)					
	A	B	C	D	E	F	A	B	C	D	E	F
Control	10/100%	10/100%	9/90%	9/90%	10/100%	10/100%	0.57	0.54	0.56	0.57	0.61	0.57
Effluent	10/100%	10/100%	10/100%	10/100%	10/100%	10/100%	0.60	0.60	0.62	0.58	0.60	0.56

Physical Data - Control

Old/New	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Dissolved Oxygen	7.0	7.2/6.4	7.1/6.2	7.3/6.9	7.6/5.7	7.7/4.5	7.4/6.1	5.7
Temperature (°C)	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.4	25.0/24.8	25.0/24.0	24.0
pH (SU)	8.45	8.44/8.27	8.37/8.20	8.10/8.04	8.22/7.93	8.33/7.82	8.50/8.06	7.84

Physical Data - Effluent

Old/New	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Dissolved Oxygen	8.3	7.7/6.6	8.0/6.0	8.5/6.7	8.4/4.5	9.2/5.5	8.6/6.2	5.4
Temperature (°C)	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.4	25.0/24.8	25.0/24.0	24.0
pH (SU)	7.71	7.70/7.81	7.63/8.29	7.60/8.17	7.68/8.06	7.70/8.12	7.62/8.12	8.12
Hardness*		472 mg/L		NA mg/L		NA mg/L		

**Testing required only on days when fresh effluent is received in the lab.*

Laboratory Director: Lee Rawlings **Laboratory:** Water & Environmental Testing, Inc.

Signature: Lee Rawlings **Date:** 10/30/11

Comments: ______

W.E.T. Inc.

Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Whole Effluent Toxicity Chemical Result Report

October 28, 2011

CUSTOMER NAME:
Utah American- Crandall Canyon Mine (Accelerated Test #3)
Attn: Dana Morrelli
194 North 100 West
Huntington, Utah 84528

SAMPLE DESCRIPTION:
Chemistries to go with Chronic Biomonitoring sampling began 10/03/2011

Analysis	Chronic Ceriodaphnia		
	Repl. 1	Repl. 2	Repl. 3
Log #	8490	NA	NA
Total Hardness, Recon (EPA 130.2), mg/L	176		
Total Hardness, Effluent (EPA 130.2), mg/L	472		
Ammonia, Effluent (EPA 350.2/350.3), mg/L	0.43		
Initial Chlorine Residual (EPA 330.5), mg/L	<0.05		
Final Chlorine Residual (EPA 330.5), mg/L	N/A		
Conductivity, Effluent (EPA 120.1), umhos/cm	970		
Alkalinity, Effluent (EPA 310.1), mg/L $CaCO^3$	382		
Recon Initial pH (EPA 150.1)	8.45		
After 24 hours pH (EPA 150.1)	8.27		
100% Initial pH (EPA 150.1)	7.71		
100% After 24 hours pH (EPA 150	7.81		

Reviewed: Lee Rawlings, Lab Director
Water & Environmental Testing, Inc.

Larval Fish Growth and Survival Test-7 Day Survival

Start Date:	10/4/2011 15:00	Test ID: GW10-11c		Sample ID:	Genwal TIE 10-11 chronic fathead
End Date:	10/11/2011 18:00	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	PP-Pimephales promelas
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	1.0000	1.0000	0.9000	0.9000	1.0000	1.0000
100	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
D-Control	0.9667	1.0000	1.3577	1.2490	1.4120	6.199	6		
100	1.0000	1.0345	1.4120	1.4120	1.4120	0.000	6	45.00	28.00

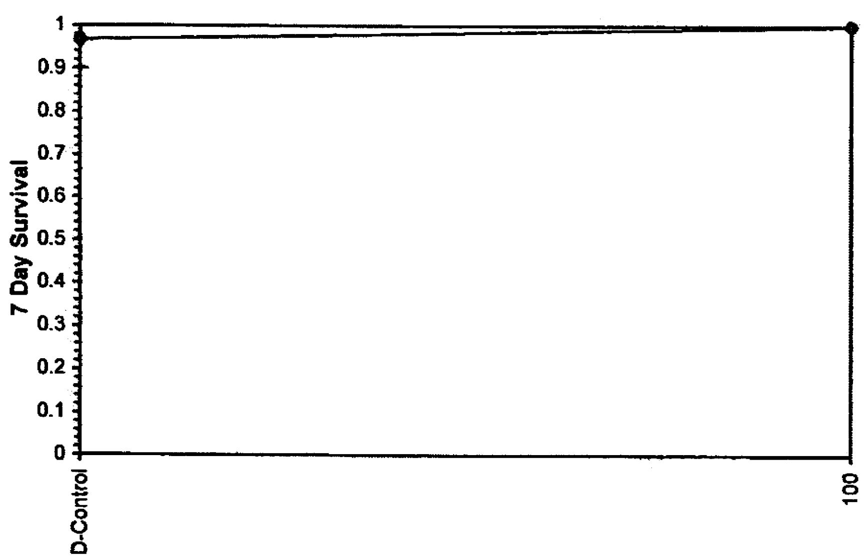
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.76674	0.859	-1.1489	0.73333
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)

Wilcoxon Two-Sample Test indicates no significant differences

Treatments vs D-Control

Dose-Response Plot



 ToxCalc v5.0.32 Reviewed by:_____

Larval Fish Growth and Survival Test-7 Day Growth

Start Date:	10/4/2011 15:00	Test ID:	GW10-11c	Sample ID:	Genwal TIE 10-11 chronic fathead
End Date:	10/11/2011 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	PP-Pimephales promelas
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	0.5680	0.5380	0.5630	0.5700	0.6120	0.5680
100	0.5950	0.5980	0.6150	0.5830	0.6020	0.5550

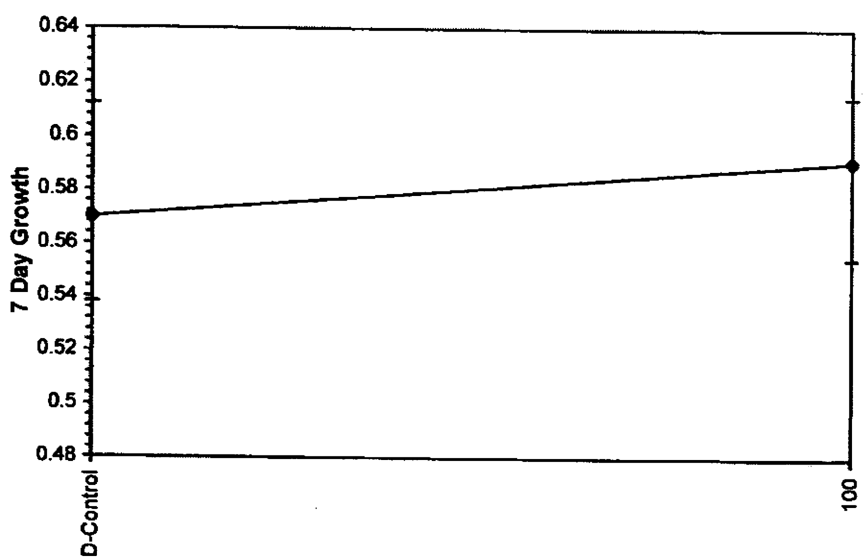
			Transform: Untransformed					Rank	1-Tailed
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
D-Control	0.5698	1.0000	0.5698	0.5380	0.6120	4.186	6		
100	0.5913	1.0377	0.5913	0.5550	0.6150	3.483	6	48.00	28.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.94762	0.859	0.09844	0.81151
F-Test indicates equal variances (p = 0.76)	1.34106	14.9394		

Hypothesis Test (1-tail, 0.05)

Wilcoxon Two-Sample Test indicates no significant differences
Treatments vs D-Control

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:______

W.E.T. Inc.

Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Cover Letter

October 28, 2011

Utah American- Crandall Canyon Mine (Accelerated Test #3)
Attn: Dana Morrelli
194 North 100 West
Huntington, Utah 84528

Dear Dana,

Enclosed is the report for the sample dated 10/03/2011. The laboratory Id assigned to these sample(s) are #8490. The sample was tested for chronic toxicity using Ceriodaphnia dubia following the procedures listed in EPA 1002.0. This report is comprised of 11 pages which include;

Cover Letter,
Chronic Whole Effluent Toxicity Reports Data Ceriodaphnia dubia,
Chronic Whole Effluent Toxicity Testing Data Ceriodaphnia dubia.
Chronic Whole Effluent Toxicity Chemical Report,
Data Reduction Ceriodaphnia dubia (Toxis Analysis Summary, 2 pages survival and growth)
Reference Toxicant Charts, Ceriodaphnia dubia (2 pages Survival-LC50 and Growth-IC25)
Completed Copies of the Chain of Custodies (3).

The work represented here along with the report format have been designed to meet requirements of National Environmental Accreditation Program, (NELAP), section 5.13. All these pages ***together*** constitute the final report, individual pages should not be removed. If copied, the report must be reconstructed in full. If you have not received any of these pages, or if you have any questions please give us a call at 801-763-0660. We look forward to doing business with you in the future.

Sincerely,

Lee Rawlings
Lab Director

QA/QC Flags: None

Comments:

W.E.T. Inc.

Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Whole Effluent Toxicity Report

Ceriodaphnia

DATE: October 28, 2011

PERMITTEE NAME: Utah American- Crandall Canyon Mine (Accelerated Test #3)

TEST (Animal/Age): Ceriodaphnia dubia <8 hours

SAMPLE (Date/Type): 10/03/2011 Grab

DATE/TIME TEST BEGAN: 10/04/2011 3:00 p.m.

DATE/TIME TEST COMPLETED: 10/12/2011 6:00 p.m.

TEST CONDITIONS

Ceriodaphnia dubia neonates were exposed to diluted effluent as specified by EPA 1002.0. At the end of the test period Survival and Reproduction were measured and compared statistically against a control to determine if Chronic Toxicity was present in the samples.

Animal Age at Test Start	<8 hours.
Number of Organisms/Dilution Volume/Replicates	1 organism/15 ml/10 replicates.
Food	Fed daily 0.1 ml YTC and Algae.
Aeration	None required.
Dissolved Oxygen	Measured daily old/new.
Water Replacement	Renewed daily.
Temperature	25 ± 1 degree C.
Photo Period	16 hours light 8 hours dark.
pH	Measured initially and at 24 hours for each sample.
Dilution Water	Reconstituted lab water approx 100 mg/L hardness.
Receiving Water	None Received
Sample Concentrations	Control, 12, 25, 50, 75, 100%

SUMMARY

Results: Pass X Fail

There WAS significant effect on reproduction. (Results of Dunnett's Test)

NOEC (Reproduction) = 25

LOEC (Reproduction) = 50

IC25 required by NPDES permit = 65.5%

IC25 estimated from test data = 34.01%

There WAS significant effect on survival. (Fisher's Exact Test)

NOEC (Survival) = 50

LOEC (Survival) = 75

Enclosed are data sheets and statistical reports.

Sincerely,

Lee Rawlings
Lab Director
Enclosure

W.E.T. Inc.

Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Toxicity Testing

Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine (Accelerated Test #3)

Mean No. Produced: Control 16.1 12.5% 19.9 25.0% 16.0 50.0% 9.1 75.0% 2.8 100% 0.5 Pass ___ Fail X

Percent Lethality: Control 0% 12.5% 0% 25.0% 0% 50.0% 0% 75.0% 40% 100% 100% Pass ___ Fail X

Sample Type/Date: 10/03/2011 2:00 p.m.

Analyses Dates/Times Beginning 10/04/2011 3:00 p.m. Ending 10/12/2011 6:00 p.m.

Dilution Water Hardness: Provo River Water Approx. 200 mg/L. **Organism Type/Age:** Ceriodaphnia dubia <8 hours

CERIODAPHNIA

Total Number of Young Produced in Three Broods ("D" = dead)

Replicates

Sample	A	B	C	D	E	F	G	H	I	J	Mean # Produced
Control	23	21	22	11	20	8	13	19	17	7	16.1
12.5	23	17	14	17	21	19	23	23	27	15	19.9
25.0	11	27	17	8	18	18	18	12	19	12	16.0
50.0	10	7	10	15	12	4	8	11	8	6	9.1
75.0	8	6	0D	0D	4	4	0D	3	3	0D	2.8
100	1D	0D	0D	0D	0D	4D	0D	0D	0D	0D	0.5

Concentration (mg/L)

Max/Min	Control	12.5	25.0	50.0	75.0	100
Dissolved Oxygen	8.0/6.7	8.5/6.7	8.6/6.7	8.7/6.9	9.2/7.0	9.3/7.1
Temperature (°C)	25.2/24.0	25.2/24.0	25.2/24.0	25.2/24.0	25.2/24.0	25.2/24.0
pH	8.56/8.09	8.59/7.98	8.66/7.90	8.67/7.75	8.58/7.64	8.49/7.61

Dilution Water (Average) Hardness: 212 mg/L **Alkalinity:** 166 mg/L **Conductivity:** 450 umhos/cm

Laboratory Director: Lee Rawlings **Laboratory:** Water & Environmental Testing, Inc

Signature: Lee Rawlings **Date:** 10/30/11

Comments:

Ceriodaphnia Survival and Reproduction Test-7 Day Survival

Start Date:	10/4/2011 15:00	Test ID: GW10-11c		Sample ID:	GW 10-11 chronic cero
End Date:	10/12/2011 18:00	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

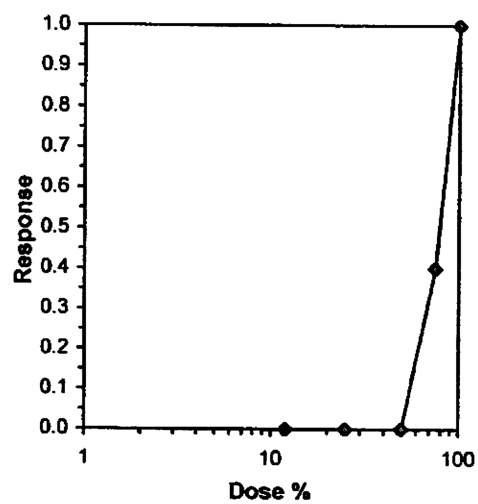
Conc-%	1	2	3	4	5	6	7	8	9	10
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
75	1.0000	1.0000	0.0000	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000	0.0000
100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

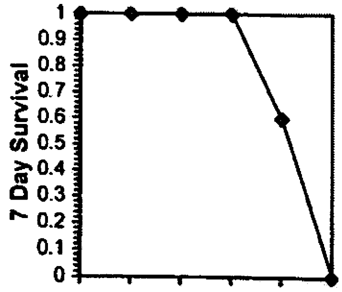
Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Number Resp	Total Number
D-Control	1.0000	1.0000	0	10	10	10			0	10
12	1.0000	1.0000	0	10	10	10	1.0000	0.0500	0	10
25	1.0000	1.0000	0	10	10	10	1.0000	0.0500	0	10
50	1.0000	1.0000	0	10	10	10	1.0000	0.0500	0	10
*75	0.6000	0.6000	4	6	10	10	0.0433	0.0500	4	10
100	0.0000	0.0000	10	0	10	10			10	10

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test Treatments vs D-Control	50	75	61.2372	2

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%	75.392	67.716	83.938
5.0%	75.874	67.291	85.553
10.0%	76.354	66.540	87.617
20.0%	77.295	63.481	94.115
Auto-0.0%	75.392	67.716	83.938





 ToxCalc v5.0.32 Reviewed by:_____

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/4/2011 15:00	Test ID:	GW10-11c	Sample ID:	GW 10-11 chronic cero
End Date:	10/12/2011 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
D-Control	23.000	21.000	22.000	11.000	20.000	8.000	13.000	19.000	17.000	7.000
12	23.000	17.000	14.000	17.000	21.000	19.000	23.000	23.000	27.000	15.000
25	11.000	27.000	17.000	8.000	18.000	18.000	18.000	12.000	19.000	12.000
50	10.000	7.000	10.000	15.000	12.000	4.000	8.000	11.000	8.000	6.000
75	8.000	6.000	0.000	0.000	4.000	4.000	0.000	3.000	3.000	0.000
100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

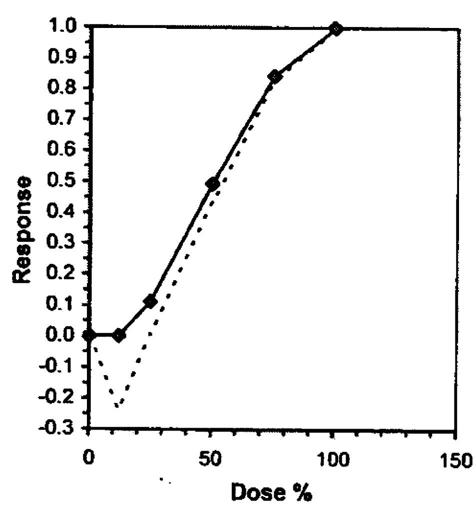
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	16.100	1.0000	16.100	7.000	23.000	36.740	10				18.000	1.0000
12	19.900	1.2360	19.900	14.000	27.000	20.982	10	-1.902	2.223	4.442	18.000	1.0000
25	16.000	0.9938	16.000	8.000	27.000	33.850	10	0.050	2.223	4.442	16.000	0.8889
*50	9.100	0.5652	9.100	4.000	15.000	34.924	10	3.503	2.223	4.442	9.100	0.5056
*75	2.800	0.1739	2.800	0.000	8.000	100.734	10	6.656	2.223	4.442	2.800	0.1556
100	0.000	0.0000	0.000	0.000	0.000	0.000	10				0.000	0.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.98098	0.947	0.03666	-0.1579
Bartlett's Test indicates equal variances (p = 0.15)	6.81316	13.2767		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	25	50	35.3553	4	4.44247	0.27593	463.07	19.9622	1.9E-10	4, 45
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL		Skew
IC05	17.850	5.268	13.728	27.848	0.4277
IC10	23.700	5.111	15.920	30.696	0.0595
IC15	27.536	5.014	17.975	33.718	-0.1458
IC20	30.797	5.005	19.968	37.030	-0.3007
IC25	34.058	4.951	22.050	40.310	-0.4936
IC40	43.841	4.174	35.636	51.753	-0.4197
IC50	50.397	3.536	43.657	57.706	-0.0163

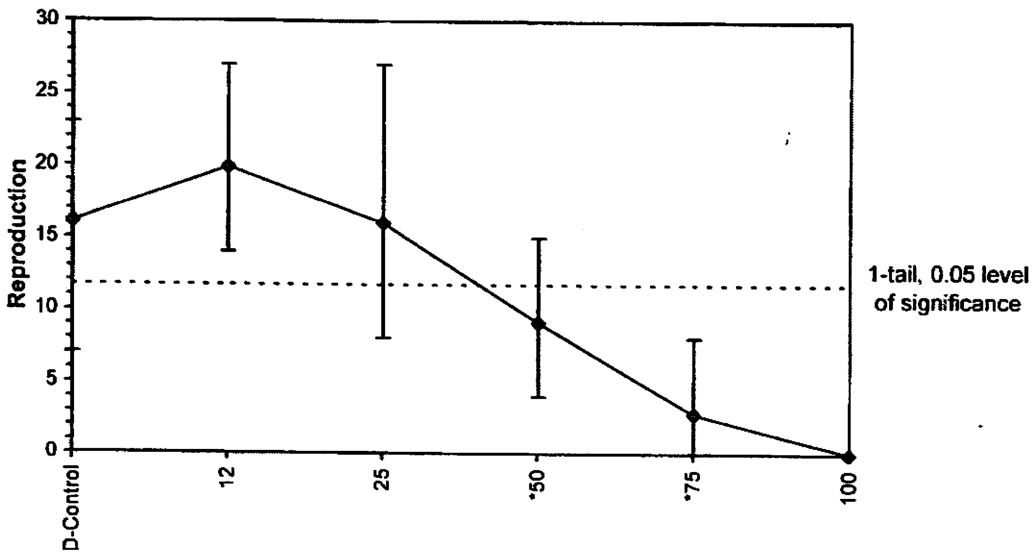


Reviewed by:_____

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/4/2011 15:00	Test ID:	GW10-11c	Sample ID:	GW 10-11 chronic cero
End Date:	10/12/2011 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:______

Phase I Characterization Testing

Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- Baseline Test

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 10:45 p.m Ending 11/3/2011 11:00 p.m **IC25 Estimated from Test:** 56.50%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	16	8	19	24	30	4	16.8	0%
25.0%	28	21	29	15	29	28	25.0	0%
50.0%	10	30	26	13	8	17	17.3	0%
100%	2	0	4	8	8	6	4.7	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	6.9	7.0/6.8	6.5/7.5	6.6/6.4	6.5/6.4	6.6/6.1	6.8/6.2	7.1/6.6	6.5
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.28	8.20/8.30	8.00/8.25	8.14/8.15	8.24/8016	8.31/8.16	8.29/8.18	7.54/8.04	8.30

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	6.8/7.2	7.6/6.6	7.0/6.4	6.8/6.3	6.6/6.0	6.9/5.9	7.4/6.6	6.9
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.19	8.12/8.38	8.10/8.36	8.08/8.31	8.27/8.33	8.24/8.29	8.23/8.31	8.23/8.31	8.47

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.1	7.3/6.9	7.7/6.7	6.9/6.3	6.8/6.4	6.5/6.2	6.8/5.4	7.4/6.9	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.07	8.10/8.40	8.15/8.38	8.05/8.40	8.18/8.39	8.21/8.38	8.14/8.39	7.96/8.32	8.53

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.5/6.9	7.7/6.8	7.1/6.6	7.0/6.6	6.6/6.2	7.0/5.9	7.7/6.9	6.6
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.04	8.10/8.31	8.24/8.28	7.97/8.25	8.15/8.26	8.16/8.26	8.06/8.31	7.84/8.17	8.40

Comments: Some fine solids formed on the surface of the 100% on days 3 & 4, with grit forming on the inside of the test chamber on most days. LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 22:45	Test ID: GenTIEB	Sample ID:	Genwal TIE Baseline Chronic Cero
End Date:	11/3/2011 23:00	Lab ID: WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:				

Conc-%	1	2	3	4	5	6
D-Control	16.000	8.000	19.000	24.000	30.000	4.000
25	28.000	21.000	29.000	15.000	29.000	28.000
50	10.000	30.000	26.000	13.000	8.000	17.000
100	2.000	0.000	4.000	8.000	8.000	6.000

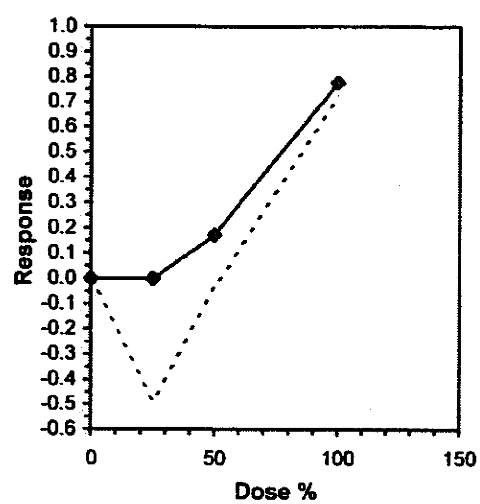
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	16.833	1.0000	16.833	4.000	30.000	57.770	6				20.917	1.0000
25	25.000	1.4851	25.000	15.000	29.000	23.048	6	-1.918	2.190	9.324	20.917	1.0000
50	17.333	1.0297	17.333	8.000	30.000	51.300	6	-0.117	2.190	9.324	17.333	0.8287
*100	4.667	0.2772	4.667	0.000	8.000	69.985	6	2.858	2.190	9.324	4.667	0.2231

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.97279	0.916	0.04748	-0.4081
Bartlett's Test indicates equal variances (p = 0.14)	5.51238	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	50	100	70.7107	2	9.32359	0.55388	423.819	54.375	0.00122	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05	32.297	10.045	24.696	64.209	0.6910
IC10	39.593	9.908	24.565	65.918	0.3194
IC15	46.890	9.659	24.618	67.627	0.0495
IC20	52.368	9.471	25.399	70.245	-0.1543
IC25	56.497	9.394	27.130	73.538	-0.3131
IC40	68.882	9.254	31.664	83.418	-0.8545
IC50	77.138	8.619	34.687	90.622	-1.2650

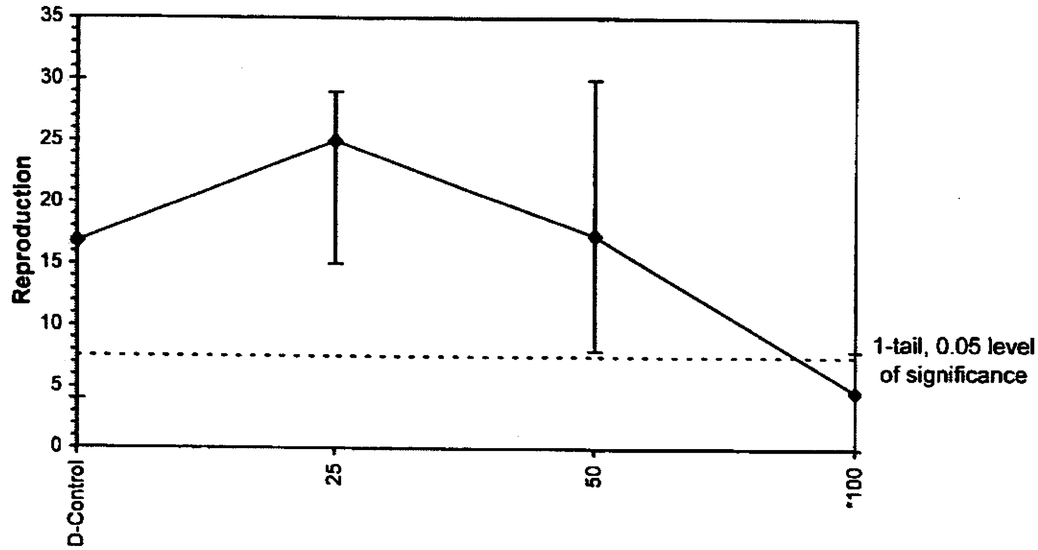


 ToxCalc v5.0.32 Reviewed by:_____

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 22:45	Test ID:	GenTIEB	Sample ID:	Genwal TIE Baseline Chronic Cero
End Date:	11/3/2011 23:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:______

Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- Aerated

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 10:45 p.m Ending 11/3/2011 11:10 p.m **IC25 Estimated from Test:** 46.41%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia
Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	17	16	20	20	15	8	16.0	0%
25.0%	21	16	16	19	24	17	18.8	0%
50.0%	25	4	12	10	15	7	12.2	0%
100%	18	0	22	19	11	5	12.5	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.1/6.9	7.7/6.7	6.8/6.5	6.8/6.4	6.6/5.9	6.9/6.0	7.2/6.7	6.1
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.8	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.31	8.28/8.31	8.25/8.27	8.16/8.19	8.32/8.15	8.26/8.17	8.30/8.17	7.86/8.07	8.34

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.4/7.0	7.7/6.8	6.9/6.6	6.8/6.3	6.6/6.3	6.9/5.5	7.4/6.5	5.9
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.25	8.24/8.32	8.26/8.35	8.05/8.29	8.30/8.26	8.26/8.29	8.28/8.20	8.09/8.17	8.44

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.4/6.9	7.7/6.8	7.0/6.5	6.8/6.2	6.6/6.3	6.8/5.1	7.2/6.8	5.8
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.21	8.20/8.34	8.18/8.41	7.96/8.36	8.23/8.33	8.23/8.41	8.23/8.37	8.06/8.28	8.51

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.4/6.8	7.8/6.9	6.9/6.6	6.6/6.4	6.5/6.5	6.7/5.9	7.7/6.7	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.6	25.0/24.0	24.2
Ph New/Old	8.12	8.15/8.34	8.17/8.36	7.88/8.35	8.06/8.32	8.07/8.30	8.06/8.33	7.96/8.18	8.39

Comments: Grit forming on the inside of the test chamber on most days. LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 22:45	Test ID:	GenTIEA	Sample ID:	Genwal TIE Aerated Chronic Cero
End Date:	11/3/2011 23:10	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	17.000	16.000	20.000	20.000	15.000	8.000
25	21.000	16.000	16.000	19.000	24.000	17.000
50	25.000	4.000	12.000	10.000	15.000	7.000
100	18.000	0.000	22.000	19.000	11.000	5.000

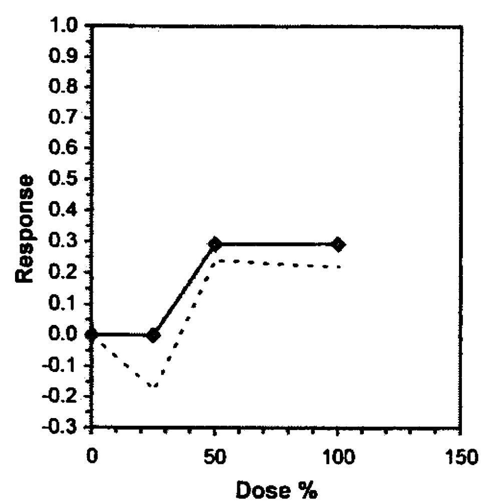
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	16.000	1.0000	16.000	8.000	20.000	27.670	6				17.417	1.0000
25	18.833	1.1771	18.833	16.000	24.000	16.930	6	-0.777	2.190	7.983	17.417	1.0000
50	12.167	0.7604	12.167	4.000	25.000	60.492	6	1.052	2.190	7.983	12.333	0.7081
100	12.500	0.7813	12.500	0.000	22.000	69.513	6	0.960	2.190	7.983	12.333	0.7081

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.98886	0.916	0.01767	0.15065
Bartlett's Test indicates equal variances (p = 0.16)	5.21762	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	100	>100		1	7.98258	0.49891	59.8194	39.8583	0.24485	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	29.283			
IC10	33.566			
IC15	37.848			
IC20	42.131			
IC25	46.414			
IC40	>100			
IC50	>100			

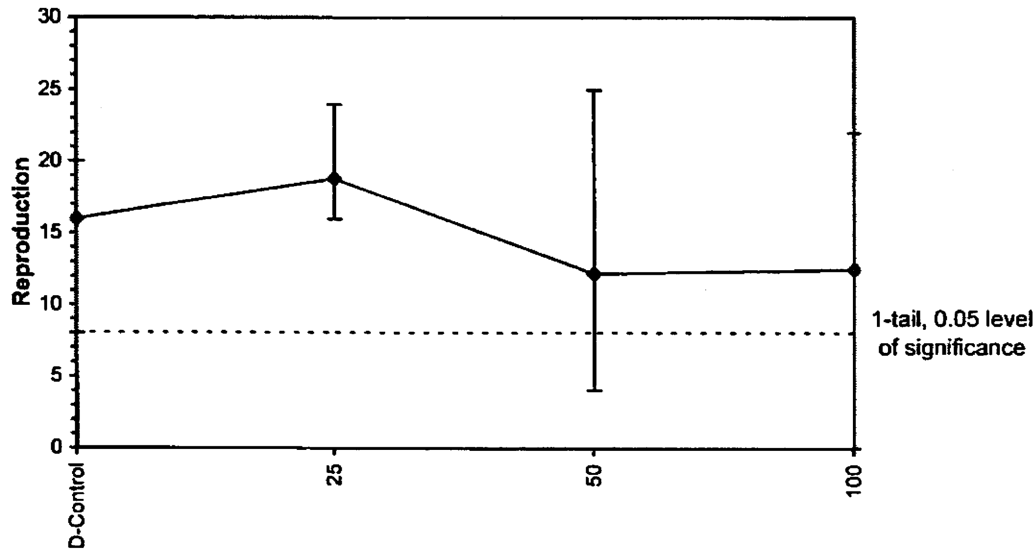


 ToxCalc v5.0.32 Reviewed by:_____

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 22:45	Test ID:	GenTIEA	Sample ID:	Genwal TIE Aerated Chronic Cero
End Date:	11/3/2011 23:10	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Chronic Toxicity Testing

Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- Filtered

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:00 p.m Ending 11/3/2011 11:20 p.m **IC25 Estimated from Test:** 86.15%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	16	8	16	23	20	19	17.0	0%
25.0%	18	28	24	26	24	26	24.3	0%
50.0%	20	21	25	26	21	15	21.3	0%
100%	16	14	17	19	11D	5D	13.7	33%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.4/6.8	7.6/6.7	6.9/6.4	6.8/6.3	6.7/6.3	6.9/6.2	7.1/6.8	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.28	8.30/8.24	8.28/8.26	8.24/8.15	8.33/8.17	8.32/8.19	8.29/8.26	8.14/8.05	8.40

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.4/6.9	7.8/6.9	7.0/6.5	6.8/6.3	6.6/6.3	7.0/6.4	7.3/6.8	6.0
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.17	8.18/8.37	8.15/8.39	8.13/8.31	8.24/8.29	8.29/8.31	8.27/8.39	8.13/8.19	8.44

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.6/6.9	7.9/6.9	7.0/6.5	6.8/6.4	6.7/6.3	6.9/6.6	7.3/6.9	6.0
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.06	8.07/8.38	8.05/8.42	8.06/8.41	8.23/8.41	8.24/8.41	8.27/8.53	8.06/8.33	8.53

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.4	7.5/7.0	7.7/7.0	7.3/6.4	6.9/6.5	6.4/6.4	6.8/6.6	7.7/7.0	6.5
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.03	8.05/8.27	8.08/8.28	8.00/8.30	8.13/8.35	8.17/8.33	8.14/8.36	7.97/8.23	8.35

Comments: Grit forming on the inside of the test chamber on most days. LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:00	Test ID: GenTIEF		Sample ID:	Genwal TIE Filtered Chronic Cero
End Date:	11/3/2011 23:20	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	16.000	8.000	16.000	23.000	20.000	19.000
25	18.000	28.000	24.000	26.000	24.000	26.000
50	20.000	21.000	25.000	26.000	21.000	15.000
100	16.000	14.000	17.000	19.000	11.000	5.000

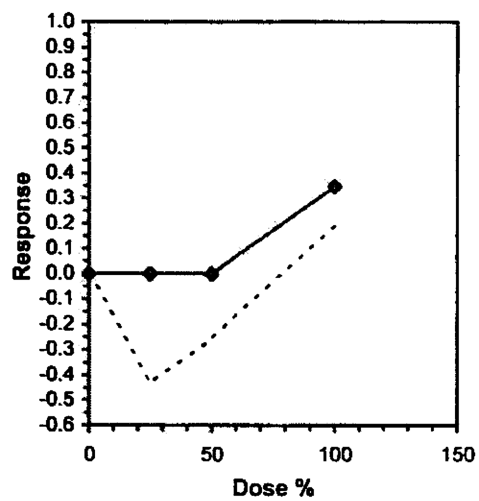
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	17.000	1.0000	17.000	8.000	23.000	30.224	6				20.889	1.0000
25	24.333	1.4314	24.333	18.000	28.000	14.157	6	-2.854	2.190	5.626	20.889	1.0000
50	21.333	1.2549	21.333	15.000	26.000	18.435	6	-1.687	2.190	5.626	20.889	1.0000
100	13.667	0.8039	13.667	5.000	19.000	36.925	6	1.297	2.190	5.626	13.667	0.6543

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.91824	0.916	-0.8296	0.12359
Bartlett's Test indicates equal variances (p = 0.80)	1.01341	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	100	>100		1	5.62621	0.33095	132.611	19.8	0.00261	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

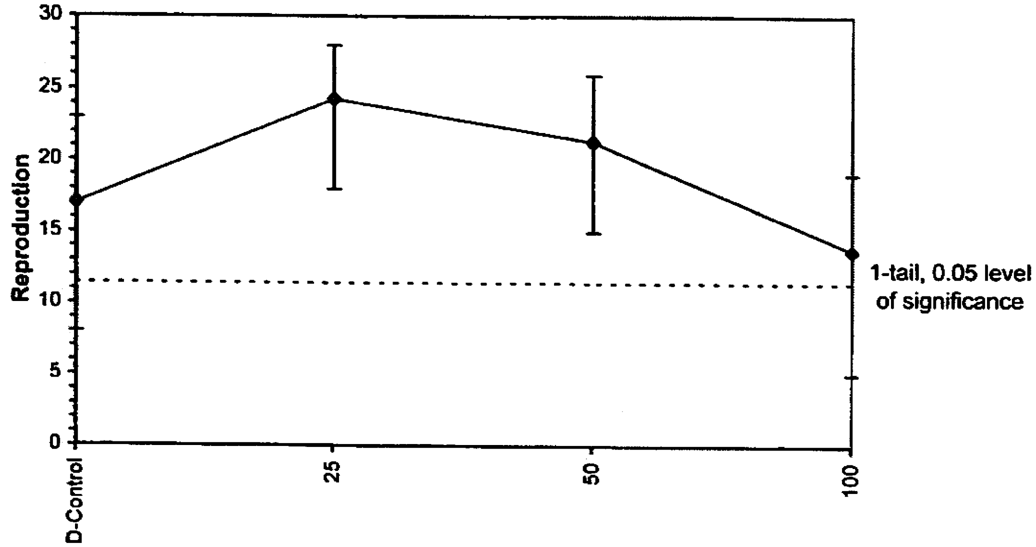
Point	%	SD	95% CL(Exp)		Skew
IC05	57.231	6.962	23.547	64.421	-1.6245
IC10	64.462	6.915	34.595	82.041	-0.7835
IC15	71.692	8.306	46.999	98.591	0.2120
IC20	78.923				
IC25	86.154				
IC40	>100				
IC50	>100				



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:00	Test ID:	GenTIEF	Sample ID:	Genwal TIE Filtered Chronic Cero
End Date:	11/3/2011 23:20	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:_____

Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- C-18

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:00 p.m Ending 11/3/2011 11:30 p.m **IC25 Estimated from Test:** 18.8%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	21	21	27	28	12	17	21.0	0%
25.0%	8	17	12	11D	14	17	13.2	17%
50.0%	13	25	21	13	22	6	14.8	0%
100%	3D	15	5	5D	9	4D	6.8	50%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.4/6.9	7.8/6.9	6.8/6.4	6.8/6.3	6.6/6.1	6.9/6.1	7.2/6.6	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.23	8.18/8.24	8.14/8.24	8.12/8.17	8.28/8.16	8.21/8.16	8.28/8.22	8.15/8.04	8.37

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.5/6.9	7.9/7.0	7.0/6.4	6.8/6.4	6.6/6.4	6.8/6.4	7.2/6.7	6.1
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.25	8.20/8.35	8.17/8.39	8.18/8.32	8.33/8.31	8.29/8.30	8.28/8.39	8.15/8.19	8.50

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.5/6.9	8.0/6.8	7.0/6.4	6.7/6.5	6.6/6.3	6.9/6.4	7.3/6.8	6.0
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.24	8.22/8.39	8.18/8.44	8.19/8.42	8.30/8.44	8.28/8.41	8.30/8.51	8.12/8.32	8.53

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.1	7.2/6.9	7.9/7.0	7.0/6.5	6.6/6.3	6.5/6.5	6.7/6.4	7.3/6.9	6.6
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.18	8.15/8.33	8.09/8.32	8.09/8.31	8.08/8.36	8.18/8.34	8.15/8.39	8.10/8.26	8.43

Comments: Grit forming on the inside of the test chamber on most days. LC50 estimated at 100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:00	Test ID: GenTIEC	Sample ID:	Genwal TIE C-18 Chronic Cero
End Date:	11/3/2011 23:30	Lab ID: WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:				

Conc-%	1	2	3	4	5	6
D-Control	21.000	21.000	27.000	28.000	12.000	17.000
25	8.000	17.000	12.000	11.000	14.000	17.000
50	13.000	25.000	21.000	13.000	11.000	6.000
100	3.000	15.000	5.000	5.000	9.000	4.000

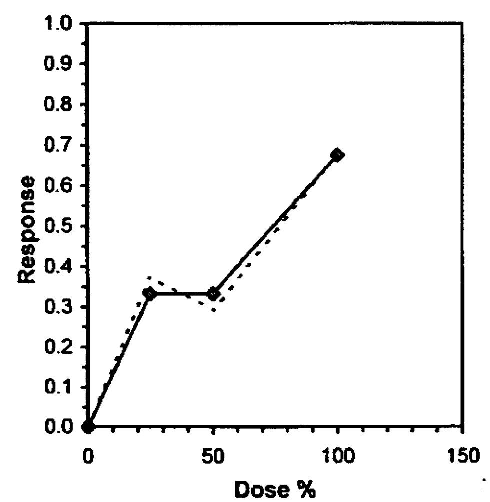
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	21.000	1.0000	21.000	12.000	28.000	28.730	6				21.000	1.0000
*25	13.167	0.6270	13.167	8.000	17.000	26.924	6	2.505	2.190	6.847	14.000	0.6667
50	14.833	0.7063	14.833	6.000	25.000	46.788	6	1.972	2.190	6.847	14.000	0.6667
*100	6.833	0.3254	6.833	3.000	15.000	65.718	6	4.531	2.190	6.847	6.833	0.3254

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)					0.96036		0.916		0.26537	-0.4034
Bartlett's Test indicates equal variances (p = 0.50)					2.35129		11.3449			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	50	100	70.7107	2	6.84703	0.32605	203.486	29.325	0.0022	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	3.750	6.438	2.083	25.877	5.9501
IC10*	7.500	9.061	4.166	75.591	4.0642
IC15*	11.250	10.401	6.249	81.327	3.2856
IC20*	15.000	13.816	8.332	85.495	2.0663
IC25*	18.750	17.336	10.415	92.018	1.1307
IC40	59.767				
IC50	74.419				

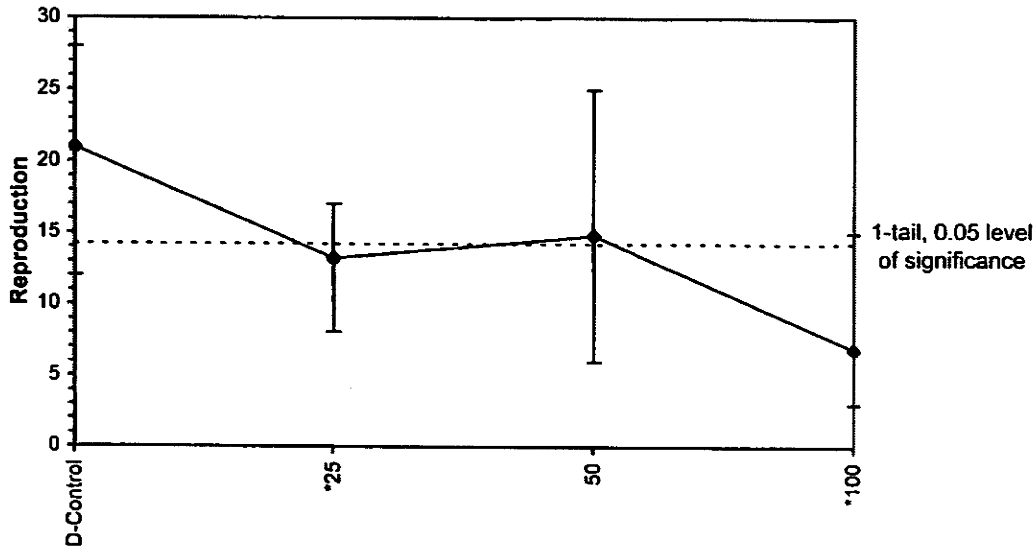
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:00	Test ID:	GenTIEC	Sample ID:	Genwal TIE C-18 Chronic Cero
End Date:	11/3/2011 23:30	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:_____

Chronic Toxicity Testing

Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- PH 6

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:15 p.m Ending 11/3/2011 11:40 p.m **IC25 Estimated from Test:** 61.76%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	32	29	28	23	22	28	27.0	0%
25.0%	22	35	33	36	35	32	32.2	0%
50.0%	21	28	29	21	24	24	24.5	0%
100%	16	22	7	14	16	13	14.7	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	6.9	7.2/6.9	7.3/6.9	6.8/6.4	6.7/6.3	6.6/6.2	6.7/6.3	7.2/6.8	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	6.00	6.01/6.09	5.97/6.04	5.98/6.06	6.15/6.05	6.04/6.01	6.06/6.06	5.98/6.06	6.06

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	6.9	7.2/6.8	7.4/7.1	6.8/6.6	6.7/6.4	6.7/6.3	7.0/6.5	7.3/7.0	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	6.25	6.20/6.31	8.18/6.44	6.24/6.44	6.30/6.49	6.31/6.49	6.31/6.47	6.19/6.47	6.48

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.1	7.3/6.8	7.3/7.0	6.7/6.6	6.7/6.4	6.6/6.5	7.1/6.7	7.1/7.0	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	6.39	6.41/6.79	6.43/6.88	6.39/6.78	6.50/6.74	6.52/6.92	6.50/6.85	6.44/6.84	6.90

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.4	7.2/6.7	7.7/7.1	7.1/6.6	6.8/6.5	6.8/6.3	7.1/6.6	7.6/7.1	6.5
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	6.62	6.64/7.13	6.68/7.01	6.66/7.51	6.80/7.47	6.92/7.64	6.79/7.69	6.63/7.66	8.09

Comments: Grit forming on the inside of the test chamber on most days. LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:15	Test ID:	GenTIE6	Sample ID:	Genwal TIE ph6 Chronic Cero
End Date:	11/3/2011 23:40	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	32.000	29.000	28.000	23.000	22.000	28.000
25	22.000	35.000	33.000	36.000	35.000	32.000
50	21.000	28.000	29.000	21.000	24.000	24.000
100	16.000	22.000	7.000	14.000	16.000	13.000

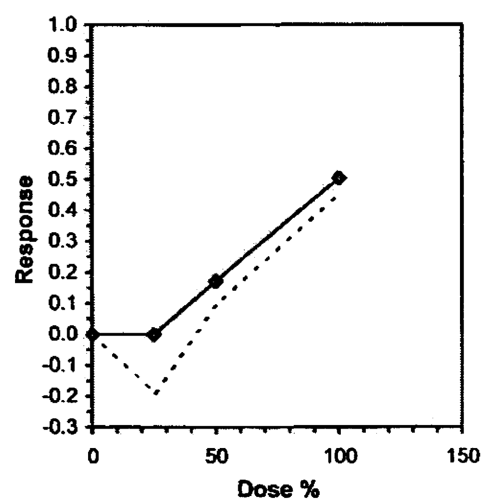
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	27.000	1.0000	27.000	22.000	32.000	14.055	6				29.583	1.0000
25	32.167	1.1914	32.167	22.000	36.000	16.144	6	-2.043	2.190	5.538	29.583	1.0000
50	24.500	0.9074	24.500	21.000	29.000	13.841	6	0.989	2.190	5.538	24.500	0.8282
*100	14.667	0.5432	14.667	7.000	22.000	33.309	6	4.877	2.190	5.538	14.667	0.4958

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.96285	0.916	-0.7038	0.57758
Bartlett's Test indicates equal variances (p = 0.78)	1.10542	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	50	100	70.7107	2	5.53791	0.20511	323.389	19.1833	1.1E-05	3, 20
Treatments vs D-Control										

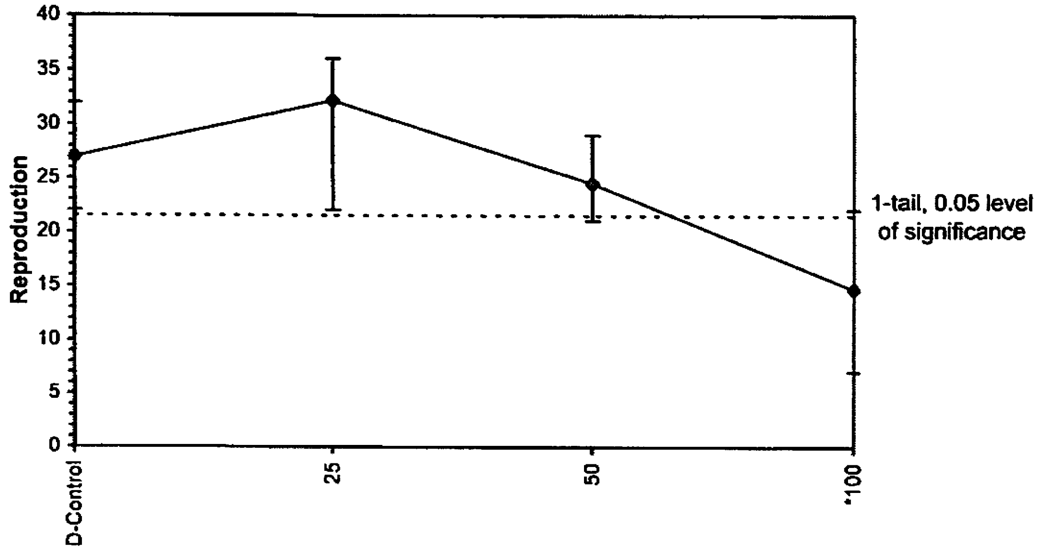
Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05	32.275	5.279	28.518	62.773	1.7837
IC10	39.549	6.002	32.112	67.058	1.1519
IC15	46.824	6.368	35.667	72.640	0.7885
IC20	54.237	6.712	39.306	76.620	0.5057
IC25	61.758	7.039	42.777	84.072	0.1977
IC40	84.322				
IC50	99.364				



Ceriodaphnia Survival and Reproduction Test-Reproduction					
Start Date:	10/26/2011 23:15	Test ID: GenTIE6		Sample ID:	Genwal TIE ph6 Chronic Cero
End Date:	11/3/2011 23:40	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- PH 7

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:15 p.m Ending 11/3/2011 11:40 p.m **IC25 Estimated from Test:** >100%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	22	26	21	27	28	28	25.3	0%
25.0%	34	27	24	26	32	26	28.2	0%
50.0%	22	25	26	23	31	23	25.0	0%
100%	23	22	13	21	27	20	21.0	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.3/6.8	7.1/7.1	6.7/6.5	6.6/6.4	6.6/6.2	6.8/6.7	7.0/6.9	6.2
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.48	7.23/8.18	7.29/8.37	7.35/7.71	7.38/7.69	7.43/7.66	7.45/7.72	7.30/7.60	7.80

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.1	7.3/6.8	7.2/7.1	6.8/6.5	6.6/6.3	6.5/6.4	6.6/6.6	7.2/6.9	6.1
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.46	7.40/8.10	7.34/8.19	7.37/7.98	7.46/7.89	7.44/7.85	7.50/7.95	7.33/7.83	8.07

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.1/6.8	7.3/7.0	6.9/6.6	6.7/6.4	6.6/6.4	6.8/6.5	7.2/7.0	6.2
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.38	7.37/8.03	7.39/8.00	7.43/8.13	7.51/8.06	7.52/8.02	7.61/8.19	7.43/8.00	8.26

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	6.8	7.4/6.9	7.6/7.0	6.9/6.7	6.7/6.6	6.6/6.4	6.9/6.6	7.3/7.0	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.34	7.35/7.80	7.41/7.79	7.52/8.37	7.59/8.29	7.59/8.33	7.63/8.41	7.48/8.26	8.35

Comments: LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction					
Start Date:	10/26/2011 23:15	Test ID:	GenTIE7	Sample ID:	Genwal TIE ph7 Chronic Cero
End Date:	11/3/2011 23:50	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

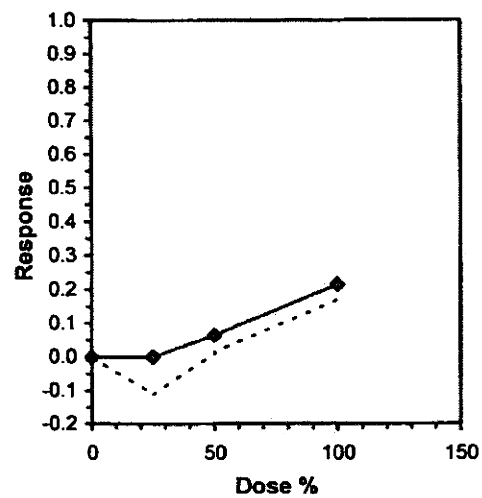
Conc-%	1	2	3	4	5	6
D-Control	22.000	26.000	21.000	27.000	28.000	28.000
25	34.000	27.000	24.000	26.000	32.000	26.000
50	22.000	25.000	26.000	23.000	31.000	23.000
100	23.000	22.000	13.000	21.000	27.000	20.000

			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	25.333	1.0000	25.333	21.000	28.000	12.145	6				26.750	1.0000
25	28.167	1.1118	28.167	24.000	34.000	13.917	6	-1.302	2.190	4.766	26.750	1.0000
50	25.000	0.9868	25.000	22.000	31.000	13.145	6	0.153	2.190	4.766	25.000	0.9346
100	21.000	0.8289	21.000	13.000	27.000	21.925	6	1.991	2.190	4.766	21.000	0.7850

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)					0.9722		0.916		-0.0317	-0.0592
Bartlett's Test indicates equal variances (p = 0.82)					0.93134		11.3449			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	100	>100		1	4.76601	0.18813	52.1528	14.2083	0.02956	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)	Skew
IC05	44.107			
IC10	61.563			
IC15	78.281			
IC20	95.000			
IC25	>100			
IC40	>100			
IC50	>100			

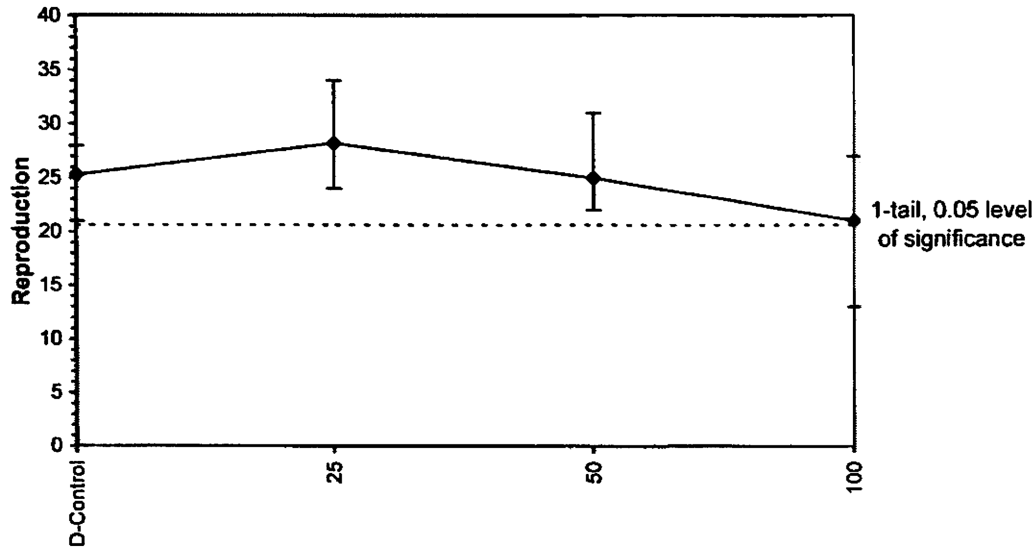


 ToxCalc v5.0.32 Reviewed by:______

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:15	Test ID:	GenTIE7	Sample ID:	Genwal TIE ph7 Chronic Cero
End Date:	11/3/2011 23:50	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Chronic Toxicity Testing

Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- EDTA 3 mg/L

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:25 p.m Ending 11/3/2011 12:00 p.m **IC25 Estimated from Test:** >100%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	24	0D	21	25	33	26	21.5	17%
25.0%	26	26	13	22	35	18	23.3	0%
50.0%	24	11	7	12	23	26	17.2	0%
100%	13	22	24	15	26	19	19.8	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.2/6.9	7.2/7.1	6.7/6.7	6.9/6.5	6.6/6.4	7.0/6.6	7.1/6.8	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.80	7.79/8.25	7.74/8.28	7.75/8.17	7.86/8.21	7.86/8.19	7.89/8.29	7.77/8.06	8.39

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.2/6.9	7.2/7.1	6.8/6.6	6.8/6.6	6.7/6.7	6.9/6.9	7.3/7.0	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.01	7.96/8.39	7.89/8.44	7.91/8.37	8.02/8.36	8.07/8.36	8.05/8.48	7.82/8.23	8.53

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.2/6.9	7.3/7.3	6.9/6.7	6.8/6.7	6.7/6.8	7.0/6.9	7.3/7.4	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.94	7.92/8.37	7.89/8.40	7.95/8.44	8.09/8.47	8.13/8.43	8.13/8.52	7.90/8.36	8.51

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.1/6.8	7.3/7.5	6.9/6.6	6.9/6.8	6.7/6.8	7.0/7.0	7.3/7.3	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.93	7.91/8.38	7.89/8.35	7.94/8.26	8.03/8.28	8.12/8.28	8.09/8.33	7.96/8.21	8.41

Comments: LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:25	Test ID: GenTIEE3		Sample ID:	Genwal TIE EDTA 3 Chronic Cero
End Date:		Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

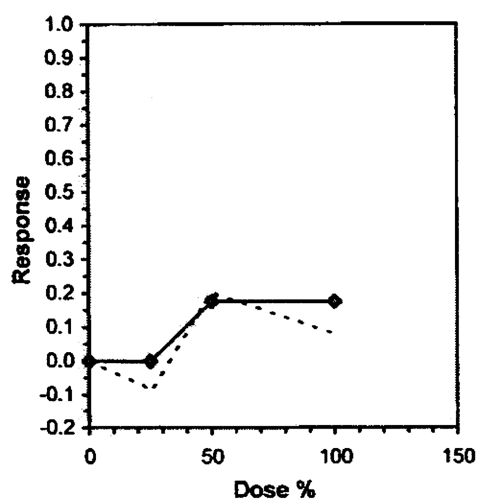
Conc-%	1	2	3	4	5	6
D-Control	24.000	0.000	21.000	25.000	33.000	26.000
25	26.000	26.000	13.000	22.000	35.000	18.000
50	24.000	11.000	7.000	12.000	23.000	26.000
100	13.000	22.000	24.000	15.000	26.000	19.000

			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	21.500	1.0000	21.500	0.000	33.000	52.354	6				22.417	1.0000
25	23.333	1.0853	23.333	13.000	35.000	32.489	6	-0.382	2.190	10.497	22.417	1.0000
50	17.167	0.7984	17.167	7.000	26.000	47.097	6	0.904	2.190	10.497	18.500	0.8253
100	19.833	0.9225	19.833	13.000	26.000	25.792	6	0.348	2.190	10.497	18.500	0.8253

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)					0.947		0.916		-0.8414	1.11354
Bartlett's Test indicates equal variances (p = 0.43)					2.74408		11.3449			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	100	>100		1	10.4972	0.48824	41.1528	68.925	0.6243	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

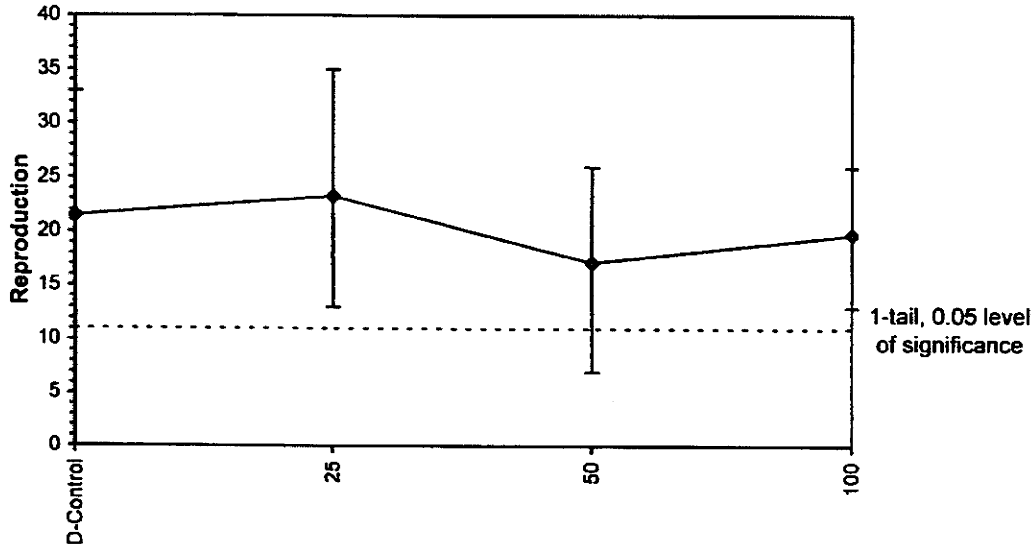
Point	%	SD	95% CL(Exp)	Skew
IC05	32.154			
IC10	39.309			
IC15	46.463			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:25	Test ID:	GenTIEE3	Sample ID:	Genwal TIE EDTA 3 Chronic Cero
End Date:		Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:_____

Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- EDTA 8 mg/L

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:25 p.m Ending 11/3/2011 12:10 p.m **IC25 Estimated from Test:** >100%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	22	24	21	10	21	11	18.2	0%
25.0%	23	30	10	26	27	26	23.7	0%
50.0%	24	27	27	20	26	23	24.5	0%
100%	9	16	18	20	18	25	17.7	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.2/6.8	7.0/7.0	6.9/6.5	6.8/6.6	6.7/6.2	7.0/6.7	7.2/7.0	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.11	8.08/8.25	8.00/8.23	8.07/8.18	8.18/8.09	8.19/8.13	8.15/8.21	7.93/8.15	8.42

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.0	7.2/6.8	7.1/7.1	6.9/6.7	6.8/6.6	6.7/6.5	7.0/6.5	7.3/7.1	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.03	8.00/8.32	7.96/8.41	8.07/8.34	8.11/8.33	8.11/8.33	8.16/8.44	7.92/8.28	8.53

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.4/6.9	7.3/7.1	6.9/6.4	6.8/6.7	6.6/6.6	6.9/6.8	7.4/7.2	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.95	7.94/8.39	7.93/8.40	8.02/8.41	8.07/8.43	8.09/8.44	8.17/8.50	7.89/8.37	8.51

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.4/6.8	7.3/7.3	7.0/6.6	6.8/6.8	6.7/6.7	7.0/6.9	7.5/7.2	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	7.91	7.93/8.32	7.96/8.35	7.96/8.27	8.04/8.25	8.10/8.31	8.07/8.32	7.89/8.23	8.42

Comments: LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:25	Test ID:	GenTIEE8	Sample ID:	Genwal TIE EDTA 8 Chronic Cero
End Date:		Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	22.000	24.000	21.000	10.000	21.000	11.000
25	23.000	30.000	10.000	26.000	27.000	26.000
50	24.000	27.000	27.000	20.000	26.000	23.000
100	9.000	16.000	18.000	20.000	18.000	25.000

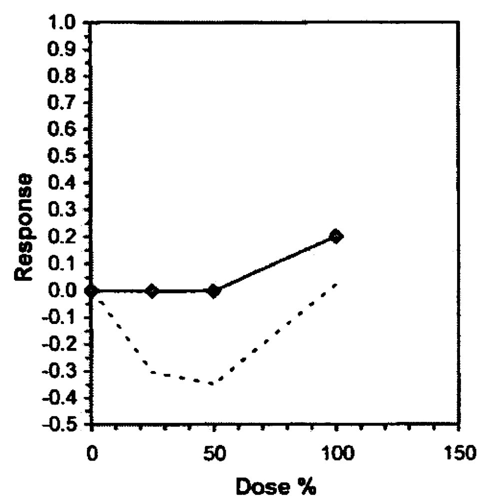
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
D-Control	18.167	1.0000	18.167	10.000	24.000	33.286	6			22.111	1.0000
25	23.667	1.3028	23.667	10.000	30.000	29.838	6	50.50	26.00	22.111	1.0000
50	24.500	1.3486	24.500	20.000	27.000	11.178	6	51.50	26.00	22.111	1.0000
100	17.667	0.9725	17.667	9.000	25.000	29.665	6	35.00	26.00	17.667	0.7990

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.90043	0.916	-1.1046	0.96996
Bartlett's Test indicates equal variances (p = 0.29)	3.76071	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	>100		1
Treatments vs D-Control				

Linear Interpolation (200 Resamples)

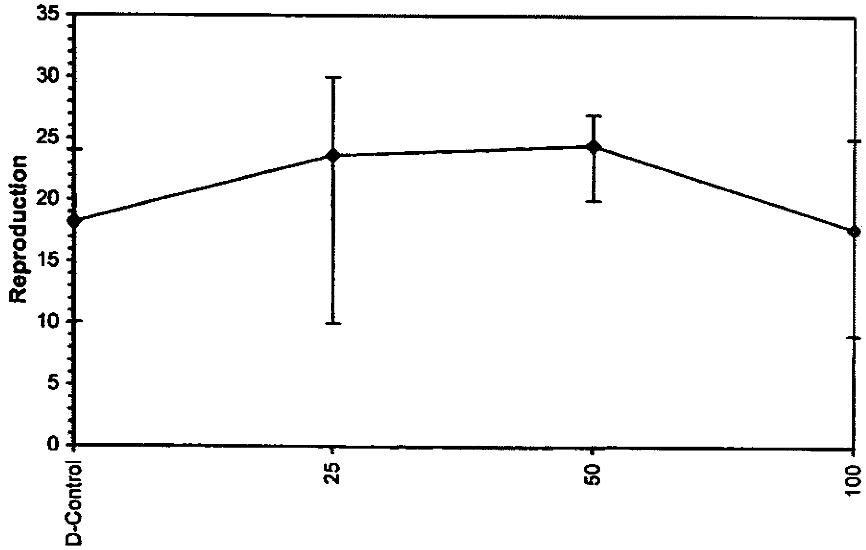
Point	%	SD	95% CL(Exp)	Skew
IC05	62.438			
IC10	74.875			
IC15	87.313			
IC20	99.750			
IC25	>100			
IC40	>100			
IC50	>100			



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:25	Test ID: GenTIEE8		Sample ID:	Genwal TIE EDTA 8 Chronic Cero
End Date:		Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- Thiosulfate 10 mg/L

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:40 p.m Ending 11/3/2011 12:20 p.m **IC25 Estimated from Test:** 43.31%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia
Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	17	16	19	13	14	15	15.7	0%
25.0%	10	14	11	18	17	20	15.0	0%
50.0%	12	11	5D	10	16	12	10.8	0%
100%	3	9	0	4	2	2	3.3	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	6.9	7.2/6.8	7.0/7.1	6.8/6.7	6.8/6.6	6.9/6.3	7.0/6.4	7.3/7.0	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.23	8.24/8.36	8.26/8.38	8.20/8.11	8.30/8.18	8.29/8.22	8.27/8.28	815/8.06	8.41

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.1	7.2/6.9	7.0/7.3	6.6/6.8	6.7/6.7	6.7/6.5	7.0/6.7	7.0/7.1	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.12	8.09/8.45	8.07/8.48	8.07/8.35	8.21/8.39	8.29/8.36	8.22/8.47	8.04/8.28	8.52

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.3/6.9	7.1/7.4	6.9/6.6	6.8/6.8	6.7/6.6	6.9/6.9	7.4/7.2	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.06	8.07/8.35	8.05/8.37	8.04/8.38	8.14/8.44	8.24/8.45	8.19/8.50	7.99/8.38	8.41

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.3	7.4/7.0	7.5/7.4	6.9/6.8	6.9/6.9	6.7/6.8	7.0/6.9	7.5/7.4	6.5
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.00	7.95/8.32	7.90/8.34	8.03/8.23	8.12/8.24	8.14/8.27	8.07/8.32	7.97/8.21	8.38

Comments: Grit forming on the inside of the test chamber on most days. LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:40	Test ID:	GenTIEt10	Sample ID:	Genwal TIE Thiosulfate 10 Chronic Cer
End Date:		Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	17.000	16.000	19.000	13.000	14.000	15.000
25	10.000	14.000	11.000	18.000	17.000	20.000
50	12.000	11.000	5.000	10.000	16.000	12.000
100	3.000	9.000	0.000	4.000	2.000	2.000

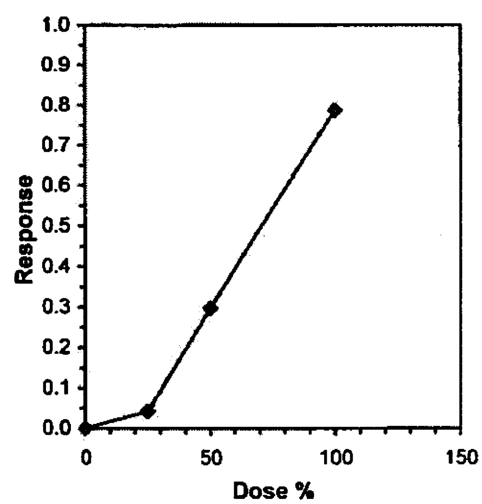
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	15.667	1.0000	15.667	13.000	19.000	13.789	6				15.667	1.0000
25	15.000	0.9574	15.000	10.000	20.000	26.667	6	0.352	2.190	4.142	15.000	0.9574
*50	11.000	0.7021	11.000	5.000	16.000	32.525	6	2.467	2.190	4.142	11.000	0.7021
*100	3.333	0.2128	3.333	0.000	9.000	92.304	6	6.520	2.190	4.142	3.333	0.2128

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.97804	0.916	0.05988	-0.2756
Bartlett's Test indicates equal variances (p = 0.62)	1.76843	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	25	50	35.3553	4	4.14239	0.26441	192.611	10.7333	6.8E-06	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

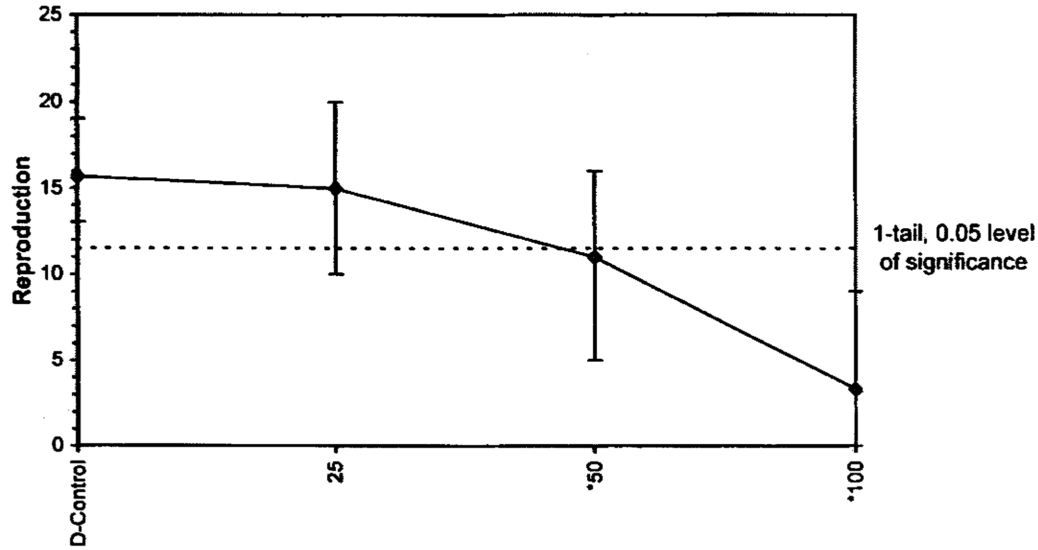
Point	%	SD	95% CL(Exp)		Skew
IC05	25.729	9.452	0.000	35.724	-0.5958
IC10	30.625	8.957	0.000	52.705	-0.5566
IC15	35.521	9.026	2.791	60.320	-0.4500
IC20	40.417	9.071	7.193	63.513	-0.4295
IC25	45.313	8.866	11.595	66.618	-0.5139
IC40	60.435	8.037	35.571	79.071	-0.1150
IC50	70.652	7.720	44.800	88.540	-0.1095



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:40	Test ID: GenTIEt10		Sample ID:	Genwal TIE Thiosulfate 10 Chronic Cer
End Date:		Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Chronic Toxicity Testing

Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase I- Thiosulfate 25 mg/L

TIE sample made by compositing samples collected: 10/3/2011

Analyses Dates/Times Beginning 10/26/2011 11:40 p.m Ending 11/3/2011 12:30 p.m **IC25 Estimated from Test:** 68.15%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	12	11	16	16	12	14	13.5	0%
25.0%	11	13	15	9	9	14	11.8	0%
50.0%	14	9	15	9	15	11	12.2	0%
100%	5	9	9	10	3	5	6.8	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	6.9	7.2/6.9	7.0/7.2	6.7/6.7	6.9/6.5	6.8/6.4	7.0/6.5	6.9/7.3	6.2
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.28	8.26/8.39	8.24/8.41	8.24/8.16	8.35/8.17	8.26/8.17	8.28/8.26	8.15/8.18	8.33

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.1	7.1/6.9	7.2/7.2	6.7/6.8	6.8/6.7	6.8/6.8	7.0/6.7	7.1/7.2	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.18	8.12/8.45	8.08/8.49	8.12/8.38	8.18/8.39	8.19/8.37	8.21/8.48	8.01/8.36	8.51

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.2/6.9	7.3/7.2	7.0/6.8	6.9/6.7	6.7/6.8	7.0/6.6	7.3/7.1	6.3
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.07	8.05/8.39	8.00/8.37	8.06/8.42	8.13/8.46	8.19/8.37	8.23/8.50	7.97/8.31	8.42

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.2	7.5/6.9	7.4/7.4	7.2/6.8	6.8/6.8	6.7/6.8	6.9/6.6	7.5/7.2	6.4
Temp New/Old	24.2	25.0/24.4	25.0/24.4	25.0/24.4	25.0/24.6	25.0/24.6	25.0/24.8	25.0/24.0	24.2
Ph New/Old	8.01	7.97/8.37	7.95/8.35	7.94/8.25	8.09/8.24	8.11/8.27	8.13/8.23	7.95/8.16	8.38

Comments: Grit forming on the inside of the test chamber on most days. LC50 estimated at >100%.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	10/26/2011 23:40	Test ID: GenTIEt25		Sample ID:	Genwal TIE Thiosulfate 25 Chronic Cer
End Date:		Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	12.000	11.000	16.000	16.000	12.000	14.000
25	11.000	13.000	15.000	9.000	9.000	14.000
50	14.000	9.000	15.000	9.000	15.000	11.000
100	5.000	9.000	9.000	10.000	3.000	5.000

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
D-Control	13.500	1.0000	13.500	11.000	16.000	16.059	6			13.500	1.0000
25	11.833	0.8765	11.833	9.000	15.000	21.655	6	32.00	26.00	12.000	0.8889
50	12.167	0.9012	12.167	9.000	15.000	23.488	6	33.00	26.00	12.000	0.8889
*100	6.833	0.5062	6.833	3.000	10.000	41.821	6	21.00	26.00	6.833	0.5062

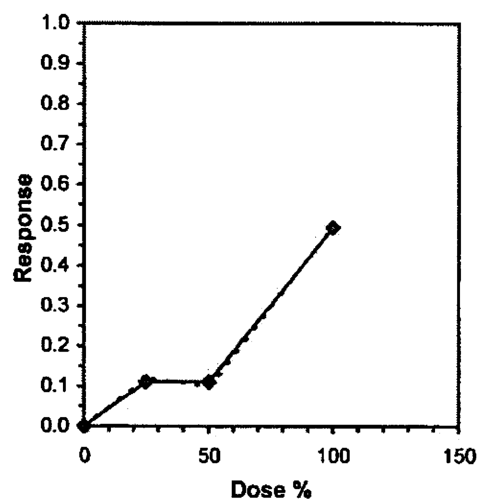
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.88009	0.916	-0.076	-1.698
Bartlett's Test indicates equal variances (p = 0.93)	0.4449	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	50	100	70.7107	2
Treatments vs D-Control				

Linear Interpolation (200 Resamples)

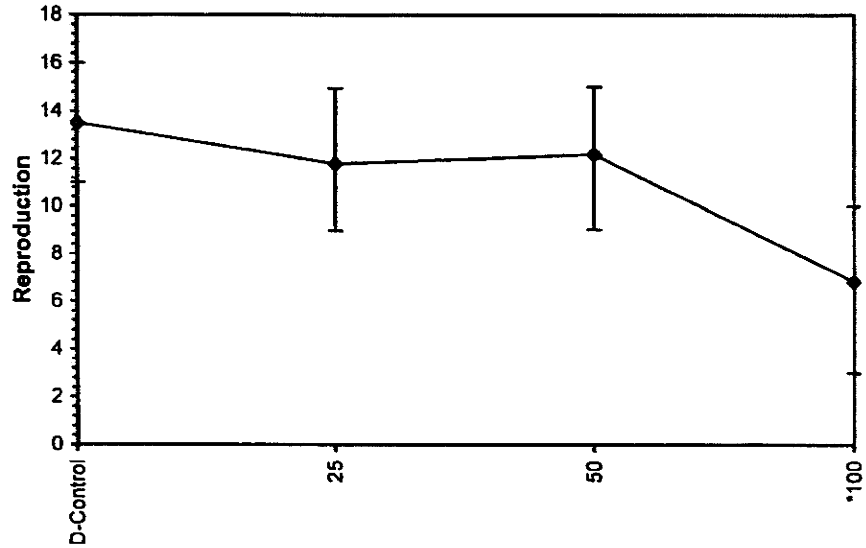
Point	%	SD	95% CL(Exp)		Skew
IC05*	11.250	17.164	2.971	79.003	1.0290
IC10*	22.500	18.376	5.941	83.006	-0.0082
IC15	55.081	16.761	0.000	76.343	-0.7685
IC20	61.613	13.990	3.576	85.658	-1.2518
IC25	68.145	10.652	31.950	96.716	-0.7489
IC40	87.742				
IC50	>100				

* indicates IC estimate less than the lowest concentration



Ceriodaphnia Survival and Reproduction Test-Reproduction					
Start Date:	10/26/2011 23:40	Test ID: GenTIEt25		Sample ID:	Genwal TIE Thiosulfate 25 Chronic Cer
End Date:		Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Sample Chemistries

W.E.T. Inc.

Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Whole Effluent Toxicity Chemical Result Report

October 28, 2011

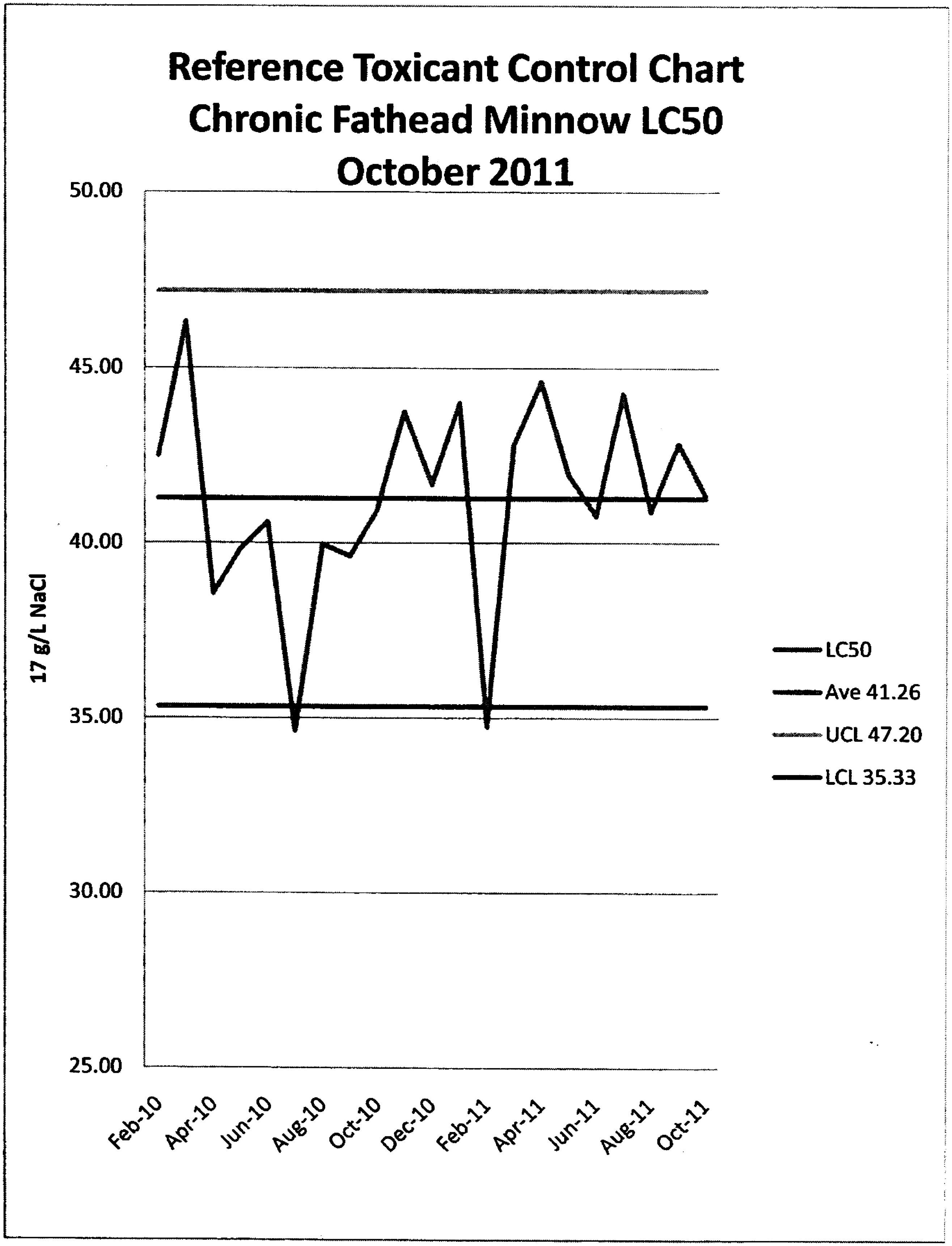
CUSTOMER NAME:
Utah American- Crandall Canyon Mine (Accelerated Test #3)
Attn: Dana Morrelli
194 North 100 West
Huntington, Utah 84528

SAMPLE DESCRIPTION:
Chemistries to go with Chronic Toxicity Test sampled on 10/03/2011.

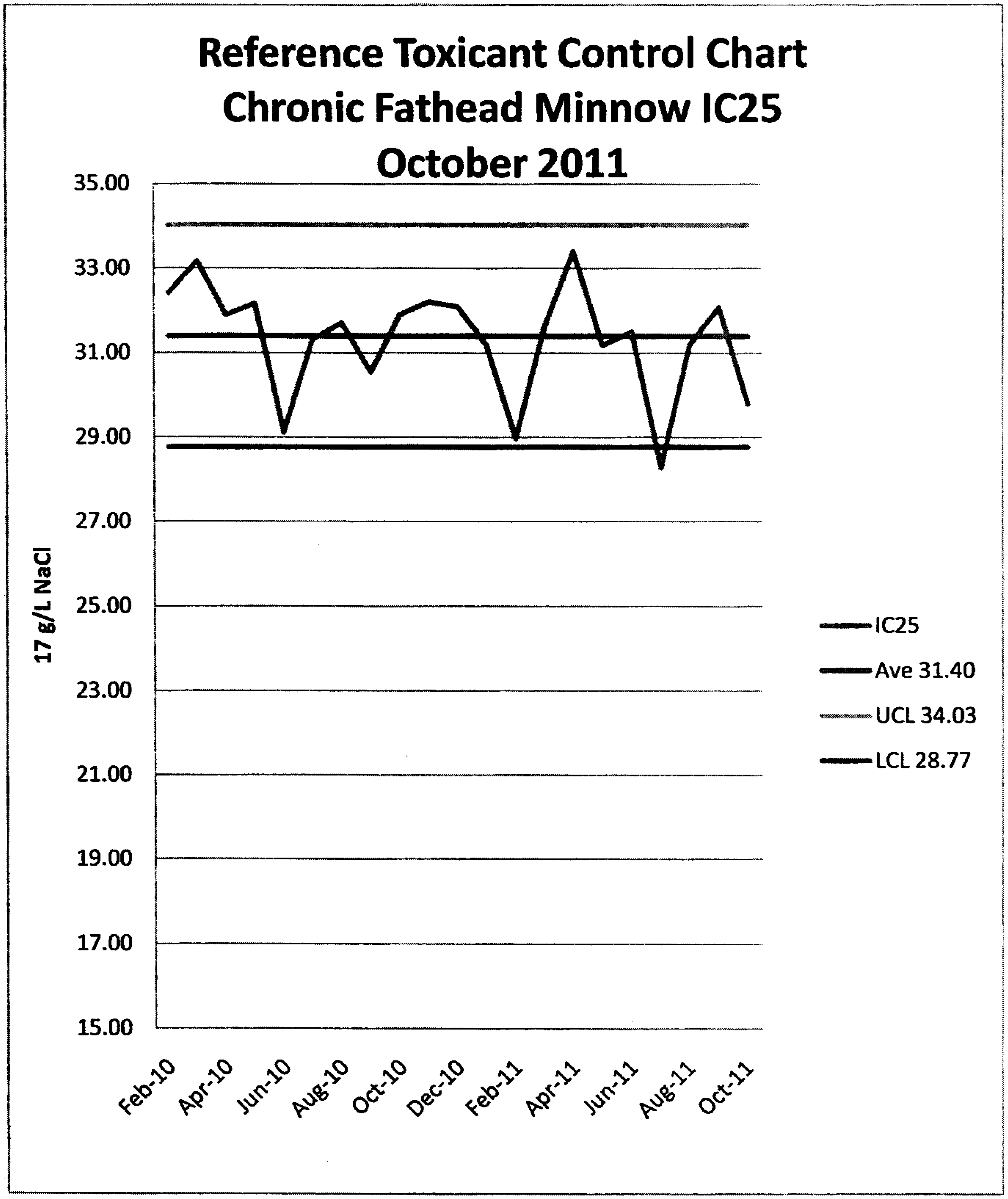
Analysis	Test Results		
	Repl. 1	Repl. 2	Repl. 3
Log #	8490	NA	NA
Total Hardness, Recon (EPA 130.2), mg/L	176		
Total Hardness, Effluent (EPA 130.2), mg/L	472		
Ammonia, Effluent (EPA 350.2/350.3), mg/L	0.43		
Initial Chlorine Residual (EPA 330.5), mg/L	<0.05		
Final Chlorine Residual (EPA 330.5), mg/L	N/A		
Conductivity, Effluent (EPA 120.1), umhos/cm	970		
Alkalinity, Effluent (EPA 310.1), mg/L $CaCO^3$	382		
Recon Initial pH (EPA 150.1)	8.45		
After 24 hours pH (EPA 150.1)	8.27		
100% Initial pH (EPA 150.1)	7.71		
100% After 24 hours pH (EPA 150.1)	7.81		

Reviewed: Lee Rawlings, Lab Director
Water & Environmental Testing, Inc.

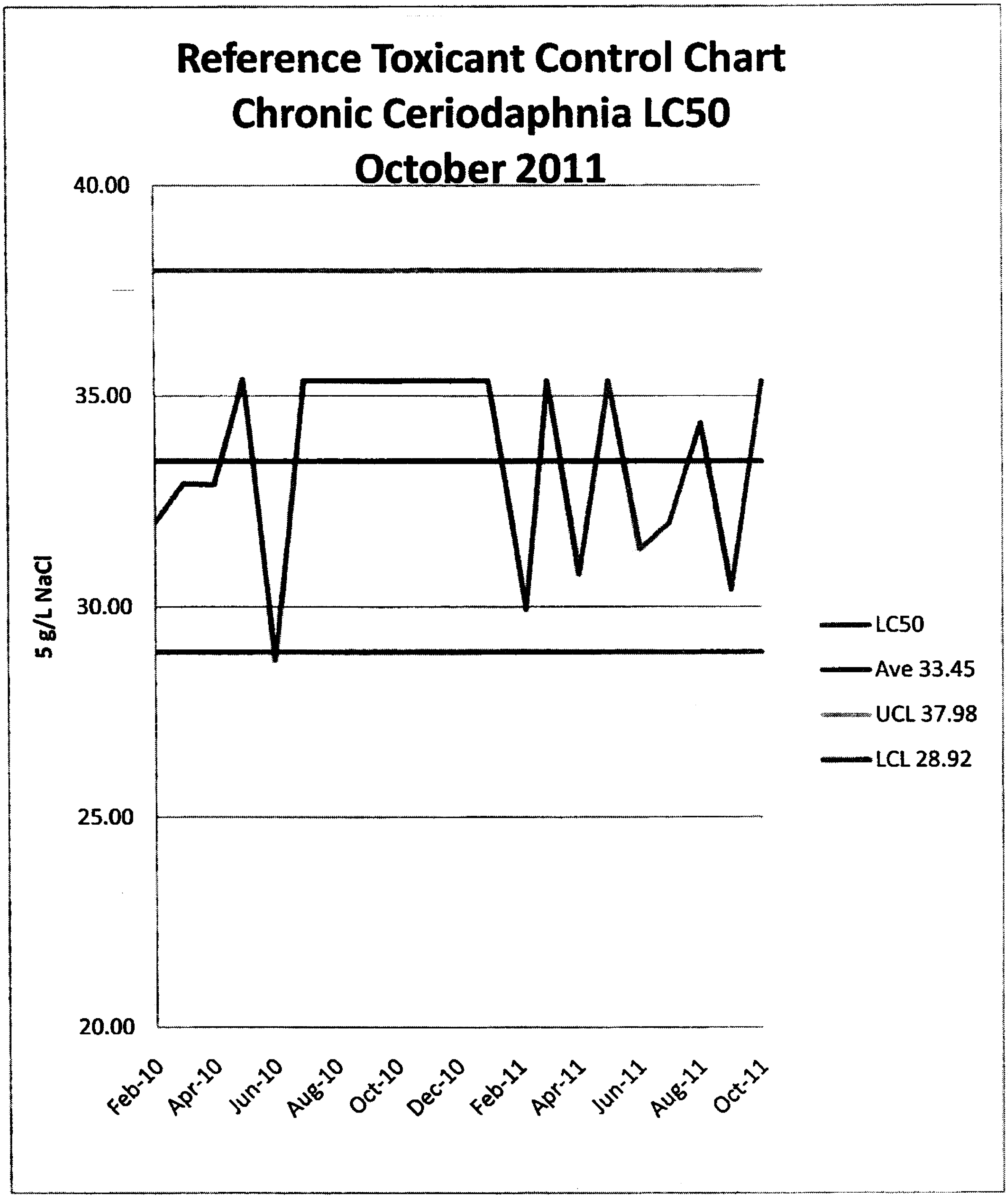
Quality Control Charts



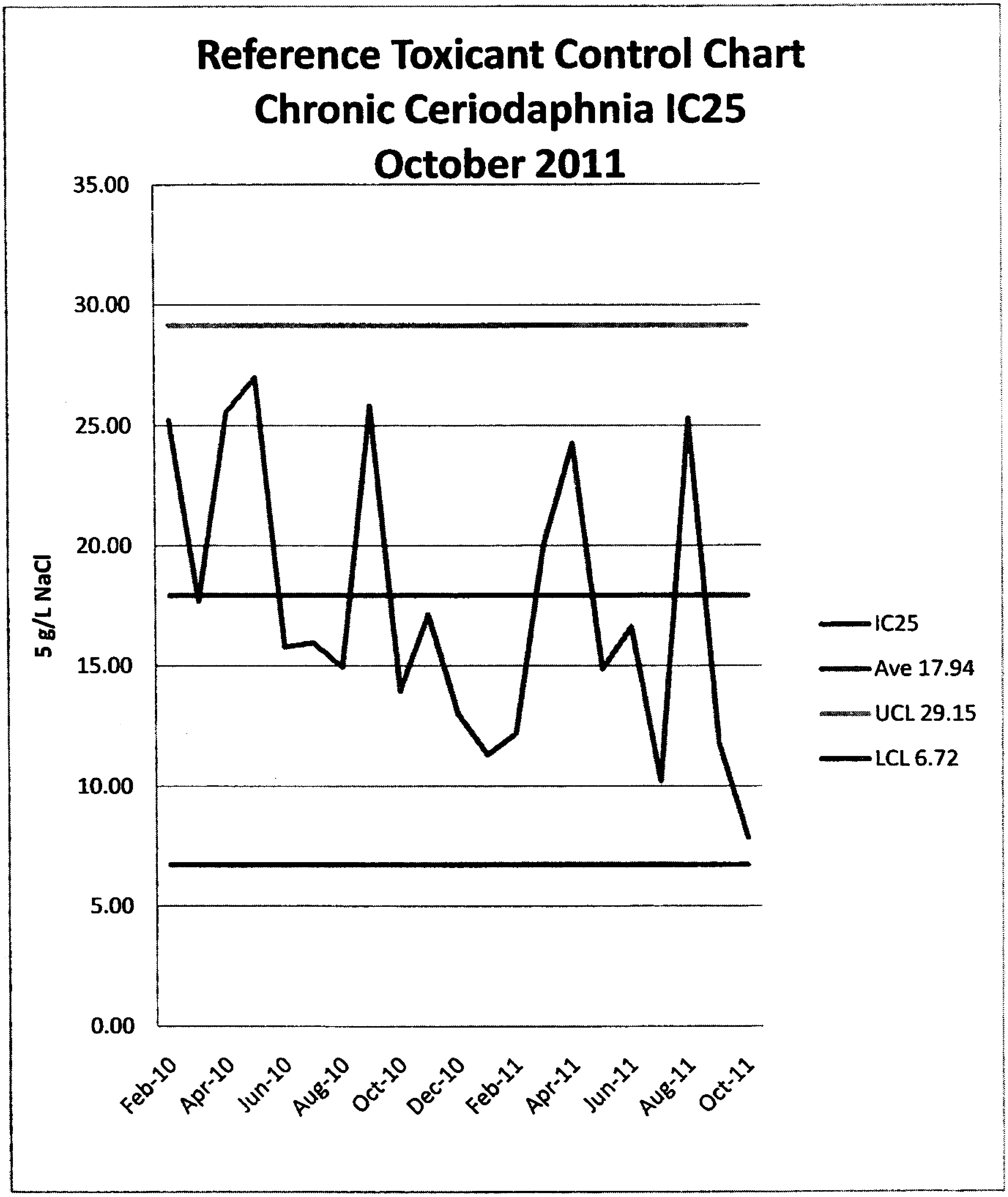
Reference Toxicant Control Chart
Chronic Fathead Minnow LC50
October 2011
50.00
45.00
40.00
35.00
30.00
25.00
17 g/L NaCl
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
LC50
Ave 41.26
UCL 47.20
LCL 35.33



Reference Toxicant Control Chart
Chronic Fathead Minnow IC25
October 2011
35.00
33.00
31.00
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
17 g/L NaCl
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
IC25
Ave 31.40
UCL 34.03
LCL 28.77



Reference Toxicant Control Chart
Chronic Ceriodaphnia LC50
October 2011
40.00
35.00
30.00
25.00
20.00
5 g/L NaCl
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
LC50
Ave 33.45
UCL 37.98
LCL 28.92


Reference Toxicant Control Chart
Chronic Ceriodaphnia IC25
October 2011
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
5 g/L NaCl
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
IC25
Ave 17.94
UCL 29.15
LCL 6.72

Chain of Custody

W.E.T. Inc.

Water & Environmental Testing Inc. 223 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax (801)763-0440

Chain of Custody Record

Customer: UTAH AMERICAN	Sampler: DANA MARRELLI
Sample Date: 10-03-11	Project: CRANDALL

Sample Information

Sample #	Date	Time	Composite/Grab	Location	Analysis Requested
1	10-3-11	9:30	GRAB	CRANDALL 002	

Sample Custody Record

Relinquished by:	Received by:	Date/Time
D Marrelli	K. H [signature]	October 3, 2011 12 45
K. H [signature]	[signature] Rawlings	10/3/11 1900

Sample Received in Lab by	Date/Time
[initials]	10-3-11 1:00

Comments: ______________________________

Temperature Received in the Lab: Effluent: 7C
Receiving Water: ________

W.E.T. Inc. Use Only

Cooler: Wet Ice ___ Blue Ice ___ None X	Hand Delivery X W.E.T. Inc. Courier ___ Shipped ___	Arrived in Shipping Container (Y) / N Sealed (Y) / N / NA	Samples- Custody Seals Used (Y) / N Intact (Y) / N / NA	COC and Labels Match? Yes X No ___	Holding Time Met (36 hours) Yes X No ___
Broken, Damaged or Leaking? Yes ___ No X	Correct Containers Used? Yes X No ___	Sufficient Quantity Sample? Yes X No ___	Sufficient Quantity of Receiving Water? Yes NA No ___	Adequate Info provided? Yes X No ___	Sample Acceptance Accepted X Rejected ___

Utah American

Crandall Canyon Mine

Toxicity Identification Evaluation- 10/03/2011

Phase II- Toxicity Identification

By: Water & Environmental Testing, Inc

February 15th, 2012

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Ceriodaphnia dubia LC50
Ceriodaphnia dubia IC25

Chain of Custody

Appendix A (pictures)

W.E.T. Inc.

Water Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801) 763-0660 FAX (801) 763 04440

February 10th, 2012

Dana Morrelli
Crandall Canyon Mine
194 North 100 West
Huntington, Utah 84528

re: Summary Report for Phase II Toxicity Identification Evaluation on the Crandall Canyon Mine

Executive Summary

Included in the executive summary are the highlights of the Phase II testing completed on the samples collected starting 10/03/2011. Actual copies of each test and the associated data reduction have been included in the data section of this report.

Summary of Phase II Testing

Second Baseline Test

A second baseline test was set up to see if the toxicity was still present and to be used as the control for the chemical precipitation test. The results of this tests gave a IC25 of 57.3%, similar to the first baseline test. This tells us that the toxicity is still present and active in the sample, making it a good control to compare results with the chemical precipitation test.

Chemical Precipitation Test

In the initial test and first baseline test it was noted by the technicians that a gritty film developed below the waterline in the test chambers during each 24 test period between renewals, especially in the 100% dilution. This grit can be seen after pouring out the water and allowing the inside of the cup to dry. I have taken pictures of several of the cups showing the solids that have developed and included them in the appendix A.

The chemical precipitation test was designed to use a chemical base to increase precipitation and rapidly complete the precipitation process. This was done by first raising the pH of the sample to 11.23 using concentrated sodium hydroxide. High pH initiates the formation of calcium carbonate molecules, combining the hardness and alkalinity, creating solids large enough to settle out of solution. Under these conditions some metals will form metal hydroxide solids and also precipitate out of solution. Next the sample was mixed for 15 minutes on a stir plate then removed from the stir plate and allowed to stand for 30 minutes. After settling for 30 minutes the supernate was poured off leaving about 20 mls of solution containing solids in the bottom of the beaker. This solution was died at room temperature and the solids submitted for metals analysis to see what if any metals were removed from solution in the precipitation process. Approximately 2.5 grams of dried solids were produced in this process, a picture of the died solids has also been included in appendix A. The chemistries before and after treatment are shown in Table 1.

Table 1

Sample	Hardness mg/L	Alkalinity mg/L	Conductivity umhos/cm2	Ammonia mg/L
Initial Sample	472	382	970	0.43
Chemical Precipitation	100	270	1,946	0.54
Natural Precipitation	412	304	870	not anlayzed

The supernate was then adjusted back the pH 7.85 using concentrated hydrochloric acid. Concentrated forms of the acid and base were used to minimize dilution of the sample. The adjusted solution was tested alongside the second baseline test to see how the procedure affected toxicity. The results of the chronic ceriodaphnia test showed no toxicity in the chemical precipitation sample, producing 33.7 young/adult in the control and 32.5 in the 100% dilution. The technicians did not notice any solids or grit forming on the inside of the test chambers in the chemical precipitation test.

Natural Precipitation Test

After seeing the results of the chemical precipitation test which was successful in removing toxicity, the question was raised if the sample was allowed to stand would precipitation occur on its own and when the sample came to equilibrium would the toxicity be removed in the process. If this process was allowed to occur over an extended time and successfully remove the toxicity, this would suggest that extending the holding time of the treated water before discharge could be a viable way to remove toxicity.

The sample was prepared by filling a 2, 1 liter beakers with sample that had been warmed to 20 degree Celsius. A magnet was added and the beakers placed on a stir plate and stirred slowly for 24 hours. After 24 hours the stirrer was turned off and the sample was allowed to stand for 30 minutes. The supernate was then poured off into a sample storage bottle and placed in the fridge until needed. Chemistries for this sample are shown in Table 1, and pictures of the beakers are in Appendix A. A new baseline test was run alongside this test using the same series 25, 50 and 100%.

Observations from sample preparation had white flakes floating on the surface of the sample after 24 hours and white solids sticking to the inside of the glass beaker. The supernate was clear and during the test no solids formed on the sides of the test chamber. However, toxicity was still present in the natural precipitation sample with data from the test estimating an IC25 of 27.2%, similar to the baseline test at 32.5%. The results from this test suggest that 24 hours is not long enough for the precipitation to happen and for the sample to come to a stable state. The test should be repeated if needed as part of phase 3.

Metals

The EDTA tests from phase I indicated the possibility toxicity from the presence of metals. Aliquots of the sample was sent out to Chemtech-Ford for analysis using 200.7/200.8 to give the lowest possible detection limits. The thirteen most common metals were analyzed and the results are shown in Table 2. None of the metals tested were at a level high enough to be considered the cause of the toxicity, nor is any combination close to the toxic limits.

Iron (ferric chloride) and Aluminum (alum) representing the metals portion of the two coagulants and/or flocculents used at the mine were analyzed to check if unreacted chemical(s) were present in the sample and perhaps contributing to the continued precipitation seen during the testing process. Both of these metals were undetectable at the method MDL in the dissolved portion which suggests what little of the metals is present in the sample is attached to molecules large enough to be filtered out.

Metals Analysis in Chemically Induced Precipitate

The solids formed in the precipitation test were dried at room temperature and delivered to the lab for analysis of the same 13 metals. The results are shown in Column 4 of Table 2. The metals concentrations of the dried solids have large portions of aluminum and iron showing that these metals were removed from solution by the chemical precipitation process.

Table 2

Metals	Total Metals mg/L (liquid)	Dissolved Metals mg/L (liquid)	Metals in Chemical Precipitate mg/kg wet (solid)
Aluminum	0.09	<0.05	4,220
Arsenic	<0.0005	---	5.74
Cadmium	<0.0005	---	<0.50
Chromium	0.0027	---	<0.50
Copper	<0.0010	0.0017	0.529
Iron	0.03	<0.02	1,750
Lead	<0.0005	---	1.77
Mercury	<0.0002	---	<0.06
Molybdenum	<0.0014	---	0.43
Nickel	0.0160	---	15.8
Selenium	0.0005	---	3.47
Silver	<0.0005	---	<0.50
Zinc	<0.01	---	2.92

Conclusions

It appears that the most likely scenario for the toxicity seen in this sample is the test organisms are being subjected to an environment where solids are forming and precipitating from solution. This process adds stress to the organisms which results in increased mortality and lower reproduction. The mechanism allowing the EDTA to remove toxicity in the Phase I tests must be one where the EDTA combines with the calcium and magnesium in solution interfering with solids formation.

The chemical precipitation test was able to remove toxicity demonstrating that if the precipitation process was completed the organisms are able to produce normal reproduction totals as compared to the control. The ongoing precipitation is most likely due to either a residual of ferric chloride, an excess of coagulant in the sample or the reaction of the coagulant initiating the hardness/alkalinity precipitation process which extends over time into the testing period.

Recommendations for Phase III Toxicity Elimination

Back in July when the first toxicity was found an on-site review of the treatment process showed a recent change of coagulant used from alum to ferric chloride. As ferric chloride is known to be an irritant it was recommended that they change back to alum which is much less of an irritant than ferric chloride. This recommendation was accepted and the chemicals changed back sometime in August. Following the change back to alum toxicity was found again in the September test where the cause was thought to be residual ferric chloride in the system and that with time the system would flush the residual out. A second failure in October initiated this Toxicity Identification Evaluation.

The routine testing for the fourth quarter passed for both the Ceriodaphnia and Fathead Minnows suggesting that the system is now clean or clean enough to pass the chronic toxicity requirements of the permit. In the fourth quarter test there were still some solids formation on the inside of the test chambers but not enough to cause the test to fail. The permit requires the IC25 to be higher than 65.5% and the result for the chronic ceriodaphnia portion of the test was 80.97%.

The fourth quarter test passing suggests that activities taken at the mine have got the situation under control and I do not recommend any additional work be done as part of Phase III at this time. Should the problem return several possible treatments have become evident through this TIE process. The first being to closely monitor the volumes of coagulant and flocculent added. The second would be to extend the time following chemical treatment to allow complete stabilization to occur. Extending the length of time would require a bigger pond or adding a secondary stabilization pond.

If you have any questions or need any additional information please feel free to give me a call at 801-763-0660, or on my cell phone at 801-360-5438.

Sincerely,

Lee Rawlings
Laboratory Director
Water & Environmental Testing, Inc

Phase II Testing

Chronic Toxicity Testing

Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase 2- Baseline Test #2

TIE sample made by compositing samples collected: 12/18/2011

Analyses Dates/Times Beginning 12/18/2011 6:00 p.m Ending 12/26/2011 6:00 p.m **IC25 Estimated from Test:** 57.27%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	36	31	35	28	20	15	27.5	0%
25.0%	25	33	30	14	18	12	22.0	0%
50.0%	16	36	20	21	29	22	24.0	0%
100%	8	11	8D	1D	7D	5D	6.7	67%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.7	7.9/7.6	7.6/7.1	7.3/7.5	7.3/7.1	7.4/7.4	7.3/7.1	7.4/7.1	7.3
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	8.28	8.14/8.35	8.11/8.31	8.52/8.54	8.34/8.50	8.47/8.53	8.43/8.44	8.30/8.44	8.38

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	8.6	8.0/7.6	8.0/7.3	7.5/7.4	7.4/7.1	7.8/7.4	7.6/7.4	7.3/7.0	7.6
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	8.26	7.98/8.46	7.99/8.40	8.26/8.54	8.14/8.54	8.26/8.52	8.19/8.44	8.21/8.46	8.41

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	8.7	8.2/7.7	7.7/7.4	7.9/7.5	7.7/7.3	8.1/7.3	7.6/7.6	7.4/7.3	7.7
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	8.16	7.88/8.43	7.88/8.37	8.14/8.48	8.04/8.48	8.12/8.45	8.06/8.37	8.14/8.41	8.40

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	9.1	8.9/7.7	8.3/7.5	8.2/7.8	8.2/7.4	8.6/7.3	8.4/7.7	7.5/7.4	7.7
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	8.04	7.84/8.26	7.85/8.26	8.01/8.36	7.90/8.34	7.99/8.31	7.94/8.23	8.02/8.29	8.31

Comments: Some fine solids formed on the surface of the 100% on days 3 & 4, with grit forming on the inside of the test chamber on most days.

LC50 estimated at 84.1%

Ceriodaphnia Survival and Reproduction Test-7 Day Survival

Start Date:	12/18/2011 18:00	Test ID:	CCPhase2cc	Sample ID:	Crandall Canyon Phase II Base chronic
End Date:	12/26/2011 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

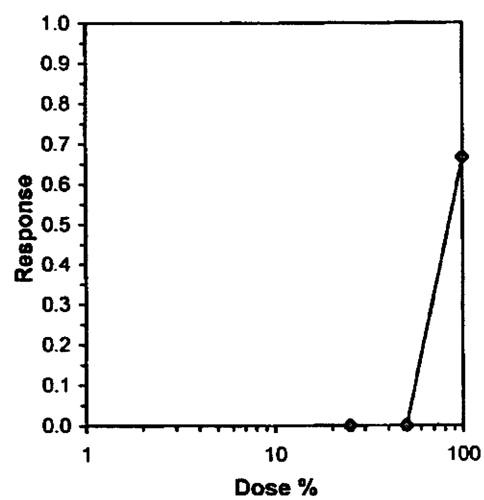
Conc-%	1	2	3	4	5	6
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000

Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Number Resp	Total Number
D-Control	1.0000	1.0000	0	6	6	6			0	6
25	1.0000	1.0000	0	6	6	6	1.0000	0.0500	0	6
50	1.0000	1.0000	0	6	6	6	1.0000	0.0500	0	6
*100	0.3333	0.3333	4	2	6	6	0.0303	0.0500	4	6

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	50	100	70.7107	2
Treatments vs D-Control				

Trimmed Spearman-Karber

Trim Level	EC50	95% CL	
0.0%			
5.0%			
10.0%			
20.0%			
Auto-33.3%	84.090	62.286	113.525

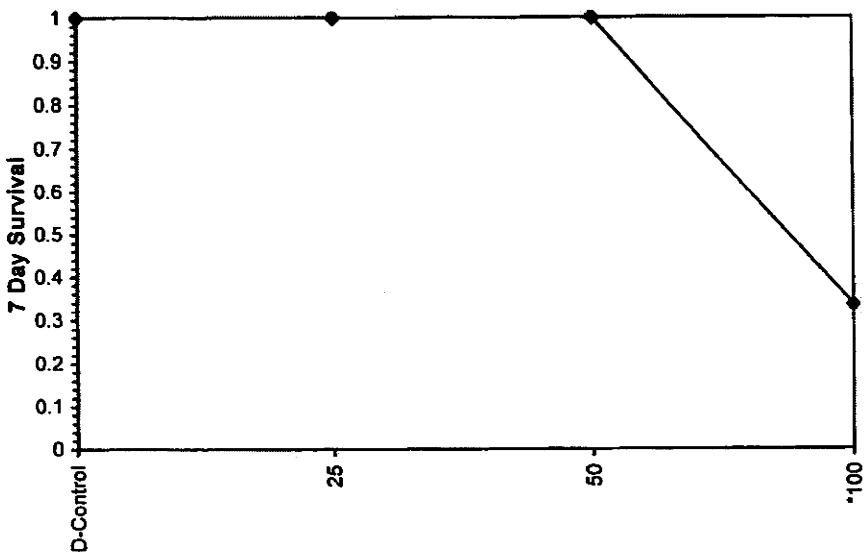


 ToxCalc v5.0.32 Reviewed by:______

Ceriodaphnia Survival and Reproduction Test-7 Day Survival

Start Date:	12/18/2011 18:00	Test ID: CCPhase2cc		Sample ID:	Crandall Canyon Phase II Base chronic
End Date:	12/26/2011 18:00	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:_____

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	12/18/2011 18:00	Test ID: CCPhase2cc		Sample ID:	Crandall Canyon Phase II Base chronic
End Date:	12/26/2011 18:00	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	36.000	31.000	35.000	28.000	20.000	15.000
25	25.000	33.000	30.000	14.000	18.000	12.000
50	16.000	36.000	20.000	21.000	29.000	22.000
100	8.000	11.000	8.000	1.000	7.000	5.000

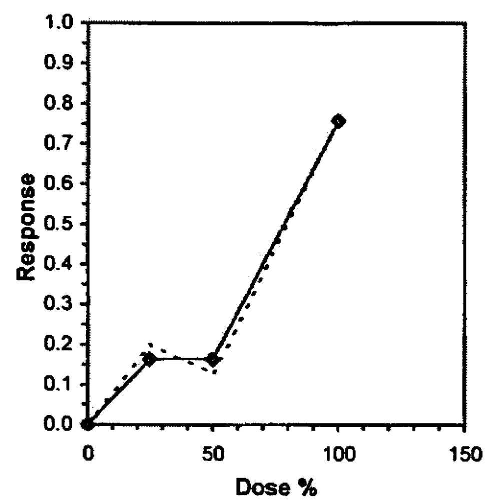
			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	27.500	1.0000	27.500	15.000	36.000	30.576	6				27.500	1.0000
25	22.000	0.8000	22.000	12.000	33.000	39.312	6	1.317	2.190	9.148	23.000	0.8364
50	24.000	0.8727	24.000	16.000	36.000	30.162	6	0.838	2.190	9.148	23.000	0.8364
*100	6.667	0.2424	6.667	1.000	11.000	50.794	6	4.988	2.190	9.148	6.667	0.2424

Auxiliary Tests					Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)					0.97846		0.916		0.02156	-0.805
Bartlett's Test indicates equal variances (p = 0.27)					3.96718		11.3449			
Hypothesis Test (1-tail, 0.05)	**NOEC**	**LOEC**	**ChV**	**TU**	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test	50	100	70.7107	2	9.1476	0.33264	508.042	52.3417	3.7E-04	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	7.639	17.490	1.187	76.808	1.2003
IC10*	15.278	18.536	2.375	78.616	0.6804
IC15*	22.917	19.261	3.562	80.424	0.1494
IC20	53.061	18.720	0.000	70.979	-0.3274
IC25	57.270	17.038	0.000	74.594	-0.8736
IC40	69.898	6.726	44.187	85.660	-0.2097
IC50	78.316	5.655	59.323	93.019	0.0332

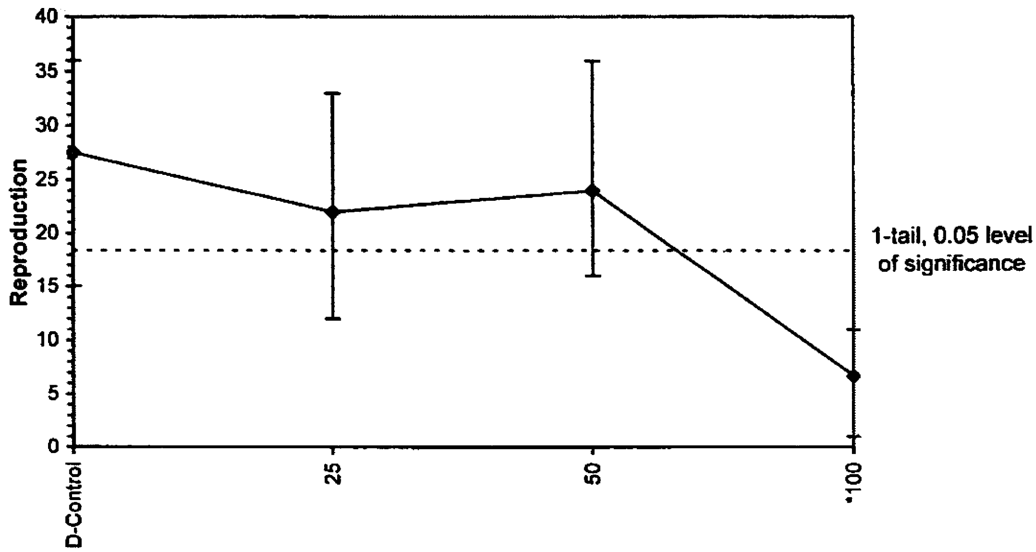
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	12/18/2011 18:00	Test ID:	CCPhase2cc	Sample ID:	Crandall Canyon Phase II Base chronic
End Date:	12/26/2011 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine   TIE Phase 2- Chemical Precipitation Test

TIE sample made by compositing samples collected: 12/18/2011

Analyses Dates/Times Beginning 12/18/2011 6:15 p.m Ending 12/26/2011 6:00 p.m   **IC25 Estimated from Test:** >100%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia
Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	32	39	32	32	34	33	33.7	0%
25.0%	36	33	36	33	36	33	34.5	0%
50.0%	31	31	32	30	38	23	30.8	0%
100%	33	35	30	35	31	31	32.5	0%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	7.8	7.6/7.7	7.4/7.4	7.5/7.7	7.3/7.3	7.7/7.4	7.1/7.1	7.3/7.1	7.7
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	8.31	8.15/8.35	8.08/8.37	8.51/8.59	8.30/8.58	8.45/8.59	8.41/8.47	8.30/8.46	8.39

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	8.0	7.5/7.7	7.6/7.3	7.7/7.5	7.4/7.2	7.8/7.4	7.5/7.5	7.1/7.0	7.7
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	8.16	8.07/8.41	8.01/7.40	8.39/8.61	8.20/8.57	8.32/8.58	8.31/8.52	8.31/8.51	8.41

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	8.2	7.5/7.6	7.6/7.4	7.9/7.4	7.7/7.1	8.3/7.3	7.6/7.7	7.2/7.0	7.6
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	8.04	8.01/8.49	8.00/8.39	8.26/8.64	8.15/8.59	8.25/8.63	8.23/8.55	8.30/8.55	8.44

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
DO New/Old	8.5	8.4/7.6	8.2/7.5	8.2/7.5	7.9/7.2	8.4/7.5	8.3/7.7	7.2/7.1	7.7
Temp New/Old	25.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	25.0/24.0	24.0
Ph New/Old	7.94	7.98/8.60	8.00/7.55	8.13/8.71	8.11/8.64	8.16/8.70	8.10/8.62	8.36/8.65	8.56

Comments: No solids formed on either the surface or on the sides of the test chambers.

Preparation of the sample- Sodium hydroxide was added to a 1 liter aliquot of sample to raise the pH to 11.38 to initiate calcium carbonate precipitation. The solution was mixed for 15 minutes on a stir plate then allowed to stand 30 minutes for the solids to settle out of solution. After 30 minutes the supernate was poured off and adjusted back to the original pH using hydrochloric acid. The prepared sample was then tested alongside the original sample to see if the forced precipitation would remove the toxicity by either stabilizing the sample or dropping out the toxicant.

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	12/18/2011 18:15	Test ID:	CCPhase2cc	Sample ID:	Crandall Canyon Phase II Prec chronic
End Date:	12/26/2011 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	32.000	39.000	32.000	32.000	34.000	33.000
25	36.000	33.000	36.000	33.000	36.000	33.000
50	31.000	31.000	32.000	30.000	38.000	23.000
100	33.000	35.000	30.000	35.000	31.000	31.000

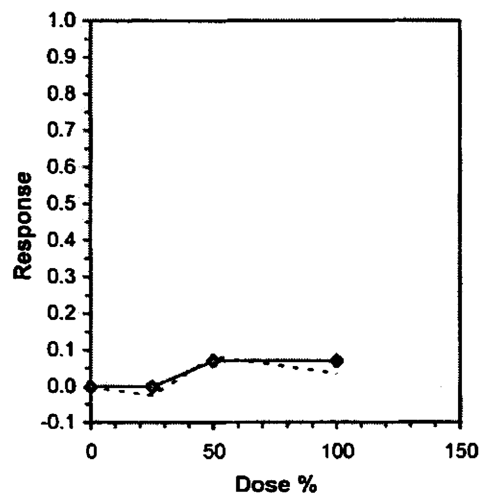
			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
D-Control	33.667	1.0000	33.667	32.000	39.000	8.116	6			34.083	1.0000
25	34.500	1.0248	34.500	33.000	36.000	4.763	6	46.50	26.00	34.083	1.0000
50	30.833	0.9158	30.833	23.000	38.000	15.543	6	27.50	26.00	31.667	0.9291
100	32.500	0.9653	32.500	30.000	35.000	6.671	6	34.50	26.00	31.667	0.9291

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.9047	0.916	0.07038	2.73836
Bartlett's Test indicates equal variances (p = 0.11)	6.01051	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	>100		1
Treatments vs D-Control				

Linear Interpolation (200 Resamples)

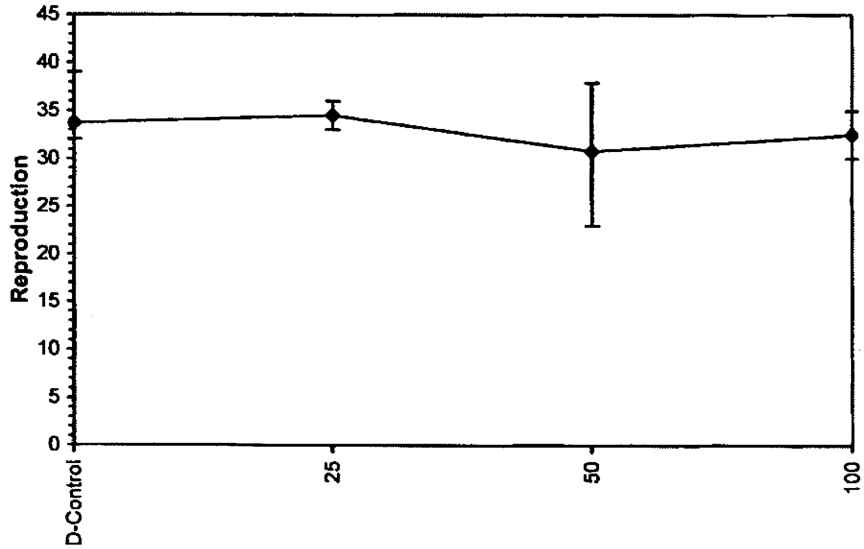
Point	%	SD	95% CL(Exp)	Skew
IC05	42.629			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	12/18/2011 18:15	Test ID: CCPhase2cc		Sample ID:	Crandall Canyon Phase II Prec chronic
End Date:	12/26/2011 18:00	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Chronic Toxicity Testing
Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine TIE Phase 2- Baseline #3 Test

TIE sample made by compositing samples collected: 1/28/2012

Analyses Dates/Times Beginning 1/28/2012 5:30 p.m Ending 2/4/2012 5:45 p.m **IC25 Estimated from Test:** 32.45%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia
Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	38	41	41	38	39	39	39.3	0%
25.0%	29	34	37	32	35	24	31.8	0%
50.0%	25	22	20	30	28	19	24.0	0%
100%	6	15	18	10D	15	8D	12.0	33%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	8.0	7.2/7.3	7.6/7.6	7.8/7.4	8.0/7.9	7.1/7.0	7.4/6.8	6.6
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.34	7.96/8.21	8.31/8.34	8.17/8.30	8.29/8.31	8.31/8.36	8.25/8.29	8.18

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	7.9	7.3/7.3	8.1/7.4	7.8/7.4	8.1/7.9	7.5/7.0	7.5/6.7	6.7
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.26	8.15/8.35	8.20/8.47	8.27/8.45	8.30/8.41	8.29/8.48	8.23/8.40	8.31

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	8.2	7.8/7.3	8.3/7.4	7.9/7.4	8.1/7.8	7.8/7.0	7.6/6.7	6.7
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.21	8.15/8.45	8.19/8.55	8.24/8.52	8.29/8.50	8.31/8.54	8.21/8.50	8.43

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	8.7	7.6/7.2	8.1/7.5	7.8/7.5	8.2/7.8	7.8/7.0	7.7/6.8	6.9
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.21	8.15/8.21	8.09/8.35	8.22/8.35	8.27/8.35	8.25/8.35	8.18/8.34	8.25

Comments: Some fine solids formed on the surface of the 100% on days 3 & 4, with grit forming on the inside of the test chamber on most days.

LC50 estimated at >100%

Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	1/28/2012 17:35	Test ID:	CCTIEP2	Sample ID:	Crandall TIE P2 base 3 chronic cero
End Date:	2/4/2012 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	38.000	41.000	41.000	38.000	39.000	39.000
25	29.000	34.000	37.000	32.000	35.000	24.000
50	25.000	22.000	20.000	30.000	28.000	19.000
100	6.000	15.000	18.000	10.000	15.000	8.000

			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	39.333	1.0000	39.333	38.000	41.000	3.474	6				39.333	1.0000
*25	31.833	0.8093	31.833	24.000	37.000	14.790	6	3.207	2.190	5.122	31.833	0.8093
*50	24.000	0.6102	24.000	19.000	30.000	18.447	6	6.556	2.190	5.122	24.000	0.6102
*100	12.000	0.3051	12.000	6.000	18.000	39.087	6	11.687	2.190	5.122	12.000	0.3051

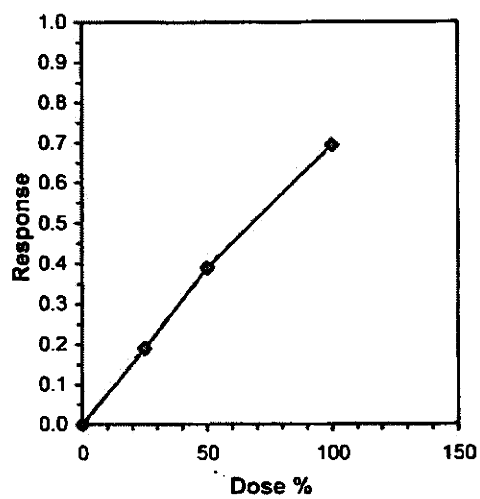
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.97631	0.916	-0.2228	-0.6163
Bartlett's Test indicates equal variances (p = 0.09)	6.47004	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<25	25			5.12172	0.13021	818.597	16.4083	1.8E-09	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	6.556	1.892	3.227	13.189	0.8785
IC10*	13.111	3.695	6.454	26.378	0.6670
IC15*	19.667	4.713	9.682	33.222	0.1379
IC20	26.170	4.970	12.935	38.956	-0.1324
IC25	32.447	5.249	16.302	44.534	-0.3038
IC40	51.667	5.341	40.110	67.772	0.3029
IC50	68.056	5.496	51.408	82.786	-0.1805

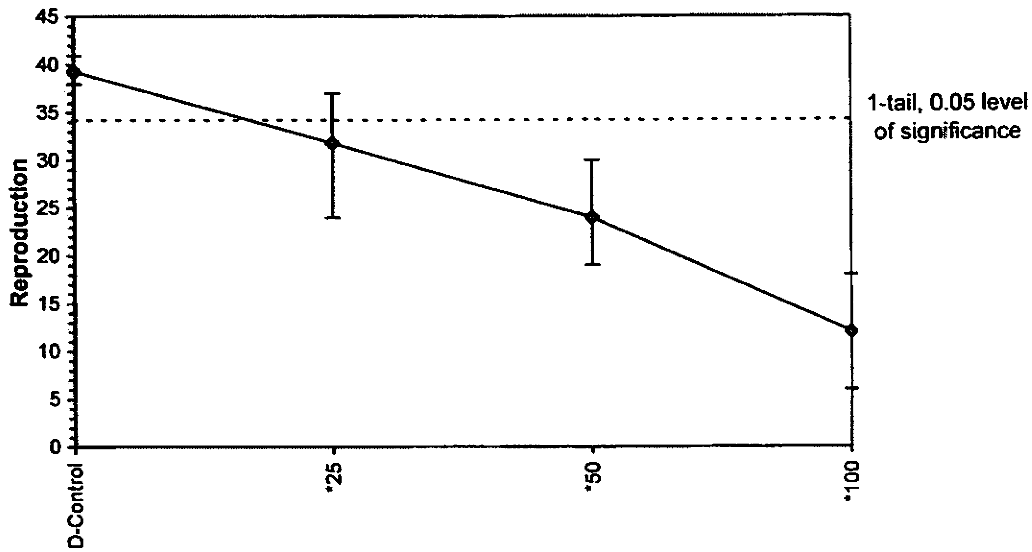
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	1/28/2012 17:35	Test ID: CCTIEP2		Sample ID:	Crandall TIE P2 base 3 chronic cero
End Date:	2/4/2012 18:00	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:_____

Chronic Toxicity Testing

Ceriodaphnia

Customer ID: Utah American- Crandall Canyon Mine   TIE Phase 2- Natural Precipitation

TIE sample made by compositing samples collected: 1/28/2012

Analyses Dates/Times Beginning 1/28/2012 5:35 p.m Ending 2/4/2012 6:00 p.m   **IC25 Estimated from Test:** 27.15%

Dilution Water Hardness: Moderately Hard Synthetic Fresh Water Approx. 200 mg/L. **Organism Age:** Ceriodaphnia dubia <8 hours

Ceriodaphnia

Replicates- Total Number of Young Produced in Three Broods ("D" = dead)

Sample ID	A	B	C	D	E	F	Mean # Produced	% Lethality
Control	36	41	39	37	39	39	38.5	0%
25.0%	26	22	35	36	34	26	29.8	0%
50.0%	13	18	18	29	19D	15D	18.7	33%
100%	4D	6	16D	11	12D	5D	9.0	67%

Physical Data - Control

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	7.9	7.4/7.2	7.5/7.1	7.5/7.4	8.2/7.7	7.4/6.8	6.9/6.7	6.7
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.31	8.17/8.21	8.30/8.35	8.34/8.30	8.37/8.28	8.36/8.35	8.28/8.27	8.17

Physical Data- 25%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	7.8	7.4/7.2	7.6/7.2	7.5/7.3	8.2/8.6	8.2/6.9	7.0/6.8	6.6
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.27	8.17/8.30	8.27/8.41	8.29/8.37	8.33/8.36	8.31/8.44	8.26/8.36	8.28

Physical Data - 50%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	7.6	7.3/7.2	7.7/7.1	7.7/7.4	8.2/7.6	7.5/6.8	7.1/6.6	6.6
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.30	8.19/8.40	8.27/8.48	8.32/8.45	8.33/8.45	8.33/8.51	8.28/8.44	8.37

Physical Data - 100%

	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
DO New/Old	7.0	6.9/7.1	7.8/7.1	7.7/7.4	8.3/7.6	7.7/6.9	7.1/6.7	6.8
Temp New/Old	25.0	25.0/25.2	25.0/25.2	25.0/25.4	25.0/25.2	25.0/25.4	25.0/25.0	25.2
Ph New/Old	8.25	8.17/8.33	8.22/8.53	8.27/8.55	8.29/8.55	8.30/8.55	8.25/8.53	8.45

Comments: No fines formed on the surface or grit on the inside of the test chamber in the 100% concentration.

LC50 estimated at 73.19%

The sample was prepared by first warming 1 liter of sample to 20 degrees Celsius in a glass beaker. A stir bar was then added and the sample placed on a stir plate and stirred at low speed for 24 hours. The sample was then allowed to stand for 30 minutes and the supernatant solution poured off into a sample storage container until needed. This solution was then tested using standard EPA methods for chronic toxicity using ceriodaphnia dubia.

Ceriodaphnia Survival and Reproduction Test-7 Day Survival

Start Date:	1/28/2012 17:35	Test ID:	CCTIEP2	Sample ID:	Crandall TIE P2 Nprecip chronic cero
End Date:	2/4/2012 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000
100	0.0000	1.0000	0.0000	1.0000	0.0000	0.0000

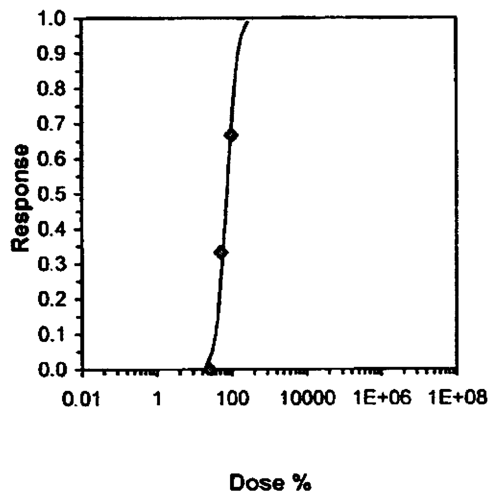
			Transform: Arcsin Square Root					Number	Total
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Resp	Number
D-Control	1.0000	1.0000	1.0472	1.0472	1.0472	0.000	6	0	6
25	1.0000	1.0000	1.0472	1.0472	1.0472	0.000	6	0	6
50	0.6667	0.6667	0.8727	0.5236	1.0472	30.984	6	2	6
100	0.3333	0.3333	0.6981	0.5236	1.0472	38.730	6	4	6

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.89707	0.916	-1E-15	0.2987
Equality of variance cannot be confirmed				

Maximum Likelihood-Probit

Parameter	Value	SE	95% Fiducial Limits		Control	Chi-Sq	Critical	P-value	Mu	Sigma	Iter
Slope	4.04627	1.76074	0.59521	7.49733	0	0.44598	3.84146	0.50425	1.86444	0.24714	5
Intercept	-2.544	3.18476	-8.7861	3.6981							
TSCR											

Point	Probits	%	95% Fiducial Limits	
EC01	2.674	19.4761	0.0205	36.1702
EC05	3.355	28.703	0.27539	46.3517
EC10	3.718	35.2951	1.07876	53.9412
EC15	3.964	40.5782	2.66123	60.8519
EC20	4.158	45.3356	5.34044	68.4007
EC25	4.326	49.8591	9.44047	77.755
EC40	4.747	63.3616	30.0569	141.742
EC50	5.000	73.1877	44.3901	276.432
EC60	5.253	84.5378	55.7347	634.132
EC75	5.674	107.432	70.7625	2898.83
EC80	5.842	118.151	76.263	5405.01
EC85	6.036	132.003	82.6426	11250.9
EC90	6.282	151.762	90.8105	28494.7
EC95	6.645	186.616	103.539	113927
EC99	7.326	275.026	130.534	1555474

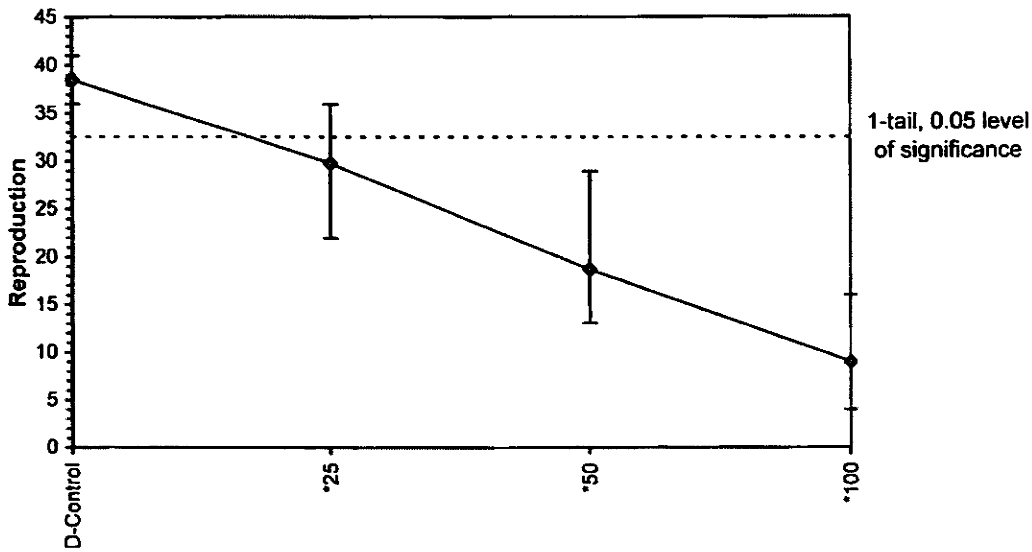


 ToxCalc v5.0.32 Reviewed by:_____

Ceriodaphnia Survival and Reproduction Test-7 Day Survival

Start Date:	1/28/2012 17:35	Test ID:	CCTIEP2	Sample ID:	Crandall TIE P2 Nprecip chronic cero
End Date:	2/4/2012 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	1/28/2012 17:35	Test ID:	CCTIEP2	Sample ID:	Crandall TIE P2 Nprecip chronic cero
End Date:	2/4/2012 18:00	Lab ID:	WET Inc	Sample Type:	EFF2-Industrial
Sample Date:		Protocol:	EPAF 94-EPA/600/4-91/002	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6
D-Control	36.000	41.000	39.000	37.000	39.000	39.000
25	26.000	22.000	35.000	36.000	34.000	26.000
50	13.000	18.000	18.000	29.000	19.000	15.000
100	4.000	6.000	16.000	11.000	12.000	5.000

			Transform: Untransformed						1-Tailed		Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
D-Control	38.500	1.0000	38.500	36.000	41.000	4.573	6				38.500	1.0000
*25	29.833	0.7749	29.833	22.000	36.000	19.707	6	3.152	2.190	6.022	29.833	0.7749
*50	18.667	0.4848	18.667	13.000	29.000	29.667	6	7.213	2.190	6.022	18.667	0.4848
*100	9.000	0.2338	9.000	4.000	16.000	52.587	6	10.728	2.190	6.022	9.000	0.2338

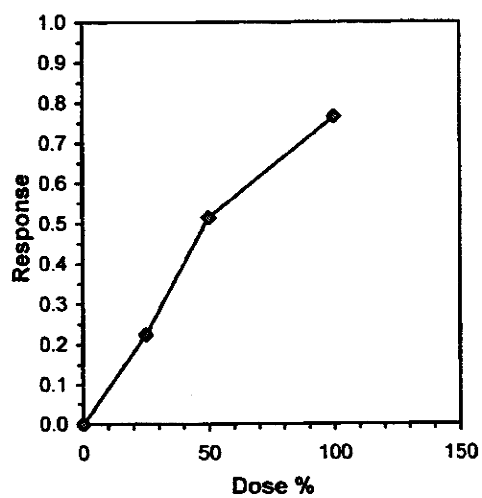
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.97531	0.916	0.47755	-0.124
Bartlett's Test indicates equal variances (p = 0.12)	5.90766	11.3449		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	<25	25			6.02195	0.15641	995.444	22.6833	5.5E-09	3, 20
Treatments vs D-Control										

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	5.553	1.824	2.705	12.508	1.6803
IC10*	11.106	3.523	5.410	25.016	1.3569
IC15*	16.659	4.531	8.115	32.163	0.7124
IC20*	22.212	4.574	10.820	34.210	0.2057
IC25	27.146	4.366	13.834	36.858	-0.0273
IC40	40.075	4.194	28.114	53.482	0.3846
IC50	48.694	5.900	38.984	71.568	0.8020

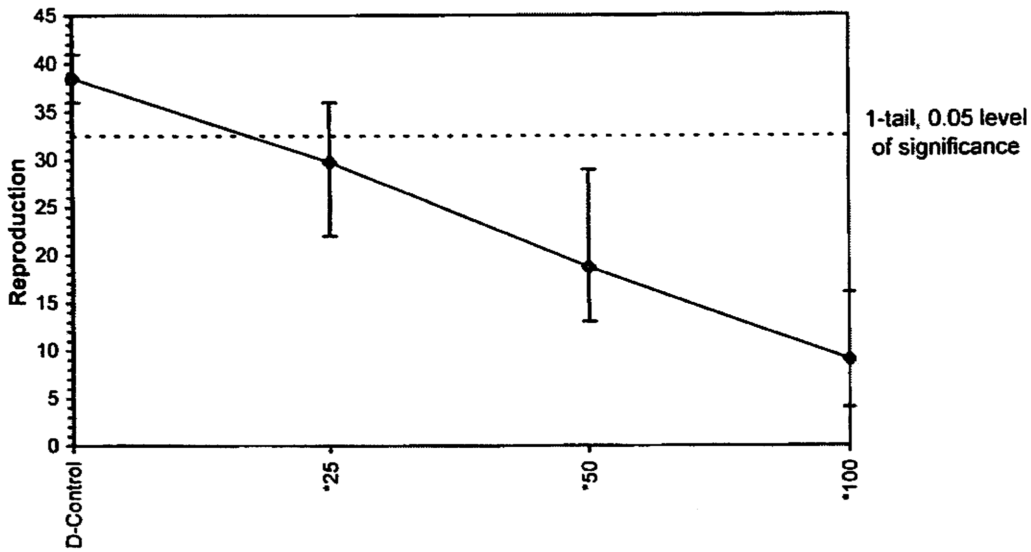
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Survival and Reproduction Test-Reproduction

Start Date:	1/28/2012 17:35	Test ID: CCTIEP2		Sample ID:	Crandall TIE P2 Nprecip chronic cero
End Date:	2/4/2012 18:00	Lab ID: WET Inc		Sample Type:	EFF2-Industrial
Sample Date:		Protocol: EPAF 94-EPA/600/4-91/002		Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



ToxCalc v5.0.32

Reviewed by:______

Metals Analysis

CHEMTECH-FORD
LABORATORIES

Certificate of Analysis

Lab Sample No.: 1109670-01

Name:	WET, Inc.	***Sample Date:***	11/15/2011 9:00 AM
Sample Site:	Gen TIE	***Receipt Date:***	11/15/2011 2:00 PM
Comments:	Gen Effluent	***Sampler:***	WET, Inc.
Sample Matrix:	Water	***Project:***	

Parameter	Sample Result	Minimum Reporting Limit	Units	Analysis Date/Time	Analyst Initials	Analytical Method	CAS No.	Flag
Metals								
Aluminum, Dissolved	ND	0.05	mg/L	11/30/2011 15:47	PNM	EPA 200.7	7429-90-5	
Aluminum, Total	0.09	0.05	mg/L	11/30/2011 15:51	PNM	EPA 200.7	7429-90-5	
Arsenic, Total	ND	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7440-38-2	
Cadmium, Total	ND	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7440-43-9	
Chromium, Total	0.0027	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7440-47-3	
Copper, Dissolved	0.0017	0.0010	mg/L	11/23/2011 15:46	MJB	EPA 200.8	7440-50-8	
Copper, Total	ND	0.0010	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7440-50-8	
Iron, Dissolved	ND	0.02	mg/L	11/30/2011 15:47	PNM	EPA 200.7	7439-89-6	
Iron, Total	0.03	0.02	mg/L	11/30/2011 15:51	PNM	EPA 200.7	7439-89-6	
Lead, Total	ND	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7439-92-1	
Mercury, Total	ND	0.0002	mg/L	11/16/2011 16:30	AKL	EPA 245.1	7439-97-6	
Molybdenum, Total	0.0014	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7439-98-7	
Nickel, Total	0.0160	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7440-02-0	
Selenium, Total	0.0005	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7782-49-2	
Silver, Total	ND	0.0005	mg/L	11/23/2011 15:49	MJB	EPA 200.8	7440-22-4	
Zinc, Total	ND	0.01	mg/L	11/30/2011 15:51	PNM	EPA 200.7	7440-66-6	

CHEMTECH-FORD
LABORATORIES

Certificate of Analysis

Lab Sample No.: 1200523-01

Name:	WET, Inc.	***Sample Date:***	12/29/2011 11:00 AM
Sample Site:	Crandal Canyon	***Receipt Date:***	1/19/2012 1:46 PM
Comments:	Precipitate	***Sampler:***	Lee Rawlings
Sample Matrix:	As Received	***Project:***	

Parameter	Sample Result	Minimum Reporting Limit	Units	Analysis Date/Time	Analyst Initials	Analytical Method	CAS No.	Flag
Metals								
Aluminum, Total	4220	10.0	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7429-90-5	
Arsenic, Total	5.74	5.00	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7440-38-2	
Cadmium, Total	ND	0.500	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7440-43-9	
Chromium, Total	ND	0.500	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7440-47-3	
Copper, Total	0.529	0.500	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7440-50-8	
Iron, Total	1750	5.00	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7439-89-6	
Lead, Total	1.77	5.00	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7439-92-1	J
Mercury, Total	ND	0.06	mg/kg wet	1/25/2012 11:00	AKL	EPA 7471A	7439-97-6	
Molybdenum, Total	0.43	1.00	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7439-98-7	J
Nickel, Total	15.8	0.500	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7440-02-0	
Selenium, Total	3.47	5.00	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7782-49-2	J
Silver, Total	ND	0.500	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7440-22-4	
Zinc, Total	2.92	1.00	mg/kg wet	1/25/2012 17:13	PNM	EPA 6010B	7440-66-6	

6100 South Stratler
Murray, UT 84107
801-262-7299 Office

Sample Chemistries

W.E.T. Inc.

Water & Environmental Testing Inc. 235 West 400 South, American Fork, Utah 84003 (801)763-0660 Fax(801)763-0440

Chronic Whole Effluent Toxicity Chemical Result Report

October 28, 2011

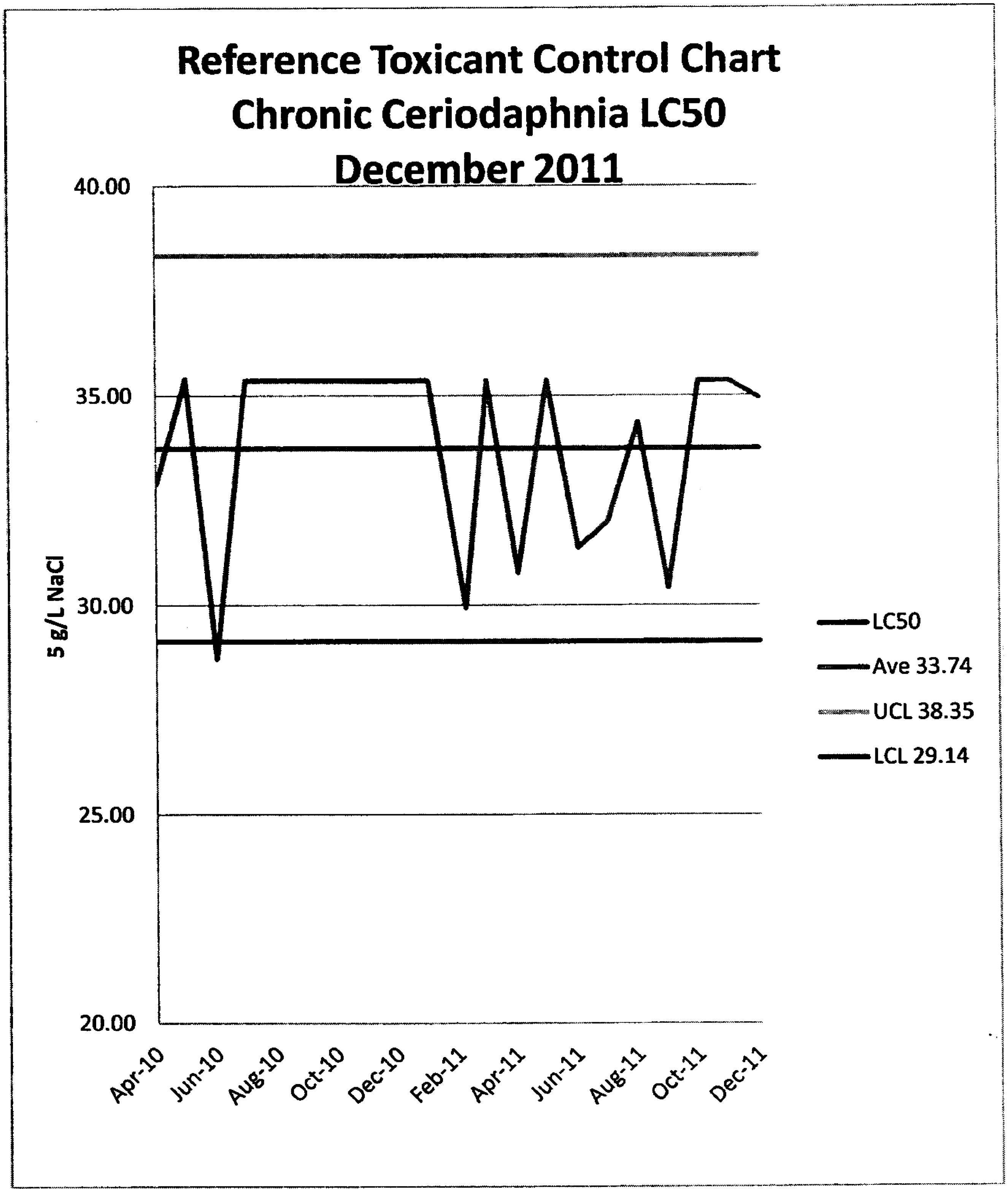
CUSTOMER NAME:
Genwal Resources
Attn: Gary Gray
194 North 100 West
Huntington, Utah 84528

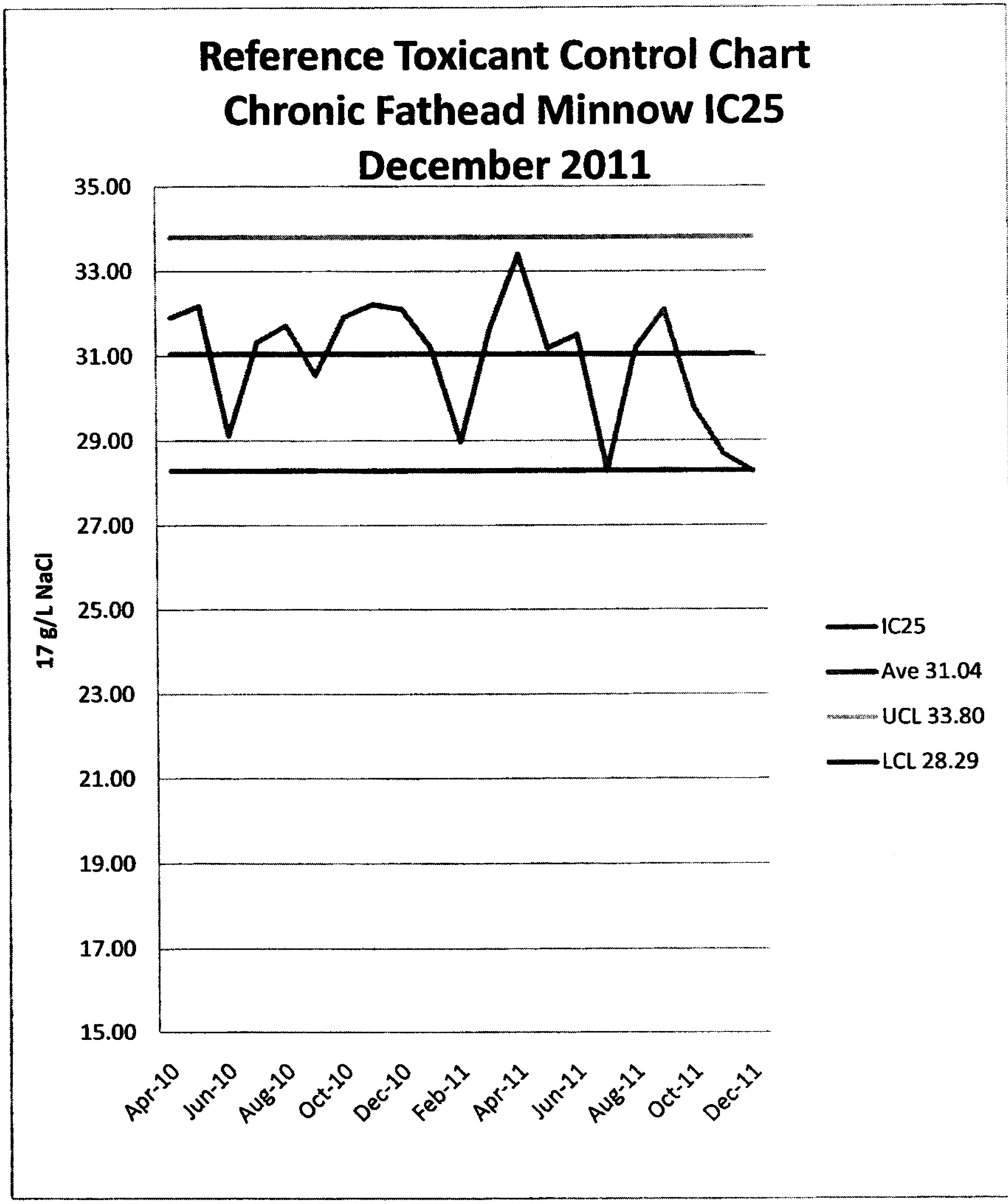
SAMPLE DESCRIPTION:
Chemistries to go with Chronic Biomonitoring sampling began 10/03/2011

Analysis	Chronic Ceriodaphnia		
	Repl. 1	Repl. 2	Repl. 3
Log #	8490	NA	NA
Total Hardness, Recon (EPA 130.2), mg/L	176		
Total Hardness, Effluent (EPA 130.2), mg/L	472		
Ammonia, Effluent (EPA 350.2/350.3), mg/L	0.43		
Initial Chlorine Residual (EPA 330.5), mg/L	<0.05		
Final Chlorine Residual (EPA 330.5), mg/L	N/A		
Conductivity, Effluent (EPA 120.1), umhos/cm	970		
Alkalinity, Effluent (EPA 310.1), mg/L $CaCO^3$	382		
Recon Initial pH (EPA 150.1)	8.45		
After 24 hours pH (EPA 150.1)	8.27		
100% Initial pH (EPA 150.1)	7.71		
100% After 24 hours pH (EPA 150	7.81		

Reviewed: Lee Rawlings, Lab Director
Water & Environmental Testing, Inc.

Quality Control Charts


Reference Toxicant Control Chart
Chronic Ceriodaphnia LC50
December 2011
40.00
35.00
30.00
25.00
20.00
5 g/L NaCl
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
LC50
Ave 33.74
UCL 38.35
LCL 29.14


Reference Toxicant Control Chart
Chronic Fathead Minnow IC25
December 2011
35.00
33.00
31.00
29.00
27.00
25.00
23.00
21.00
19.00
17.00
15.00
17 g/L NaCl
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
IC25
Ave 31.04
UCL 33.80
LCL 28.29

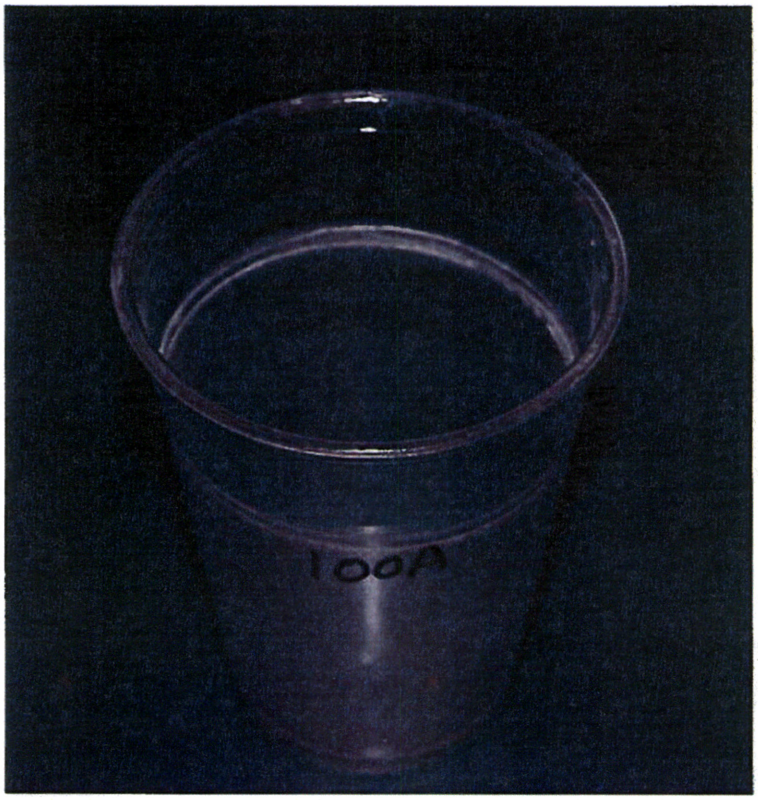
Chain of Custody

Appendix A

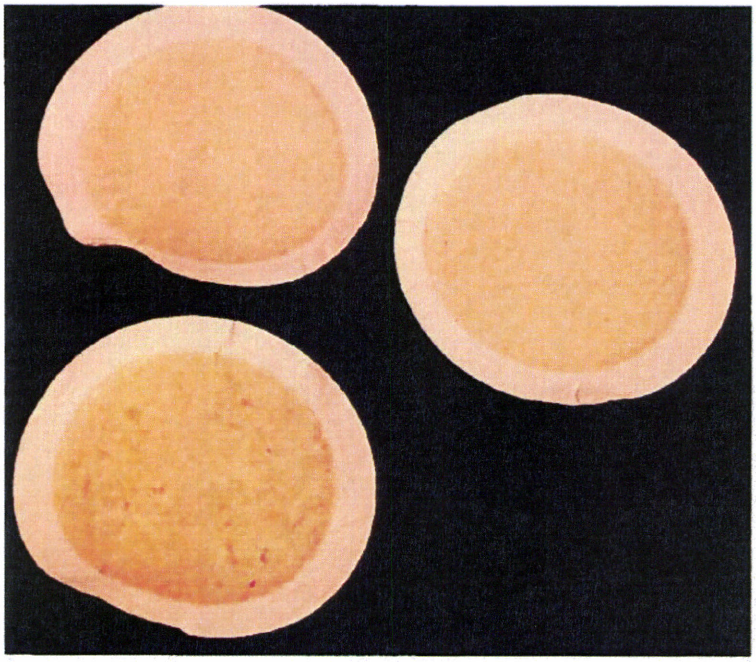
Appendix A

This appendix contains pictures of various stages of the TIE test demonstrating the observations seen by the analysts as they worked with the tests. This first picture shows the solids buildup in a Ceriodaphnia test chamber which developed during the 24 hours between renewals.

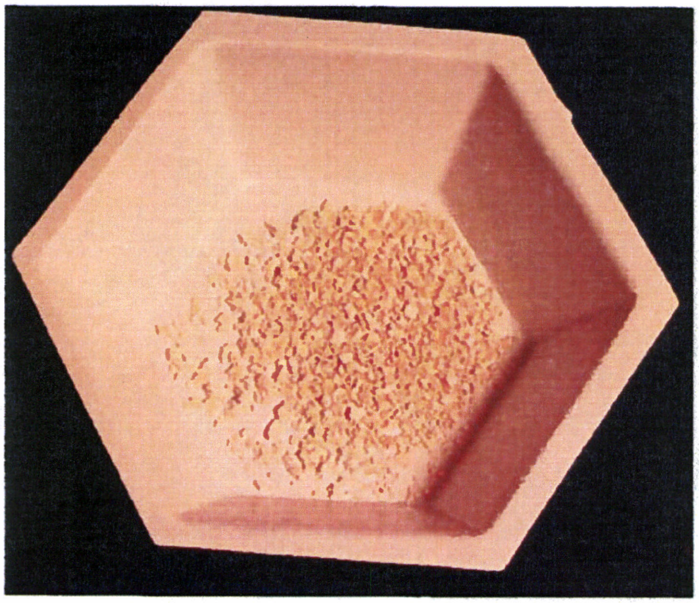
The next picture shows a week long buildup in a fathead minnow test chamber.



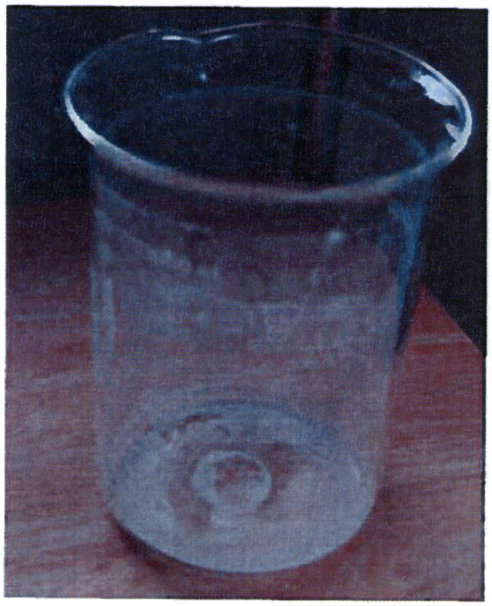
This picture is of the filter which was used in the TIE Phase I filter test showing the solids removed from the sample. This amount of solids came from filtering approximately 4 Liters of sample.



This picture shows the solids from the chemical precipitations test, approximately 2.5 grams of dried solids taken from 1 liter of sample.



These next two pictures are of the beakers where the natural precipitation process was completed, the supernate removed and the beakers being allowed to dry, again showing solids buildup.



Appendix 7-69

creating solutions for today's environment

December 5, 2011

Dana Marrelli
UtahAmerican Energy, Inc.
West Ridge Mine
P.O. Box 910
East Carbon, UT 84520

RE: Crandall Canyon Macroinvertebrate Study

Dear Dana,

Enclosed is the bound copy of the Spring 2011 Macroinvertebrate Report for the Crandall Canyon Mine. This is the same as the electronic copy that we sent earlier. We will begin work on the Fall 2011 report once we receive the lab report.

Thank you for the opportunity to conduct this ongoing work. Feel free to contact me if you have any questions or comments.

Regards,

Karla Knoop, Hydrologist

JBR Environmental Consultants, Inc.

Corporate Headquarters
8160 S. Highland Dr.
Sandy, Utah 84093
[p] 801.943.4144
[f] 801.942.1852

www.jbrenv.com

Crandall Canyon Mine Macroinvertebrate Study July 2011

Prepared for:
Genwal Resources, Inc.
Crandall Canyon Mine
P.O. BOX 910
East Carbon, Utah 84520

Prepared by:
JBR Environmental Consultants, Inc.
8160 S. Highland Drive,
Sandy, Utah 84093

801.943.4144

December 5, 2011

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Appendix 1 BugLab Report

Appendix 2 Macroinvertebrate Metrics

Crandall Canyon Mine Macroinvertebrate Study July 2011

1.0 Introduction

On July 14, 2011, JBR Environmental Consultants, Inc. (JBR) collected benthic macroinvertebrate samples from Crandall Creek, which is located near Huntington, Utah. The samples were collected both upstream and downstream of an underground coal mine operated by Genwal Resources, Inc. (Genwal) and permitted by the Utah Division of Oil, Gas and Mining (DOGM) through its coal mining program. The mine, known as the Crandall Canyon Mine, has been idle for several years. However, intercepted groundwater continues to discharge from the sealed portals and Crandall Creek is the receiving stream for the discharged water.

Beginning in the fall of 2009, JBR has sampled the creek's benthic macroinvertebrates twice yearly to determine whether or not the mine discharge is affecting Crandall Creek's aquatic community, and prepared biannual reports based upon the laboratory data (JBR 2010; JBR 2011a; JBR 2011b). This report discusses the results from the July 14, 2011 sampling event. After giving some relevant background information, it describes the data collection and analysis methodology, provides the laboratory data, and discusses the study results to date.

1.1 Background

The Crandall Canyon Mine began discharging groundwater in late 1995, and did so more or less continuously for 12 years. During operations, groundwater entering the underground mine had to be collected and pumped to the surface to ensure safe working conditions. Except for some passive in-mine settling, this groundwater was not treated prior to being released to Crandall Creek. Its discharge was regulated by the Utah Division of Water Quality (DWQ) through the Utah Pollutant Discharge Elimination System (UPDES) permit program, and water quality limits were imposed to ensure that Crandall Creek and downstream water resources were protected. With very few exceptions, those permit limits were met during the 12 years of near-continuous pumped groundwater discharge.

Subsequent to mine closure in mid-2007 and without active pumping, groundwater discharge ceased. The UPDES permit continued to be in effect, and the "no discharge" status was reflected on the monthly discharge monitoring reports. However, after about three months with no discharge, groundwater unexpectedly began flowing out of the mine from beneath the portal seals. It has continued without interruption since that time.

While gravity-flow rates have been similar to the flow rates that prevailed during the operational pumping, water quality changed once the discharge resumed in early 2008 (JBR 2010). In particular, total iron concentrations increased by up to three orders of magnitude and exceeded the established UPDES permit limits. The iron-laden discharge also resulted in iron-stained streambed substrate along an approximate 3,000-foot reach of Crandall Creek immediately downstream of where the groundwater discharge enters the stream. In early 2010, Genwal began operating an iron treatment system, and total iron concentrations have consistently been kept at less than 1.0 mg/L since March 2010. However, the iron-stained substrate is still present.

Crandall Creek is a small perennial stream that drains a 2,500-acre watershed located within the bounds of the Manti-La Sal National Forest and conveys flow to Huntington Creek. Genwal's intercepted groundwater enters Crandall Creek approximately 1.5 miles upstream of the confluence of those two streams. Both Crandall Creek and Huntington Creek support aquatic resources, and Huntington Creek is a noted trout fishery. These fish rely in part upon a healthy and abundant macroinvertebrate community as a food source. The Utah Division of Wildlife Resources (DWR), in a 1995 letter to Genwal, indicated that Crandall Creek had a small resident cutthroat population and was also important spawning habitat for trout in Huntington Creek (Moretti 1995).

Iron is an essential element for both fish and the macroinvertebrates upon which they rely as a food source, as well as all other terrestrial and aquatic biota. However, in the aquatic environment, iron can be harmful or even toxic depending upon its chemical form and its concentration. Largely as a function of the water's pH and dissolved oxygen content, iron is typically present in either an insoluble ferric form or a soluble ferrous form. It can also be present as an integral component of individual sediment particles whose parent rock contains iron. While the chemistry of iron in water can be complex and is not fully discussed here, it is important to note a couple of key points. Commonly, iron found in groundwater is in the ferrous form, but when exposed to the atmosphere, this dissolved iron often oxidizes to the ferric form and then precipitates (Hem 1985). These iron precipitates can physically degrade aquatic habitat by covering bed substrate and organic matter; the covering can also reduce food sources for both fish and macroinvertebrates. The particulates (either from precipitates or fine sediments) can clog an organism's gills or filtering apparatus, and thereby hinder oxygen intake. Iron can also precipitate directly onto an organism's body, physically harming its body structure and function. In its soluble (dissolved) form, iron can also be toxic when ingested by aquatic life.

Taking all of these things into account, EPA has conservatively recommended a (nationwide) criterion (chronic) of 1.0 mg/L iron, as part of their published National Recommended Water Quality Criteria for the protection of aquatic life (EPA 2009). Following EPA's recommendation, Utah, in its Water Quality Standards given at U.A.C. R317-2-14, adopted a maximum dissolved iron criterion of 1.0 mg/L for all streams that are classed for aquatic wildlife beneficial uses.

DWQ set the Crandall Canyon Mine's UPDES permit limit at 1.0 mg/L total iron to provide protection at an even more conservative level than the stream standard without accounting for any dilution effects.

1.2 Purpose of Study

In 2009, due to ongoing elevated iron concentrations associated with Genwal's permitted groundwater discharge, the relevant regulatory (DWQ, DOGM) and management (U.S. Forest Service (USFS), DWR) agencies became concerned about the potential impacts of the discharge on aquatic life. In mid-August, 2009, DOGM issued a Citation for Non-Compliance (#10044) that required Genwal to engage a qualified biologist to collect macroinvertebrate samples from Crandall Creek twice each year (in June and September) and prepare comprehensive reports that describe and evaluate each study's results.

This report is intended to meet the ongoing DOGM requirements for the biannual sampling and reporting. Its purpose is to assess both the spatial and temporal variation in the macroinvertebrate community of Crandall Creek with the goal of determining what, if any, iron-caused impacts have occurred or are still occurring in that community.

In addition, study results can be used to assess the overall health of Crandall Creek. Because they are sensitive to water quality and respond quickly to stressors, including water pollutants, and also because they are fairly stationary within a given stream feature, benthic macroinvertebrates integrate variations in water quality or other habitat components (Davis et al. 2001). Numerous indices and metrics such as diversity, taxa ratios, richness, and the like can be calculated and used to assess the macroinvertebrate community at a given site in regard to its ability to tolerate environmental pollution. The presence or absence of a specific macroinvertebrate taxon can indicate a perturbation that may not have been captured by grab samples analyzed for specific water chemistry. Ideally, these repeat studies may provide insight on the general condition of Crandall Creek as well as the iron-specific impact (if any) of Genwal's discharge on the creek's aquatic community.

2.0 Previous Studies

Prior to the initiation of sampling in 2009 in response to the previously noted DOGM citation, Crandall Creek's macroinvertebrate community had been periodically assessed by others. In 1980, macroinvertebrate samples were collected at several locations along Crandall Creek before the mine start-up. A follow-up macroinvertebrate study was conducted in 1994, after several years of mine operations; at the time of sampling, groundwater had not been intercepted in a quantity sufficient to require surface discharge. In addition, the USFS samples benthic macroinvertebrates in Huntington Creek every five years. Brief descriptions of each of these other studies were given in a previous JBR report (JBR 2010).

To comply with DOGM Citation #10044, JBR collected macroinvertebrate samples in Crandall Creek in September 2009 (JBR 2010), in June 2010 (JBR 2011a), and again in September 2010 (JBR 2011b). During these studies, samples were collected at three locations. The uppermost sampling reach (CRANDUP-01) was upstream of any influence of the mine's groundwater discharge, thus serving as a reference reach. The middle reach (CRANDMD-02) included the area immediately downstream of the discharge location where flow mixing, aeration, and iron precipitation were occurring. The downstream reach (CRANDLWR-03) was a short distance upstream of the confluence with Huntington Creek, outside of the area with a visibly impacted substrate. During the September 2009 event, sample collection methodology was generally based upon the reach-wide, multi-habitat sample methodology outlined in the (EMAP) Field Operations Manual for Wadeable Streams (EPA 2001), modified as per discussions with the Manti-La Sal National Forest fisheries biologist. During the 2010 sampling events, targeted-riffle samples were added to the protocol.

Overall, the study results from the 2009 and 2010 sampling indicated that the Crandall Creek macroinvertebrate community downstream of the mine's discharge appeared to have been negatively impacted. However, both downstream reaches of the creek were still supporting a variety of macroinvertebrates, signifying that the mine discharge had not completely decimated macroinvertebrate populations.

3.0 Site Locations and Descriptions

3.1 Site Locations

Prolonged snow melt runoff with high flow rates prohibited collecting macroinvertebrate samples in June 2011. With prior approval from DOGM, sampling was postponed until July. Although flows were still elevated, macroinvertebrate samples were collected on July 14, 2011 after peak runoff had diminished. The samples were collected at the same three sites that were sampled during the 2009 and 2010 sampling events. The uppermost site (CRANDUP-01) is near the upstream edge of the upper parking lot and outside of any influence of the mine's groundwater discharge. Its downstream endpoint is approximately 2 meters above the flow measurement flume and the reach extends upstream approximately 150 meters. The middle site (CRANDMD-02) includes the area immediately downstream of the discharge location where flow mixing and aeration are occurring, and where the iron previously precipitated. Its upstream endpoint (Transect K) is approximately 5 meters downstream of the discharge point, with the reach extending downstream approximately 150 meters. The downstream site (CRANDLWR-03) was chosen to be approximately 2 meters upstream of the mine road crossing near the confluence of Crandall Creek and Huntington Creek, and its reach extended upstream from that point approximately 150 meters.

As per EMAP protocol, during the September 2009 study 11 cross-section transects were established at regular intervals within each of these reaches, and were flagged and marked (JBR 2010). These same transects were used in the 2010 studies.

3.2 Site Descriptions

The report that presented the 2009 study results (JBR 2010) described stream morphology, substrate, and riparian vegetation. During the June 2010 (JBR 2011a) sampling, additional observations were made on bed substrate at each reach, in order to provide some context for variation in macroinvertebrate communities among the three reaches. Substrate at CRANDMD-02 is notable for iron-stained particles and the presence (seasonally) of filamentous algae. CRANDLWR-03 substrate is generally calcified and cemented in place.

July 2011 channel conditions were generally similar to those noted during the previous sampling events. Snow melt runoff had subsided, but a thunderstorm event elevated flows and resulted in turbidity during sampling. At Site CRANDMD-02, filamentous algae appeared to be reduced (likely due to season and scour from snow melt), and surface iron staining also appeared to be less noticeable (however, kicking up substrate during sampling re-exposed iron-stained particles). The following photos provide a visual description of the site conditions at the time of the July 2011 sampling.

CRANDUP-01 on July 14, 2011

CRANDMID-02 on July 14, 2011

CRANDLWR-03 on July 14, 2011

4.0 Methods

JBR collected two macroinvertebrate samples, a multi-habitat sample and a riffle sample, from each of the locations described above. Sample collection for the multi-habitat sample was the same as described in JBR (2010) and was based upon the reach-wide sample methodology outlined in the (EMAP) Field Operations Manual for Wadeable Streams (EPA 2001). The specific application of this sample methodology was modified as per discussions with the Manti-La Sal National Forest fisheries biologist who is responsible for USFS macroinvertebrate sampling on the Forest. Section 4.1.1 below describes the modified methodology. The riffle sample was collected following the EMAP targeted riffle sample methodology. Section 4.1.2 below describes the targeted riffle methodology.

The collected and preserved samples were then delivered to the National Aquatic Monitoring Center (the BugLab) in Logan, Utah for processing and taxonomic identification. The BugLab is a cooperative venture between the U.S. Bureau of Land Management (BLM) and Utah State University. It focuses on processing macroinvertebrate samples, and processes a large percentage of the samples collected on federal land in the western U.S. The DWQ Monitoring Manual (DWQ 2006) specifies that macroinvertebrate samples be processed by the BugLab. DWQ's methodology is described in Section 4.2., and the BubLab's complete report (Judson and Miller 2011) is attached as Appendix 1.

4.1 Sample Collection Methods

4.1.1 Modified Multi-Habitat Sample Collection

The EMAP methodology for the multi-habitat sample specifies that one macroinvertebrate subsample is taken at each of the eleven transects within the delineated reach. These subsamples are then combined into a composite sample. The sample location at the first transect is randomly selected using a six sided dice (i.e., sample is taken at a location 25, 50, or 75 percent of the distance from the channel's left edge depending upon the roll of the dice), with the sampling point at subsequent transects chosen systematically. However, the Manti-La Sal National Forest regularly collects only 4-5 macroinvertebrate subsamples within each reach, which are then combined into a single composite sample. The 4-5 subsamples are collected from as many habitat types as possible in order to sample the full range of habitat types present within the reach. In order to be more consistent with the methodology used by the Forest, the EMAP reach-wide, multi-habitat sample methodology was modified to only include five samples. However, to keep the modified methodology as similar to EMAP procedure as possible (which improves consistency and keeps the samples as replicable as possible), the five samples were collected at every other transect starting with Transect B, where possible.

As Crandall Creek is a narrow stream at all sites, and particularly CRANDUP-01, sample location at each transect was not chosen randomly or systematically, rather the site that was most suitable to sampling was chosen (i.e., the location that allowed placement of the sampler). All sampling was conducted using a 500-micron mesh D-frame kick net. The samples were collected in a downstream-to-upstream order to avoid including organisms dislodged from upstream samples.

For sampling transects the following procedures were utilized.

1. The kick net was quickly and securely positioned on the bottom of the channel with the opening facing upstream. Gaps between the frame and substrate were minimized.

2. The sample area was checked for heavy organisms, such as mussels and snails. Any such organisms were placed into the composite sample bucket. All substrate particles larger than golf balls and that were at least halfway into the sample area were picked up and rubbed with hands or a brush to dislodge organisms into the net. Particles that were more than halfway outside the sample area were pushed aside and not sampled. After particles were washed, they were placed outside of the sample area.

3. Starting at the upstream end of the sample area, the remaining substrate was kicked vigorously for 30 seconds. The water was allowed to clear before removing the net from the water column.

4. The net was lifted out of the water then quickly immersed several times to concentrate sample material in the end of net. Care was taken not to further disturb channel substrate with the net, or allow for organisms to escape.

5. The net was inverted into the composite bucket, which had been ¼ to ½ filled with stream water. The net was inspected for clinging organisms and forceps were used to place these organisms into the bucket.

6. The net was rinsed in the stream before moving to the next transect.

7. The dominant substrate and habitat type were recorded on the field data sheet.

After sampling was completed at the five transects, the following procedures were employed to prepare a multi-habitat composite index sample to be sent to the lab.

1. The contents of the sample bucket were manually swirled to separate organisms from the sample material. The sample material was poured through a 300-micron mesh sieve and the inside of the bucket was inspected for organisms. Organisms were rinsed off any large objects (rocks, organics, etc.) with a spray bottle filled with stream water before discarding the objects. Additional serial bucket rinses were employed until no remaining organisms were noted in the sample bucket.

2. Using the spray bottle, the sample material inside the sieve was rinsed to one side and transferred into the sample container using as little water as possible. The sieve was carefully examined for clinging organisms and these were placed into the sample bottle using forceps.

3. The sample container was completely filled with 95-percent ethanol so that the final concentration was between 75 and 90 percent. The container was slowly tipped horizontally and rotated to allow complete mixing of the ethanol and sample.

4. Sample containers were labeled with the information listed below. A duplicate of this label was written on ethanol-safe paper and placed inside of the container. Samples were then delivered to the BugLab for analysis.

   * Type of Sample (e.g., multi-habitat or riffle)
   * Stream Name
   * Site I.D.
   * Forest (Manti-La Sal National Forest)
   * Date and Time of Collection
   * Number of Jars

4.1.2 Targeted Riffle Sample Collection

The EMAP methodology for the targeted riffle sample specifies that eight macroinvertebrate subsamples be taken within available riffle macrohabitat units within the delineated reach. These subsamples are then combined into a composite targeted riffle sample. The sample locations are identified by surveying the delineated reach prior to sampling to visually estimate the number and area of riffle units. If the reach contains more than one distinct riffle macrohabitat unit but less than eight, the eight sampling points are allocated among the units to spread the effort throughout the reach as much as possible, with it possible to collect more than one kick sample from a single riffle unit. If the number of riffle macrohabitat units is greater than eight, one or more habitats is skipped at random. Within each riffle unit, EMAP specifies that the sample locations be chosen at random from nine equal quadrats (visually estimated). However, as already noted, Crandall Creek is a narrow stream at all sites, and particularly CRANDUP-01. As a result, the riffle samples from each macrohabitat unit were not chosen randomly, rather the site that was most suitable to sampling was chosen (i.e., the location that allowed placement of the sampler). The samples were collected in a downstream-to-upstream order to avoid including organisms dislodged from upstream samples.

Once locations were chosen, samples were collected and composited following the same procedures outlined for the modified multi-habitat sample.

4.2 Analysis Methods

As noted above, the BugLab identified the taxa represented in the macroinvertebrate samples that JBR collected. The lab processed the samples using methods similar to those recommended by the United States Geological Survey (Cuffney et al 1993, as referenced in Judson and Miller 2011). For all six samples, 100 percent of the sample material was processed (i.e., sub-sampling procedures were not used). Generally, organisms were removed under a dissecting microscope at 10-30 power and separated into taxonomic orders. Organisms were then identified to a lower taxonomic level (family, genus, and/or species, as feasible). Once identified and counted, samples were placed in 20-ml glass scintillation vials with polypropylene lids in 70% ethanol, given a catalog number, and retained. The results report (Judson and Miller 2011) includes a complete list of taxa and the number of organisms by taxa (see Appendix 1).

The BugLab also provided data summaries and calculated various indices and metrics (Judson and Miller 2011), many of which will be discussed in the results discussion. These include: abundance, total taxa richness, EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa richness, Ephemeroptera taxa richness, Plecoptera taxa richness, Trichoptera taxa richness, percent EPT abundance, percent Ephemeroptera abundance, percent Chironomidae abundance, Intolerant taxa richness, percent tolerant organisms, Community Tolerant Quotient (CTQd), Hilsenhoff Biotic Index (HBI), percent contribution of the dominant taxon, clinger taxa richness, percent clinger abundance, percent collector-filterer abundance, and percent scraper abundance. Definitions/descriptions of these individual metrics and their usefulness are given in their report (Judson and Miller 2011), which can be found in Appendix 1.

In addition, JBR used the BugLab's data set to calculate several other metrics that various literature sources consistently indicate as being potentially useful for macroinvertebrate analysis, particularly in regard to potential metals pollution. These are described below.

Ratio of Specialist Feeders to Generalist Feeders - Specialist feeders include shredders and scrapers and generalist feeders include filterers and gatherers. Generalists are typically more tolerant to environmental stressors, so their proportion often increases in response to degraded water quality or stream habitat. This ratio has been used successfully to assess impacts from mining (Mize and Deacon 2002).

Ratio of EPT to Chironomidae - Ideally, communities have a near-even distribution among all four of these major groups. The Chironimid Family, in general, is more tolerant than most of the taxa in the Ephemeroptera, Plecoptera, and Trichoptera orders (Barbour et al 1999). Therefore, this ratio can indicate environmental stress when it shows disproportionate numbers of Chironomidae (Davis et al 2001).

Percent *Baetis*, Hydropsychidae, and Orthocladinae; Ratio of *Baetis* to all Ephemeroptera – These two similar measures express the documented higher tolerances of *Baetis*, Hydropsychidae, and Orthocladinae, than other members of their families. Mize and Deacon (2002) among others have used the presence of these taxa when assessing environmental conditions specific to mining (some studies have found the opposite conclusion with *Baetis*; however, the majority appear to consider it one of the more tolerant of the mayflies).

Percent Heptageniidae, Chloroperlidae, and *Rhyacophila*; Ratio of Heptageniidae to all Ephemeroptera – Similarly to the above-noted tolerant taxa, Heptageniidae, Chloroperlidae, and *Rhyacophila* were considered by Mize and Deacon (2002) when assessing elevated trace metals impacts. Heptageniidae, Chloroperlidae, and *Rhyacophila* were chosen due to their apparent sensitivity to such elements, thus their absence can indicate poor water quality. Many other authors have associated a lack of Heptageniidae organisms, in particular, with heavy metals pollution (i.e. Kiffney and Clements 1994).

As with analysis of any set of macroinvertebrate data, multiple metrics and their predicted response to perturbations (as given by EPA (2009a) and others in the scientific community) will be relied upon to make a finding of impact or nonimpact in regard to Genwal's groundwater discharge and Crandall Creek. Whether looking at data from an individual sample, comparing data from different sites for a spatial assessment, or examining temporal changes, no one metric can ever be presumed to tell the whole story. First, there is typically some natural variability in community makeup, so reliance on a single metric can be misleading. Further, some metrics are better at ascertaining specific conditions than others (i.e., organic pollution versus metals pollution). For these reasons, most researchers use a variety of metrics and would expect to see similar indications in several of them before making a conclusion regarding impact to a given site. In contrast, there is some redundancy among metrics because they use at least some of the same data. EPA (Barbour et al 1999) and others have developed techniques for combining various metrics into a single index, and also for ranking sites based upon individual metrics in a way that a potentially impacted site can be compared to reference sites (known to be unimpacted). In this study, the low number of sample sites, lack of replicates, and inadequate information on historical baseline make these techniques impossible or impractical to use. Further, the natural variability of any of one these metrics is not known, so it is difficult to determine whether a difference between sites as shown by one metric is due to degraded conditions or simply a reflection of natural variability.

Instead, as was done for the previous JBR reports (2010; 2011a; 2011b) on macroinvertebrate sampling in Crandall Creek, individual metrics were calculated for each site and graphed to provide an easy visual means of comparison (Appendix 2). Although some metrics are not independent of each other, there was a specific intent to choose metrics that are of different types (i.e., tolerance as measured by CTQd, community composition as measured by EPT abundance, feeding mechanism as measured by specialist-to-generalist ratio), as recommended by EPA (Barbour et al 1999). Metrics that would be expected to decrease as site conditions worsen (e.g., richness) are shown in blue and those that would be expected to increase as site conditions worsen (e.g., HBI) are shown in green, further facilitating visual interpretation. Comparisons between CRANDUP-01 and CRANDMD-02, across matrices, allow an assessment of whether conditions are degraded below Genwal's discharge. The presumption is that if multiple matrices indicate the same trend (e.g., impact), there is a greater likelihood that there is a degradation between sites as a result of mine discharge. Similarly, comparisons between CRANDMD-02 and CRANDLWR-03 can be made to assess whether there is a spatial limit to the degradation (recovered conditions downstream).

5.0 Results and Discussion

The laboratory results report that was prepared by the BugLab (Judson and Miller 2011) is provided in full as Appendix 1. That report includes the raw data (taxonomic lists of organisms that were sampled, counts, etc.) as well as numerous tables giving various metrics and indices that the lab calculated based upon the data. The BugLab's report (Judson and Miller 2011) does not discuss or interpret the study results. This section focuses on those tasks, beginning with a brief summary of the data and a general discussion of the results.

A total of 61 operational taxonomic units (OTUs) were identified in the 6-sample set, which is similar to the June 2010 sampling event, when 65 OTUs were reported (JBR 2011a). At 31, the number of families and number of genera were within the ranges those previously reported in JBR (2010; 2011a; 2011b). Variations in these numbers can be caused by flow conditions, time of year, macroinvertebrate life cycles, and environmental degradation.

All of the insect orders most commonly found in macroinvertebrate communities (Coleoptera, Diptera, Ephemeroptera, Plecoptera, and Tricoptera) as well as individuals from some non-insect classes were represented in both sample sets. Composition (e.g., proportion of members of the order Diptera) continues to show that none of the three Crandall Creek sites is in optimum condition, though there is variation among the sites, which will be described further below. CTQd, which can range from about 20 in the best quality streams up to about 100 in the poorest, was between 63 and 84 in the Crandall Creek July 2011 samples. Though this range of values is improved over the previous two sampling events (JBR 2011a and 2011b), it still indicates a stream that is providing less than ideal aquatic habitat.

Although Crandall Creek as a whole may provide less-than-ideal habitat, all of the sites had at least a somewhat diverse assemblage of taxa, and all supported at least some taxa that are considered intolerant to pollution or other habitat alterations. Knowing that (1) Crandall Creek overall has an aquatic community that is not optimum, and (2) in spite of Genwal's discharge, the creek is still supporting aquatic life provides a useful context for the remainder of the results discussion. Those two things being said, by the majority of the metrics discussed below, there continues to be a less healthy macroinvertebrate community at both CRANDMD-02 and CRANDLWR-03, which are downstream of the discharge, than at CRANDUP-01, which is upstream of the discharge.

Habitat differences among the three sites (described briefly above in Section 3.2) could be at least partially reflected in the results and their interpretation. For example, CRANDUP-01 and CRANDLWR-03 have similar substrate size compositions, but at the latter much of the substrate is embedded and cemented. This lack of interstitial spaces results in poor physical habitat for macroinvertebrates at CRANDLWR-03. Therefore, the site comparisons in Section 5.2 must consider that habitat is degraded at this site due to characteristics unrelated to any that have potentially occurred due to the discharges of iron-laden water. Additionally, the substrate at CRANDMD-02 is similar to that at the other two sites, but proportionally has more graveled riffle reaches than the other two sites. These features generally offer the best physical habitat for macroinvertebrates, but at CRANDMD-02, much of this high-quality substrate is now iron-stained and covered with filamentous algae.

5.1 Comparison of Targeted Riffle and Multi-Habitat Samples

As with the 2009 and 2010 analyses (JBR 2010; 2011a; 2011b), numerous metrics and indices have been calculated and graphed for the September 2010 samples. These graphs are included in Appendix 2. They provide a visual means to determine whether there were differences between the samples collected from targeted riffle sites and those collected from the multi-habitat sites.

One of the reasons that the first study report (JBR 2010) recommended that targeted riffle samples should be collected along with the multi-habitat ones during future monitoring events was based upon the observation that habitat types varied somewhat between each reach. It was felt that the spatial data comparison would be more robust using the results of targeted riffle sampling. In addition, Utah's DWQ monitoring program calls for macroinvertebrate samples to be collected using only a targeted riffle method (DWQ 2006). Collecting targeted riffle samples in Crandall Creek, as well as continuing to collect multi-habitat samples, would allow a broader means of data interpretation in the future, as the data set grows.

Notably, at CRANDMD-02 the riffle sample reflected much better macroinvertebrate habitat than did the multi-habitat sample. Overall, however, conclusions regarding trends or spatial differences are the same regardless of sample types, so both riffle and multi-habitat results are used in the following discussions.

5.2 Spatial Variation in Macroinvertebrate Community

As noted above, numerous metrics and indices based upon the September 2010 sampling at CRANDUP-01, CRANDMD-02, and CRANDLWR-03 have been calculated and graphed. These graphs are included in Appendix 2 and provide a visual aid for analyzing the spatial variation in the macroinvertebrate community along Crandall Creek. CRANDUP-01 is upstream of any potential impact from Genwal's discharge, CRANDMD-02 is immediately below the discharge where impacts would presumably be the greatest, and CRANDLWR-03 is further downstream where impacts could presumably be either similar those seen at CRANDMD-02 or reduced, thus indicating a spatial limit to the impact.

Out of the 20 metrics graphed in Appendix 2, 14 of the targeted riffle sample results and 16 of the multi-habitat samples results indicate a decline in macroinvertebrate community health between CRANDUP-01 and CRANDMD-02. These are similar percentages as were shown with the 2009 and 2010 samples (JBR 2010; 2011a; 2011b). The noted decline in the aquatic community between these two sites is based upon a range of tolerance, community composition, diversity, and feeding group metrics, which strengthens the conclusion that the mine discharge has negatively affected habitat. Similarly, based upon the majority of the metrics (and again across metric types), CRANDUP-01 has a healthier macroinvertebrate community than does CRANDLWR-03.

5.3 Temporal Variation in Macroinvertebrate Community

As previously mentioned, macroinvertebrate studies were conducted in Crandall Creek in 1980 and 1994. However, those data are of limited use for temporal comparisons due to unknowns in either sampling locations and/or collection methodology. Instead, the four sets of data collected by JBR from September 2009, June 2010, and September 2011, and July 2011) are examined herein to assess temporal variation.

Examination of the graphed metrics does not show a strong overall trend in either improvement or degradation at any of the sites across the period of sampling; some metrics indicate improvement, some indicate degradation, and others are essentially the same. The previous sample report (JBR 2011b) noted that CRANDUP-01 had poorer macroinvertebrate conditions in June 2010 than in either of the two September sampling events. This was likely due to the high snowmelt runoff that was occurring at the time of sampling.

Comparisons made among like seasons when stream flow rates and macroinvertebrate life cycles are more likely to be similar may be more meaningful; however to date there are only two sampling events for each season, which limits interpretations. The July 2011 samples indicated improvements over the June 2010 samples at all three sites. While these noted improvements were reflected at CRANDMD-02 (particularly in the riffle set) and CRANDLWR-03, the fact that improvements were also reflected at the upstream, unaffected site precludes an interpretation that the downstream improvements reflect recovery from the iron-laden mine discharges. Instead, these differences could be all or partially due to more optimum flow conditions (e.g., later in the runoff cycle) during the more recent sampling event, for example.

5.4 Metric Refinement

With the inclusion of the latest set of data, collected July 2011, a total of four sampling events are now available for analysis. While a set of four events limits the potential for robust statistical analysis (especially given the different seasons represented) or development of an integrated index, the large number (20) of metrics can be winnowed down. As noted above in Section 4.2, there was some redundancy among the 20 metrics that were initially selected. However, different metric types (e.g., tolerance, diversity, community composition, feeding mechanism) were represented. Reducing the number of metrics that are looked at from here out should reduce the redundancy but still include a variety of metric measures; the new set of metrics should also reflect the same general conclusions as does the full set.

In order to refine the set of metrics upon which subsequent reports will focus, the range (as indicated by the highest and lowest value) of each metric across the four data sets was compared for each of the three sites. The riffle samples and the multi-habitat samples were both included in this analysis. The spread in the values of each metric encompasses at least some measure of seasonality, natural variation, or trends, albeit within the short timeframe between fall 2009 and spring 2011. The primary goal of the monitoring has been to determine whether or not the sites downstream of the mine discharge have been affected by it, and the data collected to date consistently shows that CRANDMD-02 and CRANDLWR-03 have poorer macroinvertebrate communities than does CRANDUP-01. The metrics that may show this result most clearly may be those where the distributions in the data between the upstream and downstream sites are the most divergent.

For each metric, the maximum and minimum values at the site immediately below the mine discharge (CRANDMD-02) were compared with those at the upstream, unaffected site (CRANDUP-01) and categorized as being either: within the spread of values, completely outside the it, or overlapping it. None of the 20 metrics had completely disparate spreads between CRANDUP-01 and CRANDMD-02 (i.e., there was always some overlap). For 9 out of the 20 metrics (richness, EPT taxa abundance, number of intolerant taxa, HBI, number of clinger taxa, number of long-lived taxa, percent scrapers, percent chironomids, and percent tolerant organisms), the CRANDMD-02 range was within the range reported for CRANDUP-01. The remaining 11 metrics were outside the range in one direction of the other (though sometime only minimally); in all but one of those, the direction outside the overlap reflected degradation at the downstream site compared to the upstream (i.e., was consistent with the overall interpretation using all 20 metrics). Coincidently or not, several of these are metrics that have been noted to be indicative of mining and/or elevated trace elements. Further, these divergent metrics encompassed tolerance, diversity, community composition, and feeding mechanism measures. A comparison between CRANDUP-01 and CRANDLWR-03 showed similar results, but with fewer metrics found to be within the CRANDUP-01 range. A table at the end of Appendix 2 shows this comparison.

6.0 Recommendations for Future Study

JBR recommends that future sampling events use the same methodology and equipment as was used in 2010. Samples should include both a multi-habitat sample at each site and a targeted riffle sample at each site.

Future sample reports should focus on a reduced set of metrics. The following 10 metrics are recommended based upon the assessment in Section 5.4: Shannon's Diversity; evenness; CTQd; percent shredders; ratio of specialist feeders to generalist feeders; percent EPT; ratio of EPT to Chironomids; percent Heptageniidae, Chloroperlidae, & Rhyacophila; percent Baetis, Hydropsychidae, & Orthocladiinae; and percent of Baetis to all Ephemeroptera. In addition, percent scrapers will also be retained as a metric, due to its potential usefulness to tie into the presence/absence of filamentous algae. (Note that any of the other "discarded" metrics will either still be available within the BugLab reports or can easily be calculated from data contained with those reports.) In addition to the spread of values as indicated by the maximum and minimum, box-and-whisker plots should also be considered to provide a more refined analysis.

7.0 Summary and Conclusions

In July 2011, benthic macroinvertebrate samples were collected from three reaches of Crandall Creek. One reach was located upstream of Genwal's Crandall Canyon Mine groundwater discharge while the other two reaches were located downstream of the discharge. One of the primary goals of the study was to determine whether the previously elevated iron concentrations have impacted Crandall Creek's macroinvertebrate population. Macroinvertebrate community composition at these three reaches was determined by taxonomic identification of the organisms collected during the sample collection, and numerous indices and metrics were calculated for ease in interpreting results.

Overall, the study results indicate that the Crandall Creek macroinvertebrate community immediately downstream of the mine discharge continues to show negative impacts of the mine water discharge. Although the furthest downstream reach of Crandall Creek (CRANDLWR-03) also has a degraded macroinvertebrate community, its poor substrate condition (embedded and cemented) is likely a contributing (if not dominating) factor affecting macroinvertebrate community health at that site. However, both downstream reaches of the creek are still supporting a variety of macroinvertebrates, indicating that neither the past iron-laden discharge nor the continuing treated discharge has completely eliminated macroinvertebrate populations.

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APPENDIX 1
BUGLAB REPORT

Aquatic Invertebrate Report For Samples Collected By JBR Environmental Consultants - Sandy, UT

Report prepared for:
Dave Kikkert
JBR Environmental Consultants - Sandy, UT
8160 S. Highland Drive
Sandy, UT 84093
801-943-4144; dkikkert@jbrenv.com

Report prepared by:
Sarah Judson and Scott Miller
U.S.D.I. Bureau of Land Management
National Aquatic Monitoring Center
Department of Watershed Sciences
5210 Old Main Hill
Utah State University
Logan, Utah 84322-5210
Sarah: 435.797.3310; sarah.judson@usu.edu
Scott: 435.797.2612; scott.miller@usu.edu

28 September 2011

Sampling Locations

Table 1. Sampling site locations

Station	Location	Latitude	Longitude	Elevation (meters)
CRANDLWR-03	Crandall Creek, Lower, Emery County, UT	39.464	-111.1460	2363
CRANDMD-02	Crandall Creek, Middle, Emery County, UT	39.460	-111.1650	2384
CRANDUP-01	Crandall Creek, Upstream, Emery County, UT	39.460	-111.1680	2389

Methods

Field sampling

Samples were collected on July 14, 2011 (Table 2). Aquatic invertebrates were collected quantitavely and qualitatively from riffle and reachwide habitats with a Kick Net

Laboratory methods

General procedures for processing invertebrate samples were similar to those recommended by the United States Geological Survey (Cuffney et al. 1993) and are described in greater detail and rationalized in Vinson and Hawkins (1996). Samples were sub-sampled if the sample appeared to contain more than 600 organisms. Sub-samples were obtained by pouring the sample into an appropriate diameter 500 micron sieve, floating this material by placing the sieve within an enamel pan partially filled with water and leveling the material within the sieve. The sieve was then removed from the water pan and the material within the sieve was divided into two equal parts. One half of the sieve was then randomly chosen to be processed and the other half set aside. The sieve was then placed back in the enamel pan and the material in the sieve again leveled and split in half. This process was repeated until approximately 600 organisms remained in one-half of the sieve. This material was placed into a Petri dish and all organisms were removed under a dissecting microscope at 10-30 power. Additional sub-samples were taken until at least 600 organisms were removed, All organisms within a sub-sample were removed, and separated into taxonomic Orders. When the sorting of the sub-samples was completed, the entire sample was spread throughout a large white enamel pan and searched for 10 minutes to remove any taxa that might not have been picked up during the initial sample sorting process. The objective of this "big/rare" search was to provide a more complete taxa list by finding rarer taxa that may have been excluded during the sub-sampling process. These rarer bugs were placed into a separate vial and the data entered separately from the bugs removed during the sub-sampling process. All the organisms removed during the sorting process were then identified using appropriate identification keys (see literature cited list for list of taxonomic resources used). Once the data had been entered into a computer and checked, the unsorted portion of the sample was discarded. The identified portion of the sample was placed in a 20 ml glass scintillation vial with polypropylene lids in 70% ethanol, given a catalog number, and retained. In this report, metrics were calculated using data from the sub-sampled and big/rare portions of the sample. Abundance data are presented as the estimated number of individuals per square meter for quantitative samples and the estimated number per sample for qualitative samples.

Table 2. Field comments and laboratory processing information.

Sample	Station	Sampling Date	Habitat Sampled	Sampling Method	Sampling Area Sqmts	% of sample processed	Number of individuals identified
146827	CRANDLWR-03	07/14/2011	Reachwide	Kick Net	0.37	100	77
146828	CRANDLWR-03	07/14/2011	Targeted Riffle	Kick Net	0.74	100	647
146825	CRANDMD-02	07/14/2011	Reachwide	Kick Net	0.37	100	201
146826	CRANDMD-02	07/14/2011	Targeted Riffle	Kick Net	0.74	100	456
146823	CRANDUP-01	07/14/2011	Reachwide	Kick Net	0.37	100	230
146824	CRANDUP-01	07/14/2011	Targeted Riffle	Kick Net	0.74	100	551

Data summarization

A number of metrics or ecological summaries can be calculated from an aquatic invertebrate sample. A summary and description of commonly used metrics is available in Barbour et al. (1999, http://www.epa.gov/owow/monitoring/rbp/index.html#Table%20of%20Contents) and Karr and Chu (1998). Both of these publications suggest use of the following metrics for assessing the health of aquatic invertebrate assemblages: Total taxa richness, EPT taxa richness, Ephemeroptera taxa richness, Plecoptera taxa richness, Trichoptera taxa richness, % EPT abundance, % Ephemeroptera abundance, % Chironomidae abundance, Intolerant taxa richness, % tolerant organisms, Hilsenhoff Biotic Index, % contribution of the dominant taxon, clinger taxa richness, % clinger abundance, % collector-filterer abundance, and the % scraper abundance. Assessments are best made by comparing samples to samples collected similarly at reference sites or from samples collected prior to impacts or management actions at a location. In this report, the following metrics were calculated for each sample.

Taxa richness - Richness is a component and estimate of community structure and stream health based on the number of distinct taxa. Taxa richness normally decreases with decreasing water quality. In some situations organic enrichment can cause an increase in the number of pollution tolerant taxa. Taxa richness was calculated for operational taxonomic units (OTUs) and the number of unique genera, and families. The values for operational taxonomic units may be overestimates of the true taxa richness at a site if individuals were the same taxon as those identified to lower taxonomic levels or they may be underestimates of the true taxa richness if multiple taxa were present within a larger taxonomic grouping but were not identified. All individuals within all samples were generally identified similarly, so that comparisons in operational taxonomic richness among samples within this dataset are appropriate, but comparisons to other data sets may not. Comparisons to other datasets should be made at the genera or family level.

Abundance - The abundance, density, or number of aquatic macroinvertebrates per unit area is an indicator of habitat availability and fish food abundance. Abundance may be reduced or increased depending on the type of impact or pollutant. Increased organic enrichment typically causes large increases in abundance of pollution tolerant taxa. High flows, increases in fine sediment, or the presence of toxic substances normally cause a decrease in invertebrate abundance. Invertebrate abundance is presented as the number of individuals per square meter for quantitative samples and the number of individuals collected in each sample for qualitative samples.

EPT - A summary of the taxonomic richness and abundance within the insect Orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). These orders are commonly considered sensitive to pollution (Karr and Chu 1998).

Percent contribution of the dominant family or taxon - An assemblage largely dominated (>50%) by a single taxon or several taxa from the same family suggests environmental stress. Habitat conditions likely limit the number of taxa that can occur at the site.

Shannon diversity index - Ecological diversity is a measure of community structure defined by the relationship between the number of distinct taxa and their relative abundances. The Shannon diversity index was calculated for each sampling location for which there were a sufficient number of individuals and taxa collected to perform the calculations. The calculations were made following Ludwig and Reynolds (1988, equation 8.9, page 92).

Evenness - Evenness is a measure of the distribution of taxa within a community. The evenness index used in this report was calculated following Ludwig and Reynolds (1988, equation 8.15, page 94). Value ranges from 0-1 and approach zero as a single taxa becomes more dominant.

Clinger taxa - The number of clinger taxa have been found by Karr and Chu (1998) to respond negatively to human disturbance. Clinger taxa were determined using information in Merritt et al. (2008). These taxa typically cling to the tops of rocks and are thought to be reduced by sedimentation or abundant algal growths.

Long-live taxa - The number of long-lived taxa was calculated the number of taxa collected that typically have 2-3 year life cycles. Disturbances and water quality and habitat impairment typically reduces the number of long-lived taxa Karr and Chu (1998). Life-cycle length determinations were based on information in Merritt et al. (2008).

Biotic indices - Biotic indices use the indicator taxa concept. Taxa are assigned water quality tolerance values based on their tolerance to pollution. Scores are typically weighted by taxa relative abundance. In the United States the most commonly used biotic index is the Hilsenhoff Biotic Index (Hilsenhoff 1987, Hilsenhoff 1988). The USFS and BLM throughout the western United States have also frequently used the USFS Community Tolerance Quotient.

Hilsenhoff biotic index - The Hilsenhoff Biotic Index (HBI) summarizes the overall pollution tolerances of the taxa collected. This index has been used to detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts. It is best at detecting organic pollution. Families were assigned an index value from 0- taxa normally found only in high quality unpolluted water, to 10- taxa found only in severely polluted waters. Family level values were taken from Hilsenhoff (1987, 1988) and a family level HBI was calculated for each sampling location for which there were a sufficient number of individuals and taxa collected to perform the calculations. Sampling locations with HBI values of 0-2 are considered clean, 2-4 slightly enriched, 4-7 enriched, and 7-10 polluted. Rather than using mean HBI values for a sample, taxon HBI values can also be used to determine the number of pollution intolerant and tolerant taxa occurring at a site. In this report, taxa with HBI values $\leq$ 2 were considered intolerant clean water taxa and taxa with HBI values $\geq$ 8 were considered pollution tolerant taxa. The number of tolerant and intolerant taxa and the abundances of tolerant and intolerant taxa were calculated for each sampling location.

USFS community tolerant quotient - Taxa are assigned a tolerant quotient (TQ) from 2 - taxa found only in high quality unpolluted water, to 108 - taxa found in severely polluted waters. TQ values were developed by Winget and Mangum (1979). The dominance weighted community tolerance quotient (CTQd) was calculated. Values can vary from about 20 to 100, in general the lower the value the better the water quality.

Functional feeding group measures - A common classification scheme for aquatic macroinvertebrates is to categorize them by feeding acquisition mechanisms. Categories are based on food particle size and food location, e.g., suspended in the water column, deposited in sediments, leaf litter, or live prey. This classification system reflects the major source of the resource, either within the stream itself or from riparian or upland areas and the primary location, either erosional or depositional habitats. The number of taxa and individuals of the following feeding groups were calculated for each sampling location. Functional feeding group designations were from Merritt et al. (2008).

Shredders - Shredders use both living vascular hydrophytes and decomposing vascular plant tissue - coarse particulate organic matter. Shredders are sensitive to changes in riparian vegetation. Shredders can be good indicators of toxicants that adhere to organic matter.

Scrapers - Scrapers feed on periphyton - attached algae and associated material. Scraper populations increase with increasing abundance of diatoms and can decrease as filamentous algae, mosses, and vascular plants increase, often in response to increases in nitrogen and phosphorus. Scrapers decrease in relative abundance in response to sedimentation and higher levels of organic pollution or nutrient enrichment.

Collector-filterers - Collector-filterers feed on suspended fine particulate organic matter. Collector-filterers are sensitive to toxicants in the water column and to pollutants that adhere to organic matter.

Collector-gatherers - Collector-gatherers feed on deposited fine particulate organic matter. Collector-gatherers are sensitive to deposited toxicants.

Predators - Predators feed on living animal tissue. Predators typically make up about 25% of the assemblage in stream environments and 50% of the assemblage in still-water environments.

Unknown feeding group - This category includes taxa that are highly variable, parasites, and those that for which the primary feeding mode is currently unknown.

Results

Abundance data and taxa richness are reported as the estimated number of individuals per square meter for quantitative samples and the number per sample for qualitative samples. NC = Not calculated. * = unable to calculate. EPT = totals for the insect orders, Ephemeroptera, Plecoptera, Trichoptera. QL = qualitative sample.

Sample	Sampling date	Station	Total abundance	EPT abundance	Dominant family	% contribution dominant family
146823	07/14/2011	CRANDUP-01	622	435	Baetidae	26.53
146824	07/14/2011	CRANDUP-01	741	619	Heptageniidae	34.82
146825	07/14/2011	CRANDMD-02	541	73	Chironomidae	64.14
146826	07/14/2011	CRANDMD-02	614	291	Baetidae	25.57
146827	07/14/2011	CRANDLWR-03	207	97	Chironomidae	26.09
146828	07/14/2011	CRANDLWR-03	871	348	Chironomidae	37.43
Mean			599.3	310.5		35.76

Diversity indices

Sample	Sampling Date	Station	Total taxa richness	Total genera richness	Total family richness	EPT taxa richness	Shannon diversity index	Evenness
146823	07/14/2011	CRANDUP-01	35	21	20	15	2.700	0.760
146824	07/14/2011	CRANDUP-01	26	19	17	11	2.030	0.620
146825	07/14/2011	CRANDMD-02	22	16	17	8	1.870	0.600
146826	07/14/2011	CRANDMD-02	33	21	22	13	2.550	0.730
146827	07/14/2011	CRANDLWR-03	18	9	13	8	2.450	0.850
146828	07/14/2011	CRANDLWR-03	28	16	21	13	2.140	0.640
Mean			27.0	17.0	18.3	11.3	2.290	0.700

Genera richness by major taxonomic group.

Sample	Sampling Date	Station	Coleoptera	Diptera	Ephemerotpera	Heteroptera	Megaloptera	Odonata	Plecoptera	Trichoptera	Annelida	Custacea	Mollusca
146823	07/14/2011	CRANDUP-01	1	13	6	0	0	0	5	4	1	0	1
146824	07/14/2011	CRANDUP-01	1	11	5	0	0	0	3	3	0	0	1
146825	07/14/2011	CRANDMD-02	3	9	5	0	0	0	2	1	0	0	1
146826	07/14/2011	CRANDMD-02	1	13	6	0	0	0	3	4	1	0	1
146827	07/14/2011	CRANDLWR-03	0	4	4	0	0	0	1	3	1	0	1
146828	07/14/2011	CRANDLWR-03	0	9	5	0	0	0	4	4	1	0	0
Mean			1.0	9.8	5.2	0.0	0.0	0.0	3.0	3.2	0.7	0.0	0.8

Total abundance by major taxonomic group.

Sample	Sampling Date	Station	Coleoptera	Diptera	Ephemerotpera	Heteroptera	Megaloptera	Odonata	Plecoptera	Trichoptera	Annelida	Custacea	Mollusca
146823	07/14/2011	CRANDUP-01	3	138	370	0	0	0	41	24	16	0	5
146824	07/14/2011	CRANDUP-01	3	98	531	0	0	0	47	40	0	0	4
146825	07/14/2011	CRANDMD-02	57	401	54	0	0	0	16	3	0	0	5
146826	07/14/2011	CRANDMD-02	40	215	250	0	0	0	24	16	13	0	4
146827	07/14/2011	CRANDLWR-0 3	0	70	78	0	0	0	5	13	5	0	5
146828	07/14/2011	CRANDLWR-0 3	0	422	305	0	0	0	27	16	20	0	0
Mean			17.2	224.0	264.7	0.0	0.0	0.0	26.7	18.7	9.0	0.0	3.8

Biotic Indices

Sample	Sampling date	Station	Hilsenhoff Biotic Index		USFS
			Index	Indication	Community CTQd
146823	07/14/2011	CRANDUP-01	3.53	Possible slight organic pollution	69
146824	07/14/2011	CRANDUP-01	3.65	Possible slight organic pollution	63
146825	07/14/2011	CRANDMD-02	5.01	Some organic pollution	84
146826	07/14/2011	CRANDMD-02	3.55	Possible slight organic pollution	75
146827	07/14/2011	CRANDLWR-03	3.74	Possible slight organic pollution	83
146828	07/14/2011	CRANDLWR-03	4.35	Possible slight organic pollution	77
Mean			3.97		75.2

Taxa richness and relative abundance values with respect to tolerance or intolerance to pollution were based on the Hilsenhoff Biotic Index (HBI). Intolerant taxa have HBI score <= 2. Tolerant taxa have a HBI score >= 8. Data are presented as estimated count per square meter for quantitative samples and total number per sample for qualitative samples.

Sample	Sampling date	Station	Intolerant taxa				Tolerant Taxa			
			Richness		Abundance		Richness		Abundance	
146823	07/14/2011	CRANDUP-01	9	(26)	100	(16)	0	(0)	0	(0)
146824	07/14/2011	CRANDUP-01	7	(27)	120	(16)	0	(0)	0	(0)
146825	07/14/2011	CRANDMD-02	5	(23)	24	(4)	0	(0)	0	(0)
146826	07/14/2011	CRANDMD-02	8	(24)	82	(13)	1	(3)	1	(0)
146827	07/14/2011	CRANDLWR-0	2	(11)	11	(5)	0	(0)	0	(0)
146828	07/14/2011	CRANDLWR-0	6	(21)	40	(5)	0	(0)	0	(0)
Mean			6.2	(22)	62.8	(10)	0.2	(1)	0.2	(0)

Functional feeding groups

Taxa richness by functional feeding group. The percent of the total is shown in parentheses.

Sample	Sampling date	Station	Shredders		Scrapers		Collector-filterers		Collector-gatherers		Predators		Unknown	
146823	07/14/2011	CRANDUP-01	4	(11)	4	(11)	3	(9)	9	(26)	12	(34)	3	(9)
146824	07/14/2011	CRANDUP-01	1	(4)	3	(12)	4	(15)	6	(23)	11	(42)	1	(4)
146825	07/14/2011	CRANDMD-02	2	(9)	2	(9)	2	(9)	6	(27)	8	(36)	2	(9)
146826	07/14/2011	CRANDMD-02	4	(12)	3	(9)	3	(9)	9	(27)	12	(36)	2	(6)
146827	07/14/2011	CRANDLWR-0	1	(6)	1	(6)	2	(11)	5	(28)	9	(50)	0	(0)
146828	07/14/2011	CRANDLWR-0	2	(7)	2	(7)	2	(7)	7	(25)	14	(50)	0	(0)
Mean			2.3	(8)	2.5	(9)	2.7	(10)	7.0	(26)	11.0	(42)	1.3	(5)

Invertebrate abundance by functional feed group. The percent of the total is shown in parentheses.

Sample	Sampling date	Station	Shredders		Scrapers		Collector-filterers		Collector-gatherers		Predators		Unknown	
146823	07/14/2011	CRANDUP-01	16	(3)	192	(31)	14	(2)	289	(46)	100	(16)	11	(2)
146824	07/14/2011	CRANDUP-01	11	(1)	283	(38)	19	(3)	312	(42)	114	(15)	3	(0)
146825	07/14/2011	CRANDMD-02	5	(1)	40	(7)	8	(1)	355	(66)	78	(14)	54	(10)
146826	07/14/2011	CRANDMD-02	8	(1)	83	(14)	7	(1)	324	(53)	148	(24)	43	(7)
146827	07/14/2011	CRANDLWR-0	5	(2)	11	(5)	8	(4)	126	(61)	57	(28)	0	(0)
146828	07/14/2011	CRANDLWR-0	11	(1)	7	(1)	3	(0)	651	(75)	198	(23)	0	(0)
Mean			9.3	(2)	102.7	(16)	9.8	(2)	342.8	(57)	115.8	(20)	18.5	(3)

The 10 metrics thought to be most responsive to human induced disturbance (Karr and Chu 1998).

Sample	Sampling Date	Station	Total taxa	Ephemeroptera taxa	Plecoptera taxa	Trichoptera taxa	Long-lived taxa	Intolerant taxa	Clinger taxa	% tolerant individuals	% contribution dominant taxon	% predators
146823	07/14/2011	CRANDUP-01	35	6	3	4	2	9	11	0.00	23.95	16.08
146824	07/14/2011	CRANDUP-01	26	5	2	3	2	7	11	0.00	33.47	15.38
146825	07/14/2011	CRANDMD-02	22	4	2	1	3	5	7	0.00	53.79	14.42
146826	07/14/2011	CRANDMD-02	33	5	3	3	2	8	9	0.16	25.57	24.10
146827	07/14/2011	CRANDLWR-03	18	2	0	2	0	2	4	0.00	26.09	27.54
146828	07/14/2011	CRANDLWR-03	28	3	1	3	1	6	7	0.00	36.17	22.73
Mean			27.0	4.2	1.8	2.7	1.7	6.2	8.2	0.03	33.17	20.04

Taxonomic list and counts for 6 samples collected on July 14, 2011. Count is the total number of individuals identified and retained. Samples heading refers to the number of samples containing that taxon.

Order	Family	Subfamily/Genus/Species	Samples	Count
Phylum: Annelida				
Class: Clitellata	SubClass: Oligochaeta			
			4	33
Phylum: Arthropoda				
Class: Arachnida	SubClass: Acari			
Trombidiformes			4	11
Trombidiformes	Arrenuridae	Arrenurus	3	4
Trombidiformes	Hydryphantidae	Protzia	1	3
Trombidiformes	Hydryphantidae	Wandesia	1	1
Trombidiformes	Lebertiidae	Lebertia	5	79
Trombidiformes	Sperchonidae	Sperchon	3	29
Class: Insecta	SubClass: Pterygota			
Coleoptera	Dytiscidae		1	1
Coleoptera	Elmidae	Narpus concolor	4	51
Coleoptera	Elmidae	Optioservus quadrimaculatus	1	2
Diptera			1	2
Diptera	Ceratopogonidae		3	4
Diptera	Ceratopogonidae	Ceratopogoninae Sphaeromiini Probezzia	4	27
Diptera	Chironomidae		4	20
Diptera	Chironomidae	Chironominae	4	30
Diptera	Chironomidae	Orthocladiinae	6	487
Diptera	Chironomidae	Tanypodinae	4	14
Diptera	Empididae		2	3
Diptera	Empididae	Hemerodromiinae Hemerodromiini	2	14
Diptera	Empididae	Hemerodromiinae Hemerodromiini Chelifera	5	57
Diptera	Empididae	Neoplasta	3	28
Diptera	Empididae	Wiedemannia	1	1
Diptera	Psychodidae	Pericoma	1	1
Diptera	Simuliidae		1	2
Diptera	Simuliidae	Simuliinae Prosimuliini Helodon	3	8
Diptera	Simuliidae	Simuliinae Simuliini Simulium	1	3
Diptera	Stratiomyidae	Caloparyphus	2	32
Diptera	Tabanidae	Tabanus	1	17
Diptera	Tipulidae	Dicranota	3	6
Diptera	Tipulidae	Limoniinae Antocha monticola	3	7
Diptera	Tipulidae	Limoniinae Eriopterini Ormosia	1	4
Diptera	Tipulidae	Limoniinae Hexatomini Limnophila	1	2
Diptera	Tipulidae	Tipulinae Tipula	3	4
Ephemeroptera	Ameletidae	Ameletus	4	7
Ephemeroptera	Baetidae		2	8
Ephemeroptera	Baetidae	Baetis	6	501
Ephemeroptera	Baetidae	Diphetor hageni	2	7
Ephemeroptera	Ephemerellidae	Drunella	4	69
Ephemeroptera	Heptageniidae		2	8
Ephemeroptera	Heptageniidae	Cinygmula	4	281
Ephemeroptera	Heptageniidae	Epeorus	5	111
Ephemeroptera	Leptophlebiidae		2	2

Hemiptera	Gerridae		1	1
Plecoptera	Chloroperlidae	Chloroperlinae	1	1
Plecoptera	Nemouridae	Amphinemurinae	1	7
Plecoptera	Nemouridae	Zapada	4	14
Plecoptera	Nemouridae	Zapada cinctipes	2	2
Plecoptera	Perlodidae		4	13
Plecoptera	Perlodidae	Isoperlinae Isoperla	5	58
Plecoptera	Taeniopterygidae		1	1
Trichoptera	Brachycentridae	Brachycentrus americanus	1	1
Trichoptera	Hydropsychidae	Arctopsychinae Parapsyche	1	1
Trichoptera	Hydropsychidae	Arctopsychinae Parapsyche elsis	2	3
Trichoptera	Hydropsychidae	Hydropsychinae Hydropsyche	2	2
Trichoptera	Limnephilidae		3	4
Trichoptera	Rhyacophilidae	Rhyacophila	3	19
Trichoptera	Rhyacophilidae	Rhyacophila angelita group	2	11
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	4	26
Trichoptera	Uenoidae	Neothremma	1	2
Phylum: Mollusca				
Class: Bivalvia	SubClass: Heterodonta			
Veneroida	Pisidiidae	Pisidiinae Pisidium	5	12
Phylum: Nemata				
Class:	SubClass:			
			2	3

Total: OTU Taxa: **61** Genera: **39** Families: **31** Individuals: **2162**

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Taxa Lists for Individual Samples

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected July 14, 2011 at station CRANDUP-01, Crandall Creek, Upstream, Emery county, Utah. The sample was collected from reachwide habitat using a Kick Net. The total area sampled was 0.370 square meters. The percentage of the sample that was identified and retained was 100% of the collected sample. A total of 230 individuals were removed, identified and retained. The sample identification number is 146823. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Annelida					
Class: Clitellata		SubClass: Oligochaeta			
			adult	16.22	
Phylum: Arthropoda					
Class: Arachnida		SubClass: Acari			
Trombidiformes			adult	8.11	U
Trombidiformes	Lebertiidae	Lebertia	adult	8.11	
Trombidiformes	Sperchonidae	Sperchon	adult	5.41	
Class: Insecta		SubClass: Pterygota			
Coleoptera	Elmidae	Narpus concolor	larvae	2.70	
Diptera			larvae	5.41	U
Diptera	Ceratopogonidae		pupae	2.70	
Diptera	Ceratopogonidae	Ceratopogoninae Sphaeromiini Probezzia	larvae	13.51	
Diptera	Chironomidae		pupae	13.51	
Diptera	Chironomidae	Chironominae	larvae	37.84	
Diptera	Chironomidae	Orthocladiinae	larvae	24.32	
Diptera	Chironomidae	Tanypodinae	larvae	2.70	
Diptera	Empididae	Hemerodromiinae Hemerodromiini Chelifera	larvae	13.51	
Diptera	Empididae	Wiedemannia	larvae	2.70	
Diptera	Simuliidae		pupae	5.41	U
Diptera	Tipulidae	Limoniinae Antocha monticola	larvae	2.70	
Diptera	Tipulidae	Limoniinae Eriopterini Ormosia	larvae	10.81	
Diptera	Tipulidae	Tipulinae Tipula	larvae	2.70	
Ephemeroptera	Ameletidae	Ameletus	larvae	8.11	
Ephemeroptera	Baetidae	Baetis	larvae	148.65	
Ephemeroptera	Baetidae	Diphetor hageni	larvae	16.22	
Ephemeroptera	Ephemerellidae	Drunella	larvae	35.14	
Ephemeroptera	Heptageniidae	Cinygmula	larvae	143.24	
Ephemeroptera	Heptageniidae	Epeorus	larvae	18.92	
Plecoptera	Nemouridae	Zapada	larvae	8.11	U
Plecoptera	Nemouridae	Zapada cinctipes	larvae	2.70	
Plecoptera	Perlodidae		larvae	8.11	I
Plecoptera	Perlodidae	Isoperlinae Isoperla	larvae	18.92	
Plecoptera	Taeniopterygidae		larvae	2.70	I
Trichoptera	Hydropsychidae	Arctopsychinae Parapsyche	larvae	2.70	I
Trichoptera	Rhyacophilidae	Rhyacophila	larvae	8.11	I
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	8.11	
Trichoptera	Uenoidae	Neothremma	larvae	5.41	I
Phylum: Mollusca					
Class: Bivalvia		SubClass: Heterodonta			
Veneroida	Pisidiidae	Pisidiinae Pisidium	adult	5.41	
Phylum: Nemata					
Class:		SubClass:			
			adult	2.70	

Total:	OTU Taxa:	**35**	Genera:	**23**	Families:	**20**	621.62

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected July 14, 2011 at station CRANDUP-01, Crandall Creek, Upstream, Emery county, Utah. The sample was collected from targeted riffle habitat using a Kick Net. The total area sampled was 0.743 square meters. The percentage of the sample that was identified and retained was 100% of the collected sample. A total of 551 individuals were removed, identified and retained. The sample identification number is 146824. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Arthropoda					
Class: Arachnida		SubClass: Acari			
Trombidiformes	Arrenuridae	Arrenurus	adult	2.69	
Trombidiformes	Lebertiidae	Lebertia	adult	14.80	
Class: Insecta		SubClass: Pterygota			
Coleoptera	Elmidae	Narpus concolor	larvae	2.69	
Diptera	Ceratopogonidae		pupae	1.35	
Diptera	Ceratopogonidae	Ceratopogoninae Sphaeromiini Probezzia	larvae	2.69	
Diptera	Chironomidae		pupae	8.07	
Diptera	Chironomidae	Chironominae	larvae	4.04	
Diptera	Chironomidae	Orthocladiinae	larvae	49.78	
Diptera	Chironomidae	Tanypodinae	larvae	2.69	
Diptera	Empididae	Hemerodromiinae Hemerodromiini Chelifera	larvae	12.11	
Diptera	Simuliidae	Simuliinae Prosimuliini Helodon	larvae	8.07	
Diptera	Simuliidae	Simuliinae Simuliini Simulium	larvae	4.04	
Diptera	Tipulidae	Dicranota	larvae	4.04	
Diptera	Tipulidae	Limoniinae Antocha monticola	larvae	1.35	
Ephemeroptera	Ameletidae	Ameletus	larvae	2.69	
Ephemeroptera	Baetidae	Baetis	larvae	238.15	
Ephemeroptera	Ephemerellidae	Drunella	larvae	32.29	
Ephemeroptera	Heptageniidae	Cinygmula	larvae	247.57	
Ephemeroptera	Heptageniidae	Epeorus	larvae	10.76	
Plecoptera	Nemouridae	Zapada	larvae	10.76	U
Plecoptera	Perlodidae		larvae	6.73	I
Plecoptera	Perlodidae	Isoperlinae Isoperla	larvae	29.60	
Trichoptera	Hydropsychidae	Arctopsychinae Parapsyche elsis	larvae	2.69	
Trichoptera	Rhyacophilidae	Rhyacophila	larvae	14.80	I
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	22.87	
Phylum: Mollusca					
Class: Bivalvia		SubClass: Heterodonta			
Veneroida	Pisidiidae	Pisidiinae Pisidium	adult	4.04	
Total: OTU Taxa: **26**		Genera: **20**	Families: **17**	741.37	

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected July 14, 2011 at station CRANDMD-02, Crandall Creek, Middle, Emery county, Utah. The sample was collected from reachwide habitat using a Kick Net. The total area sampled was 0.372 square meters. The percentage of the sample that was identified and retained was 100% of the collected sample. A total of 201 individuals were removed, identified and retained. The sample identification number is 146825. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Arthropoda					
Class: Arachnida		SubClass: Acari			
Trombidiformes			adult	5.38	U
Class: Insecta		SubClass: Pterygota			
Coleoptera	Dytiscidae		larvae	2.69	I
Coleoptera	Elmidae	Narpus concolor	larvae	48.44	
Coleoptera	Elmidae	Optioservus quadrimaculatus	adult	5.38	
Diptera	Ceratopogonidae	Ceratopogoninae Sphaeromiini Probezzia	larvae	10.76	
Diptera	Chironomidae	Chironominae	larvae	29.60	
Diptera	Chironomidae	Orthocladiinae	larvae	290.63	
Diptera	Chironomidae	Tanypodinae	larvae	26.91	
Diptera	Empididae	Hemerodromiinae Hemerodromiini Chelifera	larvae	13.45	
Diptera	Simuliidae	Simuliinae Prosimuliini Helodon	pupae	2.69	
Diptera	Stratiomyidae	Caloparyphus	larvae	21.53	
Diptera	Tipulidae	Dicranota	larvae	2.69	
Diptera	Tipulidae	Tipulinae Tipula	larvae	2.69	
Ephemeroptera	Baetidae	Baetis	larvae	8.07	
Ephemeroptera	Baetidae	Diphetor hageni	larvae	2.69	
Ephemeroptera	Ephemerellidae	Drunella	larvae	2.69	
Ephemeroptera	Heptageniidae	Cinygmula	larvae	37.67	
Ephemeroptera	Leptophlebiidae		larvae	2.69	D
Plecoptera	Nemouridae	Zapada	larvae	2.69	U
Plecoptera	Perlodidae	Isoperlinae Isoperla	larvae	13.45	
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	2.69	
Phylum: Mollusca					
Class: Bivalvia		SubClass: Heterodonta			
Veneroida	Pisidiidae	Pisidiinae Pisidium	adult	5.38	

Total: OTU Taxa:	**22**	Genera:	**16**	Families:	**17**	540.89

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected July 14, 2011 at station CRANDMD-02, Crandall Creek, Middle, Emery county, Utah. The sample was collected from targeted riffle habitat using a Kick Net. The total area sampled was 0.743 square meters. The percentage of the sample that was identified and retained was 100% of the collected sample. A total of 456 individuals were removed, identified and retained. The sample identification number is 146826. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Annelida					
Class: Clitellata		SubClass: Oligochaeta			
			adult	13.45	
Phylum: Arthropoda					
Class: Arachnida		SubClass: Acari			
Trombidiformes			adult	5.38	U
Trombidiformes	Hydryphantidae	Protzia	adult	4.04	
Trombidiformes	Lebertiidae	Lebertia	adult	37.67	
Class: Insecta		SubClass: Pterygota			
Coleoptera	Elmidae	Narpus concolor	larvae	40.36	
Diptera	Ceratopogonidae	Ceratopogoninae Sphaeromiini Probezzia	larvae	21.53	
Diptera	Chironomidae		pupae	1.35	
Diptera	Chironomidae	Chironominae	larvae	2.69	
Diptera	Chironomidae	Orthocladiinae	larvae	106.29	
Diptera	Chironomidae	Tanypodinae	larvae	1.35	
Diptera	Empididae		pupae	2.69	
Diptera	Empididae	Hemerodromiinae Hemerodromiini Chelifera	larvae	37.67	
Diptera	Empididae	Neoplasta	larvae	1.35	
Diptera	Psychodidae	Pericoma	larvae	1.35	
Diptera	Simuliidae	Simuliinae Prosimuliini Helodon	pupae	1.35	
Diptera	Stratiomyidae	Caloparyphus	larvae	32.29	
Diptera	Tipulidae	Dicranota	larvae	2.69	
Diptera	Tipulidae	Tipulinae Tipula	larvae	2.69	
Ephemeroptera	Ameletidae	Ameletus	larvae	1.35	
Ephemeroptera	Baetidae	Baetis	larvae	157.42	
Ephemeroptera	Ephemerellidae	Drunella	larvae	41.71	
Ephemeroptera	Heptageniidae	Cinygmula	larvae	40.36	
Ephemeroptera	Heptageniidae	Epeorus	larvae	8.07	
Ephemeroptera	Leptophlebiidae		larvae	1.35	D
Plecoptera	Nemouridae	Zapada	larvae	2.69	U
Plecoptera	Nemouridae	Zapada cinctipes	larvae	1.35	
Plecoptera	Perlodidae	Isoperlinae Isoperla	larvae	20.18	
Trichoptera	Hydropsychidae	Arctopsychinae Parapsyche elsis	larvae	1.35	
Trichoptera	Limnephilidae		larvae	1.35	I
Trichoptera	Rhyacophilidae	Rhyacophila	larvae	6.73	I,U
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	6.73	
Phylum: Mollusca					
Class: Bivalvia		SubClass: Heterodonta			
Veneroida	Pisidiidae	Pisidiinae Pisidium	adult	4.04	
Phylum: Nemata					
Class:		SubClass:			
			adult	2.69	

Total:	OTU Taxa: 33	Genera: 23	Families: 22	613.55

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected July 14, 2011 at station CRANDLWR-03, Crandall Creek, Lower, Emery county, Utah. The sample was collected from reachwide habitat using a Kick Net. The total area sampled was 0.372 square meters. The percentage of the sample that was identified and retained was 100% of the collected sample. A total of 77 individuals were removed, identified and retained. The sample identification number is 146827. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

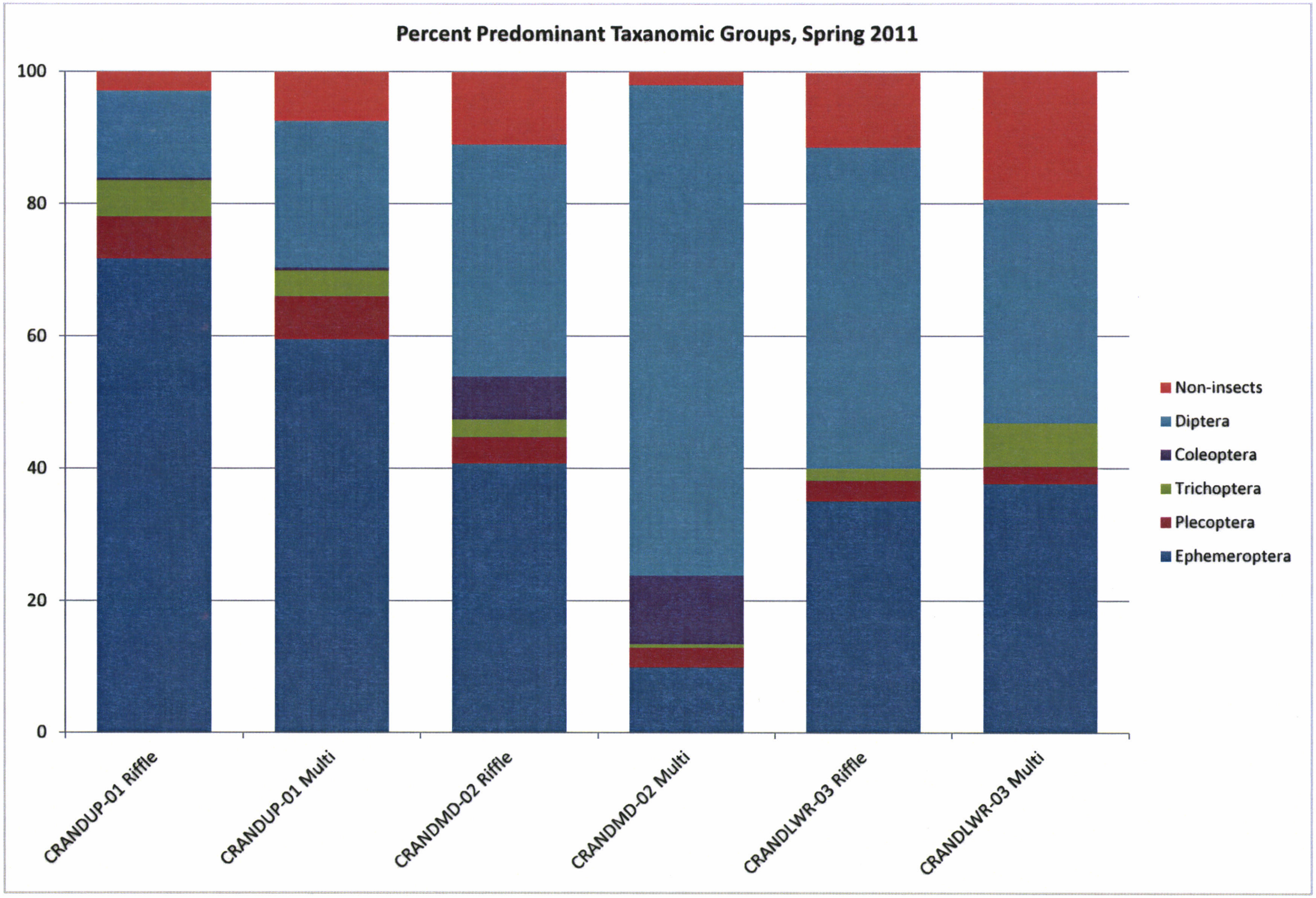
Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Annelida					
Class: Clitellata		SubClass: Oligochaeta			
			adult	5.38	
Phylum: Arthropoda					
Class: Arachnida		SubClass: Acari			
Trombidiformes			adult	5.38	D,U
Trombidiformes	Arrenuridae	Arrenurus	adult	2.69	
Trombidiformes	Lebertiidae	Lebertia	adult	10.76	
Trombidiformes	Sperchonidae	Sperchon	adult	10.76	
Class: Insecta		SubClass: Pterygota			
Diptera	Chironomidae	Orthocladiinae	larvae	53.82	
Diptera	Empididae		pupae	2.69	
Diptera	Empididae	Hemerodromiinae Hemerodromiini	larvae	5.38	I
Diptera	Empididae	Neoplasta	larvae	8.07	
Ephemeroptera	Baetidae		larvae	10.76	
Ephemeroptera	Baetidae	Baetis	larvae	37.67	
Ephemeroptera	Heptageniidae		larvae	10.76	I,D
Ephemeroptera	Heptageniidae	Epeorus	larvae	18.84	
Plecoptera	Perlodidae		larvae	5.38	D
Trichoptera	Hydropsychidae	Hydropsychinae Hydropsyche	larvae	2.69	
Trichoptera	Limnephilidae		larvae	5.38	D
Trichoptera	Rhyacophilidae	Rhyacophila angelita group	larvae	5.38	
Phylum: Mollusca					
Class: Bivalvia		SubClass: Heterodonta			
Veneroida	Pisidiidae	Pisidiinae Pisidium	adult	5.38	

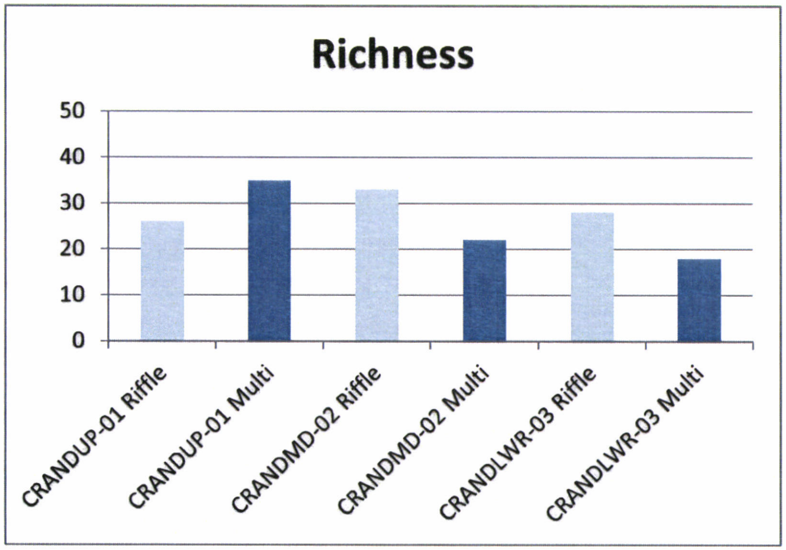
Total:	OTU Taxa:	**18**	Genera:	**9**	Families:	**13**	207.21

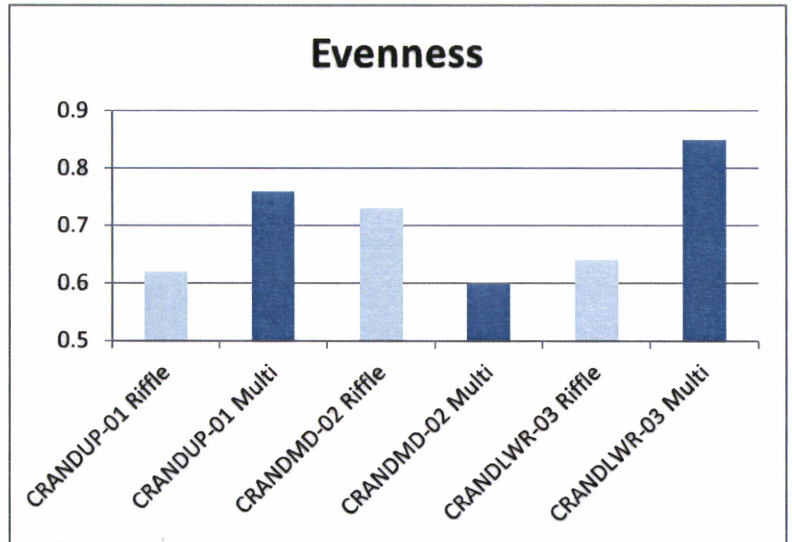
Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected July 14, 2011 at station CRANDLWR-03, Crandall Creek, Lower, Emery county, Utah. The sample was collected from targeted riffle habitat using a Kick Net. The total area sampled was 0.743 square meters. The percentage of the sample that was identified and retained was 100% of the collected sample. A total of 647 individuals were removed, identified and retained. The sample identification number is 146828. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

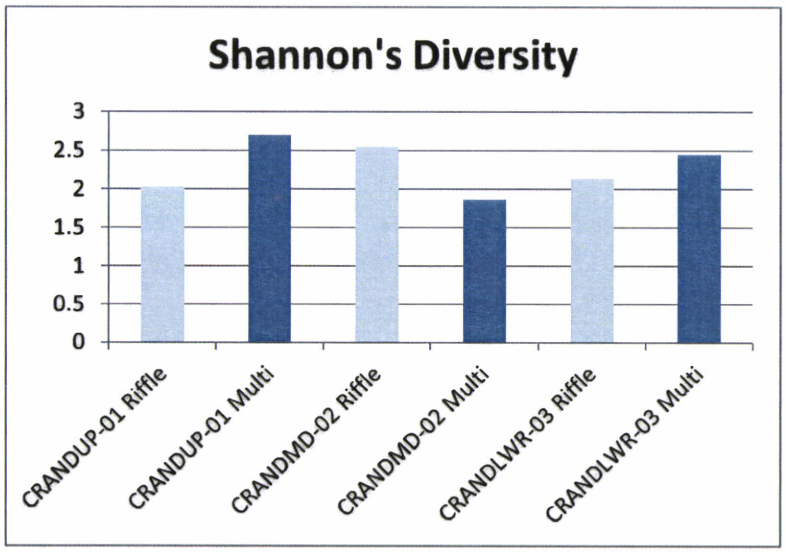
Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Annelida					
Class: Clitellata		SubClass: Oligochaeta			
			adult	20.18	
Phylum: Arthropoda					
Class: Arachnida		SubClass: Acari			
Trombidiformes	Arrenuridae	Arrenurus	adult	1.35	
Trombidiformes	Hydryphantidae	Wandesia	adult	1.35	
Trombidiformes	Lebertiidae	Lebertia	adult	44.40	
Trombidiformes	Sperchonidae	Sperchon	adult	30.95	
Class: Insecta		SubClass: Pterygota			
Diptera	Ceratopogonidae		pupae	2.69	
Diptera	Chironomidae		pupae	10.76	
Diptera	Chironomidae	Orthocladiinae	larvae	314.85	
Diptera	Empididae	Hemerodromiinae Hemerodromiini	larvae	16.15	
Diptera	Empididae	Hemerodromiinae Hemerodromiini Chelifera	larvae	13.45	
Diptera	Empididae	Neoplasta	larvae	32.29	
Diptera	Tabanidae	Tabanus	larvae	22.87	
Diptera	Tipulidae	Limoniinae Antocha monticola	larvae	3.36	
Diptera	Tipulidae	Limoniinae Hexatomini Limnophila	larvae	2.69	
Ephemeroptera	Ameletidae	Ameletus	larvae	1.35	
Ephemeroptera	Baetidae		larvae	5.38	D
Ephemeroptera	Baetidae	Baetis	larvae	181.64	
Ephemeroptera	Heptageniidae		larvae	5.38	D
Ephemeroptera	Heptageniidae	Epeorus	larvae	111.68	
Hemiptera	Gerridae		larvae	1.35	I
Plecoptera	Chloroperlidae	Chloroperlinae	larvae	1.35	D
Plecoptera	Nemouridae	Amphinemurinae	larvae	9.42	
Plecoptera	Perlodidae		larvae	4.04	D
Plecoptera	Perlodidae	Isoperlinae Isoperla	larvae	12.11	
Trichoptera	Brachycentridae	Brachycentrus americanus	larvae	1.35	
Trichoptera	Hydropsychidae	Hydropsychinae Hydropsyche	larvae	1.35	
Trichoptera	Limnephilidae		larvae	1.35	I
Trichoptera	Rhyacophilidae	Rhyacophila angelita group	larvae	12.11	
Total: OTU Taxa: **28**	Genera: **16**	Families: **21**		870.54	

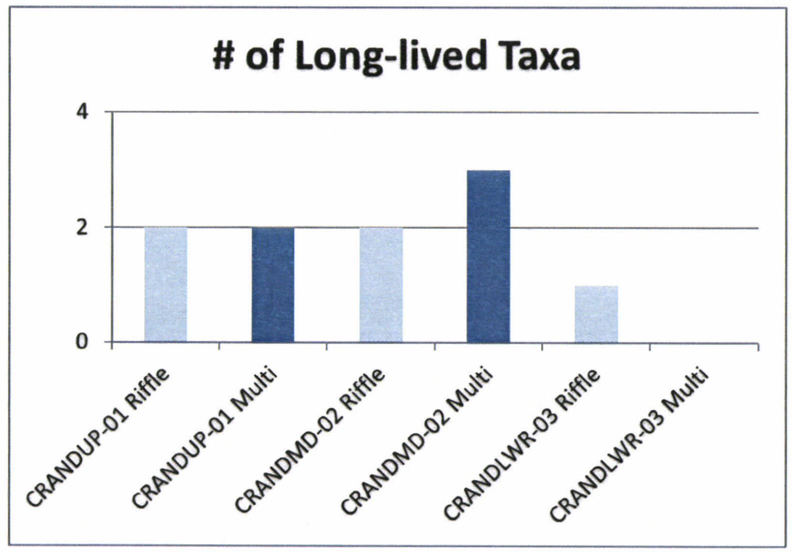
APPENDIX 2
MACROINVERTEBRATE METRICS

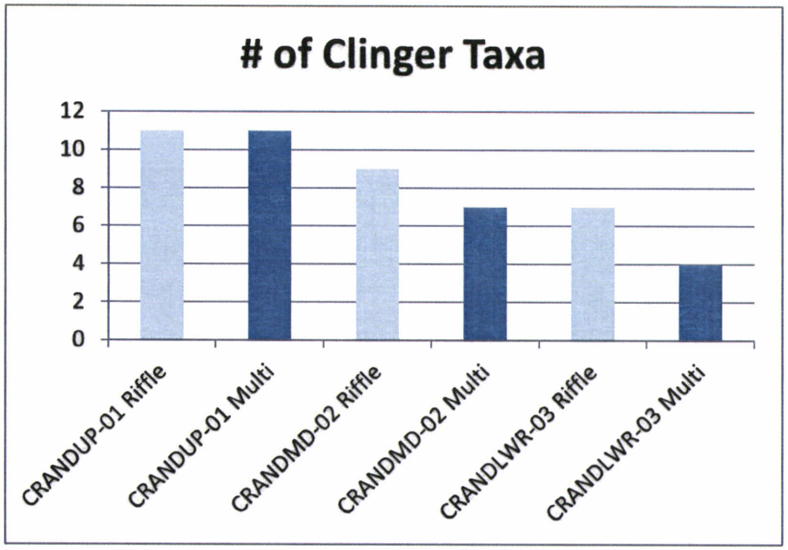

Percent Predominant Taxonomic Groups, Spring 2011
100
80
60
40
20
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi
Non-insects
Diptera
Coleoptera
Trichoptera
Plecoptera
Ephemeroptera


Richness
50
40
30
20
10
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

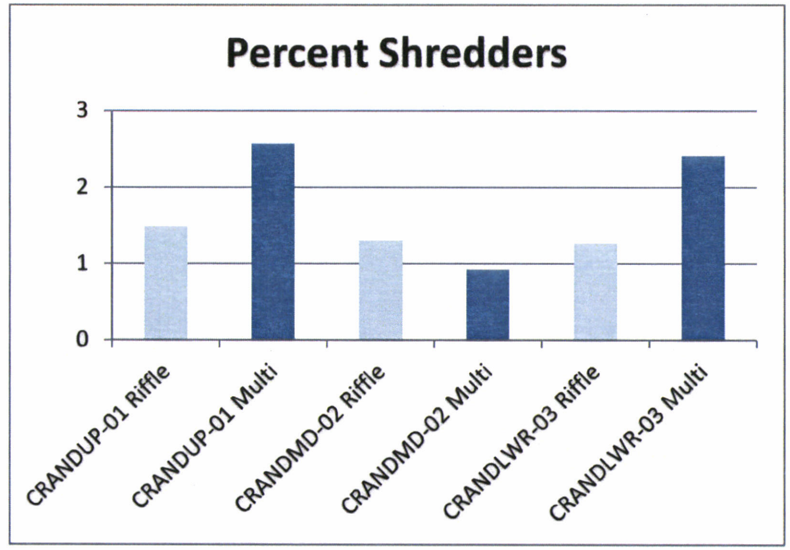

Evenness
0.9
0.8
0.7
0.6
0.5
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi


Shannon's Diversity
3
2.5
2
1.5
1
0.5
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

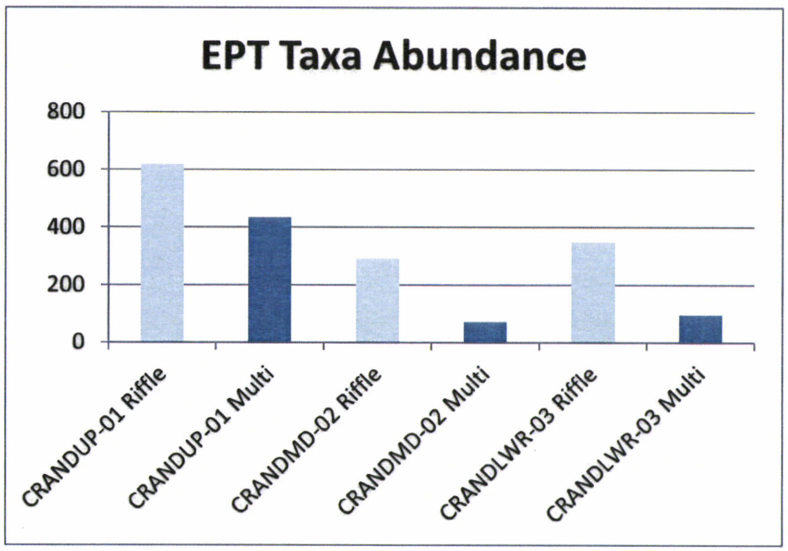

# of Long-lived Taxa
4
2
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi



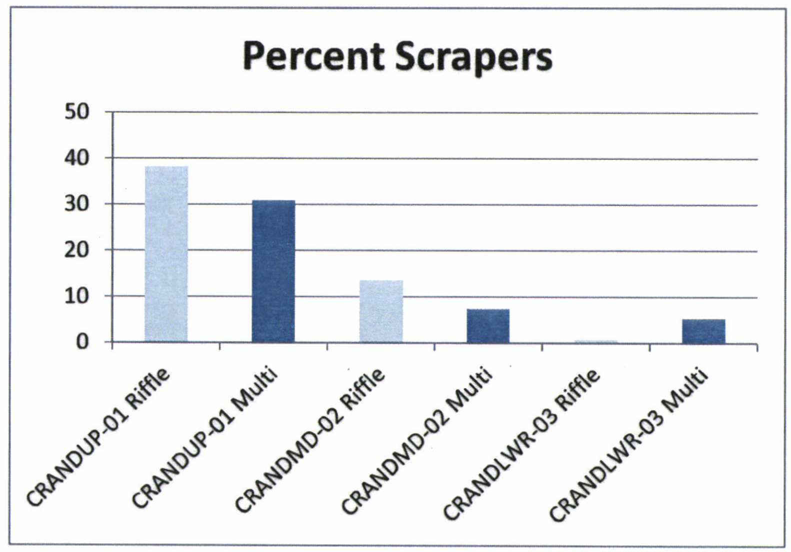
# of Clinger Taxa
12
10
8
6
4
2
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi



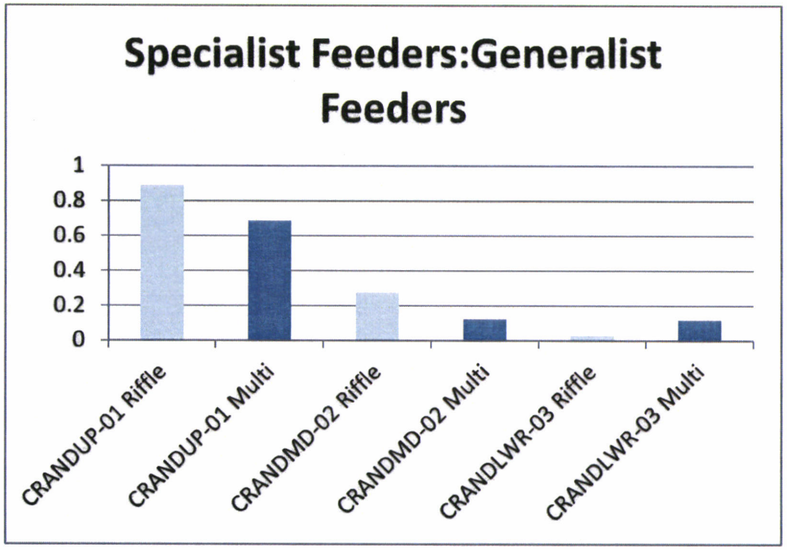
Percent Shredders
3
2
1
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

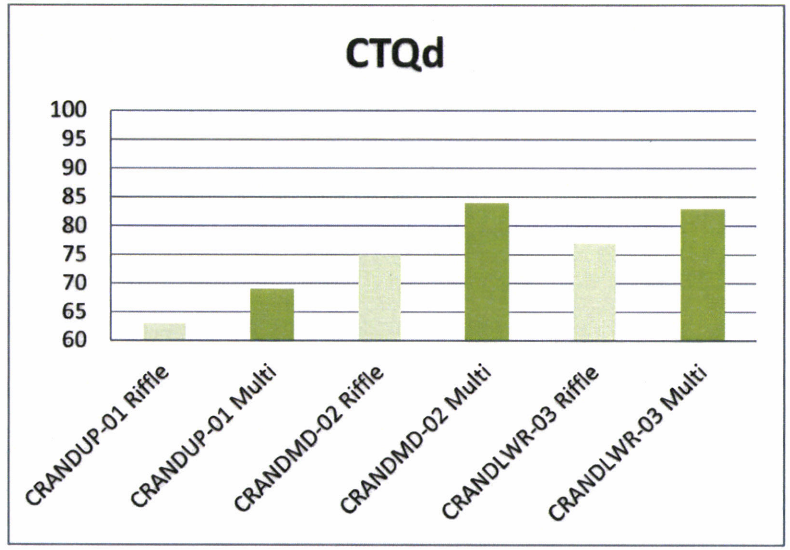


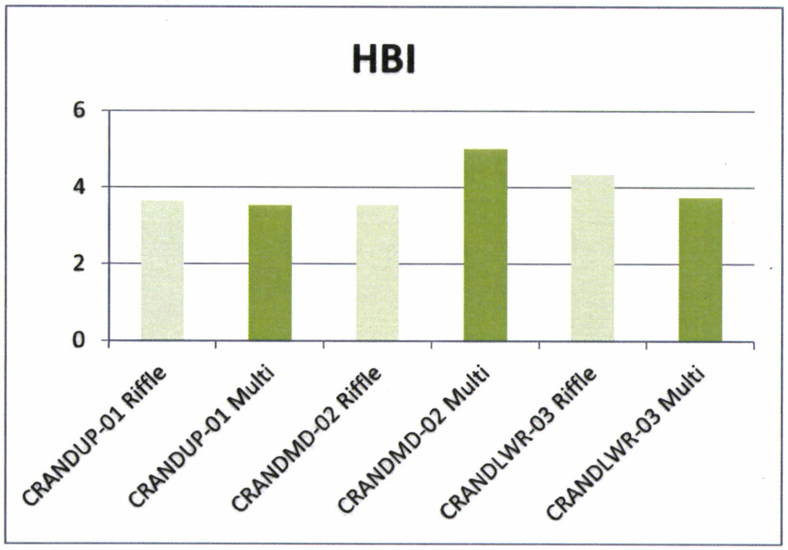
EPT Taxa Abundance
800
600
400
200
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

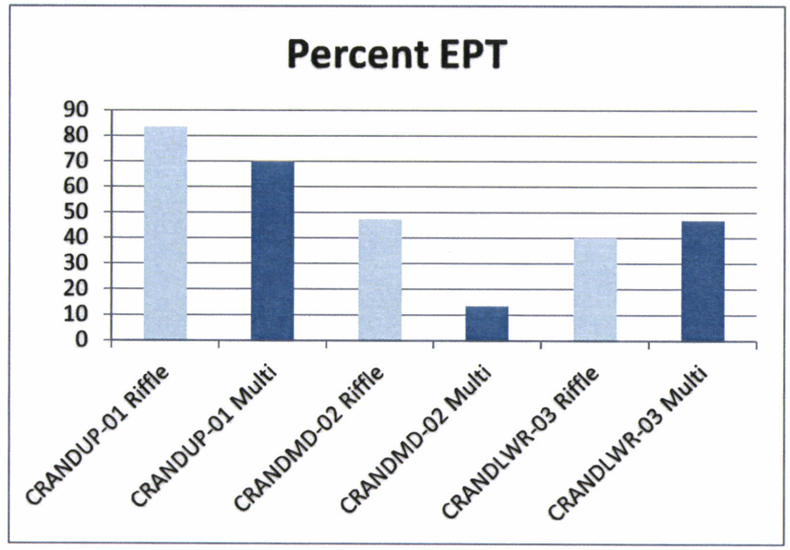


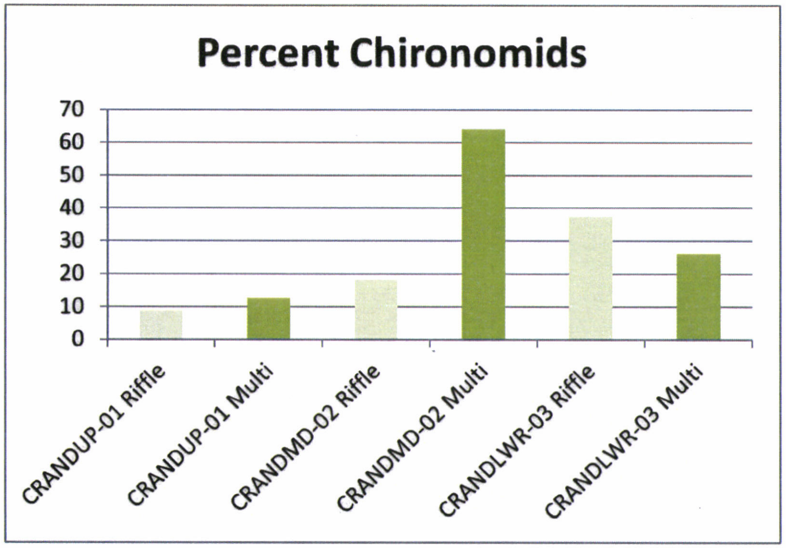
Percent Scrapers
50
40
30
20
10
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

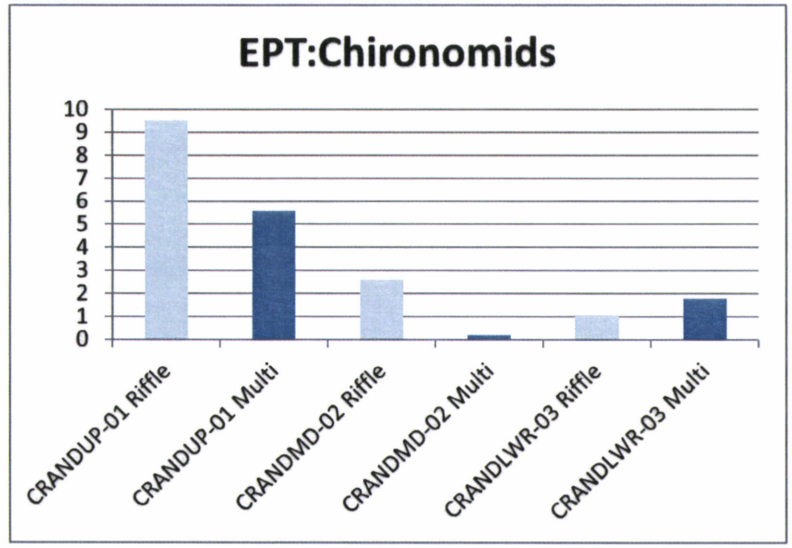

Specialist Feeders:Generalist Feeders
1
0.8
0.6
0.4
0.2
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

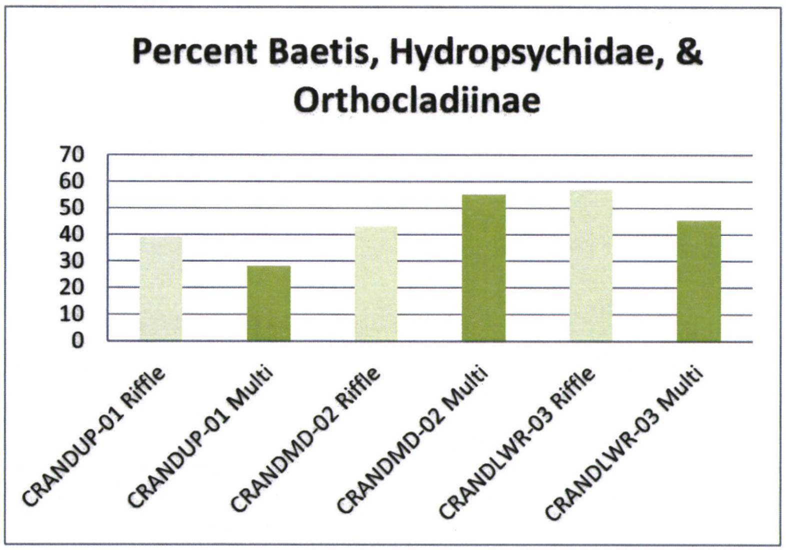

CTQd
100
95
90
85
80
75
70
65
60
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

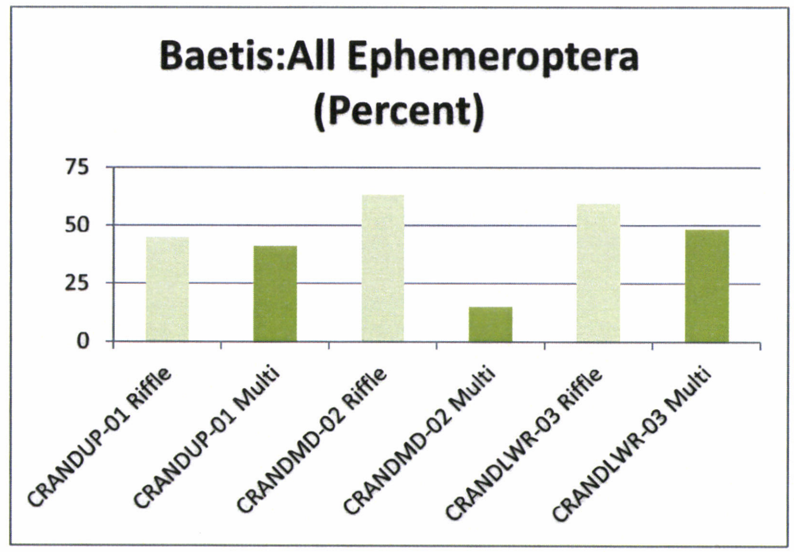

HBI
6
4
2
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

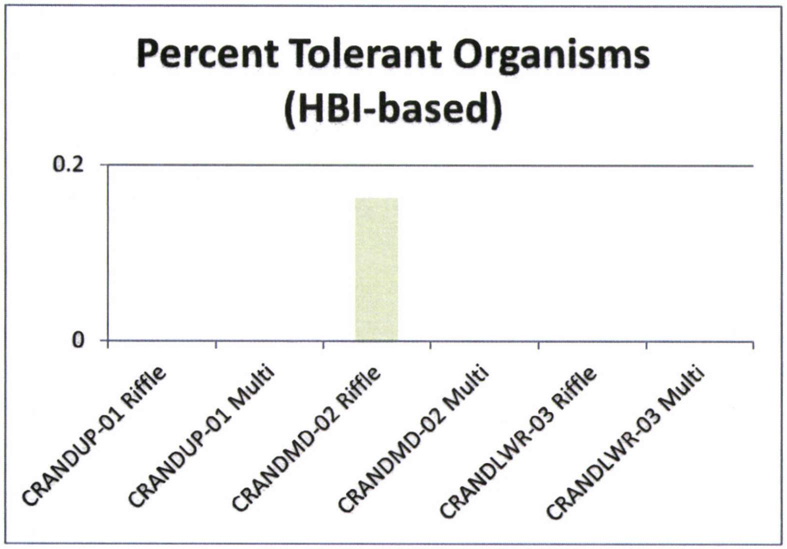

Percent EPT
90
80
70
60
50
40
30
20
10
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

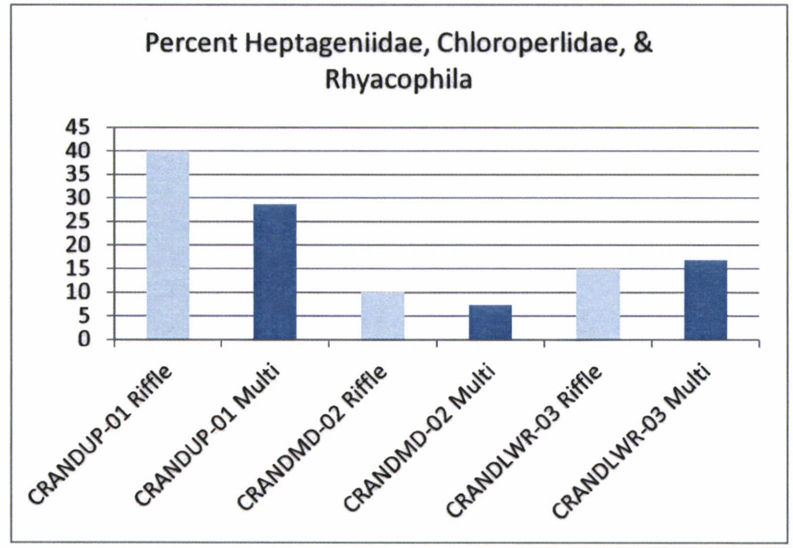

Percent Chironomids
70
60
50
40
30
20
10
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

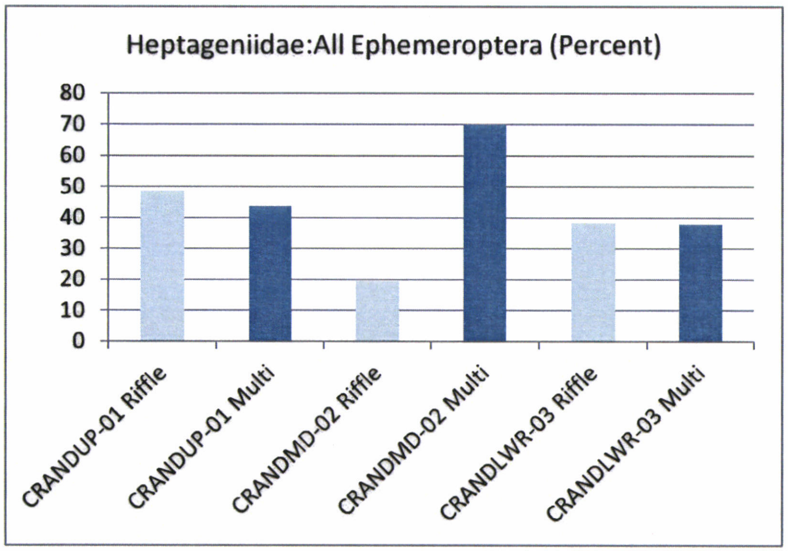

EPT:Chironomids
10
9
8
7
6
5
4
3
2
1
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

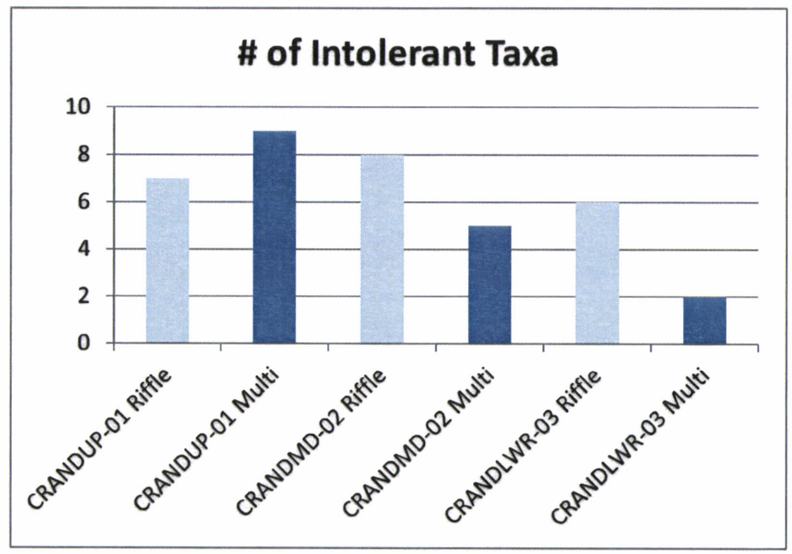

Percent Baetis, Hydropsychidae, & Orthocladiinae
70
60
50
40
30
20
10
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

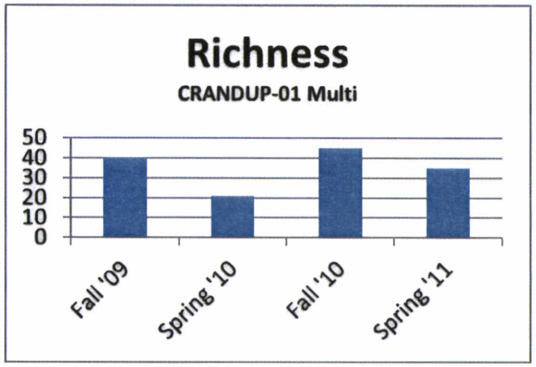

Baetis:All Ephemeroptera (Percent)
75
50
25
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

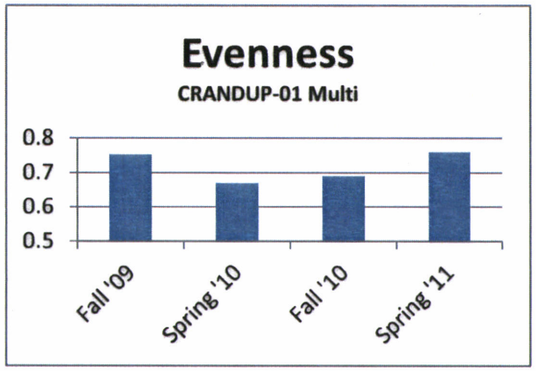

Percent Tolerant Organisms (HBI-based)
0.2
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

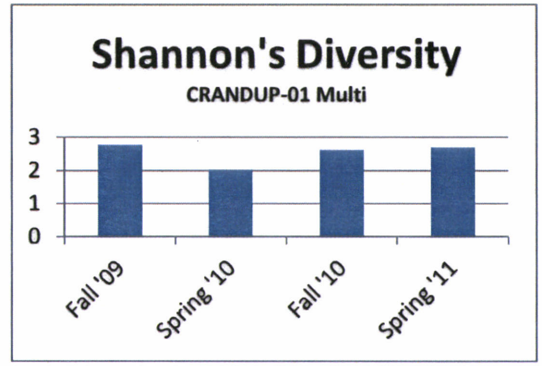

Percent Heptageniidae, Chloroperlidae, & Rhyacophila
45
40
35
30
25
20
15
10
5
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

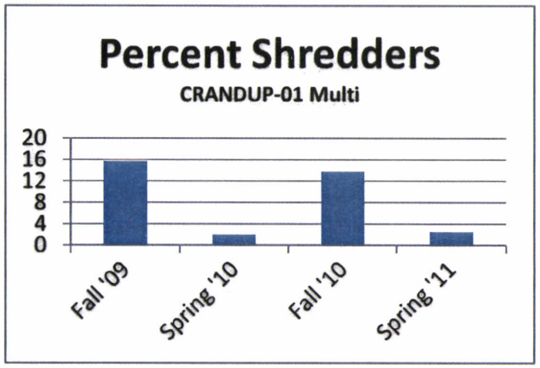

Heptageniidae:All Ephemeroptera (Percent)
80
70
60
50
40
30
20
10
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

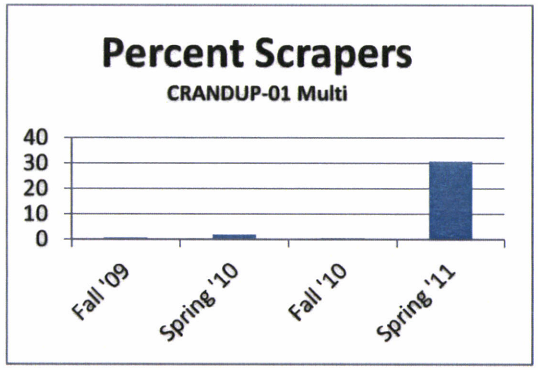

# of Intolerant Taxa
10
8
6
4
2
0
CRANDUP-01 Riffle
CRANDUP-01 Multi
CRANDMD-02 Riffle
CRANDMD-02 Multi
CRANDLWR-03 Riffle
CRANDLWR-03 Multi

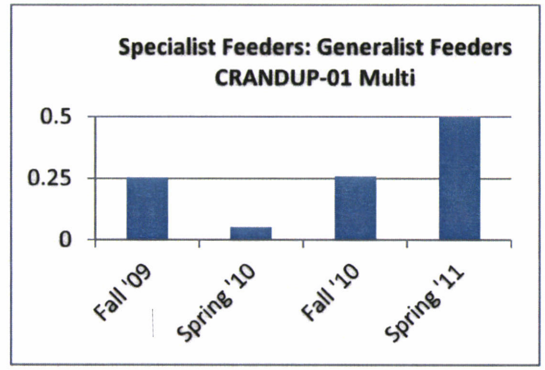

Richness
CRANDUP-01 Multi
50
40
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

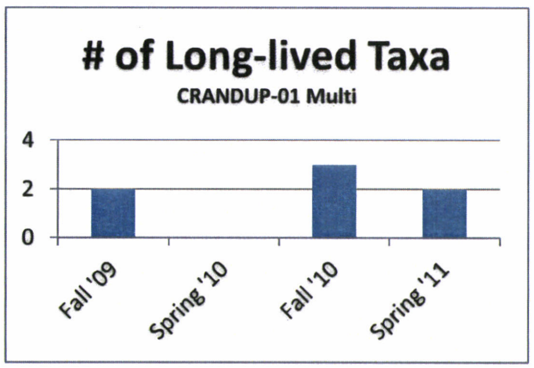

Evenness
CRANDUP-01 Multi
0.8
0.7
0.6
0.5
Fall '09
Spring '10
Fall '10
Spring '11

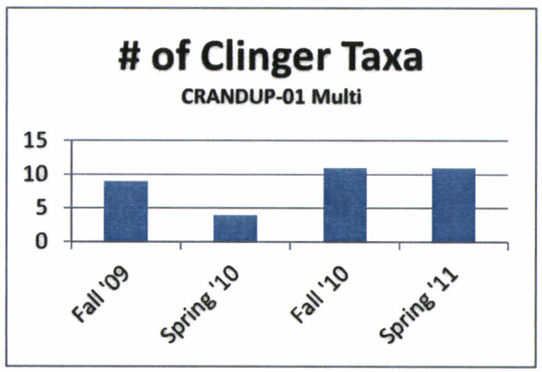

Shannon's Diversity
CRANDUP-01 Multi
3
2
1
0
Fall '09
Spring '10
Fall '10
Spring '11

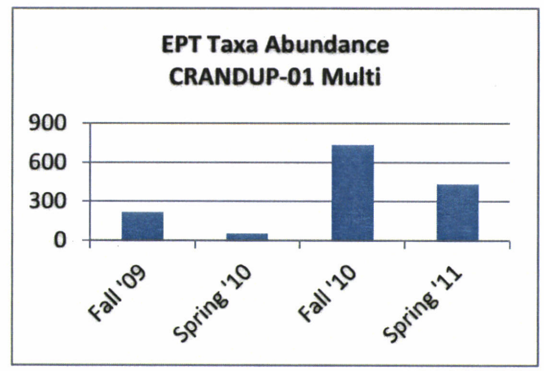

Percent Shredders
CRANDUP-01 Multi
20
16
12
8
4
0
Fall '09
Spring '10
Fall '10
Spring '11

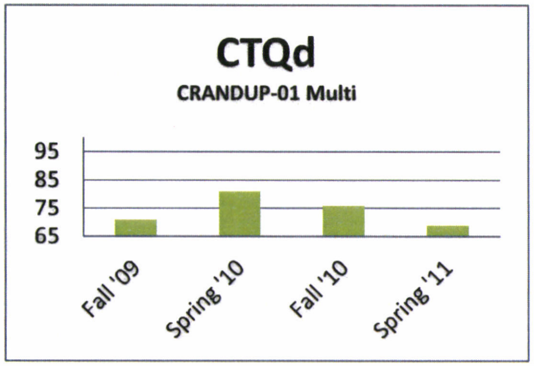

Percent Scrapers
CRANDUP-01 Multi
40
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

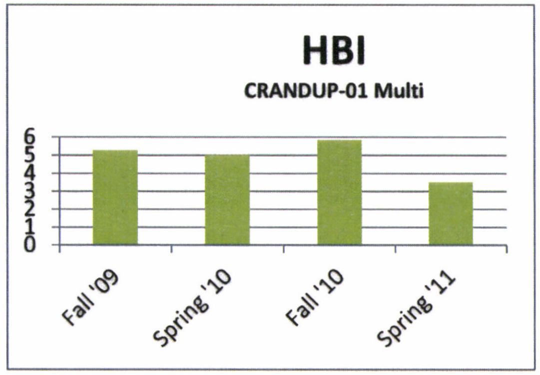

Specialist Feeders: Generalist Feeders
CRANDUP-01 Multi
0.5
0.25
0
Fall '09
Spring '10
Fall '10
Spring '11

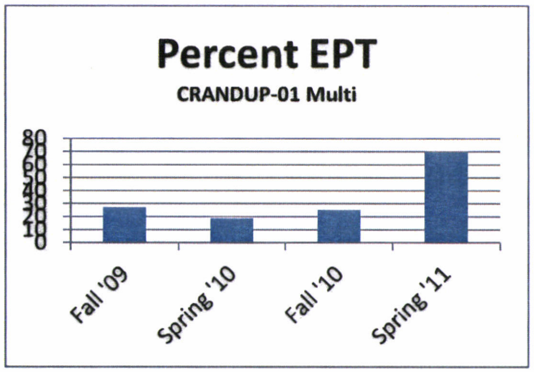

# of Long-lived Taxa
CRANDUP-01 Multi
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

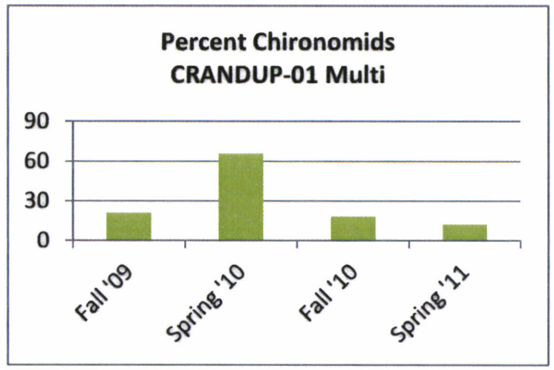

# of Clinger Taxa
CRANDUP-01 Multi
15
10
5
0
Fall '09
Spring '10
Fall '10
Spring '11

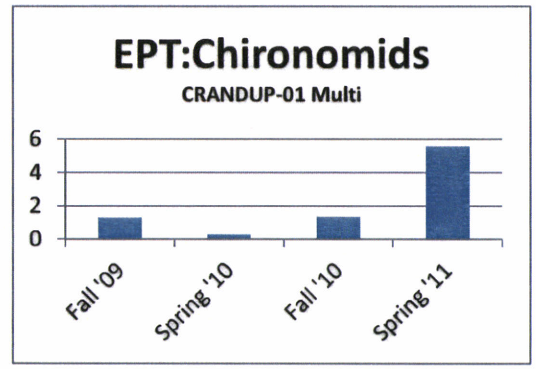

EPT Taxa Abundance
CRANDUP-01 Multi
900
600
300
0
Fall '09
Spring '10
Fall '10
Spring '11

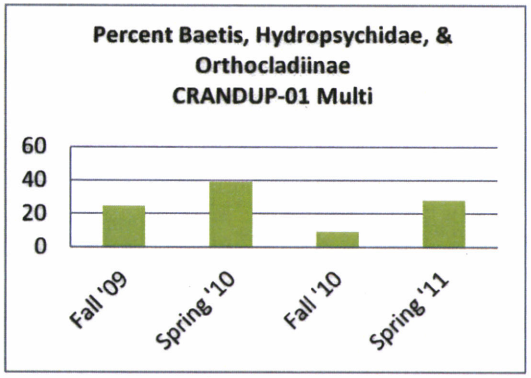

CTQd
CRANDUP-01 Multi
95
85
75
65
Fall '09
Spring '10
Fall '10
Spring '11

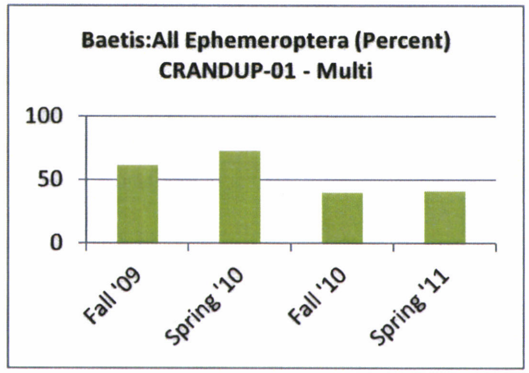

HBI
CRANDUP-01 Multi
6
5
4
3
2
1
0
Fall '09
Spring '10
Fall '10
Spring '11

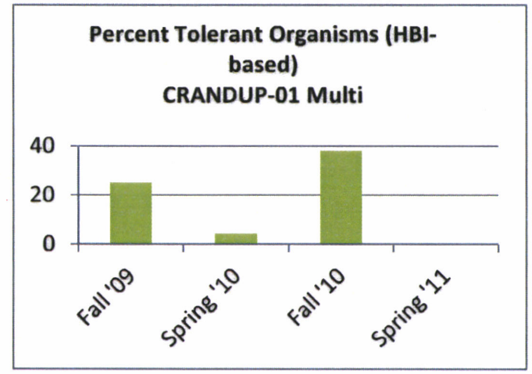

Percent EPT
CRANDUP-01 Multi
80
70
60
50
40
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

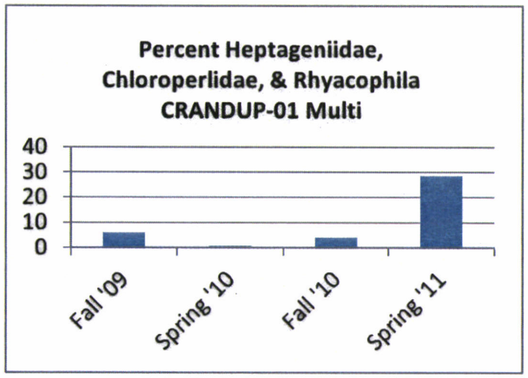

Percent Chironomids
CRANDUP-01 Multi
90
60
30
0
Fall '09
Spring '10
Fall '10
Spring '11

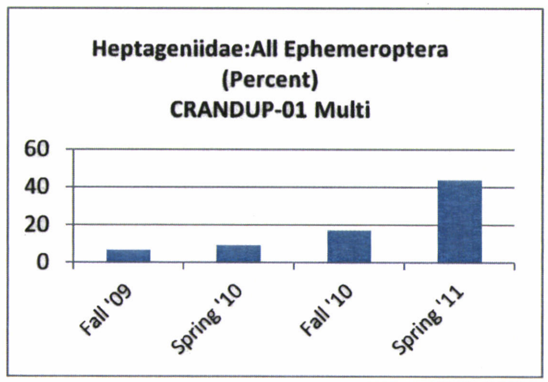

EPT:Chironomids
CRANDUP-01 Multi
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

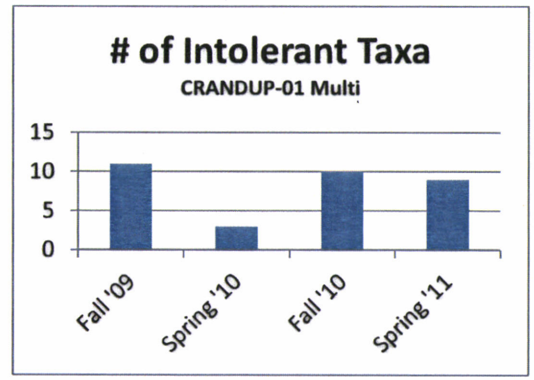

Percent Baetis, Hydropsychidae, & Orthocladiinae
CRANDUP-01 Multi
60
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

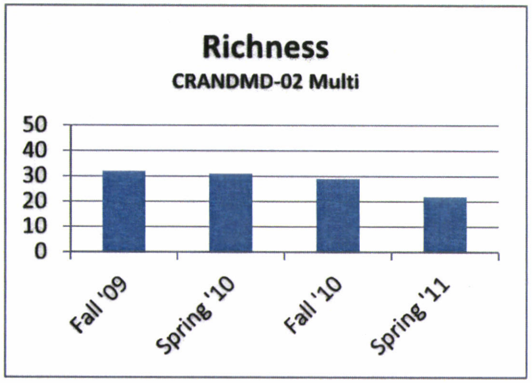

Baetis:All Ephemeroptera (Percent)
CRANDUP-01 - Multi
100
50
0
Fall '09
Spring '10
Fall '10
Spring '11

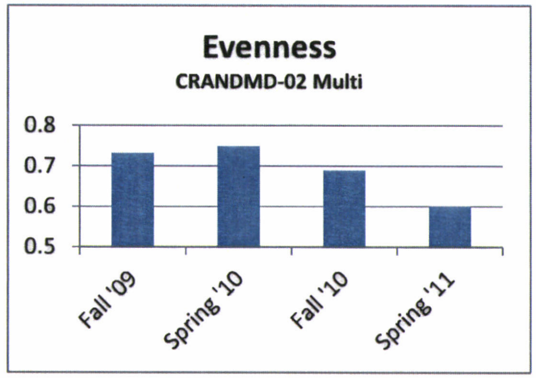

Percent Tolerant Organisms (HBI-based)
CRANDUP-01 Multi
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

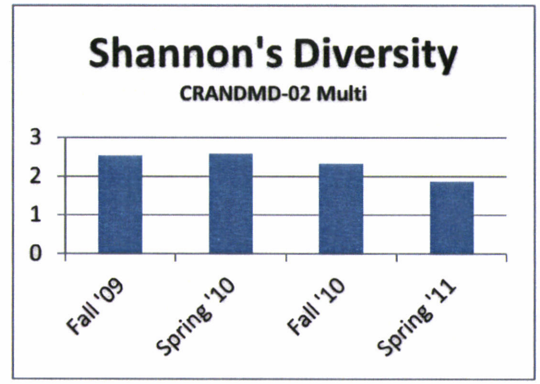

Percent Heptageniidae, Chloroperlidae, & Rhyacophila
CRANDUP-01 Multi
40
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

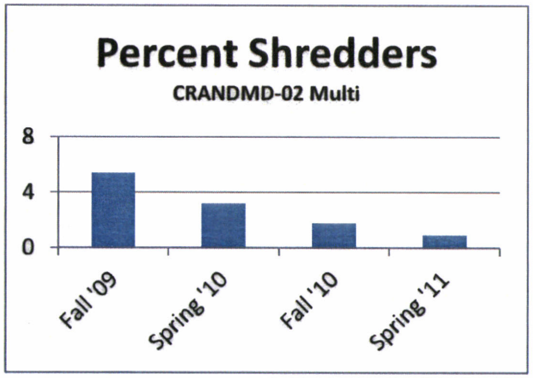

Heptageniidae:All Ephemeroptera (Percent)
CRANDUP-01 Multi
60
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

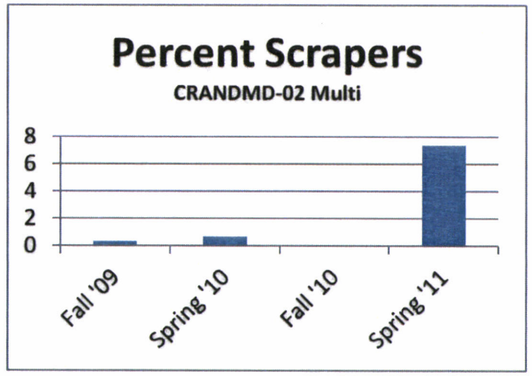

# of Intolerant Taxa
CRANDUP-01 Multi
15
10
5
0
Fall '09
Spring '10
Fall '10
Spring '11

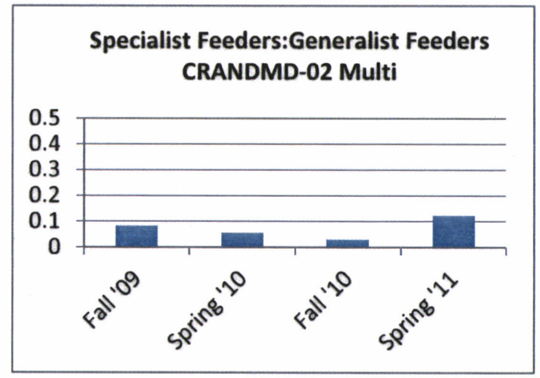

Richness
CRANDMD-02 Multi
50
40
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

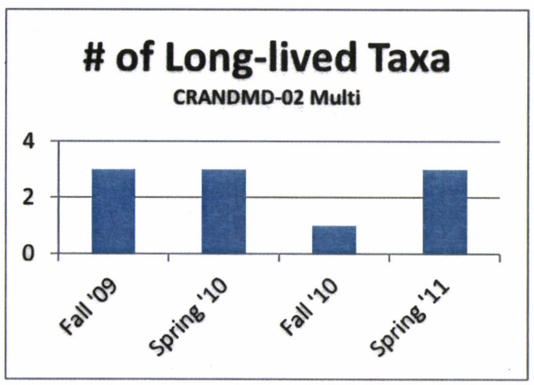

Evenness
CRANDMD-02 Multi
0.8
0.7
0.6
0.5
Fall '09
Spring '10
Fall '10
Spring '11

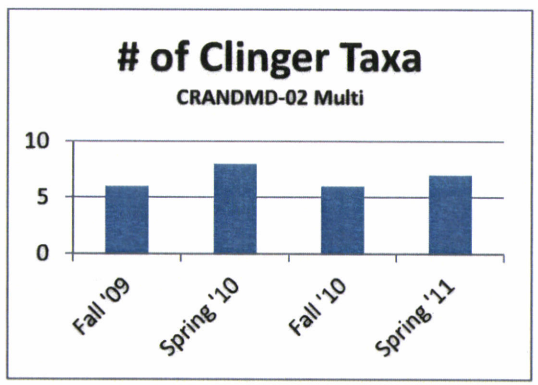

Shannon's Diversity
CRANDMD-02 Multi
3
2
1
0
Fall '09
Spring '10
Fall '10
Spring '11

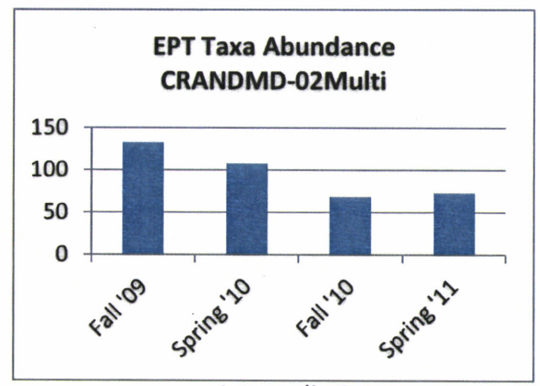

Percent Shredders
CRANDMD-02 Multi
8
4
0
Fall '09
Spring '10
Fall '10
Spring '11

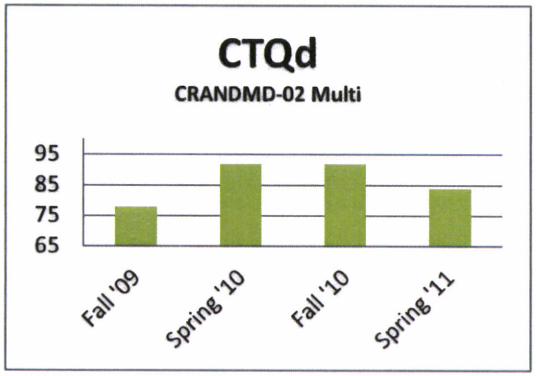

Percent Scrapers
CRANDMD-02 Multi
8
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

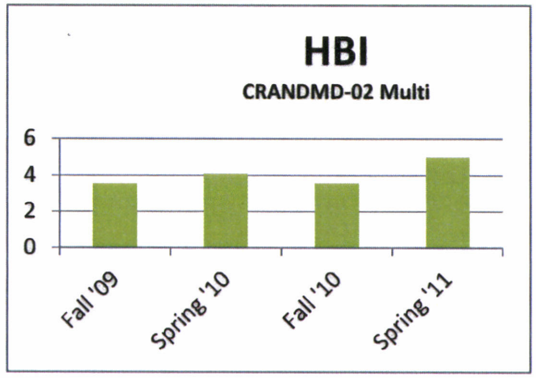

Specialist Feeders:Generalist Feeders
CRANDMD-02 Multi
0.5
0.4
0.3
0.2
0.1
0
Fall '09
Spring '10
Fall '10
Spring '11

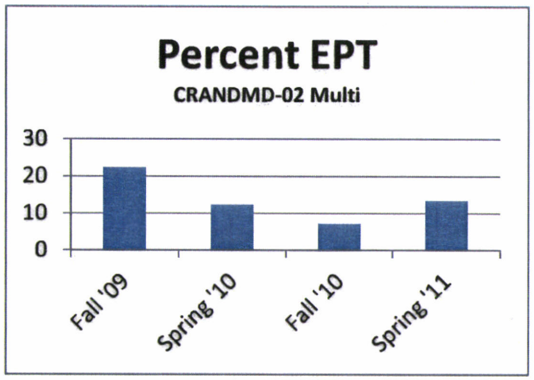

# of Long-lived Taxa
CRANDMD-02 Multi
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

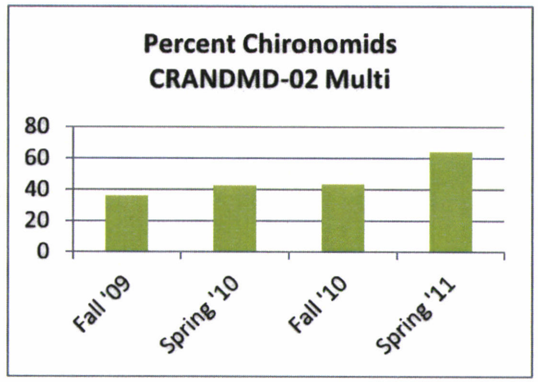

# of Clinger Taxa
CRANDMD-02 Multi
10
5
0
Fall '09
Spring '10
Fall '10
Spring '11

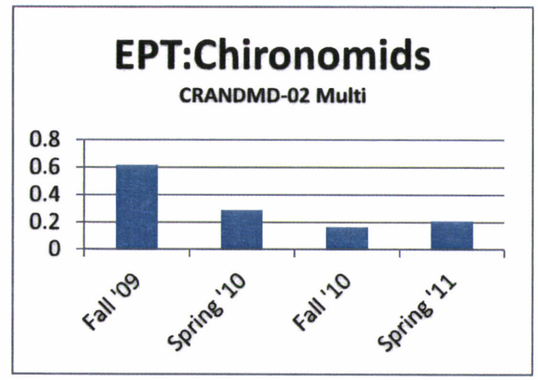

EPT Taxa Abundance
CRANDMD-02Multi
150
100
50
0
Fall '09
Spring '10
Fall '10
Spring '11

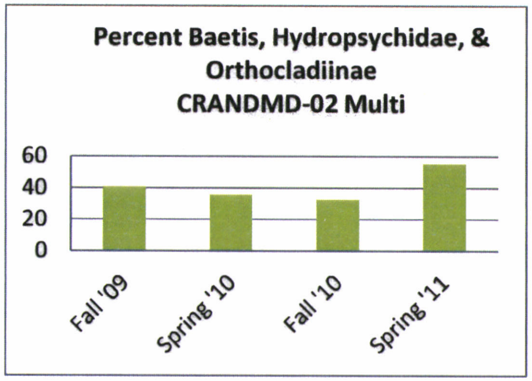

CTQd
CRANDMD-02 Multi
95
85
75
65
Fall '09
Spring '10
Fall '10
Spring '11

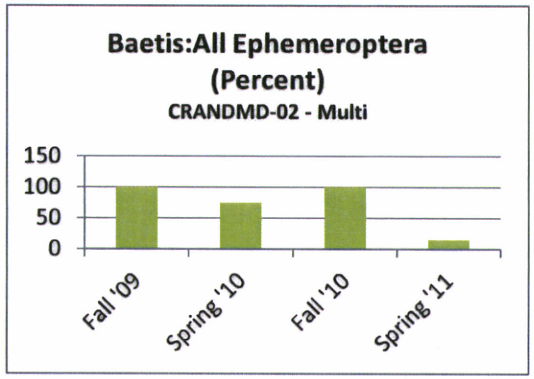

HBI
CRANDMD-02 Multi
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

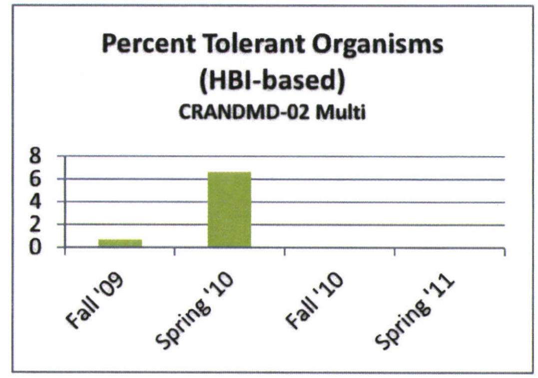

Percent EPT
CRANDMD-02 Multi
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

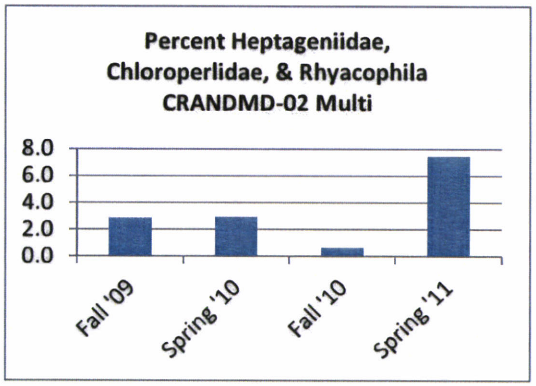

Percent Chironomids
CRANDMD-02 Multi
80
60
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

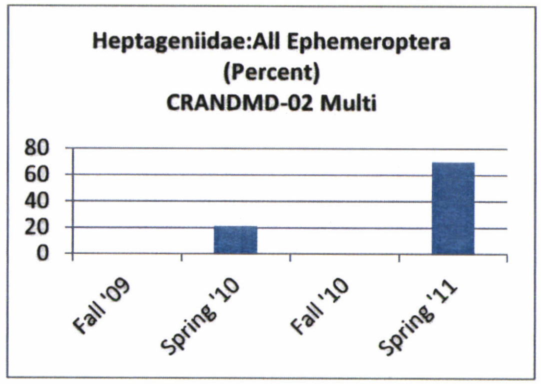

EPT:Chironomids
CRANDMD-02 Multi
0.8
0.6
0.4
0.2
0
Fall '09
Spring '10
Fall '10
Spring '11

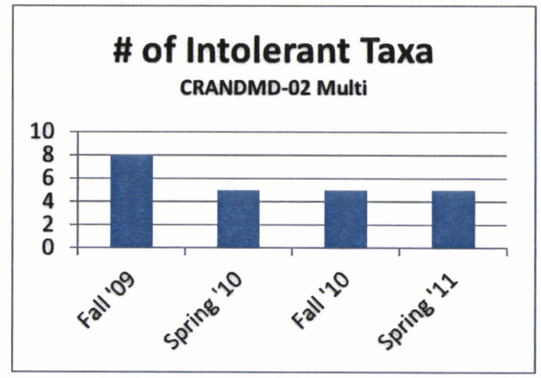

Percent Baetis, Hydropsychidae, &
Orthocladiinae
CRANDMD-02 Multi
60
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

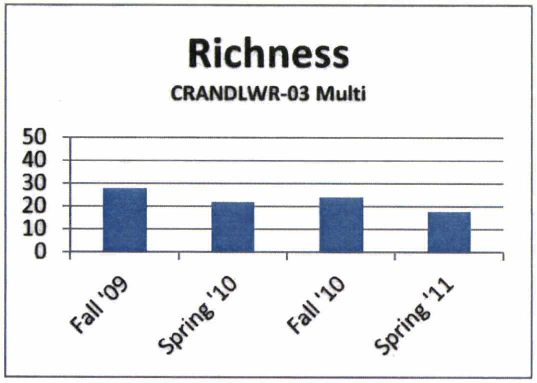

Baetis:All Ephemeroptera
(Percent)
CRANDMD-02 - Multi
150
100
50
0
Fall '09
Spring '10
Fall '10
Spring '11

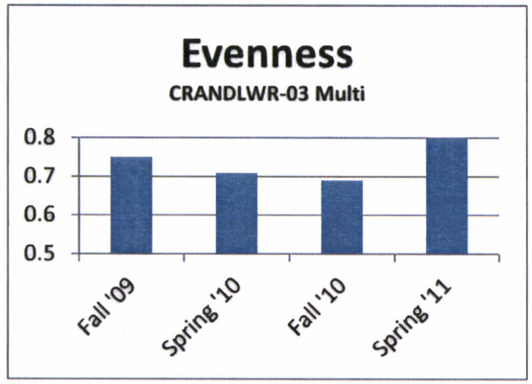

Percent Tolerant Organisms
(HBI-based)
CRANDMD-02 Multi
8
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

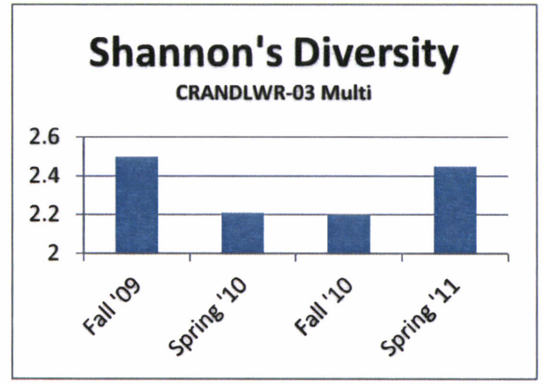

Percent Heptageniidae,
Chloroperlidae, & Rhyacophila
CRANDMD-02 Multi
8.0
6.0
4.0
2.0
0.0
Fall '09
Spring '10
Fall '10
Spring '11

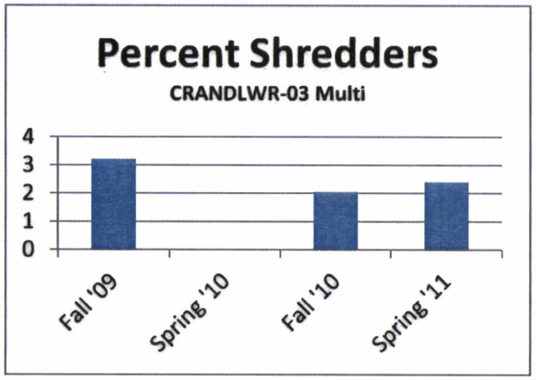

Heptageniidae:All Ephemeroptera
(Percent)
CRANDMD-02 Multi
80
60
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

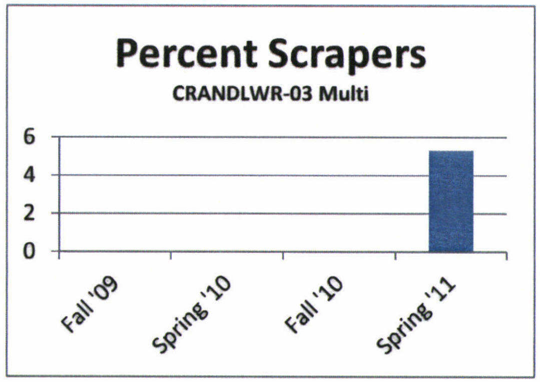

# of Intolerant Taxa
CRANDMD-02 Multi
10
8
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

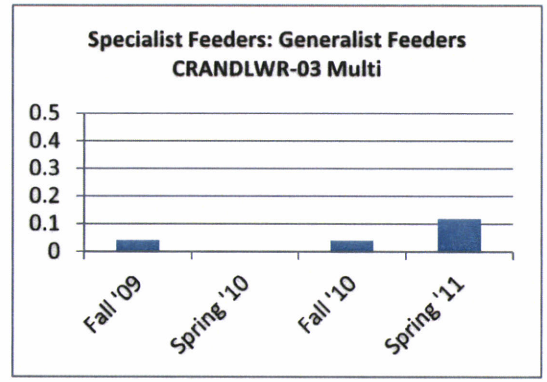

Richness
CRANDLWR-03 Multi
50
40
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

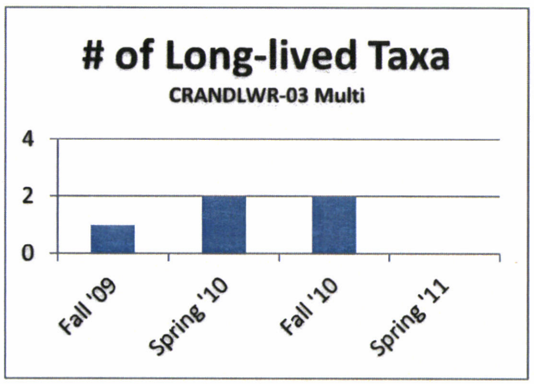

Evenness
CRANDLWR-03 Multi
0.8
0.7
0.6
0.5
Fall '09
Spring '10
Fall '10
Spring '11

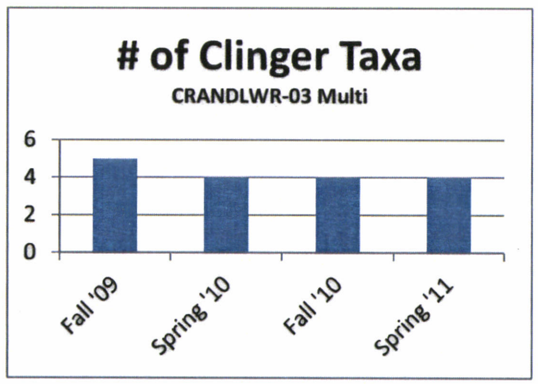

Shannon's Diversity
CRANDLWR-03 Multi
2.6
2.4
2.2
2
Fall '09
Spring '10
Fall '10
Spring '11

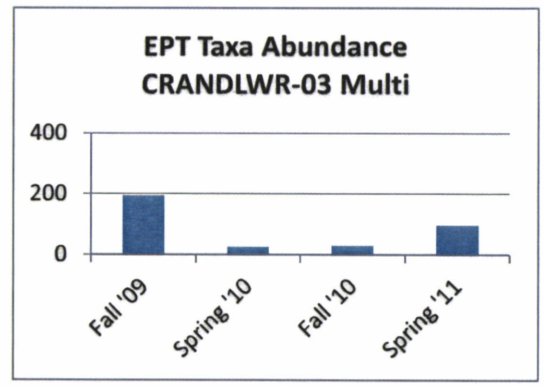

Percent Shredders
CRANDLWR-03 Multi
4
3
2
1
0
Fall '09
Spring '10
Fall '10
Spring '11

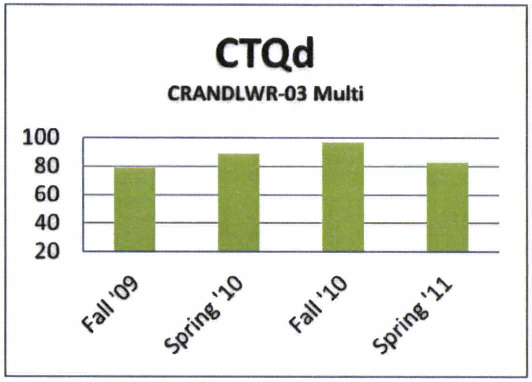

Percent Scrapers
CRANDLWR-03 Multi
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

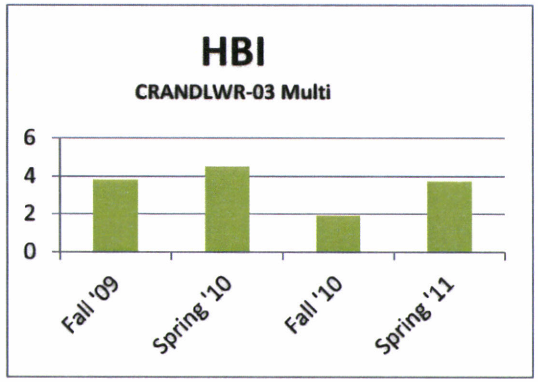

Specialist Feeders: Generalist Feeders
CRANDLWR-03 Multi
0.5
0.4
0.3
0.2
0.1
0
Fall '09
Spring '10
Fall '10
Spring '11

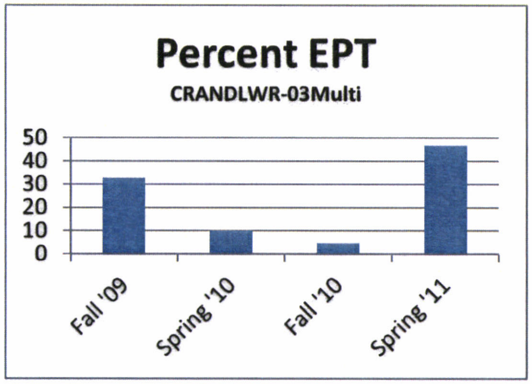

# of Long-lived Taxa
CRANDLWR-03 Multi
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

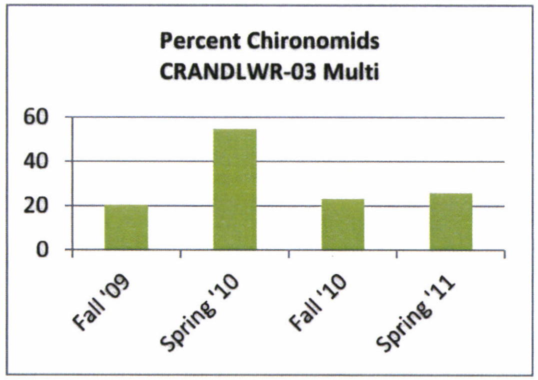

# of Clinger Taxa
CRANDLWR-03 Multi
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

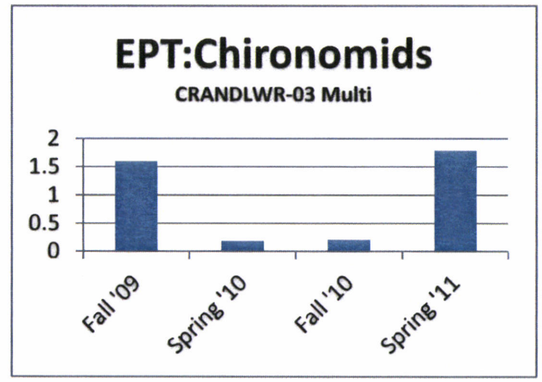

EPT Taxa Abundance
CRANDLWR-03 Multi
400
200
0
Fall '09
Spring '10
Fall '10
Spring '11

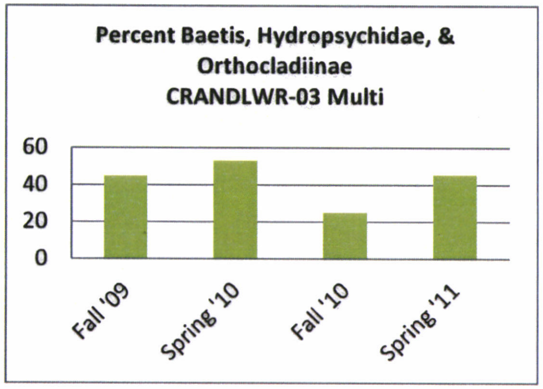

CTQd
CRANDLWR-03 Multi
100
80
60
40
20
Fall '09
Spring '10
Fall '10
Spring '11

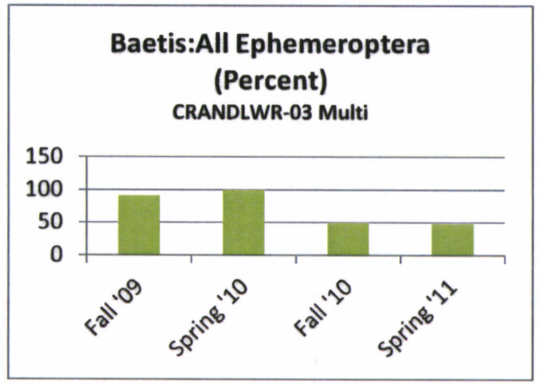

HBI
CRANDLWR-03 Multi
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

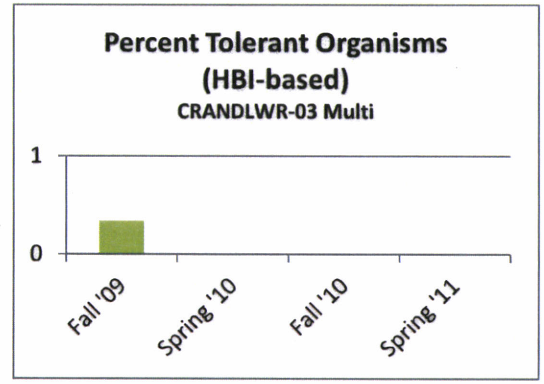

Percent EPT
CRANDLWR-03Multi
50
40
30
20
10
0
Fall '09
Spring '10
Fall '10
Spring '11

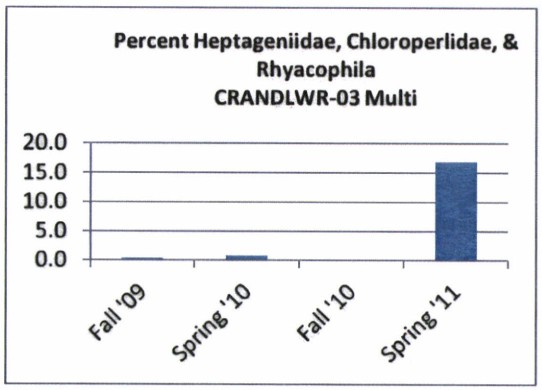

Percent Chironomids
CRANDLWR-03 Multi
60
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

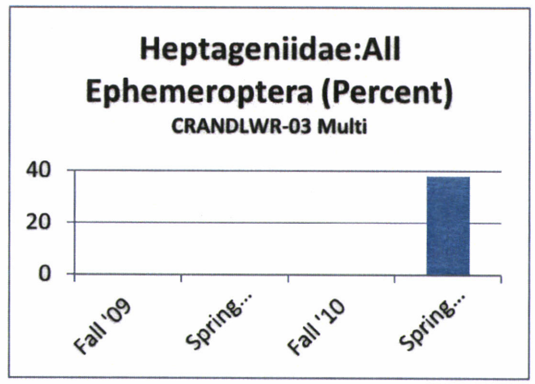

EPT:Chironomids
CRANDLWR-03 Multi
2
1.5
1
0.5
0
Fall '09
Spring '10
Fall '10
Spring '11

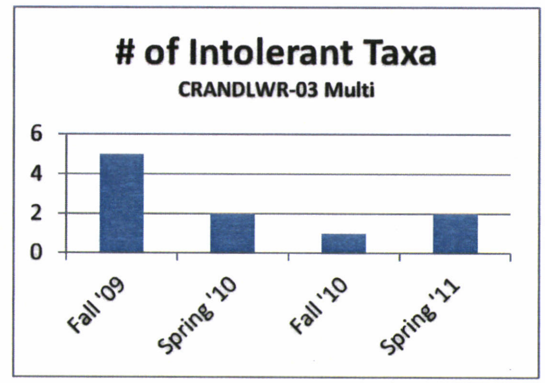

Percent Baetis, Hydropsychidae, & Orthocladiinae
CRANDLWR-03 Multi
60
40
20
0
Fall '09
Spring '10
Fall '10
Spring '11

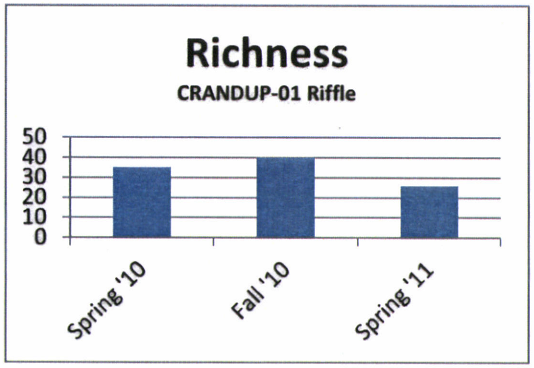

Baetis:All Ephemeroptera (Percent)
CRANDLWR-03 Multi
150
100
50
0
Fall '09
Spring '10
Fall '10
Spring '11

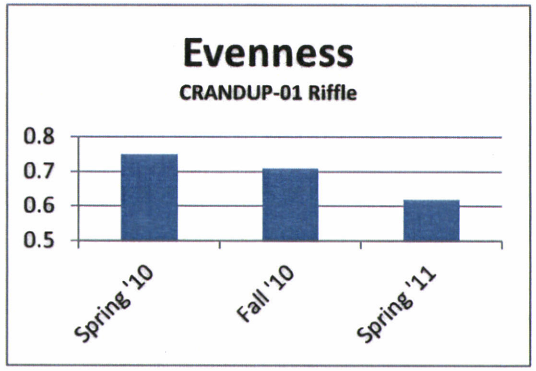

Percent Tolerant Organisms (HBI-based)
CRANDLWR-03 Multi
1
0
Fall '09
Spring '10
Fall '10
Spring '11

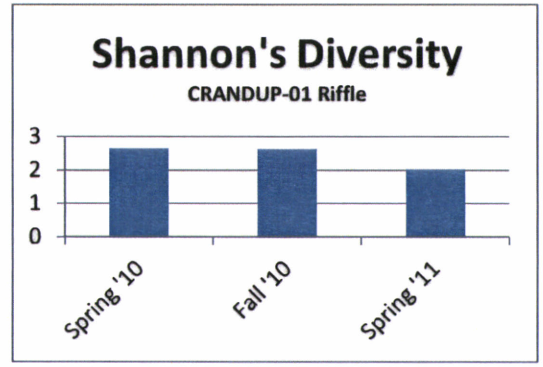

Percent Heptageniidae, Chloroperlidae, & Rhyacophila
CRANDLWR-03 Multi
20.0
15.0
10.0
5.0
0.0
Fall '09
Spring '10
Fall '10
Spring '11

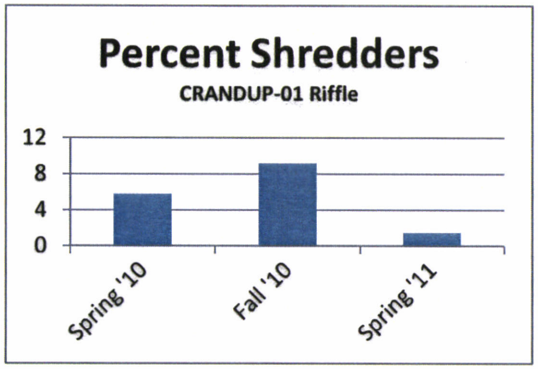

Heptageniidae:All Ephemeroptera (Percent)
CRANDLWR-03 Multi
40
20
0
Fall '09
Spring...
Fall '10
Spring...

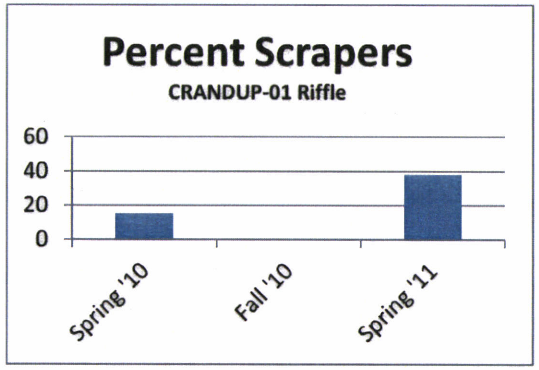

# of Intolerant Taxa
CRANDLWR-03 Multi
6
4
2
0
Fall '09
Spring '10
Fall '10
Spring '11

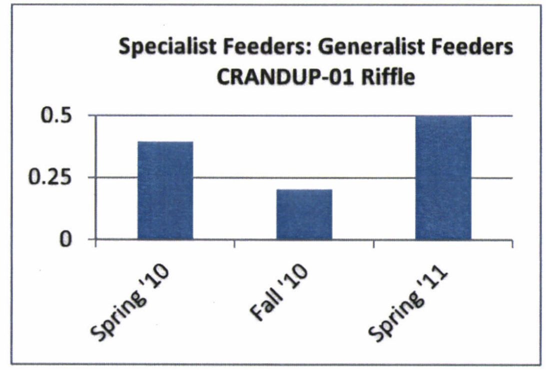

Richness
CRANDUP-01 Riffle
50
40
30
20
10
0
Spring '10
Fall '10
Spring '11

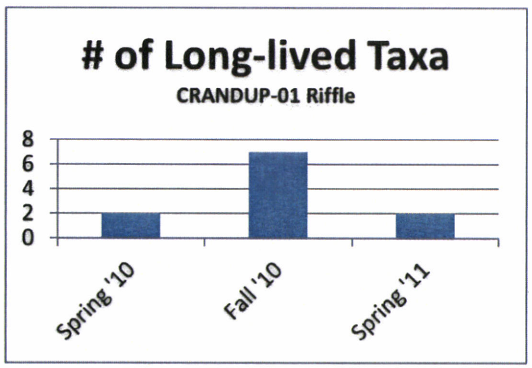

Evenness
CRANDUP-01 Riffle
0.8
0.7
0.6
0.5
Spring '10
Fall '10
Spring '11

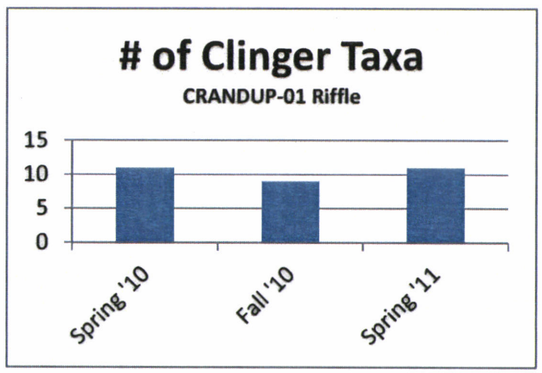

Shannon's Diversity
CRANDUP-01 Riffle
3
2
1
0
Spring '10
Fall '10
Spring '11

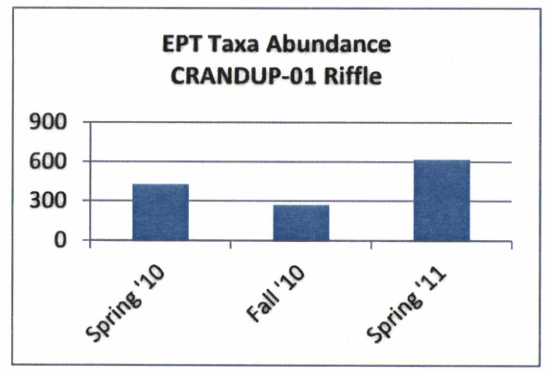

Percent Shredders
CRANDUP-01 Riffle
12
8
4
0
Spring '10
Fall '10
Spring '11

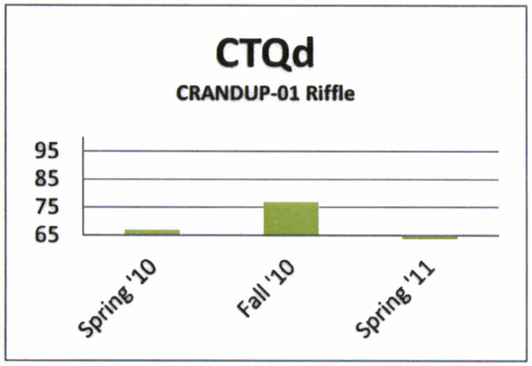

Percent Scrapers
CRANDUP-01 Riffle
60
40
20
0
Spring '10
Fall '10
Spring '11

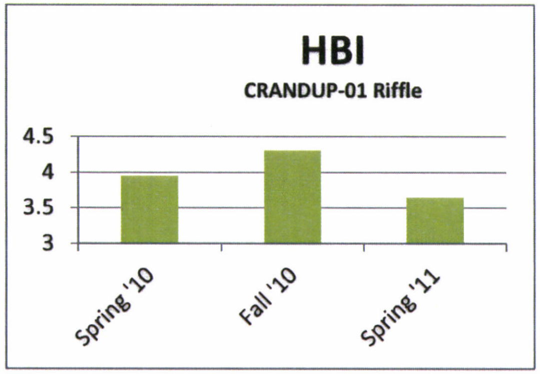

Specialist Feeders: Generalist Feeders
CRANDUP-01 Riffle
0.5
0.25
0
Spring '10
Fall '10
Spring '11

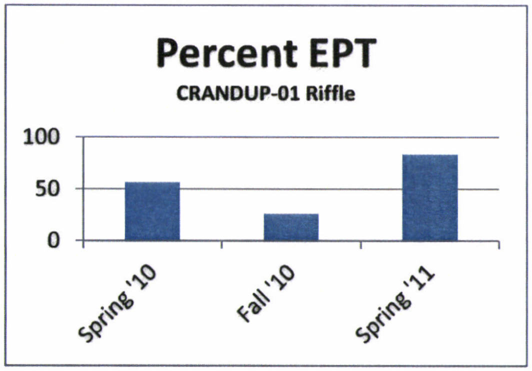

# of Long-lived Taxa
CRANDUP-01 Riffle
8
6
4
2
0
Spring '10
Fall '10
Spring '11

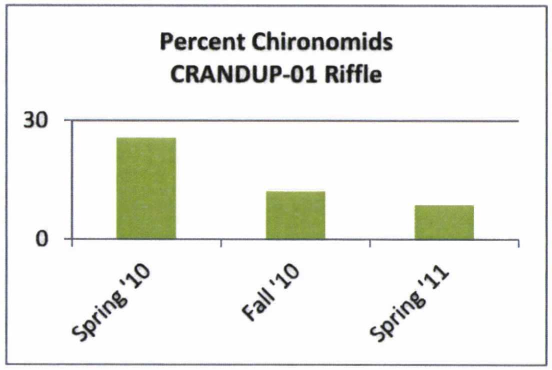

# of Clinger Taxa
CRANDUP-01 Riffle
15
10
5
0
Spring '10
Fall '10
Spring '11

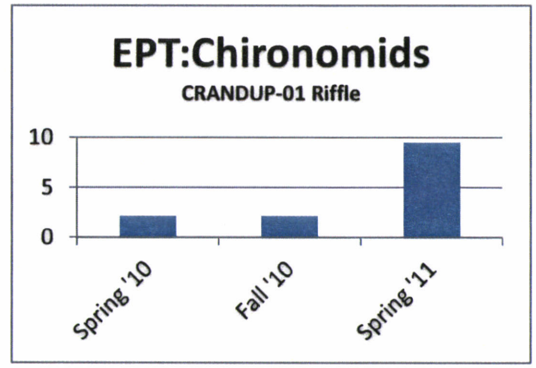

EPT Taxa Abundance
CRANDUP-01 Riffle
900
600
300
0
Spring '10
Fall '10
Spring '11

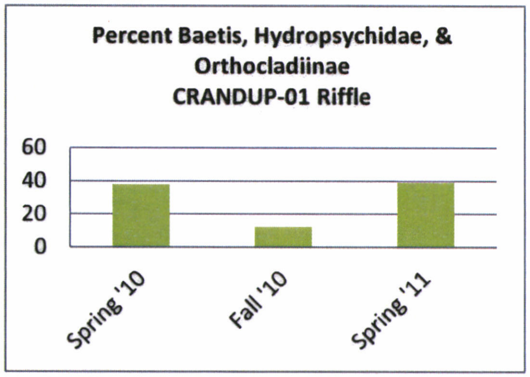

CTQd
CRANDUP-01 Riffle
95
85
75
65
Spring '10
Fall '10
Spring '11


HBI
CRANDUP-01 Riffle
4.5
4
3.5
3
Spring '10
Fall '10
Spring '11

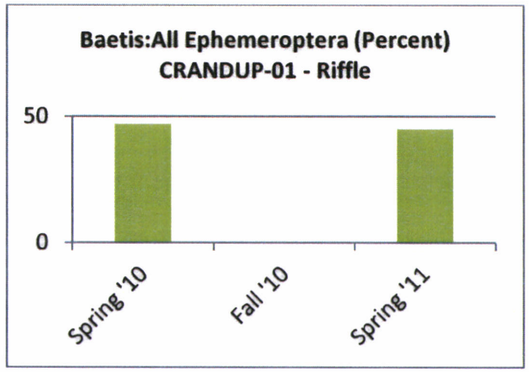

Percent EPT
CRANDUP-01 Riffle
100
50
0
Spring '10
Fall '10
Spring '11


Percent Chironomids
CRANDUP-01 Riffle
30
0
Spring '10
Fall '10
Spring '11

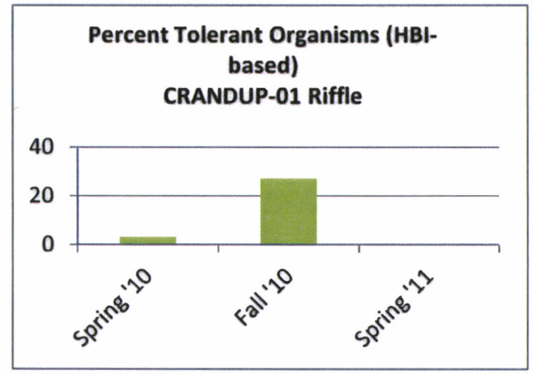

EPT:Chironomids
CRANDUP-01 Riffle
10
5
0
Spring '10
Fall '10
Spring '11



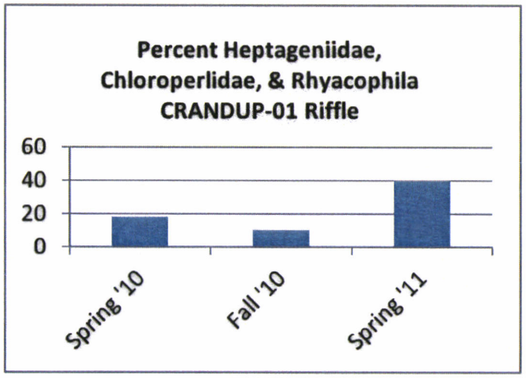
Percent Baetis, Hydropsychidae, & Orthocladiinae
CRANDUP-01 Riffle
60
40
20
0
Spring '10
Fall '10
Spring '11



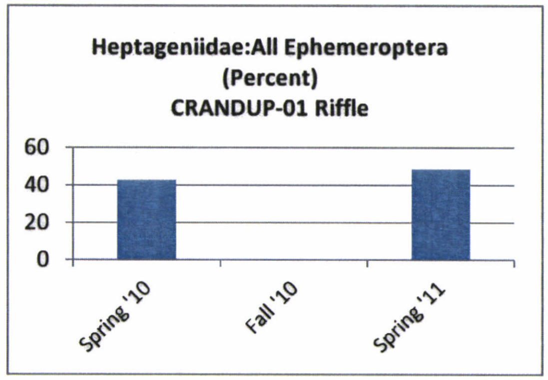
Baetis:All Ephemeroptera (Percent)
CRANDUP-01 - Riffle
50
0
Spring '10
Fall '10
Spring '11



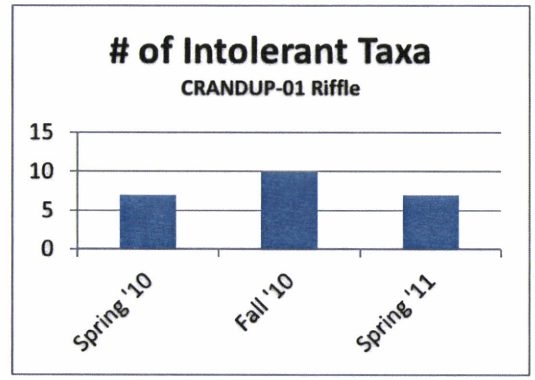
Percent Tolerant Organisms (HBI-based)
CRANDUP-01 Riffle
40
20
0
Spring '10
Fall '10
Spring '11



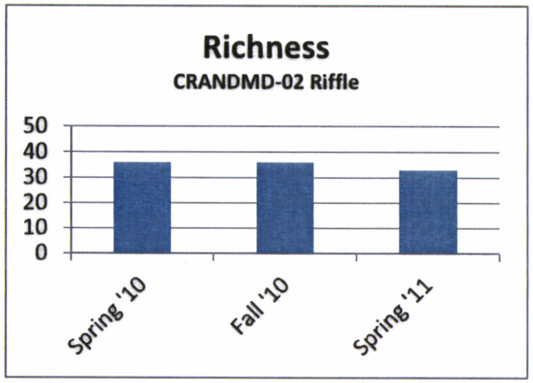
Percent Heptageniidae, Chloroperlidae, & Rhyacophila
CRANDUP-01 Riffle
60
40
20
0
Spring '10
Fall '10
Spring '11

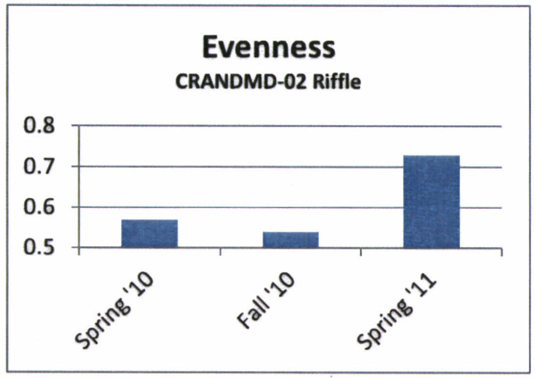


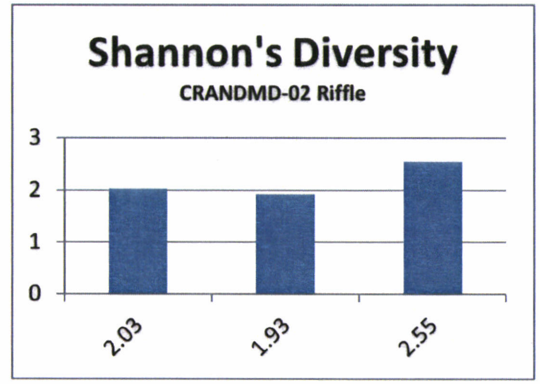
Heptageniidae:All Ephemeroptera (Percent)
CRANDUP-01 Riffle
60
40
20
0
Spring '10
Fall '10
Spring '11

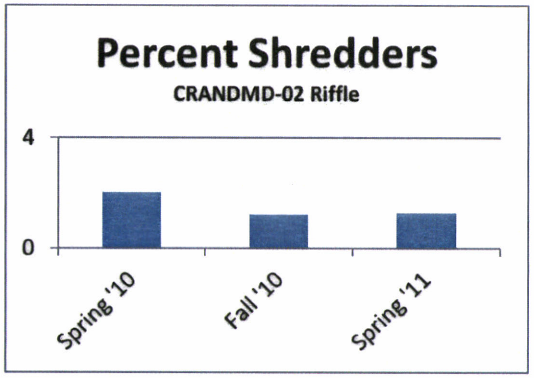


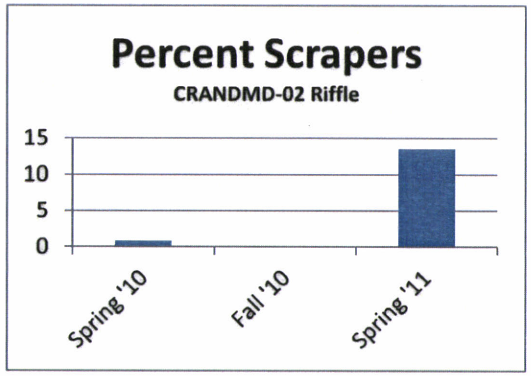
# of Intolerant Taxa
CRANDUP-01 Riffle
15
10
5
0
Spring '10
Fall '10
Spring '11

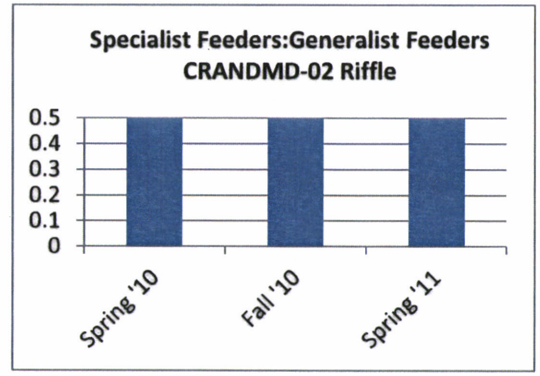

Richness
CRANDMD-02 Riffle
50
40
30
20
10
0
Spring '10
Fall '10
Spring '11

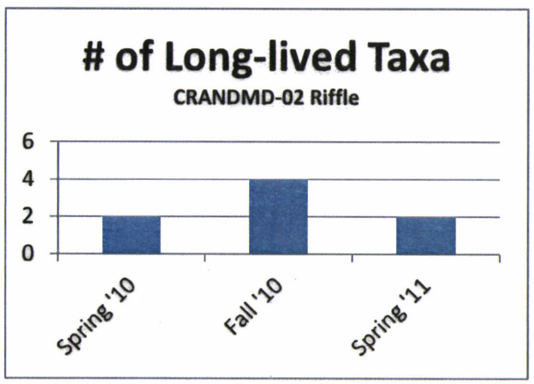

Evenness
CRANDMD-02 Riffle
0.8
0.7
0.6
0.5
Spring '10
Fall '10
Spring '11

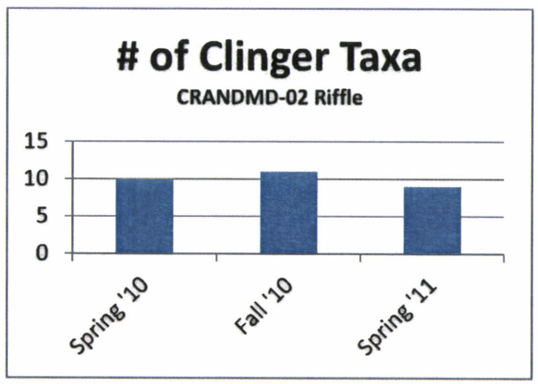

Shannon's Diversity
CRANDMD-02 Riffle
3
2
1
0
2.03
1.93
2.55

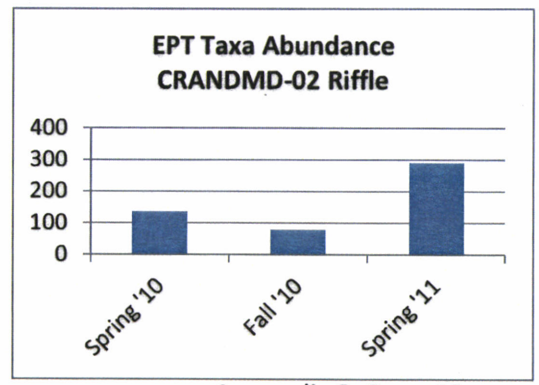

Percent Shredders
CRANDMD-02 Riffle
4
0
Spring '10
Fall '10
Spring '11

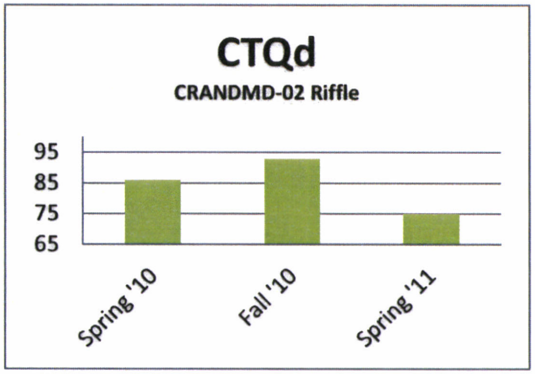

Percent Scrapers
CRANDMD-02 Riffle
15
10
5
0
Spring '10
Fall '10
Spring '11

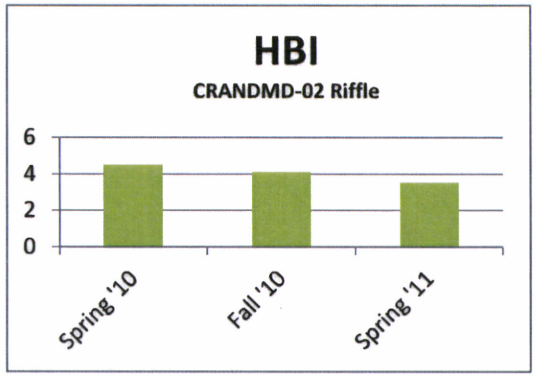

Specialist Feeders:Generalist Feeders
CRANDMD-02 Riffle
0.5
0.4
0.3
0.2
0.1
0
Spring '10
Fall '10
Spring '11

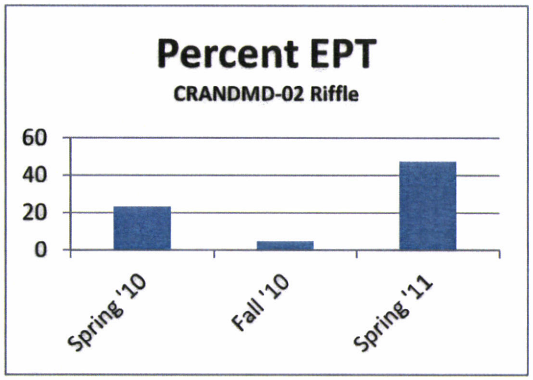

# of Long-lived Taxa
CRANDMD-02 Riffle
6
4
2
0
Spring '10
Fall '10
Spring '11

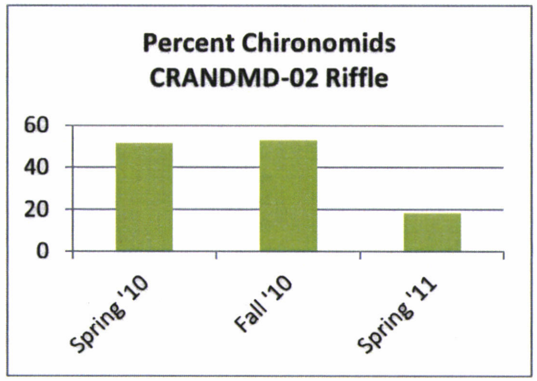

# of Clinger Taxa
CRANDMD-02 Riffle
15
10
5
0
Spring '10
Fall '10
Spring '11

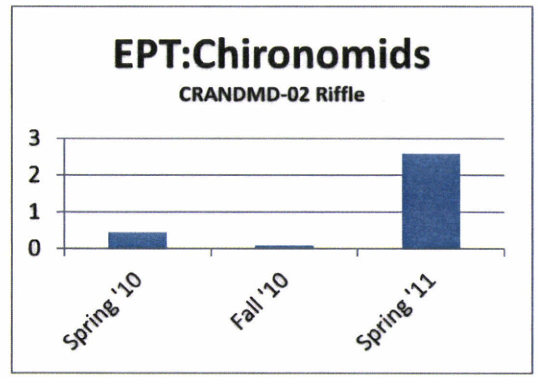

EPT Taxa Abundance
CRANDMD-02 Riffle
400
300
200
100
0
Spring '10
Fall '10
Spring '11

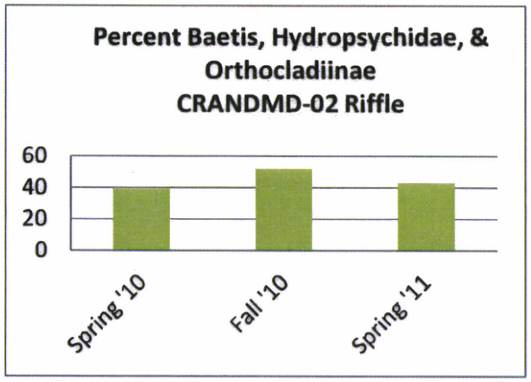

CTQd
CRANDMD-02 Riffle
95
85
75
65
Spring '10
Fall '10
Spring '11

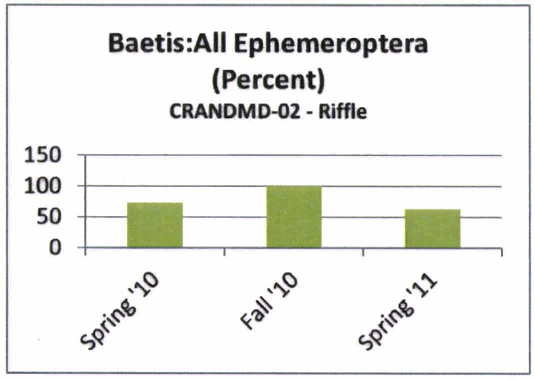

HBI
CRANDMD-02 Riffle
6
4
2
0
Spring '10
Fall '10
Spring '11

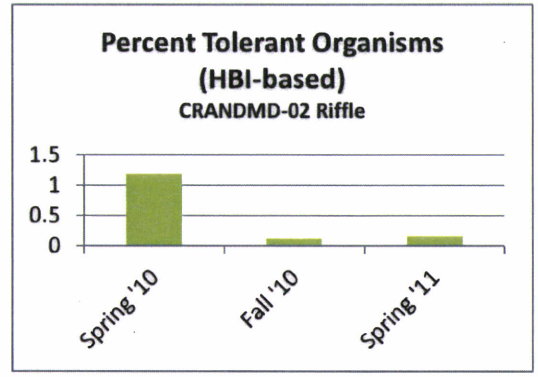

Percent EPT
CRANDMD-02 Riffle
60
40
20
0
Spring '10
Fall '10
Spring '11

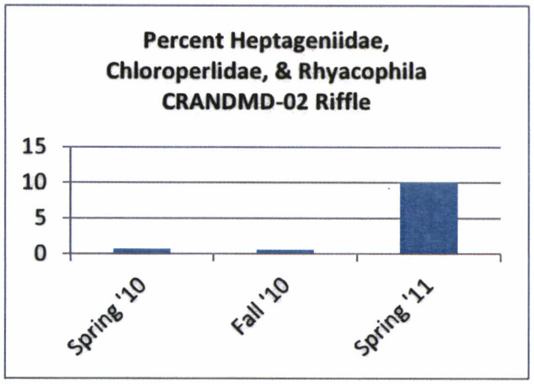

Percent Chironomids
CRANDMD-02 Riffle
60
40
20
0
Spring '10
Fall '10
Spring '11

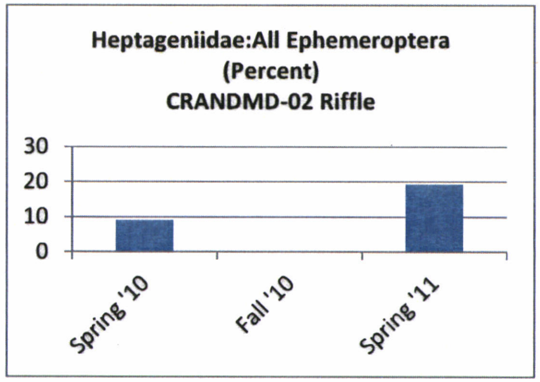

EPT:Chironomids
CRANDMD-02 Riffle
3
2
1
0
Spring '10
Fall '10
Spring '11

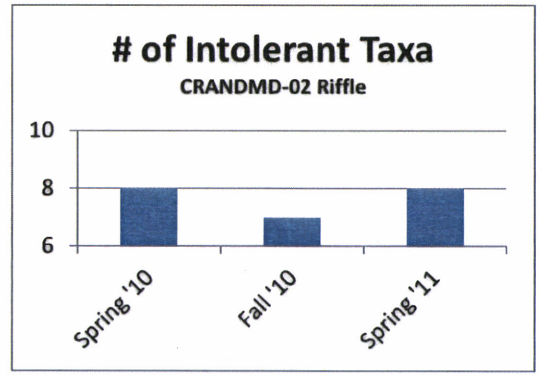

Percent Baetis, Hydropsychidae, &
Orthocladiinae
CRANDMD-02 Riffle
60
40
20
0
Spring '10
Fall '10
Spring '11

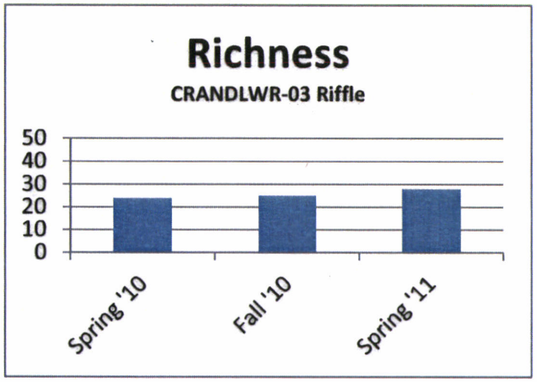

Baetis:All Ephemeroptera
(Percent)
CRANDMD-02 - Riffle
150
100
50
0
Spring '10
Fall '10
Spring '11

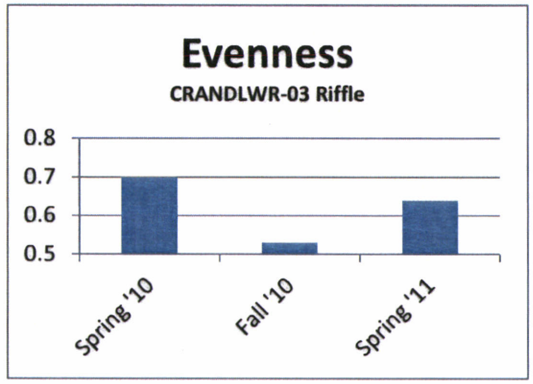

Percent Tolerant Organisms
(HBI-based)
CRANDMD-02 Riffle
1.5
1
0.5
0
Spring '10
Fall '10
Spring '11

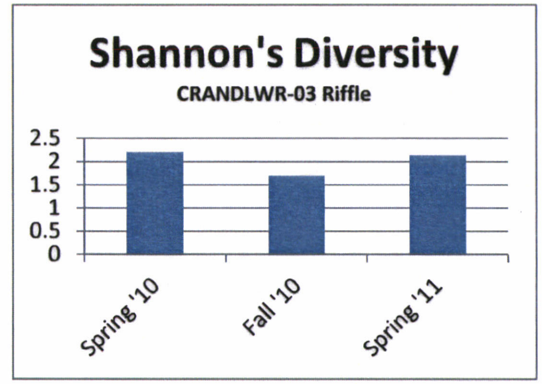

Percent Heptageniidae,
Chloroperlidae, & Rhyacophila
CRANDMD-02 Riffle
15
10
5
0
Spring '10
Fall '10
Spring '11

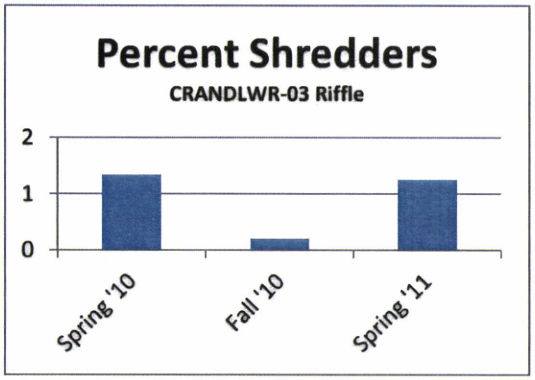

Heptageniidae:All Ephemeroptera
(Percent)
CRANDMD-02 Riffle
30
20
10
0
Spring '10
Fall '10
Spring '11

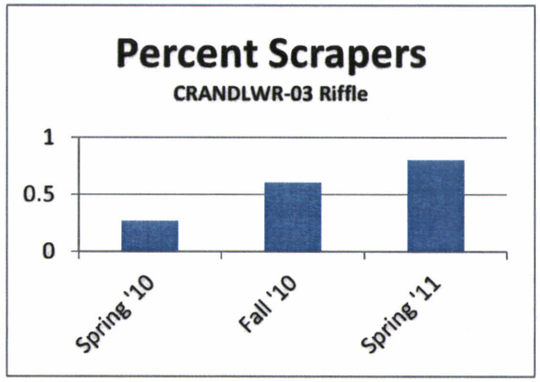

# of Intolerant Taxa
CRANDMD-02 Riffle
10
8
6
Spring '10
Fall '10
Spring '11

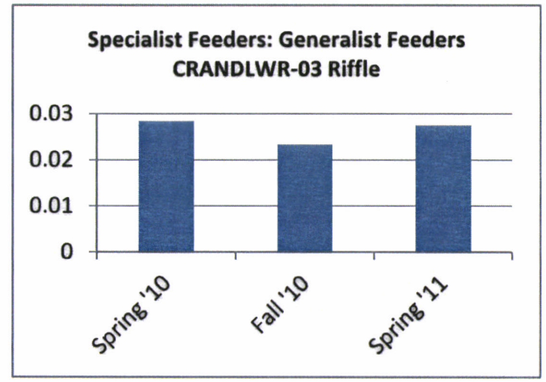

Richness
CRANDLWR-03 Riffle
50
40
30
20
10
0
Spring '10
Fall '10
Spring '11

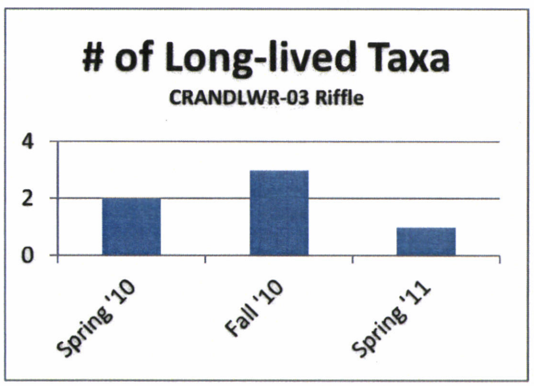

Evenness
CRANDLWR-03 Riffle
0.8
0.7
0.6
0.5
Spring '10
Fall '10
Spring '11

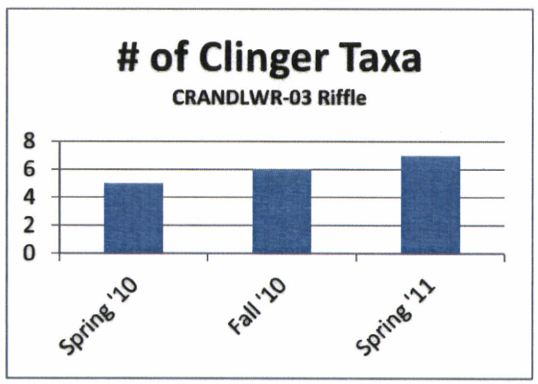

Shannon's Diversity
CRANDLWR-03 Riffle
2.5
2
1.5
1
0.5
0
Spring '10
Fall '10
Spring '11

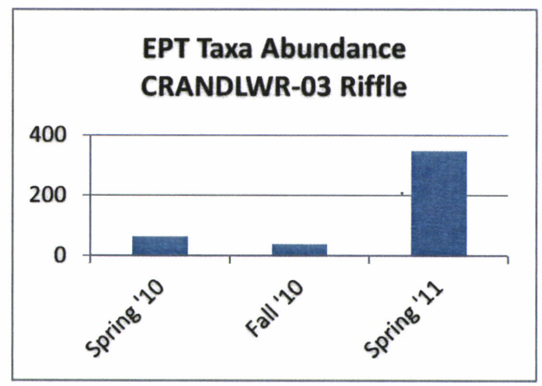

Percent Shredders
CRANDLWR-03 Riffle
2
1
0
Spring '10
Fall '10
Spring '11

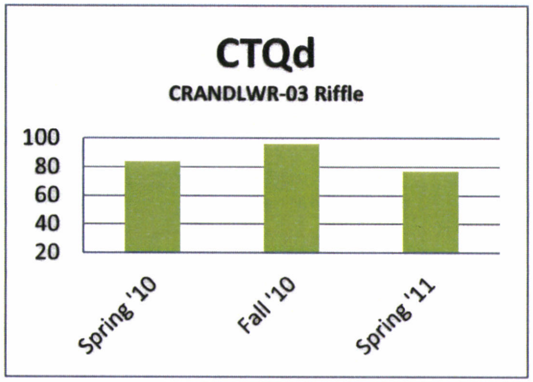

Percent Scrapers
CRANDLWR-03 Riffle
1
0.5
0
Spring '10
Fall '10
Spring '11

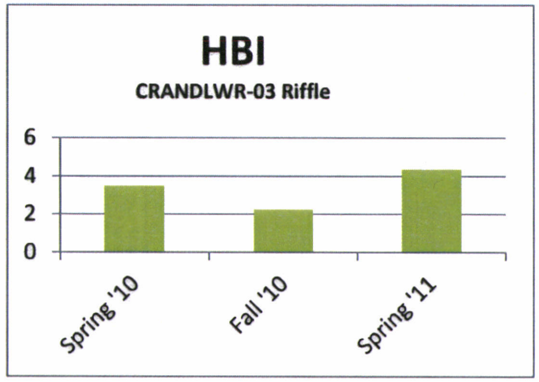

Specialist Feeders: Generalist Feeders
CRANDLWR-03 Riffle
0.03
0.02
0.01
0
Spring '10
Fall '10
Spring '11

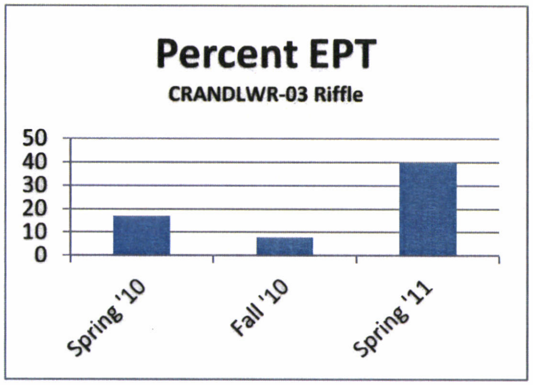

# of Long-lived Taxa
CRANDLWR-03 Riffle
4
2
0
Spring '10
Fall '10
Spring '11

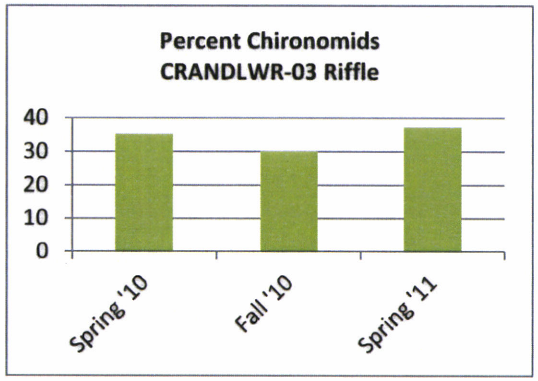

# of Clinger Taxa
CRANDLWR-03 Riffle
8
6
4
2
0
Spring '10
Fall '10
Spring '11

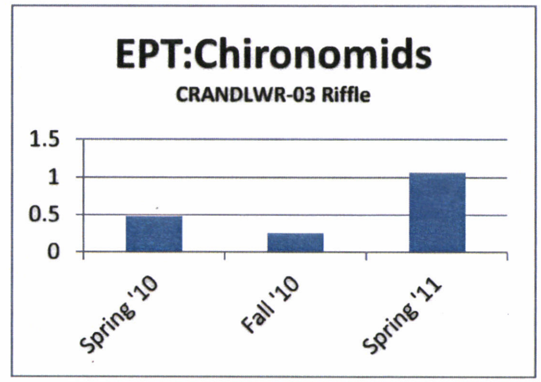

EPT Taxa Abundance
CRANDLWR-03 Riffle
400
200
0
Spring '10
Fall '10
Spring '11

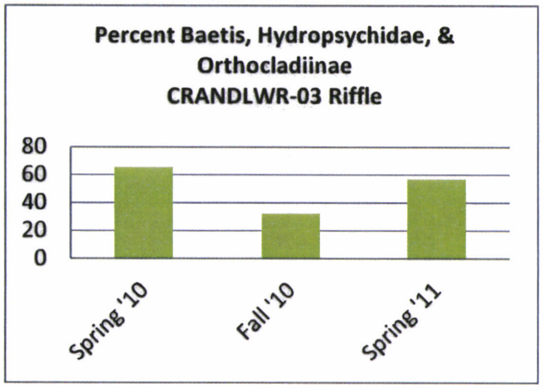

CTQd
CRANDLWR-03 Riffle
100
80
60
40
20
Spring '10
Fall '10
Spring '11

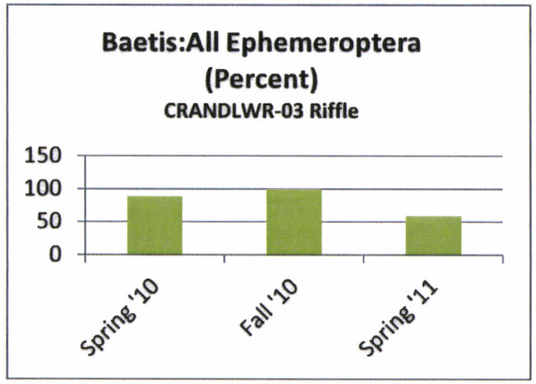

HBI
CRANDLWR-03 Riffle
6
4
2
0
Spring '10
Fall '10
Spring '11

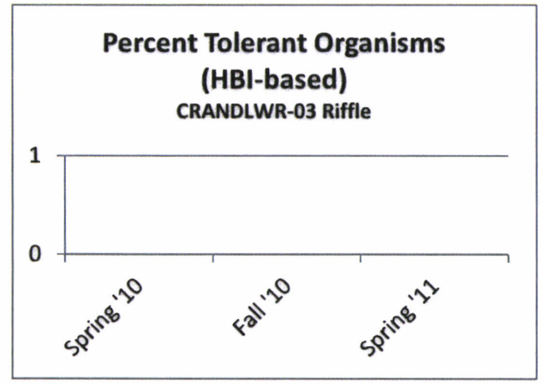

Percent EPT
CRANDLWR-03 Riffle
50
40
30
20
10
0
Spring '10
Fall '10
Spring '11

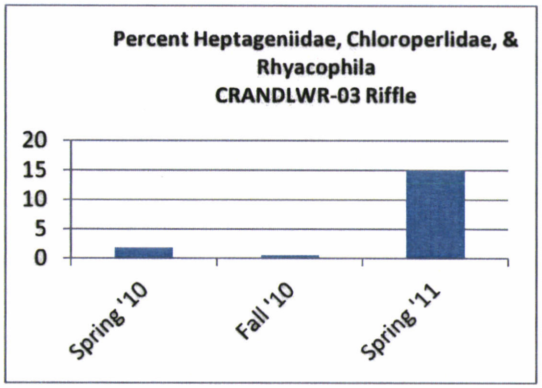

Percent Chironomids
CRANDLWR-03 Riffle
40
30
20
10
0
Spring '10
Fall '10
Spring '11

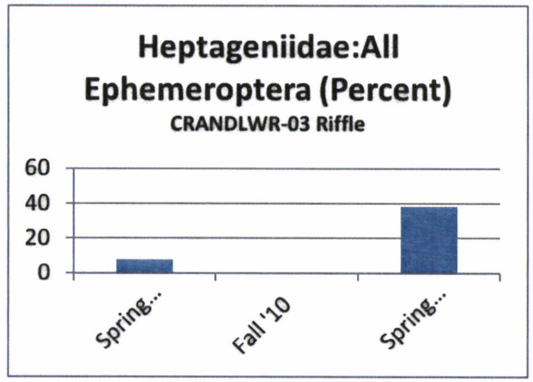

EPT:Chironomids
CRANDLWR-03 Riffle
1.5
1
0.5
0
Spring '10
Fall '10
Spring '11

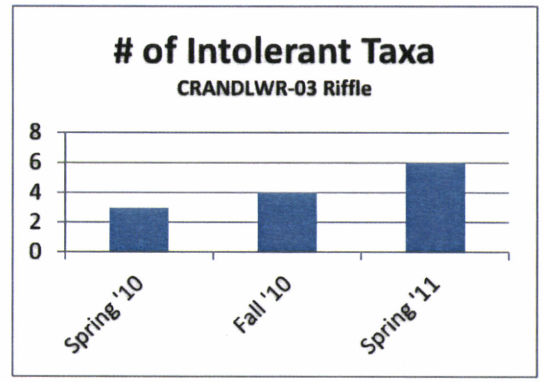

Percent Baetis, Hydropsychidae, & Orthocladiinae
CRANDLWR-03 Riffle
80
60
40
20
0
Spring '10
Fall '10
Spring '11


Baetis:All Ephemeroptera (Percent)
CRANDLWR-03 Riffle
150
100
50
0
Spring '10
Fall '10
Spring '11


Percent Tolerant Organisms (HBI-based)
CRANDLWR-03 Riffle
1
0
Spring '10
Fall '10
Spring '11


Percent Heptageniidae, Chloroperlidae, & Rhyacophila
CRANDLWR-03 Riffle
20
15
10
5
0
Spring '10
Fall '10
Spring '11


Heptageniidae:All Ephemeroptera (Percent)
CRANDLWR-03 Riffle
60
40
20
0
Spring...
Fall '10
Spring...


# of Intolerant Taxa
CRANDLWR-03 Riffle
8
6
4
2
0
Spring '10
Fall '10
Spring '11

Range (Minimum & Maximum) of Values for Each Metric, by Location

(Using data from Fall 2009 through Spring 2011)

Metric Name	CRANDUP-01		CRANDMD-02		CRANDLWR-03	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Richness	21	45	22	36	18	28
[redacted]						
Evenness	0.62	0.76	0.54	0.75	0.53	0.85
[redacted]						
# of Intolerant Taxa	3	11	5	8	1	6
[redacted]						
# of Clinger taxa	4	11	6	11	4	7
[redacted]						
CTQd	63	81	75	93	77	97
[redacted]						
Percent Scrapers	0.0	38.2	0.0	13.5	0.0	5.3
[redacted]						
Percent EPT	18.9	83.5	5.0	47.4	4.8	46.9
[redacted]						
EPT:Chironomids	0.3	9.5	0.1	2.6	0.2	1.8
[redacted]						
Baetis: All Ephemeroptera (Percent)	0.0	72.7	15.0	100.0	48.3	100.0
[redacted]						
Percent Heptageniidae, Chloroperlidae, & Rhyacophila	0.7	39.9	0.6	10.1	0.0	16.9
[redacted]						

Appendix 7-70

NALCO

SAFETY DATA SHEET

PRODUCT
NALCLEAR® 7763

EMERGENCY TELEPHONE NUMBER(S)
(800) 424-9300 (24 Hours) CHEMTREC

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : **NALCLEAR® 7763**

COMPANY IDENTIFICATION : Nalco Company
1601 W. Diehl Road
Naperville, Illinois
60563-1198

EMERGENCY TELEPHONE NUMBER(S) : (800) 424-9300 (24 Hours) CHEMTREC

NFPA 704M/HMIS RATING
HEALTH : 0 / 1 FLAMMABILITY : 1 / 1 INSTABILITY : 0 / 0 OTHER :
0 = Insignificant 1 = Slight 2 = Moderate 3 = High 4 = Extreme * = Chronic Health Hazard

2. COMPOSITION/INFORMATION ON INGREDIENTS

Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

3. HAZARDS IDENTIFICATION

****EMERGENCY OVERVIEW****

CAUTION
May cause irritation with prolonged contact.
Do not get in eyes, on skin, on clothing. Do not take internally. Wear suitable protective clothing. Keep container tightly closed. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. After contact with skin, wash immediately with plenty of water. Use a mild soap if available. Protect product from freezing.
Wear suitable protective clothing, gloves and eye/face protection.
May evolve oxides of carbon (COx) under fire conditions. May evolve oxides of nitrogen (NOx) under fire conditions.
Water in contact with the product will cause slippery floor conditions.

PRIMARY ROUTES OF EXPOSURE :
Eye, Skin

HUMAN HEALTH HAZARDS - ACUTE :

EYE CONTACT :
May cause irritation with prolonged contact.

SKIN CONTACT :
May cause irritation with prolonged contact.

INGESTION :
Not a likely route of exposure. If swallowed a jelly mass may form which in digestion may cause blockage.

INHALATION :
Not a likely route of exposure. Repeated or prolonged exposure may irritate the respiratory tract.

SYMPTOMS OF EXPOSURE :
Acute :
A review of available data does not identify any symptoms from exposure not previously mentioned.
Chronic :
Frequent or prolonged contact with product may defat and dry the skin, leading to discomfort and dermatitis.

AGGRAVATION OF EXISTING CONDITIONS :
A review of available data does not identify any worsening of existing conditions.

4. FIRST AID MEASURES

EYE CONTACT :
Immediately flush with plenty of water for at least 15 minutes. If symptoms develop, seek medical advice.

SKIN CONTACT :
Remove contaminated clothing. Wash off affected area immediately with soap and plenty of water. If symptoms develop, seek medical advice.

INGESTION :
Do not induce vomiting without medical advice. If conscious, washout mouth and give water to drink. Get medical attention.

INHALATION :
Remove to fresh air, treat symptomatically. If symptoms develop, seek medical advice.

NOTE TO PHYSICIAN :
Based on the individual reactions of the patient, the physician's judgement should be used to control symptoms and clinical condition. If swallowed a jelly mass may form which in digestion may cause blockage.

5. FIRE FIGHTING MEASURES

FLASH POINT :	Not flammable
LOWER EXPLOSION LIMIT :	Not flammable
UPPER EXPLOSION LIMIT :	Not flammable

EXTINGUISHING MEDIA :
Foam, Dry powder, Carbon dioxide, Other extinguishing agent suitable for Class B fires

UNSUITABLE EXTINGUISHING MEDIA :
Do not use water unless flooding amounts are available.

FIRE AND EXPLOSION HAZARD :
May evolve oxides of carbon (COx) under fire conditions. May evolve oxides of nitrogen (NOx) under fire conditions. Water in contact with the product will cause slippery floor conditions.

SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTING :
In case of fire, wear a full face positive-pressure self contained breathing apparatus and protective suit.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS :
Restrict access to area as appropriate until clean-up operations are complete. Notify appropriate government, occupational health and safety and environmental authorities. Ensure clean-up is conducted by trained personnel only. Do not touch spilled material. Stop or reduce any leaks if it is safe to do so. Use personal protective equipment recommended in Section 8 (Exposure Controls/Personal Protection). Spill may be slippery.

METHODS FOR CLEANING UP :
SMALL SPILLS: Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area. LARGE SPILLS: Water in contact with the product will create a voluminous, slippery gel. Soak up as thoroughly as possible with inert absorbent material or sawdust. Do NOT hose down area until all possible traces of polymer are removed. Contact an approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated in Section 13 (Disposal Considerations).

ENVIRONMENTAL PRECAUTIONS :
Harmful to aquatic organisms., Prevent material from entering sewers or waterways., If drains, streams, soil or sewers become contaminated, notify local authority.

7. HANDLING AND STORAGE

HANDLING :
Do not take internally. Have emergency equipment (for fires, spills, leaks, etc.) readily available. Ensure all containers are labeled. Do not get in eyes, on skin, on clothing. Use with adequate ventilation. Keep the containers closed when not in use.

STORAGE CONDITIONS :
Store in suitable labeled containers. Store the containers tightly closed. Store separately from oxidizers. Protect product from freezing.

SUITABLE CONSTRUCTION MATERIAL :
Compatibility with Plastic Materials can vary; we therefore recommend that compatibility is tested prior to use.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS :
This product does not contain any substance that has an established exposure limit.

ENGINEERING MEASURES :

General ventilation is recommended. Local exhaust ventilation may be necessary when dusts or mists are generated.

RESPIRATORY PROTECTION :
Where concentrations in air may exceed the limits given in this section or when significant mists, vapors, aerosols, or dusts are generated, an approved air purifying respirator equipped with suitable filter cartridges is recommended. Consult the respirator / cartridge manufacturer data to verify the suitability of specific devices. In event of emergency or planned entry into unknown concentrations a positive pressure, full-facepiece SCBA should be used. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance and inspection.

HAND PROTECTION :
When handling this product, the use of chemical gloves is recommended. The choice of work glove depends on work conditions and what chemicals are handled. Please contact the PPE manufacturer for advice on what type of glove material may be suitable. Gloves should be replaced immediately if signs of degradation are observed.

SKIN PROTECTION :
Wear standard protective clothing.

EYE PROTECTION :
Wear chemical splash goggles.

HYGIENE RECOMMENDATIONS :
Use good work and personal hygiene practices to avoid exposure. Keep an eye wash fountain available. Keep a safety shower available. If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse. Always wash thoroughly after handling chemicals. When handling this product never eat, drink or smoke.

HUMAN EXPOSURE CHARACTERIZATION :
Based on our recommended product application and personal protective equipment, the potential human exposure is: Low

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE	Emulsion
APPEARANCE	Opaque Off-white
ODOR	Hydrocarbon
SPECIFIC GRAVITY	1.03 - 1.07 @ 77 °F / 25 °C
DENSITY	8.6 - 9.0 lb/gal
SOLUBILITY IN WATER	Emulsifiable
pH (100 %)	8
VISCOSITY	400 - 1,200 cps @ 77 °F / 25 °C
FREEZING POINT	< -4 °F / < -20 °C
VOC CONTENT	27.4 % EPA Method 24

Note: These physical properties are typical values for this product and are subject to change.

10. STABILITY AND REACTIVITY

STABILITY :
Stable under normal conditions.

HAZARDOUS POLYMERIZATION :
Hazardous polymerization will not occur.

CONDITIONS TO AVOID :
Freezing temperatures. Extremes of temperature

MATERIALS TO AVOID :
Addition of water results in gelling. Contact with strong oxidizers (e.g. chlorine, peroxides, chromates, nitric acid, perchlorate, concentrated oxygen, permanganate) may generate heat, fires, explosions and/or toxic vapors.

HAZARDOUS DECOMPOSITION PRODUCTS :
Under fire conditions: Oxides of carbon, Oxides of nitrogen

11. TOXICOLOGICAL INFORMATION

No toxicity studies have been conducted on this product.

SENSITIZATION :
This product is not expected to be a sensitizer.

CARCINOGENICITY :
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).

HUMAN HAZARD CHARACTERIZATION :
Based on our hazard characterization, the potential human hazard is: Low

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL EFFECTS :

The following results are for the product, unless otherwise indicated.

ACUTE FISH RESULTS :

Species	Exposure	LC50	Test Descriptor
Sheepshead Minnow	96 hrs	> 1,000 mg/l	1% Aqueous Solution of a Similar Product
Rainbow Trout	96 hrs	> 1,000 mg/l	1% Aqueous Solution of a Similar Product
Fathead Minnow	96 hrs	34.3 mg/l	Product
Inland Silverside	96 hrs	52.5 mg/l	Product

ACUTE INVERTEBRATE RESULTS :

Species	Exposure	LC50	EC50	Test Descriptor
Daphnia magna	48 hrs	280 mg/l		1% Aqueous Solution of Product
Mysid Shrimp (Mysidopsis bahia)	96 hrs	400 mg/l		1% Aqueous Solution of Product
Daphnia magna	48 hrs	0.12 - 0.69 mg/l		Similar product tested in clean water

MOBILITY :

The environmental fate was estimated using a level III fugacity model embedded in the EPI (estimation program interface) Suite TM, provided by the US EPA. The model assumes a steady state condition between the total input and output. The level III model does not require equilibrium between the defined media. The information provided is intended to give the user a general estimate of the environmental fate of this product under the defined conditions of the models.

If released into the environment this material is expected to distribute to the air, water and soil/sediment in the approximate respective percentages;

Air	Water	Soil/Sediment
<5%	10 - 30%	70 - 90%

BIOACCUMULATION POTENTIAL

This preparation or material is not expected to bioaccumulate.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION

Based on our hazard characterization, the potential environmental hazard is: Moderate

Based on our recommended product application and the product's characteristics, the potential environmental exposure is: Moderate

If released into the environment, see CERCLA/SUPERFUND in Section 15.

13. DISPOSAL CONSIDERATIONS

If this product becomes a waste, it is not a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous waste, it is not subject to federal regulation. Consult state or local regulation for any additional handling, treatment or disposal requirements. For disposal, contact a properly licensed waste treatment, storage, disposal or recycling facility.

14. TRANSPORT INFORMATION

The information in this section is for reference only and should not take the place of a shipping paper (bill of lading) specific to an order. Please note that the proper Shipping Name / Hazard Class may vary by packaging, properties, and mode of transportation. Typical Proper Shipping Names for this product are as follows.

LAND TRANSPORT :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING

TRANSPORTATION

AIR TRANSPORT (ICAO/IATA) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

MARINE TRANSPORT (IMDG/IMO) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

15. REGULATORY INFORMATION

This section contains additional information that may have relevance to regulatory compliance. The information in this section is for reference only. It is not exhaustive, and should not be relied upon to take the place of an individualized compliance or hazard assessment. Nalco accepts no liability for the use of this information.

NATIONAL REGULATIONS, USA :

OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200 :
Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

CERCLA/SUPERFUND, 40 CFR 302 :
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312, AND 313 :

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355) :
This product does not contain substances listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 AND 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370) :
Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372) :
This product does not contain substances on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA) :
The substances in this preparation are included on or exempted from the TSCA 8(b) Inventory (40 CFR 710)

FOOD AND DRUG ADMINISTRATION (FDA) Federal Food, Drug and Cosmetic Act :
When use situations necessitate compliance with FDA regulations, this product is acceptable under : 21 CFR 176.170 Components of paper and paperboard in contact with aqueous and fatty foods and 21 CFR 176.180 Components of paper and paperboard in contact with dry foods.

Limitation: For use as an adjuvant in the manufacture of paper and paperboard in an amount not to exceed that necessary to accomplish the technical effect and not to exceed 2 percent (as polymer) by weight of the paper or paperboard.

NSF INTERNATIONAL :

This product has received NSF/International certification under NSF/ANSI Standard 60 in the coagulation and flocculation category. This product has received NSF/International certification under NSF/ANSI Standard 60 in the Filtration Aid category. The official name is "Polyacrylamide." Maximum product application dosage is : 3 mg/l.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 / formerly Sec. 307, 40 CFR 116.4 / formerly Sec. 311 :

This product may contain trace levels (<0.1% for carcinogens, <1% all other substances) of the following substance(s) listed under the regulation. Additional components may be unintentionally present at trace levels.

Substance(s)	Citations
• Benzene	Sec. 307, Sec. 311

CLEAN AIR ACT, Sec. 112 (Hazardous Air Pollutants, as amended by 40 CFR 63), Sec. 602 (40 CFR 82, Class I and II Ozone Depleting Substances) :

This product may contain trace levels (<0.1% for carcinogens, <1% all other substances) of the following substance(s) listed under the regulation. Additional components may be unintentionally present at trace levels.

Substance(s)	Citations
• Benzene • Acrylamide	Sec. 112

CALIFORNIA PROPOSITION 65 :

This product contains no listed substances known to the State of California to cause cancer, birth defects or other reproductive harm, at levels, which would require a warning under the statute.

MICHIGAN CRITICAL MATERIALS :

Substances listed under this regulation are not intentionally added or expected to be present in this product. Listed components may be present at trace levels.

STATE RIGHT TO KNOW LAWS :

Substances listed under this regulation are not intentionally added or expected to be present in this product. Listed components may be present at trace levels.

INTERNATIONAL CHEMICAL CONTROL LAWS :

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) :
The substance(s) in this preparation are included in or exempted from the Domestic Substance List (DSL).

AUSTRALIA
All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

CHINA
All substances in this product comply with the Provisions on the Environmental Administration of New Chemical Substances and are listed on the Inventory of Existing Chemical Substances China (IECSC).

EUROPE
The substances in this preparation have been reviewed for compliance with the EINECS or ELINCS inventories.

JAPAN
All substances in this product comply with the Law Regulating the Manufacture and Importation Of Chemical Substances and are listed on the Existing and New Chemical Substances list (ENCS).

KOREA
All substances in this product comply with the Toxic Chemical Control Law (TCCL) and are listed on the Existing Chemicals List (ECL)

NEW ZEALAND
All substances in this product comply with the Hazardous Substances and New Organisms (HSNO) Act 1996,and are listed on or are exempt from the New Zealand Inventory of Chemicals.

PHILIPPINES
All substances in this product comply with the Republic Act 6969 (RA 6969) and are listed on the Philippines Inventory of Chemicals & Chemical Substances (PICCS).

16. OTHER INFORMATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

* The human risk is: Low

* The environmental risk is: Moderate

Any use inconsistent with our recommendations may affect the risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH., (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS™ CD-ROM Version),
Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA), (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH,
(TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Ariel Insight™ (An integrated guide to industrial chemicals covered under major regulatory and advisory programs), North American Module, Western European Module, Chemical Inventories Module and the Generics Module (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Prepared By : Product Safety Department
Date issued : 04/14/2011
Version Number : 1.24

DETERMINATION OF THE PRESENCE OF POLYMER USING THE FLOCCULATION METHOD

1. PURPOSE

The purpose of this method is to provide a means of qualitatively determining the presence of a flocculent or coagulant within a solution, water sample, etc. Additionally, in cases where the polymer present within a sample is known, this method can be tentatively used as a quantitative measure.

2. PRINCIPLE

Slurry of kaolin clay is very easily flocculated or coagulated when either a flocculent or a coagulant is present. Therefore, for qualitative purposes, the sample being tested is mixed with kaolin clay slurry, and the effects are visually assessed by comparison to a blank. If polymer is present, significant coagulation or flocculation will be seen from the sample being tested as compared to that seen in the blank.

These principles can also be applied to the quantification of the concentration of polymer present within a sample. However, the exact product present within the sample must be known, and the water used to prepare all solutions must be similar in pH, hardness, etc. to the water present in the sample being tested. Standard solutions containing the known product are prepared at different concentrations. Each solution is then mixed with a kaolin clay slurry, and the settlement time of each is measured. A curve and the equation of the curve are then generated from the obtained results, the settlement time of the unknown sample is measured, and the concentration of the specific product in the unknown sample is calculated by substitution into the obtained equation.

3. PROCEDURE DESCRIPTION

3.1 Hazards and Safety Precautions

The information provided below is not a substitute for the MSDS but is supplementary to it. All users must have read and be familiar with the appropriate manufacturer's MSDS before using the chemicals listed below.

All unknown water samples and polymer solutions should be considered irritants to the skin and eyes.

Contact with calcium chloride powder may cause irritation to the skin, eyes, or respiratory tract.

General laboratory safety procedures should be followed.

3.2 Apparatus and Reagents

Apparatus	Reagents
General Apparatus: 1) 100 mL Glass Mixing Cylinders with Stoppers 2) Syringes (as appropriate) 3) Three Place Top Loading Balance 4) Bottles with Caps (as appropriate) **Additional Apparatus Required for Quantification Procedure:** 1) Stopwatch 2) Graduated Cylinders [200 mL and 50 mL] 3) 400 mL Glass Beakers (2)	1) ACS Grade Calcium Chloride 2) Laboratory Grade Kaolin Clay

3.3 Procedures

<u>Preparation of the Clay Slurry</u>

1. Preparation of a 1% Calcium Chloride Solution

   a. Determine how much 1% calcium chloride will be needed to perform the required testing. Please note that approximately 1.7 mL of a 1% calcium chloride solution is required for each test.
   b. Calculate the required weight of calcium chloride needed to obtain the desired weight of 1% calcium chloride solution using the equation below.

$$W_1 = \frac{W_2 \ x \ C_2}{C_1}$$

   Where:
   W_1 = Weight of Calcium Chloride Required to Prepare the Solution (g)
   C_1 = Concentration of the Calcium Chloride Being Used (%)
   W_2 = Desired Weight of 1% Calcium Chloride Solution (g)
   C_2 = Concentration of Calcium Chloride Solution Required (1%)

   c. Tare an appropriately sized bottle on a three place top loading balance.
   d. Accurately weigh out the calculated weight of calcium chloride required into the tared bottle. The accuracy of this weight should be ±0.002 g. Add deionized water to the bottle to achieve the desired final solution weight. For example, if 100 g of 1% calcium chloride solution is desired, add 1.000 g of pure calcium chloride to a tared bottle, and add deionized water to achieve a final weight of 100.000 g.

2. Preparation of the Clay Slurry

a. Determine how much clay slurry will be needed to perform the required testing. Please note that 5 mL of slurry is needed for each test.
b. Tare an appropriately sized bottle on a three place top loading balance.
c. Into the tared bottle, weigh out 1 parts laboratory grade Kaolin clay and 3 part 1% calcium chloride solution.
d. Cap the bottle, and shake vigorously until the contents are homogeneous.

Qualitative Determination of the Presence of Polymer in a Sample

1. Perform a blank as follows. To a 100 mL glass mixing cylinder, add 5 mL of the previously prepared clay slurry and 90 mL of water. Please note that the water used for this blank should be similar in quality to the water present in the sample which is to be tested with regard to hardness, pH, etc.

2. To a second 100 mL glass mixing cylinder, add 5 mL of the previously prepared clay slurry and 90 mL of the sample being tested.

3. Invert both cylinders three times, and visually assess whether flocculation or coagulation has occurred in the sample being tested by comparing the settlement rate and floc size of the clay in the sample cylinder to the settlement rate and floc size of the clay in the blank sample. Record observations.

Quantitative Determination of the Presence of a Specific Product in a Sample

1. A quantitative determination of the presence of polymer in a sample can only be performed with any accuracy in cases where the exact product present within a sample is known and when the quality of the water being used to prepare all solutions does not vary significantly from the quality of the water sample being tested.

2. Obtain a sample of the product which is known to be present within the sample to be tested.

3. For Liquid Dispersion or Emulsion Grade Products – Prepare a 0.5% standard stock solution using a sample of the product known to be present and water which is similar in quality to the water present in the sample to be tested.

   a. Measure 200 mL of sample water in a graduated cylinder.
   b. With a 1 mL syringe measure 1 mL of the product know to be present.
   c. Cap the cylinder and mix vigorously for two minutes.

4. Prepare a series of standard solutions with various ppm from the stock solution.

5. Measure the settlement time of each solution.

a. To a 50 mL glass graduated cylinder with topper, add 5 mL of the previously prepared clay slurry and 90 mL of the sample with a predetermined ppm.
b. Invert the cylinder three times, and using a stopwatch, measure the time taken for the mudline formed by the flocculated clay to travel from the 50 mL mark on the cylinder to the 40 mL mark on the cylinder. The stopwatch is to be started after the third inversion and stopped when the mudline reaches the 40 mL. This constitutes the settlement time, in seconds, given by the know ppm standard.
c. Repeat Steps a and b for the various known ppm standard, and for the water sample being tested.

6. Determine the quantity of the specific product in the sample being tested.

a. Using the obtained settlement times for the standards, plot a graph of settlement time vs. concentration.
b. Fit this data with the best fit curve, and obtain the equation of the generated curve from the software.
c. Substitute the obtained settlement time from the unknown sample for Y in the obtained equation. Solve this equation for X. The resulting value obtained for X is the concentration of the specific product, in mg/L, within the sample.

SAFETY DATA SHEET

PRODUCT

ULTRION® 8187

EMERGENCY TELEPHONE NUMBER(S)

(800) 424-9300 (24 Hours) CHEMTREC

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME :	**ULTRION® 8187**
APPLICATION :	WATER CLARIFICATION AID
COMPANY IDENTIFICATION :	Nalco Company 1601 W. Diehl Road Naperville, Illinois 60563-1198
EMERGENCY TELEPHONE NUMBER(S) :	(800) 424-9300 (24 Hours) CHEMTREC

NFPA 704M/HMIS RATING
HEALTH : 2 / 2 FLAMMABILITY : 0 / 0 INSTABILITY : 0 / 0 OTHER :
0 = Insignificant 1 = Slight 2 = Moderate 3 = High 4 = Extreme * = Chronic Health Hazard

2. COMPOSITION/INFORMATION ON INGREDIENTS

Our hazard evaluation has identified the following chemical substance(s) as hazardous. Consult Section 15 for the nature of the hazard(s).

Hazardous Substance(s)	CAS NO	% (w/w)
Aluminum Chloride Hydroxide	12042-91-0	30.0 - 60.0

3. HAZARDS IDENTIFICATION

****EMERGENCY OVERVIEW****

WARNING
Irritating to eyes.
Do not get in eyes, on skin, on clothing. Do not take internally. Use with adequate ventilation. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. After contact with skin, wash immediately with plenty of water.
Wear suitable protective clothing.
Not flammable or combustible. May evolve HCl under fire conditions.

PRIMARY ROUTES OF EXPOSURE :
Eye, Skin, Inhalation

HUMAN HEALTH HAZARDS - ACUTE :

EYE CONTACT :
Can cause moderate irritation.

SKIN CONTACT :
May cause irritation with prolonged contact.

INGESTION :
Not a likely route of exposure. May cause mucosal damage.

INHALATION :
Not a likely route of exposure. May cause irritation of mucous membranes.

SYMPTOMS OF EXPOSURE :
Acute :
A review of available data does not identify any symptoms from exposure not previously mentioned.
Chronic :
A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS :
A review of available data does not identify any worsening of existing conditions.

HUMAN HEALTH HAZARDS - CHRONIC :
No adverse effects expected other than those mentioned above.

4. FIRST AID MEASURES

EYE CONTACT :
Immediately flush eye with water for at least 15 minutes while holding eyelids open. Get medical attention.

SKIN CONTACT :
Remove contaminated clothing. Wash off affected area immediately with plenty of water. If symptoms develop, seek medical advice.

INGESTION :
Do not induce vomiting without medical advice. If conscious, washout mouth and give water to drink. Get medical attention.

INHALATION :
Remove to fresh air, treat symptomatically. If symptoms develop, seek medical advice.

NOTE TO PHYSICIAN :
Based on the individual reactions of the patient, the physician's judgement should be used to control symptoms and clinical condition.

5. FIRE FIGHTING MEASURES

FLASH POINT : None

EXTINGUISHING MEDIA :
Not expected to burn. Use extinguishing media appropriate for surrounding fire. Keep containers cool by spraying with water.

FIRE AND EXPLOSION HAZARD :
Not flammable or combustible. May evolve HCl under fire conditions.

SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTING :
In case of fire, wear a full face positive-pressure self contained breathing apparatus and protective suit.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS :
Restrict access to area as appropriate until clean-up operations are complete. Use personal protective equipment recommended in Section 8 (Exposure Controls/Personal Protection). Stop or reduce any leaks if it is safe to do so. Ventilate spill area if possible. Ensure clean-up is conducted by trained personnel only. Do not touch spilled material. Have emergency equipment (for fires, spills, leaks, etc.) readily available. Notify appropriate government, occupational health and safety and environmental authorities.

METHODS FOR CLEANING UP :
SMALL SPILLS: Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area. LARGE SPILLS: Contain liquid using absorbent material, by digging trenches or by diking. Reclaim into recovery or salvage drums or tank truck for proper disposal. Wash site of spillage thoroughly with water. Contact an approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated in Section 13 (Disposal Considerations).

ENVIRONMENTAL PRECAUTIONS :
Do not contaminate surface water.

7. HANDLING AND STORAGE

HANDLING :
Do not get in eyes, on skin, on clothing. Do not take internally. Use with adequate ventilation. Do not breathe vapors/gases/dust. Keep the containers closed when not in use. Have emergency equipment (for fires, spills, leaks, etc.) readily available. Ensure all containers are labeled. Use personal protective equipment recommended in Section 8 (Exposure Controls/Personal Protection).

STORAGE CONDITIONS :
Store the containers tightly closed. Store separately from bases.

SUITABLE CONSTRUCTION MATERIAL :
PVC, Buna-N, Polyurethane, Polypropylene, Polyethylene, Viton, HDPE (high density polyethylene), 100% phenolic resin liner

UNSUITABLE CONSTRUCTION MATERIAL :
Brass, Hypalon, Stainless Steel 304, EPDM, Mild steel, Stainless Steel 316L, Neoprene, Epoxy phenolic resin

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS :
Exposure guidelines have not been established for this product. Available exposure limits for the substance(s) are shown below.

Country/Source	Substance(s)	Category:	ppm	mg/m3

ENGINEERING MEASURES :
General ventilation is recommended.

RESPIRATORY PROTECTION :
Due to its low volatility and toxicity, the hazard potential associated with this material is relatively low. Respiratory protection is not normally needed.

HAND PROTECTION :
When handling this product, the use of chemical gloves is recommended. The choice of work glove depends on work conditions and what chemicals are handled. Please contact the PPE manufacturer for advice on what type of glove material may be suitable. Gloves should be replaced immediately if signs of degradation are observed.

SKIN PROTECTION :
Wear standard protective clothing.

EYE PROTECTION :
Wear chemical splash goggles.

HYGIENE RECOMMENDATIONS :
Use good work and personal hygiene practices to avoid exposure. Keep an eye wash fountain available. Keep a safety shower available. If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse. Always wash thoroughly after handling chemicals. When handling this product never eat, drink or smoke.

HUMAN EXPOSURE CHARACTERIZATION :
Based on our recommended product application and personal protective equipment, the potential human exposure is: Low

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE	Liquid
APPEARANCE	Colorless
ODOR	None
SPECIFIC GRAVITY	1.34 @ 77 °F / 25 °C
DENSITY	11.1 lb/gal
SOLUBILITY IN WATER	Complete
pH (100 %)	3.5
FREEZING POINT	32 °F / 0 °C
BOILING POINT	219.2 °F / 104 °C
VAPOR PRESSURE	Same as water
VOC CONTENT	0.00 % EPA Method 24

Note: These physical properties are typical values for this product and are subject to change.

10. STABILITY AND REACTIVITY

STABILITY :
Stable under normal conditions.

HAZARDOUS POLYMERIZATION :
Hazardous polymerization will not occur.

CONDITIONS TO AVOID :
Avoid extremes of temperature.

MATERIALS TO AVOID :
Strong Bases

HAZARDOUS DECOMPOSITION PRODUCTS :
Under fire conditions: HCl

11. TOXICOLOGICAL INFORMATION

No toxicity studies have been conducted on this product.

SENSITIZATION :
This product is not expected to be a sensitizer.

CARCINOGENICITY :
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).

HUMAN HAZARD CHARACTERIZATION :
Based on our hazard characterization, the potential human hazard is: Low

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL EFFECTS :

The following results are for the product.

ACUTE FISH RESULTS :

Species	Exposure	LC50	Test Descriptor
Inland Silverside	96 hrs	> 5,000 mg/l	Product
Rainbow Trout	96 hrs	590 mg/l	Product
Fathead Minnow	96 hrs	1,094 mg/l	Product

ACUTE INVERTEBRATE RESULTS :

Species	Exposure	LC50	EC50	Test Descriptor
Daphnia magna	48 hrs	> 5,000 mg/l		Product
Mysid Shrimp (Mysidopsis bahia)	96 hrs	4,773 mg/l		Product
Ceriodaphnia dubia	48 hrs	> 5,000 mg/l		Product

CHRONIC INVERTEBRATE RESULTS :

Species	Test Type	NOEC / LOEC	End Point	Test Descriptor
Ceriodaphnia dubia		15 mg/l / 30 mg/l	Reproduction	Product

PERSISTENCY AND DEGRADATION :

Total Organic Carbon (TOC) : 99 mg/l

Chemical Oxygen Demand (COD) : 490 mg/l

Biological Oxygen Demand (BOD) :

Incubation Period	Value	Test Descriptor
5 d	< 14 mg/l	Product

Greater than 95% of this product consists of inorganic substances for which a biodegradation value is not applicable.

MOBILITY :

The environmental fate was estimated using a level III fugacity model embedded in the EPI (estimation program interface) Suite TM, provided by the US EPA. The model assumes a steady state condition between the total input and output. The level III model does not require equilibrium between the defined media. The information provided is intended to give the user a general estimate of the environmental fate of this product under the defined conditions of the models.

If released into the environment this material is expected to distribute to the air, water and soil/sediment in the approximate respective percentages;

Air	Water	Soil/Sediment
<5%	30 - 50%	50 - 70%

The portion in water is expected to be soluble or dispersible.

BIOACCUMULATION POTENTIAL

This preparation or material is not expected to bioaccumulate.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION

Based on our hazard characterization, the potential environmental hazard is: Low

Based on our recommended product application and the product's characteristics, the potential environmental exposure is: Low

If released into the environment, see CERCLA/SUPERFUND in Section 15.

13. DISPOSAL CONSIDERATIONS

If this product becomes a waste, it is not a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous waste, it is not subject to federal regulation. Consult state or local regulation for any additional handling, treatment or disposal requirements. For disposal, contact a properly licensed waste treatment, storage, disposal or recycling facility.

14. TRANSPORT INFORMATION

The information in this section is for reference only and should not take the place of a shipping paper (bill of lading) specific to an order. Please note that the proper Shipping Name / Hazard Class may vary by packaging, properties, and mode of transportation. Typical Proper Shipping Names for this product are as follows.

LAND TRANSPORT :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

AIR TRANSPORT (ICAO/IATA) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

MARINE TRANSPORT (IMDG/IMO) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

15. REGULATORY INFORMATION

This section contains additional information that may have relevance to regulatory compliance. The information in this section is for reference only. It is not exhaustive, and should not be relied upon to take the place of an individualized compliance or hazard assessment. Nalco accepts no liability for the use of this information.

NATIONAL REGULATIONS, USA :

OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200 :
Based on our hazard evaluation, the following substance(s) in this product is/are hazardous and the reason(s) is/are shown below.

Aluminum Chloride Hydroxide : Eye irritant

CERCLA/SUPERFUND, 40 CFR 117, 302 :
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312, AND 313 :

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355) :
This product does not contain substances listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 AND 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370) :
Our hazard evaluation has found this product to be hazardous. The product should be reported under the following indicated EPA hazard categories:

X	Immediate (Acute) Health Hazard
-	Delayed (Chronic) Health Hazard
-	Fire Hazard
-	Sudden Release of Pressure Hazard
-	Reactive Hazard

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372) :
This product does not contain substances on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA) :
The substances in this preparation are included on or exempted from the TSCA 8(b) Inventory (40 CFR 710)

FOOD AND DRUG ADMINISTRATION (FDA) Federal Food, Drug and Cosmetic Act :
When use situations necessitate compliance with FDA regulations, this product is acceptable under : 21 CFR 176.170 Components of paper and paperboard in contact with aqueous and fatty foods and 21 CFR 176.180 Components of paper and paperboard in contact with dry foods.

Product must be used at a pH above 5.5 to retain its FDA status. Limitations: no more than required to produce intended technical effect.

This product has been certified as KOSHER/PAREVE for year-round use INCLUDING THE PASSOVER SEASON by the CHICAGO RABBINICAL COUNCIL.

NSF INTERNATIONAL :
This product has received NSF/International certification under NSF/ANSI Standard 60 in the coagulation and flocculation category. The official name is "Polyaluminum Chloride." Maximum product application dosage is : 180 mg/l.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 / formerly Sec. 307, 40 CFR 116.4 / formerly Sec. 311 :
Substances listed under this regulation are not intentionally added or expected to be present in this product. Listed components may be present at trace levels.

CLEAN AIR ACT, Sec. 112 (40 CFR 61, Hazardous Air Pollutants), Sec. 602 (40 CFR 82, Class I and II Ozone Depleting Substances) :
Substances listed under this regulation are not intentionally added or expected to be present in this product. Listed components may be present at trace levels.

CALIFORNIA PROPOSITION 65 :
Substances listed under California Proposition 65 are not intentionally added or expected to be present in this product.

MICHIGAN CRITICAL MATERIALS :
Substances listed under this regulation are not intentionally added or expected to be present in this product. Listed components may be present at trace levels.

STATE RIGHT TO KNOW LAWS :
Substances listed under this regulation are not intentionally added or expected to be present in this product. Listed components may be present at trace levels.

NATIONAL REGULATIONS, CANADA :

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) :
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS CLASSIFICATION :
D2B - Materials Causing Other Toxic Effects - Toxic Material

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) :
The substance(s) in this preparation are included in or exempted from the Domestic Substance List (DSL).

AUSTRALIA
All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

CHINA
All substances in this product comply with the Provisions on the Environmental Administration of New Chemical Substances and are listed on the Inventory of Existing Chemical Substances China (IECSC).

EUROPE
The substances in this preparation have been reviewed for compliance with the EINECS or ELINCS inventories.

JAPAN
This product contains substance(s) which are not in compliance with the Law Regulating the Manufacture and Importation Of Chemical Substances and are not listed on the Existing and New Chemical Substances list (ENCS).

KOREA
All substances in this product comply with the Toxic Chemical Control Law (TCCL) and are listed on the Existing Chemicals List (ECL)

PHILIPPINES
All substances in this product comply with the Republic Act 6969 (RA 6969) and are listed on the Philippines Inventory of Chemicals & Chemical Substances (PICCS).

16. OTHER INFORMATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

* The human risk is: Low

* The environmental risk is: Low

Any use inconsistent with our recommendations may affect the risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH., (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA), (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH, (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

Ariel Insight (An integrated guide to industrial chemicals covered under major regulatory and advisory programs), North American Module, Western European Module, Chemical Inventories Module and the Generics Module (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

Prepared By : Product Safety Department
Date issued : 07/31/2009
Version Number : 3.0

THE DETERMINATION OF THE PRESENCE OF ALUMINUM.

- Crandall Canyon Mine - Done monthly as a grab sample and brought to the SGS Lab for Lab results. SGS has already been running aluminum tests on the UPDES samples, therefore UEI does not need to do another monthly test for **Coagulant Ultrion 8187** because it is taken care of in the while sampling UPDES #002.

APPENDIX 7-71

PH

PETERSEN HYDROLOGIC

11 May 2012

Mr. David Hibbs
Genwal Resources, Inc.
P.O. Box 1077
East Carbon, Utah 84501

RE: Stable and unstable isotopic compositions of Crandall Canyon Mine discharge water (UPDES 002 pre-treatment)

David,

At your request, we have performed an investigation of stable and unstable isotopic compositions of mine discharge water from the Genwal Resources, Inc. Crandall Canyon Mine. The results of this investigation are presented in this letter report.

Introduction

The Crandall Canyon Mine is located in Huntington Canyon, approximately 15 miles northwest of the town of Huntington, Utah (Figure 1). Mining operations began in 1984 and continued until 2007. Beginning in 1996, sufficient groundwater began to be encountered in the underground mine workings such that it became necessary to pump water from the mine on a nearly continuous basis. In September 2007 the mine pumps were decommissioned and discharge of pumped water from the mine ceased. Beginning in early 2008, gravity discharge of water from the Crandall Canyon Mine portals began to occur. The gravity discharge from the Crandall Canyon Mine portal is the water sampled in this investigation.

2695 N. 600 E. Lehi, Utah 84043 (801) 766-4006

Methods of Study

On 18 October 2011, we visited the Crandall Canyon Mine to collect samples of mine discharge water for stable and unstable isotopic analysis. The sampling location is identified as site UPDES 002 pre-treatment. This water represents raw, untreated mine discharge water flowing from the HDPE discharge pipe into the adjacent mine surface facility.

Mine water samples were collected for solute chemical analysis (for use in geochemical modeling) and for unstable radiocarbon (^{14}C) and tritium (^{3}H) analysis, and for the stable isotopes deuterium ($\delta^{2}H$), oxygen-18 ($\delta^{18}O$), and carbon-13 ($\delta^{13}C$). Radiocarbon, tritium, deuterium, oxygen-18, and carbon-13 analyses were performed at the Brigham Young University Laboratory of Isotope Geochemistry of Provo, Utah. A split of the sampled water was sent to the University of Miami, Tritium Laboratory in Miami, Florida for replicate tritium analysis. Solute chemical analyses were performed by SGS Minerals Services of Huntington, Utah.

Mean groundwater residence times were calculated using methods described by Fontes (1979), and Pearson (1972). Input parameters used in the mean residence time calculations were assigned as follows: $\delta^{13}C$ soil gas -18 to -22 ‰, $\delta^{13}C$ mineral carbonate 0 ‰, ^{14}C soil gas 100 percent modern carbon (pmC), and ^{14}C mineral carbonate 0 pmC.

The mine water discharge rate was measured using a Marsh-McBirney brand electromagnetic current-velocity meter and wading rod. Temperature was measured using a Taylor brand digital thermometer. The specific conductance was measured using an Extech brand model EC400 conductivity meter with automatic temperature compensation. The instrument was calibrated using NIST traceable conductivity standard solutions. The pH Measurement was performed using an Oakton brand model pH Testr 30 with automatic temperature compensation, which was calibrated using NIST traceable pH standard solutions. The dissolved oxygen measurement was performed using a YSI brand Model 55 dissolved oxygen meter, which was calibrated using atmospheric oxygen calibration methods.

Results

The results of the laboratory stable and unstable isotopic measurements are presented in Table 1. Calculated groundwater mean residence times are presented in Table 2. Isotopic and solute laboratory reporting sheets are included in the Appendix.

Radiocarbon (^{14}C)

The measured ^{14}C content of the sampled UPDES 002 pre-treatment water is 13.52 +/- 0.07 pmC (percent modern carbon). The modeled radiocarbon age of the water (depending on the model used and the $\delta^{13}C_{(gas)}$ assumption) ranges from 12,050 to 15,000 years. In evaluating radiocarbon ages of groundwaters, it is important to consider that groundwaters rarely travel from recharge areas to discharge areas via pure piston flow. Rather, it is not uncommon for groundwaters arriving at a well or spring sampling location to have recharged at different times and different locations. Accordingly, it is best to think of a groundwater radiocarbon "age" as the "mean residence time" of all of the water molecules present in the collected sample.

Tritium (^{3}H)

The measured tritium content of the sampled UPDES 002 pre-treatment water is 2.0 +/- 0.1 TU.

The presence of measurable tritium in the sampled water indicates the presence of a component of recharge that is less than about 50 years old.

Deuterium ($\delta^{2}H$) and oxygen-18 ($\delta^{18}O$)

The measured deuterium composition of the sampled UPDES 002 water is -130.7 ‰ +/- 0.5 ‰ (VSMOW). The measured oxygen-18 composition is -18.05 ‰ +/- 0.20 ‰ (VSMOW).

Discussion

Taken together, the very old radiocarbon age (>12,000 years) and the presence of measureable tritium (2 TU) in the sampled water are indicative of a mixed source for the mine discharge water. The very low measured ^{14}C activity (13.52 pmC) suggests that the bulk of the sampled water is likely from a source that recharged many thousands of years ago. The presence of measurable tritium indicates that there is also some component of modern water present.

Because the tritium content of the modern recharge component is not known, it is not possible to quantitatively determine the relative proportions of the ancient and modern components of the groundwater. However, based on reported typical tritium contents of streams and springs discharging from shallow, active groundwater systems in the region, some general assumptions can be made. Mayo and Associates (1997) report tritium contents for springs and creeks in the vicinity of the Crandall Canyon Mine ranging from 9.3 to 38.2 TU. Mayo and others (2003) report that shallow active-zone groundwaters in the Wasatch Plateau and Book Cliffs coal districts of Utah contain appreciable amounts tritium (mostly in the range of about 6 to 22 TU – refer to Mayo Figure 12). Based on these assumptions (and assuming a 0 TU tritium content for the old component), it would follow that for a mixed water to have a tritium content of 2.0 TU, the amount of the modern contribution would be modest.

A plot of historic stable isotopic deuterium and oxygen-18 compositions at the Crandall Canyon Mine is presented in Figure 2 (See Mayo and Associates, 1997 for historic sampling locations and isotopic compositions). Also plotted on Figure 2 is the UPDES 002 pre-treatment water. Waters plotting near the global meteoric water line ($\delta^2H = 8\ \delta^{18}O + 10$) are indicative of waters originating from meteoric sources. Plots of deuterium and oxygen-18 compositions of groundwaters are often used to differentiate waters that recharged at different locations and/or under different climatic conditions. Using this isotopic technique it is also often possible to distinguish paleogroundwaters that recharged during cooler climatic conditions (such as the late Pleistocene time in North America or Europe) from waters that are more recent in origin. Such paleogroundwaters will be depleted with respect to modern waters and will be shifted along the meteoric water line towards the more negative values (Clark and Fritz, 1997). This pattern is apparent in the plot of Crandall Canyon Mine waters shown in Figure 2. This suggests that the groundwaters intercepted in the Crandall Canyon Mine (including UPDES 002 pre-treatment) may largely represent paleorecharge. The disparate plotting locations for the underground and surface samples strongly suggest different recharge origins for these two water types.

References Cited

Clark, I.D., and Fritz, P., 1997, Environmental isotopes in Hydrogeology, CRC Press, LLC, Boca Raton, Florida, 328 p.

Fontes, J.C., and Garnier, J.M., 1979, Determination of the initial ^{14}C activity of the total dissolved carbon: A review of existing models and a new approach: Water Resources Research, v. 15, p. 399-413.

Mayo, A.L., Thomas, H.M., Peltier, S., Petersen, E.C., Payne, K., Holman, L.S., Tingey, D., Fogel, T., Black, B.J., Gibbs, T.D., 2003, Active and inactive groundwater flow systems: Evidence from a stratified, mountainous terrain, Geological Society of America Bulletin, V. 115; no. 12; p. 1456-1472.

Mayo and Associates, 1997, Summary of new isotopic information for LBA 11, consulting report for Genwal Resources, Inc., Huntington, Utah.

Pearson, F.J., Jr., Bedinger, M.S., and Jones, B.F., 1972, Carbon-14 dates of water from Arkansas Hot springs, in Proceeding of eighth international conference on radiocarbon dating: Wellington, Royal Society of New Zealand, v. 1. P. 330-247.

Please feel free to contact me should you have any questions in this regard.

Sincerely,

LICENSED PROFESSIONAL GEOLOGIST
ERIK CARL PETERSEN
No. 5373615-2250
STATE OF UTAH

Erik C. Petersen, P.G.
Principal Hydrogeologist
Utah PG #5373615-2250

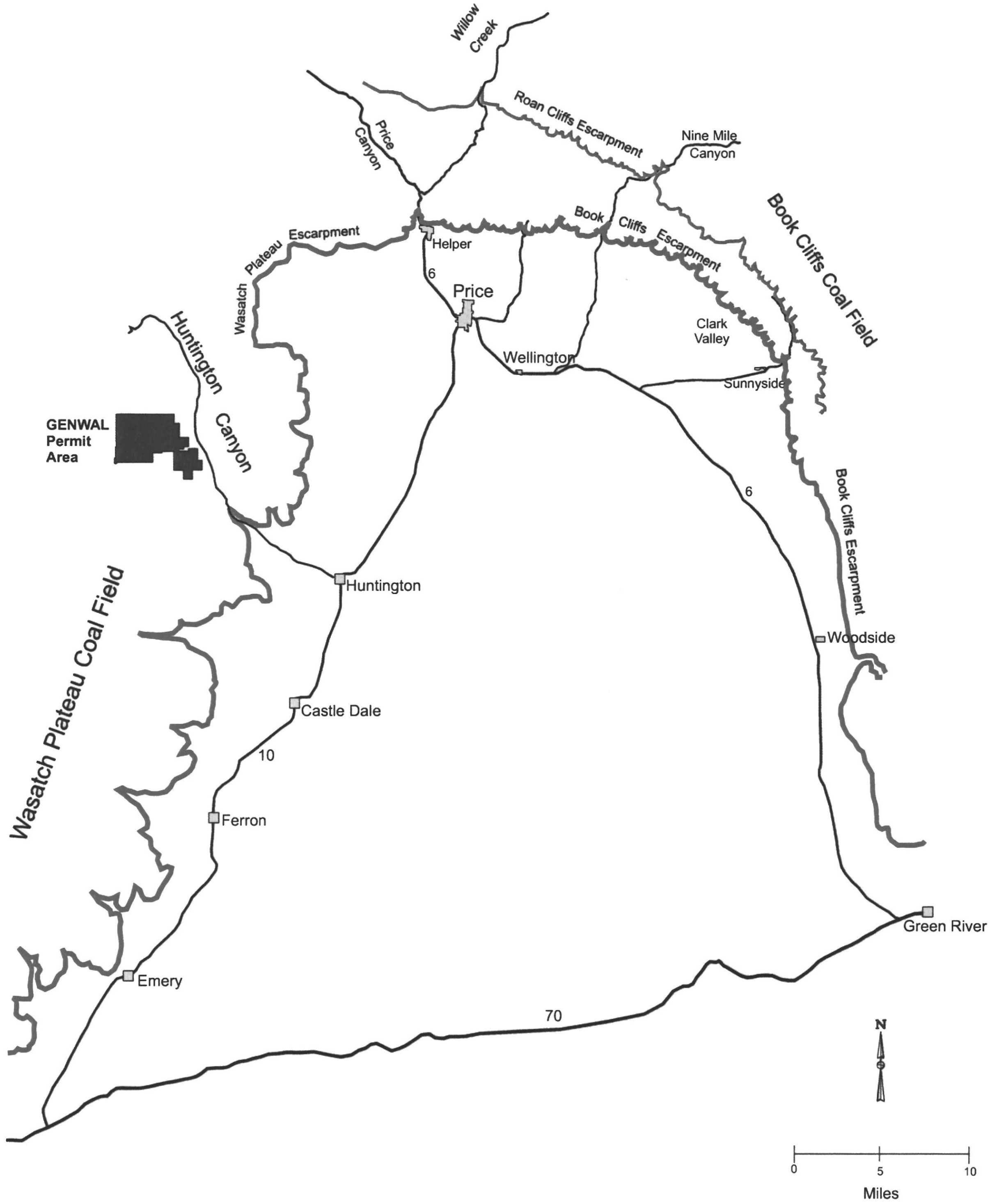


Figure 1 Location of the Genwal Resources, Inc. Crandall Canyon Mine.

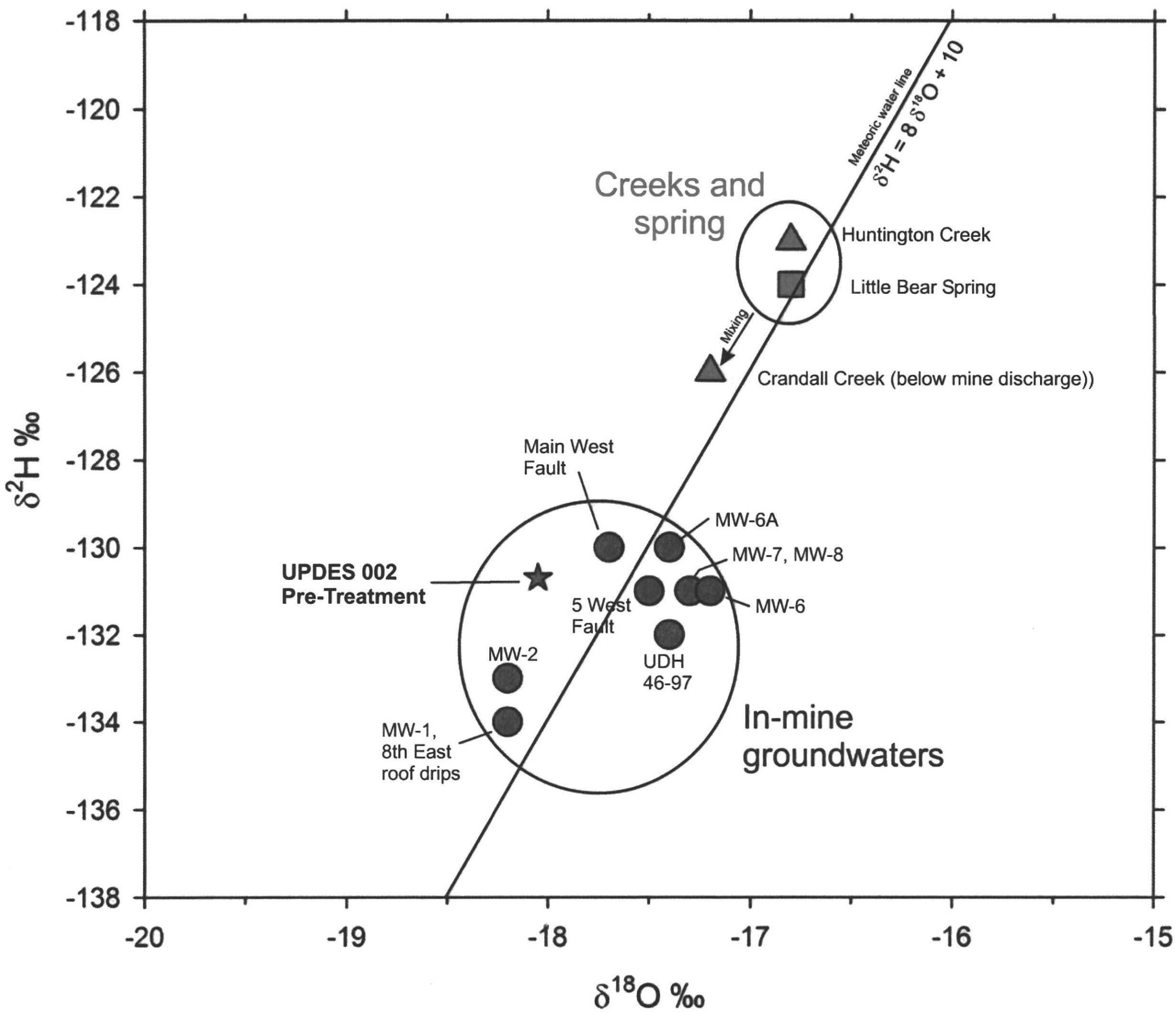


Figure 2 Stable isotopic deuterium and oxygen-18 composition of Crandall Canyon Mine discharge water (UPDES 002 Pre-treatment) plotted together with creek, spring, and other Crandall Canyon Mine in-mine groundwaters.

Table 1 Solute and isotopic compositions of Crandall Canyon Mine discharge water.

Field measurements		
Date/time sampled	18-Oct-2011	16:45
Discharge	427	gpm
Temperature	11.3	°C
pH	7.17	S.U.
Sp. Conductance	971	µS/cm
Dissolved oxygen	6.0	mg/L
Laboratory solute measurements		
Calcium (Ca^{2+})	84.14	mg/L
Magnesium (Mg^{2+})	50.64	mg/L
Sodium (Na^{+})	26.51	mg/L
Potassium (K^{+})	3.46	mg/L
Bicarbonate (HCO_3^{-})	454.3	mg/L
Fluoride (F^{-})	0.29	mg/L
Chloride (Cl^{-})	11.89	mg/L
Nitrate (NO_3^{-})	0.40	mg/L
Bromide (Br^{-})	<0.01	mg/L
O-Phosphate (HPO_4^{2-})	<0.01	mg/L
Sulfate (SO_4^{2-})	90.10	mg/L
Cations	9.61	mg/L
Anions	9.70	mg/L
analytical error	-0.4	%
Laboratory isotopic mesurements		
Deuterium (δ^2H_{VSMOW})	-130.7	‰
Oxygen-18 ($\delta^{18}O_{VSMOW}$)	-18.05	‰
Carbon-13 ($\delta^{13}C$)	-14.98	‰
Radiocarbon (^{14}C)	13.52	pmC
Tritium (^{3}H)	2.00	TU

Table 2 Radiocarbon "age" calculations for UPDES 002 pre-treatment water.

	$\delta^{13}C_{(soil\ gas)}$ = -18 ‰	$\delta^{13}C_{(soil\ gas)}$ = -20 ‰	$\delta^{13}C_{(soil\ gas)}$ = -22 ‰	
Fontes model	12,050	12,050	12,050	radiocarbon years
Pearson model	15,000	14,150	13,350	radiocarbon years

Input parameters used in all calculations:

$\delta^{13}C_{(mineral\ carbonate)}$ = 0 ‰

$^{14}C_{(soil\ gas)}$ = 100 pmC

$^{14}C_{(mineral)}$ = 0 pmC

Appendix

Solute and isotope laboratory reporting sheets

BYU *Laboratory of Isotope Geochemistry*
Department of Geological Sciences
BYU campus, Provo, Utah 84602
phone: (801) 422-3918

Client: Petersen Hydrologic, LLC
2695 N. 600 E.
Lehi, UT 84043

Reporting Date: 5-Feb-2012

Project: West Ridge
Snell & Willmer, LLP

Radiocarbon Age Analysis

Sample ID	BYU ID	Sample Date	^{14}C (pmc)	+/- 1 σ	$\delta^{13}C$ (‰)	+/- 1 σ
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
UPDES 002 pre-treatment	9318	18-Oct-2011	13.52	0.07	-14.98	0.04

NOTES:

Pretreatment: Carbon was extracted from the water sample as barium carbonate precipitate. Carbon dioxide was recovered from the carbonate in a high-vacuum system for processing into benzene and isotopic analysis.

Comments: Percent modern carbon was calculated according to Stuvier, M. and Polach, HA, 1997, Discussion of ^{14}C data: Radiocarbon 19:355-63 by comparison against the activities of 4990C NBS oxalic acid and a total process blank. Based upon a Libby half life of 5568 years for ^{14}C.

David G. Tingey
Research Professor

BYU *Laboratory of Isotope Geochemistry*
Department of Geological Sciences
BYU campus, Provo, Utah 84602
phone: (801) 422-3918

Client: Petersen Hydrologic, LLC
2695 N. 600 E.
Lehi, UT 84043

Reporting Date: 7-Jan-2012

Project: West Ridge
Snell & Wilmer, LLP

Stable Isotopic Data

Sample ID	BYU ID	Sample Date	$\delta^{18}O_{VSMOW}$	+/- 1 σ	δD_{VSMOW}	+/- 1 σ
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
UPDES 002 pre-treatment	9318	18-Oct-2011	-18.05	0.20	-130.7	0.5

NOTES:
$\delta^{18}O_{VSMOW\,(sample)} = [(^{18}O/^{16}O)_{sample} - (^{18}O/^{16}O)_{VSMOW} / (^{18}O/^{16}O)_{VSMOW}] * 1000$
$\delta D_{VSMOW(sample)} = [(^{2}H/^{1}H)_{sample} - (^{12}H/^{1}H)_{VSMOW} / (^{2}H/^{1}H)_{VSMOW}] * 1000$
$\delta^{13}C_{VPDB\,(sample)} = [(^{13}C/^{12}C)_{sample} - (^{13}C/^{12}C)_{VPDB} / (^{13}C/^{12}C)_{VPDB}] * 1000$
$\delta^{18}O_{VSMOW\,(sample)}$, $\delta D_{VSMOW\,(sample)}$ and $\delta^{13}C_{VPDB\,(sample)}$ are the measured "delta" values for the given sample. $(^{18}O/^{16}O)_{sample}$, $(^{2}H/^{1}H)_{sample}$ and $(^{13}C/^{12}C)_{sample}$ are raw isotope ratios, and $(^{18}O/^{16}O)_{VSMOW}$ $(^{2}H/^{1}H)_{VSMOW}$ are the defined isotope ratios for hydrogen and oxygen of the VSMOW international standard. VPDB values for carbon are produced by analysis with reference gases calibrated to NBS-19.
Values are normalized to the VSMOW/SLAP scale (Coplen, 1988; Nelson, 2000; Nelson and Detlman, 2001); however, uncertainties in normalization are not included in error estimates.

David G. Tingey
Research Professor

BYU *Laboratory of Isotope Geochemistry*
Department of Geological Sciences
BYU campus, Provo, Utah 84602
phone: (801) 422-3918

Client: Petersen Hydrologic, LLC
2695 N. 600 E.
Lehi, UT 84043

Reporting Date: 7-Jan-2012

Project: West Ridge
Snell & Wilmer, LLP

Tritium Analysis

Sample ID	BYU ID	Sample Date	^{3}H (TU)	+/- 1 σ	Sample Preparation
[redacted]	[redacted]	[redacted]			
UPDES 002 pre-treatment	9318	18-Oct-2011	2.0	0.1	Enriched

NOTES:

Standardization was done using NIST Radioactivity Standard Reference Material SRM 436 1C Hydrogen-3.
Pretreatment:

David G. Tingey
Research Professor

Client: PETERSEN HYDROLOGIC
Recvd : 12/05/04
Job# : 2986
Final : Preliminary Results

Purchase Order: Bill to: Erik Petersen
Contact: E. Petersen, 801/766-4006
2695 N. 600 E.
Lehi, UT 84043

Cust LABEL INFO	JOB.SX	REFDATE	QUANT	ELYS	TU	eTU
PETERSEN - UPDES 002 Pre-treat	2986.01	111018	1000	275	2.01	0.09

SGS

Analysis Report

October 26, 2011

GENWAL RESOURCES INC
794 "C" CANYON ROAD
EAST CARBON UT 84520

Client Sample ID:	PRE 002	Sample ID By:	Genwal Resources Inc.
Date Sampled:	Oct 18, 2011	Sample Taken At:	PRE 002
Date Received:	Oct 19, 2011	Sample Taken By:	E.Peterson
Product Description:	WATER	Time Received:	1325
		Time Sampled:	1645
		Mine:	8

Comments: Dissolved Metals Field Filtered

SGS Minerals Sample ID: 782-1110378-001

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
Sulfate, SO4	157	mg/L	EPA 300.0	1	2011-10-25	16:03:00	AL
Total Dissolved Solids	606	mg/L	SM2540-C	30	2011-10-19	14:40:00	CM
Chloride, Cl	10	mg/L	EPA 300.0	1	2011-10-25	16:03:00	AL
Alkalinity, mg CaCO3/L (pH 4.5)	381	mg/L	SM2320-B	5	2011-10-20	09:00:00	AL
Carbonate Alkalinity as CaCO3	<5	mg/L	SM2320-B	5	2011-10-20	09:00:00	AL
Bicarbonate Alkalinity as CaCO3	381	mg/L	SM2320-B	5	2011-10-20	09:00:00	AL
METALS BY ICP							
Calcium, Ca - Dissolved	96.86	mg/L	EPA 200.7	0.03	2011-10-20	15:16:00	AL
Iron, Fe - Dissolved	0.29	mg/L	EPA 200.7	0.03	2011-10-20	15:16:00	AL
Iron, Fe - Total	2.15	mg/L	EPA 200.7	0.05	2011-10-26	15:20:00	AL
Magnesium, Mg - Dissolved	54.10	mg/L	EPA 200.7	0.01	2011-10-20	15:16:00	AL
Potassium, K - Dissolved	8.24	mg/L	EPA 200.7	0.14	2011-10-20	15:16:00	AL
Sodium, Na - Dissolved	33.44	mg/L	EPA 200.7	0.09	2011-10-20	15:16:00	AL

Lab Supervisor

Domenic Ibanez
Lab Supervisor

Appendix 7-72

Table 1 Summary of spring and seep results, 1980-95.

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
Notes:	a = no representative sample to measure parameter b = ice prevents measurement						
UJV 1	1993	a	a	Seep	a		
	1994	7.85	445	1	5		
	1995			Dry			
UJV 2	1993	a	a	Seep	a		
	1994			Dry			
	1995			Dry			
UJV 3	1993			Dry			
	1994	7.55	566	4	4		
	1995			Dry			
UJV 3A	1993	7.86	430	0.5	5		
	1994	8.27	461	1	6		
	1995	7.82	358	0.5	4		
UJV 4	1993	a	a	Seep	a		
	1994	7.49	606	5	4		
	1995			Damp			
UJV 4A	1993	a	a	0.25	4		
	1994	a	a	Seep	a		
	1995	7.44	392	0.25	3		
UJV 5	1993	a	a	Seep	a		
	1994			Dry			
	1995			Damp			
UJV 6	1993	a	a	Seep	a		
	1994			Dry			
	1995	a	a	Seep	2		
UJV 6A	1993	a	a	Seep	a		
	1994	7.93	612	1	4		
	1995	a	a	Seep	4		
UJV 7	1993	a	a	Seep	a		
	1994	8.14	515	1.5	4		
	1995			Dry			
UJV 7A	1993	7.57	430	2	5		
	1994	8.11	527	8	4		
	1995	7.36	411	3	5		
UJV 8	1993			Dry			
	1994	7.9	547	9	4		
	1995			Dry			
UJV 8A	1993	7.89	476	1	6		
	1994	7.82	555	10	4		
	1995	7.78	391	1	5		
UJV 8B	1993	7.76	426	1	6		
	1994	7.99	545	2	4		
	1995	7.33	438	10	6		
UJV 8C	1993	7.82	430	4	4		
	1994	7.84	550	4	4		
	1995	a	a	Seep	4		
UJV 9	1993	a	a	Seep	a		
	1994	8.15	572	2	4		
	1995	7.7	361	0.25	2		
UJV 9A	1993	7.93	444	0.25	7		
	1994	8.27	563	1	4		
	1995	7.41	432	5	5		
UJV 10	1993	7.77	484	0.05	4		
	1994	7.82	562	1	5		
	1995	7.47	430	0.5	6		
UJV 11	1993	8.07	445	0.03	4		
	1994	7.86	524	0.5	5		
	1995	7.73	453	1	6		
UJV 12	1993	7.47	602	1	5		
	1994						
	1995	7.79	533	3	4		
UJV 13	1993	7.53	820	<1	5		
	1994	7.76		3	6		
	1995	7.32	516	2	6		
UJV 14	1993	7.72	539	<1	5		
	1994	a	a	Seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995	7.59	533	1	5		
UJV 15	1993	7.84	548	<1	5		
	1994	7.77	794	5	5		
	1995	7.38	534	1	5		
UJV 16	1993	a	a	Seep	a		
	1994	7.8	652	5	5		
	1995	7.15	536	1	5		
UJV 17	1993	7.6	553	<1	5		
	1994	7.9	595	5	5		
	1995	7.96	635	2	4		
UJV 17A	1993						
	1994	7.94	591	2	6		
	1995	7.71	495	1	4		
UJV 20	1993	7.96	562	2	4		
	1994			Dry			
	1995	7.26	505	4	6		
UJV 21	1993	7.87	563	2	4		
	1994	a	a	Seep	a		
	1995	7.85	488	1	5		
UJV 22	1993	7.52	743	Seep	4		
	1994	7.65	615	1	a		
	1995	7.86	473	1	5		
UJV 23	1993	8.02	486	Seep	4		
	1994			Dry	8		
	1995	7.51	450	1	4		
UJV 24	1993	7.83	683	Seep	4		
	1994			Dry			
	1995	8.01	621	2	5		
UJV 25	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	7.45	513	0.5	4		
UJV 26	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	7.31	530	0.25	4		
UJV 27	1993	a	a	Seep	a		
	1994	7.57	540	2	4		
	1995	7.74	555	1	4		
UJV 28	1993	7.61	560	1	4		
	1994	a	a	Seep	a		
	1995	7.4	607	0.25	6		
UJV 29	1993	7.7	444	1	4		
	1994	7.6	559	<.3	4		
	1995	7.7	535	<.3	5		
UJV 30	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	7.82	464	0.5	5		
UJV 31	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	7.99	624	<.3	5		
UJV 32	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	7.8	552	<.3	5		
UJV 33	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	8.02	703	0.25	5		
UJV 34	1993	7.67	485	<.25	4		
	1994	7.6	630	<.3	6		
	1995	7.99	578	<.3	4		
UJV 35	1993	a	a	Seep			
	1994			Dry			
	1995	7.54	594	8	5		
UJV 36	1993	7.89	493	5	4		
	1994	7.54	648	5	4		
	1995	7.27	499	2	6		
UJV 50	1993	a	a	Seep			
	1994	7.88	575	0.5	6		
	1995	7.45	506	1	5		
UJV 52	1993	a	a	Seep			
	1994	7.84	610	3	6		
	1995	7.82	512	1	3		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
UJV 53	1993	a	a	Seep	a		
	1994	8.06	467	0.5	15		
	1995	7.8	773	2	5		
UJV 54	1993	a	a	Seep	a		
	1994	7.85	593	0.5	8		
	1995	7.86	457	1	3		
UJV 55	1993	7.92	556	2			
	1994	7.93	502	1	8		
	1995	7.44	437	2	4		
UJV 55A	1993						
	1994	7.94	501	1	9		
	1995	7.35	433	2	6		
UJV 56	1993	8.24	475	3			
	1994	8.09	487	0.5	16		
	1995	7.84	597	5	2		
UJV 57	1993	8.22	538	2	9		
	1994	8.16	485	1	7		
	1995	7.45	435	2	4		
UJV 58	1993	7.78	493	2	6		
	1994	8.3	587	1	6		
	1995	7.95	458	2	2		
UJV 59	1993	7.98	533	1	10		
	1994	8.09	700	<.3	10		
	1995	7.87	514	4	2		
UJV 60	1993	8.15	519	1.5	10		
	1994	7.82	529	2	8		
	1995	7.38	665	2	4		
UJV 61	1993	8.17	453	1	8		
	1994	7.79	509	2	5		
	1995	7.76	633	1	2		
UJV 62	1993	a	a	Seep	a		
	1994	7.74	523	3	5		
	1995	7.95	485	1	2		
UJV 63	1993	7.56	483	1	6		
	1994	7.74	534	0.5	6		
	1995	7.35	431	0.5	4		
UJV 64	1993	8.03	547	3	8		
	1994	7.77	521	0.5	6		
	1995	7.16	450	0.5	5		
UJV 65	1993	a	a	Seep	a		
	1994	7.71	565	0.5	7		
	1995	7.74	449	1.5	3		
UJV 66	1993	a	a	Seep	a		
	1994	7.72	492	2	8		
	1995	7.76	430	8	3		
UJV 66A	1993						
	1994	a	a	Seep	a		
	1995	7.83	430	10	2		
UJV 67	1993	a	a	Seep	a		
	1994			Dry			
	1995	7.28	441	0.5	6		
UJV 68	1993	a	a	Seep	a		
	1994			Dry			
	1995	7.6	524	3	3		
UJV 69	1993	a	a	Seep	a		
	1994	8.32	469	0.5	8		
	1995	7.59	440	2	3		
UJV 70	1993	8.13	499	3	12		
	1994	8.32	469	0.5	8		
	1995	7.59	440	2	3		
UJV 71	1993	7.99	485	3	10		
	1994			Dry			
	1995	7.72	443	2	3		
UJV 72	1993	a	a	Seep	a		
	1994	8.22	491	0.5	8		
	1995	7.82	435				
UJV 80	1993	a	a	Seep	a		
	1994	7.47	922	1	18		
	1995	7.67	585				
UJV 81	1993	a	a	Seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	7.91	642	<.3	13		
	1995	7.81	574				
UJV 81A	1993						
	1994	7.99	456	1			
	1995	7.25	613				
UJV 82	1993	a	a	Seep	a		
	1994			Dry	11		
	1995	7.36	438				
UJV 83	1993	a	a	Seep	a		
	1994			Dry			
	1995	7.6	424				
UJV 100	1993	7.09	470	Seep	10		
	1994	7.47	300	2	4		
	1995	a	a	Seep	a		
UJV 100A	1993						
	1994						
	1995	a	a	Seep	a		
UJV 100B	1993						
	1994						
	1995	a	a	Seep	a		
UJV 100C	1993						
	1994						
	1995	a	a	Seep	a		
UJV 101	1993	7.18	581	Seep	9		
	1994	a	a	Seep	a		
	1995	7.34	467	<.3	5.9		
UJV 102	1993	7.27	496	Seep	10		
	1994	7.75	320	<.3	8		
	1995						
UJV 102A	1993						
	1994	7.54	325	1	6		
	1995	7.64	500	<.3	5.3		
UJV 103	1993	7.92	368	1	4		
	1994			Dry			
	1995			Ice			
UJV 104	1993	7.89	408	0.25	3		
	1994			1.5	8		
	1995	7.51	481	0.5	5		
UJV 105	1993	8.06	454	2	4		
	1994			0.5	6		
	1995	7.6	504	0.25	5		
UJV 105A	1993						
	1994						
	1995	8.33	457	0.25	5		
UJV 106	1993	7.66	462	Seep	12		
	1994			Seep			
	1995	8.13	558	0.25	5		
UJV 106A	1993						
	1994						
	1995	8.92	489	0.25	5.5		
UJV 106B	1993						
	1994						
	1995	8.17	605	<.3	5.5		
UJV 107	1993	7.65	404	Seep	3		
	1994						
	1995						
UJV 108	1993	7.78	443	1	4		
	1994	8.22	375				
	1995	7.48	405	0.25	4.3		
UJV 109	1993	7.91	473	1	8		
	1994						
	1995	8.07	497	0.75	4		
UJV 109A	1993						
	1994						
	1995	a	a	Seep	a		
UJV 150	1993	7.75	415	0.25	4		
	1994	7.77	290	1	3		
	1995	8.57	538	0.5	6		
UJV 151	1993	8.03	411	0.25	4		
	1994	7.45	300	1	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995	8.23	677	1.5	5		
UJV 152	1993	7.71	517	0.25	6		
	1994	8.21	568	0.5	7		
	1995	7.96	566	0.5	5.5		
UJV 153	1993	8.07	523	0.25	6		
	1994	8.21	568	1	7		
	1995	8.22	565	<.3	6		
UJV 154	1993	7.31	665	Seep	6		
	1994			Dry			
	1995	7.65	481	<.3	6		
UJV 155	1993	7.62	494	Seep	6		
	1994			Dry			
	1995	7.3	460	Seep	1		
UJV 200	1993	7.42	478	1	6		
	1994						
	1995						
UJV 201	1993	7.74	574	1	5		
	1994						
	1995						
UJV 202	1993	8.18	434	5	3		
	1994			3	6		
	1995	7.97	607	<.3	4.5		
UJV 203	1993	8.14	429	1	4		
	1994			5	6		
	1995	8.85	529	<.3	4		
UJV 204	1993	8.08	387	3	7		
	1994	6.87	427	0.5	6		
	1995	7.45	461	<.3	5		
UJV 205	1993	8	430	7	4		
	1994	7.02	507	2	6		
	1995	7.66	467	1.5	4.5		
UJV 206	1993	a	a	Seep	5		
	1994	7.18	491	0.5	8		
	1995	7.32	462	Seep	5		
UJV 207	1993	8.13	448	5	5		
	1994	8.09	553	2	5		
	1995	7.15	504	1.5	6		
UJV 208	1993	7.93	456	6	7		
	1994	8.18	602	5	4		
	1995	7.46	503	3	6		
UJV 209	1993	8.37	401	4	5		
	1994	8.48	528	5	3		
	1995	7.73	509	1.5	6		
UJV 209A	1993	8.32	407	4	7		
	1994	7.04	458	4	7		
	1995	7.43	466	<.3	4.5		
UJV 210	1993	a	a	Seep	a		
	1994	a	a	a	a		
	1995	7.82	428	<.3	5		
UJV 211	1993	a	a	Seep	a		
	1994	a	a	a	a		
	1995	a	a	Seep	a		
UJV 212	1993	7.98	486	1	6		
	1994	7.9	663	2	5		
	1995	7.24	549	0.25	6		
UJV 8B	21-Jun-95	8.35	342				
UJV 8C	21-Jun-95	8.33	380				
UJV 11	21-Jun-95	8.45	333	3	7		
UJV 13	21-Jun-95	7.66	274	3	6		
UJV 14	21-Jun-95	7.6	350	Seep	12		
UJV 17A	21-Jun-95	8.79	400	<1	5		
UJV 3A	21-Jun-95	8.85	330				
UJV 21	21-Jun-95	7.82	333	<1	6		
UJV 22	21-Jun-95	7.8	360	<1	11		
UJV 24	21-Jun-95	8.95	320	Seep	9		
UJV 25	21-Jun-95	9.21	255	Seep	7		
UJV 26	21-Jun-95	8.79	310	Seep			
UJV 27	21-Jun-95	8.43	340	Seep	5		
UJV 28	21-Jun-95	7.7	380	Seep	6		
UJV 35	21-Jun-95	7.69	385	<1	17		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
UJV 36	21-Jun-95	7.85	372	5	6		
UJV 50	21-Jun-95			dr			
UJV 52	21-Jun-95	8.27	356	0.5	7		
UJV 53	21-Jun-95	8.01	310	Seep	7		
UJV 54	21-Jun-95	7.92	341	Seep	8		
UJV 55	21-Jun-95	7.59	320	Seep	15		
UJV 55A	21-Jun-95	8.75	360	3	10		
UJV 56	21-Jun-95	8.33	387	10	7		
UJV 57	21-Jun-95	7.91	310	Seep	12		
UJV 58	21-Jun-95	8.57	437	2	10		
UJV 59	21-Jun-95	8.07	408	2	10		
UJV 60	21-Jun-95	8.03	322	Seep	14		
UJV 61	21-Jun-95	7.66	344	Seep	14		
UJV 62	21-Jun-95	8.07	347	Seep	11		
UJV 63	21-Jun-95	7.94	344	Seep	10		
UJV 64	21-Jun-95			1	7		
UJV 65	21-Jun-95	8.18	308	Seep	16		
UJV 66A	21-Jun-95	7.62	331	1	18		
UJV 68	21-Jun-95	8.04	285	1	5		
UJV 70	21-Jun-95	7.91	360	1	9		
UJV 71	21-Jun-95	7.93	292	Seep	8		
UJV 72	21-Jun-95	7.95	363	Seep	8		
UJV 207	21-Jun-95	8.09	302	3	7		
UJV 208	21-Jun-95	8.45	308	5	4		
UJV 209	21-Jun-95	9.33	365	3	6		
UJV 209A	21-Jun-95	9.33	313	25	4		
UJV 210	21-Jun-95	8.91	322	Seep	7		
UJV 211	21-Jun-95	7.67	320	Seep	7		
UJV 212	21-Jun-95	8.11	342	1	5		
RR1	Sep/Oct 93	7.12	449	0.25	6		
RR2	1993	7.1	468	0.5	2		
	1994	7.46	473	20	2		
	1995	7.85	527	2	3		
RR 2A	1993						
	1994	7.51	481	2	4		
	1995	8.01	543	1	2.5		
RR 2B	1993						
	1994						
	1995	8.04	555	3	5		
RR 3	1993	6.85	451	<.25	8		
	1994	7.17	475	1	3		
	1995			Ice			
RR 3A	1993						
	1994						
	1995	7.88	463	0.5	4.5		
RR 4	1993						
	1994	7.23	551	1	7		
	1995			Dry			
RR 4A	1993						
	1994	6.92	422	15	5		
	1995	7.52	663	5	4		
RR 5	1993						
	1994	7.35	405	2	3.5		
	1995			Dry			
RR 5A	1993						
	1994	6.97	415	8	3		
	1995	8.29	349	2	5.5		
RR 6	1993						
	1994	7	414	<.3	6.5		
	1995	7.78	359	2	5		
RR 6A	1993						
	1994	7	414	2	4		
	1995	7.97	270	<.3	5		
RR 7	1993						
	1994	7.18	357	1.5	4		
	1995	7.58	343	0.25	4.5		
RR 7A	1993						
	1994						
	1995	a	a	Seep	a		
RR 8	1993						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	a	a	Seep	a		
	1995	8.25	375	0.5	7		
RR 8A	1993						
	1994						
	1995	a	a	Seep	a		
RR 9	1993						
	1994	7.24	432	15	4		
	1995	7.68	377	5	5.5		
RR 10	1993						
	1994	7.23	427	15	4.5		
	1995	7.52	521	2	6		
RR 11	1993						
	1994	7.28	476	10	5		
	1995	7.55	510	5	5		
RR 12	1993						
	1994	7.35	476	18	4.5		
	1995	7.61	379	5	5		
RR 13	1993						
	1994	7.31	435	1.5	5		
	1995	7.94	483	0.25	4.5		
RR 14	1993						
	1994	6.99	405	1.5	4		
	1995	7.84	375	7	4.5		
RR 14A	1993						
	1994						
	1995	7.98	532	0.25	5.5		
RR 14B	1993						
	1994						
	1995	7.67	356	1	5		
RR 14C	1993						
	1994						
	1995	7.51	518	0.5	4.5		
RR 15	1993						
	1994	7.06	495	20	2		
	1995	7.8	467	10	4		
RR 16	1993						
	1994	7.09	489	10	2.5		
	1995	7.68	320	0.5	3.5		
RR 17	1993						
	1994						
	1995	a	a	<.3	4		
RR 18	1993						
	1994						
	1995	a	a	Seep	a		
RR 19	1993						
	1994						
	1995			Dry			
RR 20	1993						
	1994						
	1995			Dry			
RR 21	1993						
	1994	8.02	400				
	1995	7.7	334	0.5	4		
RR 22	1993						
	1994						
	1995			Dry			
RR 23	1993						
	1994	8.08	511				
	1995	a	a	Seep	a		
RR 23A	1993						
	1994						
	1995	7.57	378	5	5.5		
RR 24	1993						
	1994						
	1995	7.57	545	0.25	4.5		
RR 25	1993						
	1994						
	1995	7.71	513	0.25	4.5		
RR 26	1993						
	1994						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995	a	a	Seep	a		
RR 27	1993						
	1994	7.73	395				
	1995			Dry			
RR 28	1993						
	1994	7.43	379				
	1995	8.11	403	<.3	3.5		
MF 1	1993	7.96	395	3	4		
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 2	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 3	1993	7.72	436	6	5		
	1994	7.76	500	10	6		
	1995	a	a	Seep	a		
MF 4	1993	7.95	341	Seep	4		
	1994	7.77	334	10	6		
	1995	a	a	Dry	a		
MF 4A	1993						
	1994	7.76	341	10	4.5		
	1995	8.39	285	3	0		
MF 5	1993	8.99	388	Seep	5		
	1994	8.37	381	15	4		
	1995	8.28	316	1	1		
MF 5A	1993	a	a	Seep			
	1994	7.84	441	0.5	4		
	1995	8.08	303	0.25	2		
MF 6	1993	8.4	405	Seep	4		
	1994	7.85	464	8	3		
	1995	7.84	396	1	5		
MF 7	1993	7.78	460	20	4		
	1994	7.79	504	10	6		
	1995	a	a	a	a		
MF 8	1993	7.75	431	17	4		
	1994	7.64	437	9	6		
	1995	a	a	a	a		
MF 9	1993	8.29	362	5	2		
	1994	8.31	412	10	3.5		
	1995	8	322	7	3		
MF 10	1993	7.95	324	0.5	3		
	1994	8.16	356	0.25	5		
	1995	8.4	309	10	2.5		
MF 11	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 12	1993	7.95	341	0.5	2		
	1994	8.13	409	1	5		
	1995	7.98	309	0.25	3		
MF 13	1993	7.62	332	0.5	2		
	1994	8.42	409	1	2.5		
	1995	7.9	351	1	2		
MF 14	1993	7.97	336	0.5	2		
	1994	8.4	399	1	4		
	1995	8.21	287	0.5	3		
MF 14A	1993						
	1994						
	1995	8.29	318	1	2.5		
MF 15	1993	7.98	335	0.5	2		
	1994	8.13	345	0.25	6		
	1995	7.95	403	0.5	5.5		
MF 15A	1993						
	1994	7.79	465	20	4		
	1995	8.18	338	0.25	5		
MF 15B	1993						
	1994	7.9	488	15	2.5		
	1995	a	a	a	a		
MF 16	1993	7.76	371	5	3		
	1994	a	a	a	a		
	1995	7.94	355	0.5	5.5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
MF 17	1993	7.71	392	8	3		
	1994	a	a	a	a		
	1995	8.24	349	0.5	2		
MF 17A	1993						
	1994						
	1995	8.26	273	0.25	6		
MF 18	1993	7.78	403	5	3		
	1994	a	a	a	a		
	1995	7.9	343	1.5	2		
MF 18A	1993						
	1994						
	1995	8.29	294	6	4		
MF 18B	1993						
	1994						
	1995	7.99	275	1	8		
MF 18C	1993						
	1994						
	1995	7.41	437	2	6		
MF 19	1993	7.8	429	2	3		
	1994	8.26	412	3	6		
	1995						
MF 19A	1993						
	1994	7.79	466	0.25	4		
	1995	7.78	327	1	4		
MF 19B	1993						
	1994	8.07	391	0.25	7.5		
	1995	8.37	283	0.5	4		
MF 19C	1993						
	1994	8.16	408	1	5		
	1995	a	a	Seep	a		
MF 19D	1993						
	1994	8.09	477	2	4		
	1995	a	a	Seep	a		
MF 19E	1993						
	1994	8.01	494	0.5	4.5		
	1995	a	a	Dry	a		
MF 19F	1993						
	1994	7.98	519	0.25	6		
	1995	a	a	Dry	a		
MF 19G	1993						
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 19H	1993						
	1994	7.81	539	1.5	5		
	1995	a	a	Dry	a		
MF 19I	1993						
	1994						
	1995	a	a	Dry	a		
MF 20	1993	8.09	437	0.25	3		
	1994	8.18	497	a	a		
	1995	8.25	354	2	5		
MF 21	1993	7.46	430	Seep	a		
	1994	7.87	436	1	6		
	1995	7.77	363	3	4		
MF 22	1993	7.52	436	0.25	3		
	1994	8.22	485	2	3.5		
	1995	8.17	351	3	3		
MF 23	1993	a	a	Seep			
	1994	8.26	453	1	4		
	1995	8.25	355	Seep	3		
MF 24A	1993	a	a	Seep			
	1994	7.95	462	0.5	5		
	1995	7.8	389	2	4		
MF 24B	1993						
	1994	7.71	480	0.25	5		
	1995						
MF 171	1993						
	1994	7.78	366	5	4		
	1995						
MF 172	1993						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	8.06	353	10	5		
	1995						
MF 173	1993						
	1994	8.04	392	10	4		
	1995	7.67	395	0.5	3		
MF 212	1993						
	1994	7.09	605	a	a		
	1995						
MF 214	1994			Dry			
	1995			Dry			
	1996	7.46	276	63.6	10		
MF 216	1994			Dry			
	1995	8.97	795	57.2	8		
	1996	7.31	342	63.6	11		
MF 214	1991			Dry			
	1992			Dry			
	1993	8.5	300	550	4.5		
MF 216	1991			Dry			
	1992			Dry			
	1993	8.5	300	570	4.5		
MF 214	1989			Dry			
	1990			Dry			
MF 216	1989	7.9	535	86	3		
	1990			Dry			
MF 213	1980						
	1981						
	1982	7	215	29			
MF 214	1980	7.74	424	2.56			
	1981						
	1982	8.28	390		12		
MF 215	1980	7.63	573.3	1.43			
	1981	7.76	644.1	0.01			
	1982	7.93	565	0.02			
LB 1	1993	7.95	478	1	6		
	1994			Dry			
	1995						
LB 2	1993	7.95	495	2	4		
	1994	8.12	375	5	7		
	1995						
LB 3	1993	7.89	400	0.25	3		
	1994	8.19	340	1	7		
	1995						
LB 4	1993	8.37	771	0.25	4		
	1994			Dry			
	1995						
LB 5	1993	7.73	425	1	7		
	1994						
	1995						
LB 5A	1993	a	a	Seep	a		
	1994						
	1995						
LB 6	1993	7.83	489	2	6		
	1994						
	1995						
LB 7	1993	7.97	413	1	7		
	1994	a	a	Seep	a		
	1995						
LB 7A	1993	8.05	390	0.5	6		
	1994	7.92	360	0.5			
	1995						
LB 7B	1993	8.09	408	0.5	8		
	1994	7.98	325	0.5			
	1995						
LB 8	1993	8.22	402	0.25	4		
	1994	8.06	290				
	1995						
LB 9	1993	8.17	480	0.5	4		
	1994	7.98	300				
	1995						
LB 9A	1993						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	7.95	300				
	1995						
LB 10	1980						
	1981	7.73	543.3	.69 (cfs)	9		
	1982	7.47	450	.71 (cfs)	8.3		
LB 11	1980						
	1981	8.1	558.6	.01 (cfs)	9.9		
	1982						
LB 12	1980						
	1981						
	1982	7.35	563.5	4.4			
LB 13	1980						
	1981						
	1982	7.95	290.5	1.5			
LB 14	1980	7.6	520				
	1981	8.3	620	.002 (cfs)	20		
	1982	7.45	333	22			
LB 15	1980	7.2	495				
	1981	7.65	547.8				
	1982	7.56	490.7	.66 (cfs)	16		
LB 16	1980	7.4	500				
	1981	8.76	559.2				
	1982	7.8	487.5	.01 (cfs)			
LB 16	1990	7.2	430	282			
	1993	7	561	291			
	1995	7.7	490	300			
EM 50	1993	7.06	392	0.25	4		
	1994						
	1995			Ice			
EM 51	1993	a	a	Seep	a		
	1994						
	1995			Ice			
EM 213	1993	8.19	435	5	5		
	1994	8.37	478	5	5		
	1995	8.35	387	1.5	2.5		
EM 214	1993	8.12	475	2	4		
	1994	8.37	555	2	3		
	1995	7.8	382	<.3	3		
EM 215	1993	a	a	Seep	a		
	1994	8.37	548	<.3	7		
	1995			Dry			
EM 216	1993	a	a	Seep	a		
	1994	8.32	450	<.3	15		
	1995	a	a	Seep	a		
EM 217	1993	a	a	Seep	a		
	1994	8.16	556	<.3	9		
	1995	a	a	Seep	a		
EM 218	1993	8.06	489	1	3		
	1994	a	a	Seep	a		
	1995			Dry			
EM 218A	1993						
	1994	7.91	412	1	5		
	1995						
EM 219	1993	8.14	335	7	4		
	1994	8.04	382	5	4		
	1995			Ice			
EM 220	1993	a	a	Seep	a		
	1994	8.05	388	<.3	4		
	1995			Ice			
EM 221	1993	a	a	Seep	a		
	1994						
	1995	7.46	479	Seep	3.7		
EM 221A	1993						
	1994	a	a	Seep	a		
	1995	a	a	Seep	a		
EM 222	1993	8.1	376	0.25	5		
	1994	7.88	459	0.5	4		
	1995			Ice			
EM 223	1993	8.11	376	<.25	4		
	1994	8	462	<.3	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995			Ice			
EM 224	1993	7.99	391	0.5	10		
	1994	8.39	457	0.5	12		
	1995			Dry			
EM 224Z	1993						
	1994	8.23	535	<.3	15		
	1995			Dry			
EM 225	1993	8.18	367	0.5	3		
	1994	8.07	452	0.5	6		
	1995						
EM 226	1993	7.8	393	2	5		
	1994	8.16	451	0.75	4		
	1995						
EM 227	1993	7.98	347	0.25	5		
	1994	8.13	452	0.25	6		
	1995						
EM 228	1993	8.21	310	0.25	4		
	1994	8.18	407	0.5	4		
	1995						
EM POND 1	1993			3	4		
	1994	8.24	556	6	5		
	1995	7.81	370	0.5	4		
UJV 1	Jun 24-27,96	8.04	438	5	4	TKn	Joe's Valley
UJV 2	Jun 24-27,96	7.61	410	<1	7	TKn	Joe's Valley
UJV 3	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 3A/4A	Jun 24-27,96	7.55	419	13	4	TKn	Joe's Valley
UJV 4	Jun 24-27,96			N/F		TKn	Joe's Valley
UJV 5	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 6	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 6A	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 7	Jun 24-27,96	8.08	418	28	3	TKn	Joe's Valley
UJV 7A	Jun 24-27,96	7.81	492	1	8	TKn	Joe's Valley
UJV 8	Jun 24-27,96	7.68	434	80	8	TKn	Joe's Valley
UJV 8A	Jun 24-27,96			Seep		TKn	Joe's Valley
UJV 8B	Jun 24-27,96	7.95	415	50	7	TKn	Joe's Valley
UJV 8C	Jun 24-27,96	7.5	432	5	8	TKn	Joe's Valley
UJV 9	Jun 24-27,96	7.62	473	70	7	TKn	Joe's Valley
UJV 9A	Jun 24-27,96			Seep		TKn	Joe's Valley
UJV 10	Jun 24-27,96	8.04	424	4	7	TKn	Joe's Valley
UJV 11	Jun 24-27,96	7.84	435	5	8	TKn	Joe's Valley
UJV 12	Jun 24-27,96	7.69	573	25	8	TKn	Joe's Valley
UJV 13	Jun 24-27,96	7.69	541	5	6	Alluvium/Fault	Joe's Valley
UJV 14	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 15	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 16	Jun 24-27,96	7.77	483	<1	7	Alluvium/Fault	Joe's Valley
UJV 17	Jun 24-27,96	7.85	494	<1	5	Alluvium/Fault	Joe's Valley
UJV 17A	Jun 24-27,96	7.71	487	3	5	Alluvium/Fault	Joe's Valley
UJV 20	Jun 24-27,96	7.75	474	2	11	Alluvium/Fault	Joe's Valley
UJV 21	Jun 24-27,96	7.54	434	<1	9	Alluvium/Fault	Joe's Valley
UJV 22	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 23	Jun 24-27,96			Seep		Alluvium/Fault	Joe's Valley
UJV 24	Jun 24-27,96			Seep		Alluvium/Fault	Joe's Valley
UJV 25	Jun 24-27,96	7.79	404	<1	16	Alluvium/Fault	Joe's Valley
UJV 26	Jun 24-27,96	7.87	367	4	11	Alluvium/Fault	Joe's Valley
UJV 27	Jun 24-27,96	7.7	438	<1	5	Alluvium/Fault	Joe's Valley
UJV 28	Jun 24-27,96	7.76	492	3	7	Alluvium/Fault	Joe's Valley
UJV 29	Jun 24-27,96	7.74	498	1	8	Alluvium/Fault	Joe's Valley
UJV 30	Jun 24-27,96	7.77	522	2	7	Alluvium/Fault	Joe's Valley
UJV 31	Jun 24-27,96	7.8	451	5	5	Alluvium/Fault	Joe's Valley
UJV 32	Jun 24-27,96	7.71	473	3	5	Alluvium/Fault	Joe's Valley
UJV 33	Jun 24-27,96	7.88	401	<1	12	Alluvium/Fault	Joe's Valley
UJV 34	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 35	Jun 24-27,96	7.76	403	8	10	Alluvium/Fault	Joe's Valley
UJV 36	Jun 24-27,96	7.74	475	2	7	TKn	Joe's Valley
UJV 50	Jun 24-27,96	8.13	508	1	7	Alluvium/Fault	Joe's Valley
UJV 52	Jun 24-27,96	8.1	480	1	15	Alluvium/Fault	Joe's Valley
UJV 53	Jun 24-27,96	8.06	397	3	5	Alluvium/Fault	Joe's Valley
UJV 54	Jun 24-27,96	8.05	421	2	7	Alluvium/Fault	Joe's Valley
UJV 55	Jun 24-27,96	8.01	403	4	8	Alluvium/Fault	Joe's Valley
UJV 55A	Jun 24-27,96	8.1	440	2	9	Alluvium/Fault	Joe's Valley

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
UJV 56	Jun 24-27,96	7.9	462	4	4	Alluvium/Fault	Joe's Valley
UJV 57	Jun 24-27,96	8.19	450	2	6	Alluvium/Fault	Joe's Valley
UJV 58	Jun 24-27,96	8.18	379	35	11	Alluvium/Fault	Joe's Valley
UJV 59	Jun 24-27,96	7.85	459	25	9	Alluvium/Fault	Joe's Valley
UJV 60	Jun 24-27,96	7.49	764	3	11	Alluvium/Fault	Joe's Valley
UJV 61	Jun 24-27,96	8.08	423	60	8	Alluvium/Fault	Joe's Valley
UJV 62	Jun 24-27,96	8	468	2	4	Alluvium/Fault	Joe's Valley
UJV 63	Jun 24-27,96	8.05	465	4	6	Alluvium/Fault	Joe's Valley
UJV 64	Jun 24-27,96	8.13	407	2	7	Alluvium/Fault	Joe's Valley
UJV 65	Jun 24-27,96	7.99	549	12	6	Alluvium/Fault	Joe's Valley
UJV 66	Jun 24-27,96	7.99	411	5	10	Alluvium/Fault	Joe's Valley
UJV 66A	Jun 24-27,96	7.8	466	18	12	Alluvium/Fault	Joe's Valley
UJV 67	Jun 24-27,96	7.94	610	10	9	Alluvium/Fault	Joe's Valley
UJV 68	Jun 24-27,96	8.06	441	8	7	Alluvium/Fault	Joe's Valley
UJV 69/70	Jun 24-27,96	8.18	405	60	11	Alluvium/Fault	Joe's Valley
UJV 71	Jun 24-27,96	8.15	435	10	9	Alluvium/Fault	Joe's Valley
UJV 72	Jun 24-27,96	7.95	439	3	7	Alluvium/Fault	Joe's Valley
UJV 80	Jun 24-27,96	7.67	532	5	5	Alluvium/Fault	Joe's Valley
UJV 81	Jun 24-27,96	7.73	596	2	7	Alluvium/Fault	Joe's Valley
UJV 81A	Jun 24-27,96	7.72	594	2	4	Alluvium/Fault	Joe's Valley
UJV 82	Jun 24-27,96	7.9	402	7	9	Alluvium/Fault	Joe's Valley
UJV 83	Jun 24-27,96	7.84	397	6	17	Alluvium/Fault	Joe's Valley
UJV 100	Jun 24-27,96						
UJV 100A	Jun 24-27,96	7.99	343	3	5	TKn	~300'
UJV 100B	Jun 24-27,96	7.83	402	4	5	KP	Flows to canyon mouth
UJV 100C	Jun 24-27,96	7.85	462	8	5	Kp	Flows to canyon mouth
UJV 101/102	Jun 24-27,96	8.12	430	20	6	Kc	Same spring
UJV 102A	Jun 24-27,96			N/F		Kc/Alluvium?	Disappears into alluvium
UJV 103	Jun 24-27,96	7.98	356	7	2	TKn	~100'
UJV 104	Jun 24-27,96	8.03	426	15	5	TKn	To stream
UJV 105	Jun 24-27,96	8.12	444	5	4	TKn	To stream
UJV 106	Jun 24-27,96	8.41	422	1	7	Kp	To stream
UJV 106A	Jun 24-27,96	8.03	455	2	5	Kp	~100'
UJV 106B	Jun 24-27,96	7.85	372	<1	6	Kp	~100'
UJV 107	Jun 24-27,96	7.91	460	4	5	TKn	To stream
UJV 108	Jun 24-27,96	7.75	488	10	5	TKn	To stream
UJV 109	Jun 24-27,96	8.09	505	10	5	Kp/Kc?	~200-300'
UJV 109A	Jun 24-27,96	8.04	516	<1	10	Kp	~50'
UJV 109B	Jun 24-27,96	8.05	479	10	4	Kp/Kc	~200-300'
UJV 150	Jun 24-27,96	8.05	451	7	7	Kp	~200-300'
UJV 151	Jun 24-27,96	7.85	491	10	6	Kp	~200-300'
UJV 151B	Jun 24-27,96	7.93	413	10	5	Kp?	~200-300'
UJV 152	Jun 24-27,96	7.95	531	18	5	Kc	To stream
UJV 153	Jun 24-27,96	8.02	459	5	6	Kc	To stream
UJV 154	Jun 24-27,96	8.04	416	<1	6	Kp	~100-200'
UJV 155	Jun 24-27,96	8.16	435	1	8	Kp	~100-200'
UJV 202	Jun 24-27,96	7.96	490	2	4	TKn	To stream
UJV 203	Jun 24-27,96	8.01	573	1	6	TKn/Kp	To stream
UJV 204	Jun 24-27,96	8.09	397	15	5	Kp	~300-400'
UJV 205	Jun 24-27,96	8.16	517	15	5	Kp	To cliff base
UJV 206	Jun 24-27,96	8.1	432	1		Kp	~200-300'
UJV 207	Jun 24-27,96	7.93	459	20	4	Kp	To stream
UJV 208	Jun 24-27,96	7.87	458	45	4	Kc	To stream
UJV 209	Jun 24-27,96			Dry		Kp?	To stream
UJV 209A	Jun 24-27,96	8.06	441	15	6	Kp	To stream
UJV 210	Jun 24-27,96			Dry		Kc	
UJV 211	Jun 24-27,96	7.88	460	2	6	Kc	To stream
UJV 212	Jun 24-27,96	7.84	492	3	5	Kc	To stream
EM POND	Jun 24-27,96	8.27	403	20	3	TKn	~200-300'
EM 50	Jun 24-27,96	7.67	311	10	3	TKn	To stream
EM 51	Jun 24-27,96	7.7	316	20	3	TKn	To stream
EM 213	Jun 24-27,96	7.91	433	23	5	Kp	To stream
EM 214	Jun 24-27,96	8.18	397	8	4	Kp	To stream
EM 215	Jun 24-27,96			N/F		Kp	~50'
EM 216	Jun 24-27,96	8.18	482	3	6	Kp	~100'
EM 217	Jun 24-27,96			Seep		Kp	~100'
EM 218	Jun 24-27,96			Dry		Kp	~100'
EM 219	Jun 24-27,96	8.25	361	15	3	TKn	Unknown
EM 220	Jun 24-27,96	7.93	411	1	5	TKn	Unknown
EM 221	Jun 24-27,96	8	390	8	5	Base of Tf	<50'

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
EM 221A	Jun 24-27,96	8.05	317	1	5	Base of Tf	~100'
EM 221B	Jun 24-27,96	7.92	281	6	4	Base of Tf	~100'
EM 222	Jun 24-27,96	8.17	481	2	7	TKn	~100'
EM 223	Jun 24-27,96	8.19	406	1	10	TKn	~100'
EM 224	Jun 24-27,96	8.19	412	3	7	TKn	~100'
EM 224Z	Jun 24-27,96	8	386	12	3	TKn	~100'
EM 225	Jun 24-27,96					TKn	Same as EM-228
EM 226	Jun 24-27,96					TKn	Same as EM-228
EM 227	Jun 24-27,96					TKn	Same as EM-228
EM 228	Jun 24-27,96	7.72	357	3	3	TKn	~300-500'
MF 1	Jun 24-27,96	7.71	310	10	6	Base of TKn	To stream
MF 2	Jun 24-27,96			N/F		Base of Kc?	To stream
MF 3	Jun 24-27,96	7.95	470	50	7	Kb	To stream
MF 4	Jun 24-27,96	7.96	466	1	3	Kp	To stream
MF 4A	Jun 24-27,96			Seep		Kp	To stream
MF 5	Jun 24-27,96	7.77	281	30	4	Kp	Unknown
MF 5A	Jun 24-27,96	7.95	297	7	4	Kp	Unknown
MF 6	Jun 24-27,96	8.35	343	8	4	TKn	To stream
MF 7	Jun 24-27,96	7.6	489	30	4	Kb	To stream
MF 7A	Jun 24-27,96	7.72	350	2		Kb	To stream
MF 8	Jun 24-27,96						No spring where marked
MF 8A	Jun 24-27,96	7.66	382	1	6	Kb	To stream
MF 9	Jun 24-27,96	8.13	310	7	4	TKn	To stream
MF 10	Jun 24-27,96	8.33	291	10	5	TKn	To stream
MF 11	Jun 24-27,96	8.31	289	<1	4	TKn	~100-200'
MF 12	Jun 24-27,96	8.36	336	1	4	TKn	~100-200'
MF 13	Jun 24-27,96	8.31	360	1	4	TKn	~100-200'
MF 14	Jun 24-27,96	8.28	351	1	5	TKn	~100-200'
MF 14A	Jun 24-27,96	8.03	334	2	6	TKn	~100-200'
MF 14B	Jun 24-27,96	8.29	317	4	9	TKn	~100-200'
MF 15	Jun 24-27,96	8.31	341	1	5	TKn	To stream?
MF 15A	Jun 24-27,96	8.08	365	3	5	TKn	To stream
MF 15B	Jun 24-27,96	8.04	393	3	4	TKn	To stream
MF 16	Jun 24-27,96	7.98	419	7	4	TKn	To stream
MF 17	Jun 24-27,96	8.23	384	2	10	TKn	To stream
MF 17A	Jun 24-27,96	8.14	395	15	5	TKn	To stream
MF 17X	Jun 24-27,96	8.14	478	<1	6	TKn	Unknown
MF 18	Jun 24-27,96	8.23	328	2	5	TKn	To stream
MF 18A	Jun 24-27,96	8.28	414	12	9	TKn	~200-300'
MF 18B	Jun 24-27,96	8.23	389	6	5	TKn	~200-300'
MF 18C	Jun 24-27,96	7.99	517	12	4	TKn	To stream
MF 18D	Jun 24-27,96			N/F			Unknown
MF 19A	Jun 24-27,96	8.27	352	1	4	TKn	To stream?
MF 19B	Jun 24-27,96	8.33	393	1	5	TKn	To stream?
MF 19C	Jun 24-27,96	7.73	355	4	4	TKn	To stream?
MF 19D	Jun 24-27,96	7.85	408	1	4	TKn	~100-200'
MF 19E	Jun 24-27,96	7.78	405	5	4	TKn	~100-200'
MF 19F	Jun 24-27,96	7.8	447	3	6	TKn	~100-200'
MF 19G	Jun 24-27,96	7.79	410	<1	7	TKn	~100-200'
MF 19H	Jun 24-27,96	7.76	450	10	4	TKn	~500'
MF 19I	Jun 24-27,96	8.06	395	2	3	TKn	~500'
MF 19J	Jun 24-27,96	7.89	408	3	3	TKn	Unknown
MF 19K	Jun 24-27,96	7.93	374	15	4	TKn	~200-300'
MF 20	Jun 24-27,96	7.92	414	15	4	Kp	Unknown
MF 21	Jun 24-27,96	8.02	428	5	4	TKn/Kp	To stream
MF 22	Jun 24-27,96	7.93	422	25	4	TKn/Kp	~100'
MF 23	Jun 24-27,96	8.02	381	15	4	TKn/Kp	To stream
MF 24	Jun 24-27,96			N/F		Kc	Unknown
MF 24A	Jun 24-27,96			N/F		Kc	Unknown
MF 24B	Jun 24-27,96			N/F		Kc	Unknown
RR 2	Jun 24-27,96	7.74	413	8	3	TKn	To stream
RR 2A	Jun 24-27,96	8.36	370	15	2	TKn	To stream
RR 2B	Jun 24-27,96	8.05	317	12	3	TKn	To stream
RR 2C	Jun 24-27,96	7.65	418	3	1	TKn	Unknown
RR 3	Jun 24-27,96	7.64	470	20	4	TKn/Kp	To stream
RR 3A	Jun 24-27,96	8.08	480	15	4	TKn/Kp	To stream
RR 3B	Jun 24-27,96	7.54	478	12	4	TKn/Kp	To stream
RR 4	Jun 24-27,96	7.5	480	30	4	TKn	To stream
RR 4A	Jun 24-27,96	8.62	466	15	5	TKn	To stream
RR 5	Jun 24-27,96	7.79	347	2	3	TKn	~50-100'

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
RR 5A	Jun 24-27,96	7.66	426	5	10	TKn	To stream
RR 6	Jun 24-27,96	7.71	359	10	4	TKn	To stream
RR 6A	Jun 24-27,96	7.82	312	1	4	TKn	To stream
RR 7	Jun 24-27,96	7.56	353	3	4	TKn	To stream
RR 7A	Jun 24-27,96	7.84	328	1	8	TKn	To stream
RR 8	Jun 24-27,96	7.8	395	3	4	TKn	To stream
RR 8A	Jun 24-27,96			N/F		TKn	Unknown
RR 9	Jun 24-27,96	7.56	368	10	4	TKn	To stream
RR 10	Jun 24-27,96	7.73	386	18	4	TKn	To stream
RR 11	Jun 24-27,96	7.59	418	12	4	TKn	To stream
RR 12	Jun 24-27,96	7.49	388	25	4	TKn	To stream
RR 13	Jun 24-27,96	7.53	355	5	5	TKn	~100-200'
RR 14	Jun 24-27,96	8.21	363	20	3	TKn	To stream
RR 14A	Jun 24-27,96	8.08	367	3	6	TKn	To stream
RR 14B	Jun 24-27,96	7.75	707	12	4	TKn	To stream
RR 14C	Jun 24-27,96	7.68	391	3	3	TKn	To stream
RR 15	Jun 24-27,96	7.9	313	50	3	TKn	To stream
RR 16	Jun 24-27,96	7.88	344	40	4	TKn	To stream
RR 17	Jun 24-27,96			Seep		TKn	~100-200'
RR 18	Jun 24-27,96	7.85	348	5	3	TKn	~50'
RR 19	Jun 24-27,96	7.44	321	1	4	TKn	~50'
RR 20	Jun 24-27,96	7.89	333	4	4	TKn	~50'
RR 21	Jun 24-27,96			Seep		TKn	~20'
RR 22	Jun 24-27,96	7.8	337	2	4	TKn	~20'
RR 23	Jun 24-27,96	7.86	403	3	4	TKn	~20'
RR 23A	Jun 24-27,96	7.84	375	40	3	TKn	~20'
RR 24	Jun 24-27,96	7.5	365	10	4	TKn	~50'
RR 25	Jun 24-27,96	7.83	404	1	3	TKn	~50'
RR 26	Jun 24-27,96	7.93	335	<1	6	TKn	~20'
RR 27	Jun 24-27,96	7.8	302	4	2	TKn	~100'
RR 28	Jun 24-27,96	7.91	319	4	3	TKn	To stream
RR 29	Jun 24-27,96	7.78	338	1	4	TKn	~50'
SP 2-1	Jun 24-27,96	8.14	392	31	3	TKn	To stream
SP 1-33	Jun 24-27,96	8.07	395	25	8	TKn	Unknown
SP 1-47	Jun 24-27,96	7.89	419	4	3	TKn	Unknown
LB 1	Jun 24-27,96					Kc	Unknown
LB 2	Jun 24-27,96	7.78	415			Kc	Unknown
LB 3	Jun 24-27,96	7.79	393			Kb	Unknown
LB 4	Jun 24-27,96					Kb	Unknown
LB 5	Jun 24-27,96	7.67	440	15	7	Kp	To stream
LB 5A	Jun 24-27,96	7.98	436	15	7	Kb	To stream
LB 6	Jun 24-27,96			Dry		Kp	~20'
LB 7	Jun 24-27,96			Seep		Kc	~200-300'
LB 7A	Jun 24-27,96			Seep		Kc	~200-300'
LB 7B	Jun 24-27,96	7.77	498	1	9	Kc	~200-300'
LB 8	Jun 24-27,96	7.92	428			Kp	Unknown
LB 9	Jun 24-27,96					Kp	Unknown
LB 9A	Jun 24-27,96					Kc	Unknown
SP-1	Jun-85			seep		Ksp over Masuk Shale of Mancos Shale	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-2	Jun-85			seep		Ksp over Masuk Shale of Mancos Shale	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-3	Jun-85	8.12	730	4	17	Ksp	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-4	Jun-85	7.86	660	6	10	Colluvium at head of landslide in Kbh	Wildlife
	Oct-85			seep			
	Sep/Oct 93			seep			
SP-5	Jun-85			seep		Colluvium at head of landslide in Kbh	None
	Oct-85			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Sep/Oct 93			seep			
SP-6	Jun-85	7.67	590	5	4.5	Kbh	Wildlife
	Oct-85			dry			
	Jun-93			seep			
	Sep/Oct 93			dry			
SP-7	Jun-85	8.36	440	10	10	Kc	Wildlife
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	8.31	379	4	6		
	Oct/Nov 90						
	Jun-91			dry	a		
	Oct/Nov 91			dry	a		
SP-8	Jun-85	7.95	280	20	3.5	Kc	Wildlife
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	8.21	194	5	4		
	Oct/Nov 90						
	Jun-91	8.07	176	20	2		
	Oct/Nov 91	7.63	428	2	3		
SP-9	Jun-85			seep		Kc/Kbh interface	None
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	8.35	306	5	4		
	Oct/Nov 90						
	Jun-91		seep	seep	4		
	Oct/Nov 91			0.5	4		
SP-10	Jun-85	7.9	220	40	10	Kc	Wildlife
	Oct-85			seep			
	Oct-89			dry			
	Jun-90	7.62	244	5	3		
	Oct/Nov 90						
	Jun-91		seep	seep	5		
	Oct/Nov 91	8.19	354	1	4		
SP-11	Jun-85		a	seep	a	Kc	None
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	7.87	126	1	10		
	Oct/Nov 90						
	Jun-91	7.32	202	2.5	4		
	Oct/Nov 91		a	0.1	5		
SP-12	Jun-85	7.66	250	15	3	Kpr	Wildlife
	Oct-85		a	seep	a		
	Oct-89			dry			
	Jun-90	8	112	5	3		
	Oct/Nov 90						
	Jun-91		seep	seep	5		
	Oct/Nov 91						
SP-13	Jun-85	8.57	100	3	7	Kpr	Wildlife
	Oct-85			dry			
	Oct-89		a	seep	a		
	Jun-90	7.91	187	3	6		
	Oct/Nov 90						
	Jun-91		seep	seep	6		
	Oct/Nov 91		a	0.1	6		
SP-14	Jun-85	8.1	150	25	5.5	Kpr	Wildlife
	Oct-85	7.74	340	1	6		
	Oct-89	7.8	380	1	6		
	Jun-90	7.77	150	10	4		
	Oct/Nov 90						
	Jun-91	8.38	301	1.5	6		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct/Nov 91	7.87	360	0.1	5		
SP-14a	Jun-90	7.89	280	1.5	4	Kpr	Wildlife
	Oct/Nov 90						
	Jun-91	7.56	259	2	5		
	Oct/Nov 91						
	Jun-93	8.27	0.55	8	3		
	Sep/Oct 93	8.4	301	3	4		
SP-14b	Jun-90	7.74	306	1.5	4	Kpr	Wildlife
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91						
SP-15	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP-16	Sep/Oct 93	a	a	seep		Kbh	Wildlife
	Jun-85	8.34	560	1	14.5		
	Oct-85			dry			
	Jun-93	8.35	462	1/5	8		
SP-17	Jun-85	7.71	460	2	10	Kbh	Wildlife
	Oct-85			dry			
	Jun-93	8.48	407	3	10		
	Sep/Oct 93			dry			
SP-18	Jun-85	7.42	500	10	7	Ksp	Wildlife
	Oct-85	8.15	450	2	3		
	Jun-93	8.5	447	<1/8	8		
	Sep/Oct 93	a	a	seep			
SP-19	Jun-85	7.6	620	5	6.5	Kbh	None
	Oct-85	8.27	530	1	3.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP-20	Jun-85		a	seep	a	Ksp	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-21	Jun-85	8.53	820	2	13.5	Ksp	Wildlife
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-22	Jun-85	8.05	230	4	3.5	Kbh	None
	Oct-85	7.32	350	1	3.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-22a	Jun-85					Kbh/Tufa deposits	Wildlife
	Oct-85						
	Jun-93	7.96	472	0.5	4		
	Sep/Oct 93	a	a	seep			
SP-23	Jun-85	8.02	550	5	6	Kbh	None
	Oct-85	8.08	670	2	3.5		
	Jun-93	8.19	498	0.5	10		
	Sep/Oct 93	a	a	seep			
SP-24	Jun-85	7.35	790	2	6	Kbh	Wildlife
	Oct-85			dry			
	Jun-93	8.54	555	10	8		
	Sep/Oct 93	a	a	seep			
SP-25	Jun-85	6.8	820	<1	10	Ksp	None

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-25a	Jun-85					Ksp	None
	Oct-85						
	Sep/Oct 93			dry			
SP-26	Jun-85		a	seep	a	Ksp	None
	Oct-85		a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-27	Jun-85		a	seep	a	Ksp	None
	Oct-85		a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-28	Jun-85		a	seep	a	Ksp	None
	Oct-85			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-29	Jun-85		a	seep	a	Ksp	None
	Oct-85			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-30	Jun-85	8.1	1150	1	16.5	Kbh	None
	Oct-85	8.19		<1	4		
	Sep/Oct 93		1060	dry			
SP-31	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-32	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-33	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-34	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-35	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-36	Jun-85	8.39	890	2	16	Kbh	Wildlife
	Oct-85	7.85	950	1	4		
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-37	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-38	Jun-85	8.22	1180	<1	9	Kbh	Wildlife
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-39	Jun-85		a	seep	a	Kbh	None

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-85			dry			
	Jun-93	8.64	718	2	8		
	Sep/Oct 93			dry			
SP-40	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-41	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-42	Jun-85		a	seep	a	Kbh	Wildlife
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-43						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-44						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-45						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-46						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-47						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-47a	Jun-85						Developed
	Oct-85						
	Jun-91	7.81	368	2	5		
	Oct/Nov 91	7.67	345	0.1	6		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct/Nov-90						
	Sep/Oct 93	a	a	seep			
SP-48						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91	7.68	342	dry			
	Oct/Nov 91	7.04		dry			
SP-48a						Kbh	None
	Jun-85						
	Oct-85						
	Jun-90	8.19	602	2	6		
	Oct/Nov-90						
	Jun-91	7.84	362	dry			
	Oct/Nov 91			dry			
SP-48b						Kbh	None
	Jun-90	7.59	642	1.5	6		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-49						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			
SP-50						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91	7.61	381	2.5	6		
	Oct/Nov 91			dry			
SP-51						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-52						Kbh	Wildlife
	Jun-85	7.99	600	1	12		
	Oct-85	8	540	1	7		
	Oct-89	8.3	392	<<1	6.7		
	Jun-90	8.6	545	<1	11		
	Oct/Nov-90			dry			
	Jun-91	8.12	337	0.25	5		
	Oct/Nov 91	8.06	602	0.5	6		
SP-53						Kbh	Wildlife
	Jun-85	7.31	490	8	5.5		
	Oct-85	7.95	470	5	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-89			dry			
	Jun-90	7.91	506	<1	6		
	Oct/Nov-90	8.18	236	4	5		
	Jun-91	7.42	536	dry			
	Oct/Nov 91			dry			
SP-54						Kbh	Wildlife
	Jun-85	7.35	500	15	5.5		
	Oct-85	8.07	500	5	5.5		
	Oct-89	8.47	352	<<1	2.2		
	Jun-90	8.23	536	2	5		
	Oct/Nov-90			dry			
	Jun-91	7.5	333	3	4		
	Oct/Nov 91	8.44	550	5	4		
SP-55						Kbh	Wildlife
	Jun-85	7.36	480	10	5.5		
	Oct-85	7.59	530	10	5.5		
	Oct-89		a	seep	a		
	Jun-90	7.97	466	5	6		
	Oct/Nov-90			dry			
	Jun-91	7.95	314	8	4		
	Oct/Nov 91		a	seep	a		
SP-56						Kbh	Wildlife
	Jun-85	7.61	490	15	5.5		
	Oct-85	7.9	470	15	6.5		
	Oct-89		a	seep	a		
	Jun-90	7.99	536	5	6		
	Oct/Nov-90			dry			
	Jun-91	7.83	512	3	4		
	Oct/Nov 91	8.36	483	1	7		
SP-57						Kbh	Wildlife
	Jun-85	7.35	480	6	5.5		
	Oct-85	7.56	470	4.5	4.5		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90		b	b			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-57a						Kbh	Wildlife
	Jun-85						
	Oct-85						
	Oct-89						
	Jun-90						
	Oct/Nov-90						
	Jun-91	7.24	331	1	4		
	Oct/Nov 91						
SP-58						Kbh	Wildlife
	Jun-85	7.4	500	10	5		
	Oct-85	7.7	500	5	9		
	Oct-89	7.88	470	4	5.6		
	Jun-90	7.79	437	20	5		
	Oct/Nov-90	8.27	466	6	5		
	Jun-91	7.46	318	15	4		
	Oct/Nov 91	7.95	481	5	5		
SP-59						Kbh	Wildlife
	Jun-85	7.43	690	1	7		
	Oct-85	7.86	520	1	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-60						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91						
SP-61						Kpr	Wildlife
	Jun-85	7.36	450	15	2		
	Oct-85	8.16	450	1	9		
	Oct-89			dry			
	Jun-90	8.28	362	3	4		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91						
SP-62						Kpr	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91						
SP-63						Kpr	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.49	458	0.75	2		
	Oct/Nov 91						
SP-64						Kpr	Wildlife
	Jun-85	7.33	440	10	3		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	7.81	376	2	5		
	Oct/Nov-90						
	Jun-91	7.6	451	0.5	2		
	Oct/Nov 91						
	Jun-93	8.34	1180	5	5		
SP-65						Kpr	Wildlife
	Jun-85	7.43	430	15	5		
	Oct-85	8.18	500	<1	3.5		
	Jun-93	8.3	1170	5	6		
SP-66						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
SP-67						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
SP-68						Kc	None
	Jun-85		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-85			dry			
	Jun-93	8.16	444	10	6		
SP-69						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	8.1	473	10	5		
SP-70						Kpr	Wildlife
	Jun-85	7.17	550	15	3.5		
	Oct-85		a	seep	a		
	Jun-93	8.33	430	10	6		
SP-71						Kc	None
	Jun-85		a	seep	a		
	Oct-85		a	seep	a		
	Jun-93	8.08	468	2	5		
SP-72						Kpr	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	8.27	445	0.5	7		
SP-73						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	8.26	417	10	5		
SP-74						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-75						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-76						Kbh	Wildlife
	Jun-85	7.48	960	1	10		
	Oct-85	8.35	850	1	5		
	Jun-93			dry			
SP-77						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
SP-78						Ksp	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-79						Ksp	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-80						Ksp	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	a	a	seep	a		
SP1-1						Alluvium/valley floor	Wildlife
	Jul-87	7.71	360	<<1	2.9		
	Oct-87	7.24	440	3	7		
	Oct-89		a	seep	a		
	Jun-90	8.16	437	<1	7		
	Oct/Non-90	7.43	418	seep	8		
	Jun-91	7.6	1740	0.5	9		
	Oct/Nov 91	8.1	384	dry			
	Jun-92	7.38	247	seep	a		
	Oct-92			dry			
SP1-2						Alluvium/valley floor	Developed
	Jul-87	7.81	280	2	4		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.61	214	2.5	9		
	Oct/Nov-90		b	b			
	Jun-91		a	0.5	5		
	Oct/Nov 91	8.05	341	b	b		
	Jun-92		a	seep	a		
	Oct-92	7.98	517	semi-frozen	0		
	Jun-93			b			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-2a	Jul-87	7.8	280	5	4	Alluvium/valley floor	Wildlife
	Oct-87	7.97	320	1	7		
	Oct-89	8.68	292	<<1	2.9		
	Jun-90	7.87	202	3	3		
	Oct/Nov 91	8.1	291	1	2		
	Jun-91	8.17	314	7	2		
	Jun-92						
	Oct-92						
	Oct/Nov 90	8.21	264	seep	1		
	Sep/Oct 93	8.34	298	5	4		
SP1-2b	Jun-91	7.56	219	2	3	Alluvium/valley floor	None
	Oct/Nov 91			dry			
	Jun-92						
	Oct-92						
SP1-3						Kpr	Developed
	Jul-87	7.61	190	<1	2		
	Oct-87	7.61	250	<1	2		
	Oct-89	7.7	280	<<1	2.8		
	Jun-90	8.1	164	3	3		
	Oct/Nov-90	7.88	249	b	2		
	Jun-91	7.49	304	0.5	5		
	Oct/Nov 91		b	b	b		
	Jun-92						
	Oct-92						
SP1-3a	Jun-91	7.8	191	0.5	3	Alluvium/valley floor	None
	Oct/Nov 91			dry			
	Sep/Oct 93	7.7	275	1	4		
SP1-4						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.37	257	<1	3		
	Oct/Nov-90			dry			
	Jun-91	7.56	326	5	6		
	Oct/Nov 91	8.3	456	2	5		
	Jun-92						
	Oct-92						
SP1-4a	Jun-91	8.26	376	1	12	Kbh	Wildlife
	Oct/Nov 91		a	seep	a		
	Jun-92	8.16	564	seep	a		
	Oct-92			dry			
	Jun-93	8.63	214	25	5		
	Sep/Oct 93	8.19	344	2	6		
SP1-4a1	Jun-92		a	seep	a	Kbh	None
	Oct-92	a	a	seep	a		
	Sep/Oct 93	a	a	seep	a		
SP1-4b	Jun-91					Kpr	None
	Oct/Nov 91		a				
	Jun-93	7.83	244	15	5		
	Sep/Oct 93	8.52	351	6	6		
SP1-4b1	Jun-92		a	seep	a	Kbh	None
	Oct-92	a	a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.92	305	3	6		
SP1-4c	Jun-92		a	seep	a	Kbh	None
	Oct-92	8.21	517	7	7		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	8.21	362	4	5		
SP1-5						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-89			dry			
	Jun-90	7.97	169	<1	4		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91		a	0.25	8		
SP1-6						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.14	346	<1	4		
	Oct/Nov-90		a	seep	a		
	Jun-91	8.26	150	15	5		
	Oct/Nov 91	8.14	316	1.5	5		
SP1-7						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	7.72	348	<1	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.8	282	0.25	5		
	Oct/Nov 91	8.24	498	0.5	8		
SP1-8						TKfn	Wildlife
	Jul-87	7.54	420	<<1	11		
	Oct-87			dry			
	Oct-89	7.99	282	<<1	5.6		
	Jun-90	7.22	197	1	10		
	Oct/Nov-90		a	seep	6		
	Jun-91	8.05	299	15	3		
	Oct/Nov 91			dry	a		
SP1-9						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90	7.84	260	1.5	4		
	Oct/Nov-90		a	seep	8		
	Jun-91	7.59	164	7	3		
	Oct/Nov 91		a	1	7		
SP1-10						TKfn/Kpr	Wildlife
	Jul-87		a	seep			
	Oct-87		a	seep			
	Oct-89			dry			
	Jun-90	7.87	311	2	4		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91		a	0.5	2		
SP1-10a	Oct-89			b		Kpr	Wildlife
	Jun-90		a	dry			
	Jun-91	7.91	259	dry			
	Oct/Nov 91	8.2	458	0.5	7		
	Jun-93	8.33	329	5	3		
	Sep/Oct 93	8.42	290	2	5		
SP1-10b	Jun-90	7.92	281	4		TKfn/Kpr	Wildlife
	Oct/Nov-90			4			
	Jun-91	7.73	320	25	3		
	Oct/Nov 91			dry			
	Jun-93	8.02	404	<1/8	5		
	Sep/Oct 93	8.29	293	1	7		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-11						TKfn	Developed
	Jul-87	7.76	360	3	4		
	Oct-87			dry			
	Oct-89			b			
	Jun-90	7.69	352	5	4		
	Oct/Nov-90			dry			
	Jun-91	8.07	365	0.5	4		
	Oct/Nov 91		a	1	4		
SP1-12						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89	8.09	340	<<1	3.3		
	Jun-90	7.88	350	10	5		
	Oct/Nov-90			dry			
	Jun-91	7.37	320	30	3		
	Oct/Nov 91		b	b	b		
SP1-13						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90		a	3	6		
	Oct/Nov-90		a	seep	a		
	Jun-91		a	seep	a		
	Oct/Nov 91		a	seep	a		
	Jun-92						
	Oct-92						
SP1-13a						TKfn	Wildlife
	Jun-90	8.13	420	2	5		
	Oct/Nov-90			5	6		
	Jun-91	7.22	a	seep	a		
	Oct/Nov 91						
	Jun-93	8.26	362	<1/8	10		
	Sep/Oct 93	8.59	280	4	6		
SP1-13b						TKfn	Wildlife
	Jun-90	7.83	539	5	3		
	Oct/Nov-90			1	5		
	Jun-91		156	5	4		
	Oct/Nov 91						
SP1-13bb	Oct-92	8.35	484	2.5	8	TKfn	Wildlife
	Jun-93	7.97	363	5	4		
	Sep/Oct 93	8.52	363	5	6		
SP1-13c	Jun-92		a	<1/8	10	TKfn	Wildlife
	Oct-92	a	a	seep	8		
	Jun-93	8.23	398	1	6		
	Sep/Oct 93	a	a	seep			
SP1-13d	Oct-92	7.84	560	1	12	TKfn	Developed
	Jun-93	8.14	411	1	10		
	Sep/Oct 93	8.53	488	5	6		
SP1-14						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90		a	10	4		
	Oct/Nov-90		a	seep	a		
	Jun-91			dry			
	Oct/Nov 91			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-15						TKfn	Wildlife
	Jul-87	7.4	380	<<1	5		
	Oct-87		a	dry			
	Oct-89	8.16	326	<<1	2.2		
	Jun-90	8.19	352	10	6		
	Oct/Nov-90			dry			
	Jun-91	7.42	251	30	4		
	Oct/Nov 91			dry			
SP1-16						TKfn	Wildlife
	Jul-87	8.8	280	<<1	11		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.68	364	20	5		
	Oct/Nov-90	8.34	350	0.25	5		
	Jun-91	7.32	338	10	4		
	Oct/Nov 91			dry			
SP1-16a						TKfn	Wildlife
	Jun-90	7.68	360	15	5		
	Oct/Nov-90	8.14	330	seep	5		
	Jun-91	7.58	316	5	3		
	Oct/Nov 91			dry			
	Jun-93	8.03	583	15	4		
	Sep/Oct 93	8.32	298	2	5		
SP1-17						TKfn	Wildlife
	Jul-87	7.85	390	10	5		
	Oct-87	7.85	410	2	4		
	Oct-89			dry			
	Jun-90	7.9	354	40	5		
	Oct/Nov-90			dry			
	Jun-91	7.8	332	0.5	5		
	Oct/Nov 91	8.27	321	0.5	4		
SP1-17a						TKfn	Wildlife
	Jun-90	7.82	340	10	5		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91	8.44	381	15	1		
	Sep/Oct 93			dry			
SP1-18						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	7.72	350	50	5		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.41	287	7	3		
	Oct/Nov 91			dry			
SP1-18a						TKfn	Wildlife
	Jun-91						
	Oct/Nov 91	8.28	275	3	5		
	Jun-93	8.93	258	10	6		
	Sep/Oct 93	8.36	276	1	5		
SP1-19						TKfn	Wildlife & Livestock
	Jul-87	8.05	400	<<1	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.95	304	30	4		
	Oct/Nov-90	8.39	139	0.25	50		
	Jun-91	8.17	341	10	4		
	Oct/Nov 91			dry			
SP1-20						TKfn	Wildlife & Livestock
	Jul-87	8.01	360	<1	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-87	8.27	350	<1	8		
	Oct-89			b			
	Jun-90	7.95	304	10	4		
	Oct/Nov-90	8.41	223	0.25	5		
	Jun-91	8.03	250	5	4		
	Oct/Nov 91			dry			
SP1-21						TKfn	Wildlife & Livestock
	Jul-87	7.9	370	<1	4		
	Oct-87			dry			
	Oct-89			b			
	Jun-90	8	174	15	4		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.86	214	1	4		
	Oct/Nov 91			dry			
SP1-21a						TKfn	Wildlife & Livestock
	Jun-90	8	174	10	6		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.28	274	2	3		
	Oct/Nov 91			dry			
	Sep/Oct 93	8.26	305	2	6		
SP1-21b						TKfn	Wildlife & Livestock
	Jun-90	7.88	236	5	4		
	Oct/Nov-90			dry			
	Jun-91	7.36	265	2	4		
	Oct/Nov 91			dry			
	Jun-93	8.62	315	5	5		
	Sep/Oct 93	8.34	338	3	6		
SP1-22						TKfn	Wildlife & Livestock
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90		a	5	4		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91	8.18	311	1	4		
	Jun-93	7.17	556	1	4		
SP1-23						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.03	369	7	5		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.57	297	5	4		
	Oct/Nov 91	8.22	313	0.25	4		
SP1-24						TKfn	Wildlife & Livestock
	Jul-87	7.86	310	<1	5		
	Oct-87		a	seep	a		
	Oct-89	8.22	389	<<1	3.3		
	Jun-90	7.89	311	5	5		
	Oct/Nov-90	8.09	368	seep	5.5		
	Jun-91	7.48	295	2.5	4		
	Oct/Nov 91		a	0.5	5		
SP1-25						TKfn	Wildlife
	Jul-87	7.76	490	3	3.6		
	Oct-87	7.81	330	2	7		
	Oct-89	7.8	294	<1	4.4		
	Jun-90	8.03	268	3	3		
	Oct/Nov-90	8.05	356	0.5	4		
	Jun-91	7.92	130	10	2		
	Oct/Nov 91	8.34	332	1	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-26						TKfn	Wildlife
	Jul-87	7.74	430	2	3.7		
	Oct-87	7.78	340	2	7		
	Oct-89	7.97	282	<1	4.4		
	Jun-90	7.78	277	3	3		
	Oct/Nov-90	8.36	288	0.5	4		
	Jun-91	7.83	310	10	2		
	Oct/Nov 91	8.82	308	0.5	4		
SP1-27						TKfn	Wildlife
	Jul-87	7.69	450	<1	2.8		
	Oct-87			dry			
	Oct-89	8.17	282	<<1	5		
	Jun-90	8.06	320	2	2		
	Oct/Nov-90	8.54	298	0.5	3		
	Jun-91	7.34	473	4	2		
	Oct/Nov 91	7.82	438	0.5	4		
SP1-28						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.82	390	8	8		
	Oct/Nov 91						
SP1-28a	Jun-91	8.03	308	5	5	Kc	Wildlife
	Oct/Nov 91			dry			
SP1-28b	Jun-91		269	3	5	Kc	Wildlife
	Oct/Nov 91	8.05	492	0.25	7		
SP1-28c	Jun-91	7.9				Kc	Wildlife
	Oct/Nov 91	8.46	412	3	6		
SP1-29						TKfn	Wildlife
	Jul-87	7.63	470	<<1	3		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	7.81	403	2	4		
	Oct/Nov-90		b	b			
	Jun-91	7.55	694	1	2		
	Oct/Nov 91			dry			
	Jun-93	7.98	315	3	5		
SP1-29a						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90		b	b			
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			
SP1-29b						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90		b	b			
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-30						TKfn	Wildlife
	Jul-87	7.47	440	<1	3.1		
	Oct-87			dry			
	Oct-89	8.49	992	<<1	6.8		
	Jun-90	7.01	326	10.5	4		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP1-30a						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.8	394	10	3		
	Oct/Nov 91		a	seep	a		
	Jun-93	8.12	350	2	5		
SP1-30b						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91		a	<<1	5		
	Oct/Nov 91		a	seep	a		
SP1-31						TKfn	Wildlife
	Jul-87	7.59	430	<1	3.3		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	7.56	326	5	7		
	Oct/Nov-90						
	Jun-91	7.81	361	10	4		
	Oct/Nov 91	8	560	1	3		
SP1-31a	Jun-91	7.76	350	4	3	TKfn	Wildlife
	Oct/Nov 91						
	Jun-93	8.12	350	2	5		
SP1-32						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89						
	Jun-90	7.33	374	5	4		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91			dry			
	Jun-93	8.71	388	1	6		
SP1-32a						Kpr	Wildlife
	Jun-90	7.66	383	10	4		
	Oct/Nov-90			dry			
	Jun-91						
	Oct/Nov 91	8.2	466	seep	a		
	Jun-93	7.75	407	1	4		
SP1-33						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	8.27	390	<1	7		
	Oct-89	7.03	410	<1	5.5		
	Jun-90	7.74	468	2	16		
	Oct/Nov-90	7.99	498	3	7		
	Jun-91	7.63	1770	<<1	4		
	Oct/Nov 91	8.19	415	seep	a		
	Jun-92		a	dry			
	Oct-92	8.04	529	<.25	5.5		
SP1-34						Alluvium/valley floor	Wildlife
	Jul-87	8.16	480	<<1	4		
	Oct-87	8.14	460	15	8		
	Oct-89	7.63	550	<<1	10.8		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	8.24	850	8	14		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.53	1890	1	5		
	Oct/Nov 91	8.09	601	0.5	3		
	Jun-92		a	dry			
	Oct-92		a	seep	a		
SP1-35						Alluvium/valley floor	Wildlife
	Jul-87	8.26	470	1	11		
	Oct-87	8.3	480	4	7		
	Oct-89	8.02	375	<<1	14.5		
	Jun-90	8.55	383	15	6		
	Oct/Nov-90	7.75	417	0.5	7		
	Jun-91	7.83	1870	5	7		
	Oct/Nov 91	8.23	390	1	2		
	Jun-92		a	seep	a		
	Oct-92	8.09	542	0.5	5		
SP1-36						Alluvium/valley floor	Wildlife
	Jul-87	7.51	490	<<1	4		
	Oct-87	7.65	500	3	8		
	Oct-89	7.59	390	<<1	9.3		
	Jun-90	7.74	731	3	7		
	Oct/Nov-90	8.08	499	1	7		
	Jun-91	7.74	1810	<<1	7		
	Oct/Nov 91	8.12	482	1	0		
	Jun-92		a	seep	a		
	Oct-92	8.22	481	<.25	5.5		
SP1-37						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	7.67	450	4	5		
	Oct-89	7.29	325	<<1	5.6		
	Jun-90	8.19	461	2	15		
	Oct/Nov-90	8.11	411	2	7		
	Jun-91	7.77	1770	<<1	7		
	Oct/Nov 91	8.51	401	7	5		
	Jun-92		a	dry			
	Oct-92	8.31	538	0.5	4		
SP1-37a						Alluvium/valley floor	Wildlife
	Jul-87	7.42	500	<1	4.2		
	Oct-87	7.56	490	3	7		
	Oct-89	7.13	363	<1	6.5		
	Jun-90	8.44	880	1	16		
	Oct/Nov-90		a	seep	a		
	Jun-91		a	<<1	6		
	Oct/Nov 91	8.04	609	3	4		
	Jun-92		a	seep	a		
	Oct-92	8.12	546	0.5	5		
SP1-37b						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	7.7	591	0.5	5.5		
	Jun-93	8.2	449	0.25	11		
	Sep/Oct 93	7.66	461	5	7		
SP1-38						Alluvium/valley floor	Wildlife
	Jul-87	7.29	480	<<1	4.2		
	Oct-87	7.24	470	2	7		
	Oct-89	7.22	360	<<1	7.4		
	Jun-90	7.97	1159	6	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.87	1830	<<1	10		
	Oct/Nov 91	8.34	427	7	3		
	Jun-92		a	seep	a		
	Oct-92	8.25	534	0.25	3		
SP1-38a						Alluvium/valley floor	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-91	7.52	12500	1	6		
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92	8.16	587	0.25	5.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.55	414	0.5	12		
SP1-39						Alluvium/valley floor	Wildlife
	Jul-87	8.17	460	<1	4.1		
	Oct-87	7.48	450	3	7		
	Oct-89	6.69	360	<<1	9		
	Jun-90	8.05	409	4	10		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.53	1870	1	4		
	Oct/Nov 91	7.8	398	4	7		
	Jun-92		a	seep	a		
	Oct-92	8.14	511	<.25	5.5		
SP1-40	Jul-87	7.17	530	<<1	4.4	Alluvium/valley floor	Wildlife
	Oct-87	7.17	690	10	7		
	Oct-89	7.27	310	<1	6.8		
	Jun-90	8.49	1100	1	12		
	Oct/Nov-90	8.24	423	0.5	0.5		
	Jun-91	8.25	1710	2	11		
	Oct/Nov 91	8.32	499	0.5	6		
	Jun-92	7.98	433	1.5	16		
	Oct-92	7.81	537	<.25	3		
SP1-40a						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	7.78	490	5	7		
	Oct-89	6.85	350	<<1	5.4		
	Jun-90	8.27	624	5	13		
	Oct/Nov-90						
	Jun-91	8.31	1650	1	11		
	Oct/Nov 91	8.18	417	5	3		
	Jun-92	7.86	399	0.5	13		
	Oct-92	a	a	seep	a		
SP1-41						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	7.63	450	2	7		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90		a	seep	a		
	Jun-91			1	11		
	Oct/Nov 91	8.63	406	0.5	6		
	Jun-92		a	seep	a		
	Oct-92	a	a	dry	a		
SP1-41a						Alluvium/valley floor	Wildlife
	Oct/Nov-90	8.35	363	0.5	9		
	Jun-91	7.43	1680	6	4		
	Oct/Nov 91	8.42	403	seep	0		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8	399	3	5		
	Sep/Oct 93	8.12	469	0.5	7		
SP1-42						Alluvium/valley floor	Wildlife
	Jul-87	7.43	490	1	3.3		
	Oct-87	8.15	420	<1	10		
	Oct-89			dry			
	Jun-90	8.23	412	1	8		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.57	1680	3	5		
	Oct/Nov 91	8.45	426	1	3		
	Jun-92	8.56	379	0.25	8		
	Oct-92	a	a	seep	a		
SP1-42a						Alluvium/valley floor	Wildlife
	Jun-91						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct/Nov 91		a	seep	3		
	Jun-92		a	seep	a		
	Oct-92	8	577	<.25	5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP1-43						Alluvium/valley floor	Wildlife
	Jul-87	7.49	470	<1	3.3		
	Oct-87	7.46	460	1	7		
	Oct-89			dry			
	Jun-90	7.68	385	10	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.71	420	4	7		
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92	7.77	560	<.25	5.5		
SP1-43a						TKfn	Wildlife
	Jun-91						
	Oct/Nov 91			seep	a		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
	Jun-93	7.79	461	2	4		
	Sep/Oct 93	7.71	483	0.25	7		
SP1-44						Alluvium/valley floor	Wildlife
	Jul-87	7.8	490	3	12		
	Oct-87	7.76	480	5	7		
	Oct-89			dry			
	Jun-90	7.72	669	2	14		
	Oct/Nov-90	7.55	458	3	7		
	Jun-91	7.75	1680	4	4		
	Oct/Nov 91	7.14	510	0.25	6		
	Jun-92		a	seep	a		
	Oct-92	8.23	533	1	5.5		
SP1-45						Alluvium/valley floor	Wildlife
	Oct-89	6.92	315	<<1	6.1		
	Jun-90	8.01	864	5	11		
	Oct/Nov-90	8.35	383	2	7		
	Jun-91	8.28	1860	<<1	9		
	Oct/Nov 91	7.8	461	seep	6		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
SP1-45a						Alluvium/valley floor	Wildlife
	Jun-91	7.21	1760	1	4		
	Oct/Nov 91		a	dry			
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.84	550	2	9		
SP1-46						Alluvium/valley floor	Wildlife
	Oct-89	6.94	340	<<1	9		
	Jun-90	8.15	834	7	15		
	Oct/Nov-90	8.38	395	2	12		
	Jun-91	8.38	1590	1.5	10		
	Oct/Nov 91	8.04	651	seep	3		
	Jun-92		a	seep	a		
	Oct-92	7.88	538	1	3		
SP1-47						Alluvium/valley floor	Wildlife
	Oct-89	7.61	305	<<1	6.8		
	Jun-90	8	347	4	11		
	Oct/Nov-90	8.47	443	0.5	9		
	Jun-91	7.46	1690	0.5	4		
	Oct/Nov 91	8.21	398	seep	3		
	Jun-92		a	seep	a		
	Oct-92	7.69	524	<.25	5		
SP1-48						Kpr	Wildlife
	Oct-89	8.01	380	<<1	4.1		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	7.98	312	1.5	4		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.71	354	4	2		
	Oct/Nov 91		a	seep	2		
SP1-48a	Jun-91	7.29	310	15	4	Kpr	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.13	383	5	5		
SP1-49						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	7.86	288	5	5		
	Oct/Nov-90						
	Jun-91	7.45	342	15	3		
	Oct/Nov 91			dry			
	Jun-93	8.23	385	8	5		
SP1-49a	Jun-91	8.2	317	2	3	Kpr	Wildlife
	Oct/Nov 91			dry			
	Jun-93	7.75	441	1.5	4		
SP1-50						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	8.24	299	2.5	6		
	Oct/Nov-90						
	Jun-91	7.96	320	6	5		
	Oct/Nov 91		a	seep	a		
	Jun-93	8.02	427	1	5		
SP1-50a	Jun-91	7.78	354	7	3	Kpr	Wildlife
	Oct/Nov 91			dry			
SP1-51						Kpr	Wildlife
	Oct-89	8.79	350	<<1	7.9		
	Jun-90	7.98	242	5	4		
	Oct/Nov-90						
	Jun-91	8.29	322	5	3		
	Oct/Nov 91			dry			
	Jun-93	7.58	556	1	4		
SP1-51a	Jun-91	8.39	348	14	2	Kpr	Wildlife
	Oct/Nov 91	8.05	382	seep	a		
	Jun-93	7.74	465	5	5		
SP1-51b	Jun-91	7.82	325	2	2	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8	371	8	5		
SP1-51c	Jun-91					TKfn	Wildlife
	Oct/Nov 91		a	seep	a		
	Jun-93	8.88	231	8	5		
SP1-52						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	7.2	305	10	4		
	Oct/Nov-90						
	Jun-91	7.99	372	15	2		
	Oct/Nov 91	8.07	418	1	3		
SP1-53						Alluvium/valley floor	Wildlife
	Oct-89	7.65	310	<<1	7.5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	8.33	367	1	6		
	Oct/Nov-90	8.35	402	seep	a		
	Jun-91			dry			
	Oct/Nov 91	8.25	198	3	1		
1-53aa	Jun-93					Alluvium/valley floor	Wildlife
1-53b						Alluvium/valley floor	Wildlife
SP1-53a	Oct-89	7.9				Alluvium/valley floor	Wildlife
	Jun-90	8.15		<1	10		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-93	8.74	427	1	3		
1-53aa						Alluvium/valley floor	Wildlife
SP1-53b	Jun-93	8.3	395	5	4	Alluvium/valley floor	Wildlife
SP1-53c	Jun-93	8.16	390	10	3	Alluvium/valley floor	Wildlife
SP1-54						Kpr	Wildlife
	Oct-89	7.9	642	<<1	4.9		
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-93	a	a	seep	a		
SP1-55	Jun-91	7.5	427	5	4		
	Oct/Nov 91						
SP2-1						TKfn	Wildlife
	Jul-87	7.72	430	4	5		
	Oct-87			dry			
	Oct-89	8.25	474	1.5	10		
	Jun-90	8.33	380	10	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.98	1650	8	7		
	Oct/Nov 91	8.25	420	3	5		
	Jun-92	8.12	411	3	15		
	Oct-92	8	610	0.5	5.5		
SP2-2						TKfn	None
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.32	406	15	7		
	Oct/Nov-90			dry			
	Jun-91	7.29	1770	<1	5		
	Oct/Nov 91	8.18	450	2	4		
	Jun-92	7.99	401	5	11		
	Oct-92	8.01	590	1	3		
SP2-2a						TKfn	None
	Jun-90	7.44	423	5	13		
	Oct/Nov 90	8.31	385	0.5	4		
	Jun-91	8.54	391	20	2		
	Oct/Nov 91	7.68	486	2	4		
	Jun-92		a	dry			
	Oct-92			dry			
SP2-3						Colluvium over limestone	Wildlife
	Jul-87	8.15	380	5	14		
	Oct-87			dry			
	Oct-89	8.28	458	<<1	5.5		
	Jun-90	8.06	408	1	8		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.45	1670	8	5		
	Oct/Nov 91	7.6	530	3	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-92	7.78	389	2	7		
	Oct-92	8.07	553	<.25	5.5		
SP2-3a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	0.5	5		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
	Jun-93	7.84	432	4	5		
SP2-3b	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-92	8.01	397	2	8		
	Oct-92	a	a	seep	a		
	Jun-93	7.95	408	2	5		
SP2-4						Alluvium/valley floor	Wildlife
	Jul-87	8.17	400	10	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.25	379	6	9		
	Oct/Nov-90			dry			
	Jun-91	7.4	1660	13	4		
	Oct/Nov 91		a	seep	a		
	Jun-92		a	dry			
	Oct-92			dry			
SP2-5						TKfn	Wildlife
	Jul-87	7.56	410	2	5		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.59	428	<1	4		
	Oct/Nov-90			dry			
	Jun-91	7.52	1910	1	7		
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92			dry			
SP2-6						TKfn	Wildlife
	Jul-87	7.7	410	5	5		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.24	426	3	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.53	1680	7	4		
	Oct/Nov 91		a	seep	a		
	Jun-92		a	seep	a		
	Oct-92	8.07	565	1	4		
SP2-7						TKfn	Wildlife
	Jul-87	8.19	410	4	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.1	353	<1	15		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92			dry			
SP2-8						TKfn	None
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.8	333	1	12		
	Oct/Nov-90	7.61	419	1	6		
	Jun-91	7.98	1570	3	11		
	Oct/Nov 91	8.14	341	seep	7		
	Jun-92		a	dry			
	Oct-92	7.63	600	<.25	5.5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP2-9						TKfn	Developed
	Jul-87	7.56	250	5	5		
	Oct-87	7.76	270	1	4		
	Oct-89	8.37	234	<<1	4.4		
	Jun-90	7.55	350	2	4		
	Oct/Nov-90	7.48	301	seep	a		
	Jun-91	7.06	560	3	4		
	Oct/Nov 91		b	b	b		
	Jun-93	8.06	293	8	3		
SP2-9a	Jun-91	6.72	260	0.5	5	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.27	270	10	5		
SP2-10						TKfn	Wildlife
	Jul-87	8.71	300	2	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90			dry			
	Jun-91	7.87	225				
	Oct/Nov 91			dry			
SP2-11						Kpr	None
	Jul-87	8.11	270	<<1	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.52	266	1	6		
	Oct/Nov-90			dry			
	Jun-91	8.48	226	10	4		
	Oct/Nov 91			dry			
SP2-12						Kpr	None
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.8	387	<1	6		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91		a	seep	a		
SP2-13	Jul-87	7.94	230			Kpr	Wildlife
	Jun-90	8.38	135				
	Oct/Nov 90						
	Jun-91	7.31	153	3	4		
	Oct/Nov 91		a	seep	a		
	Jun-93	8.3	236	5	6		
SP2-14	Jul-87	8.24	200			Kpr	Wildlife
	Jun-90		a				
	Oct/Nov 90						
	Jun-91	7.41	286	1	5	Kpr	Wildlife
	Oct/Nov 91		a	1	1		
	Jun-93	8.49	220	3	5		
SP2-15						Kpr	Wildlife
	Jul-87	8.6	210	2	8		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.34	162	2	9		
	Oct/Nov-90						
	Jun-91	7.74	178	1	5		
	Oct/Nov 91		a	0.5	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-92	7.97	387	0.25	4		
SP2-15a						Kpr	Wildlife
	Jun-91		a	seep	4		
	Oct/Nov 91			dry			
	Oct-92	a	a	seep	7		
	Jun-93	8.17	226	2	5		
	Sep/Oct 93	7.84	289	1	6		
SP2-15b						Kpr	Wildlife
	Jun-91		a	seep	5		
	Oct/Nov 91			dry			
	Oct-92			b			
	Jun-93	8.06	278	4	6		
	Sep/Oct 93	8.53	363	1	7		
SP2-16						Kpr	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91		a	0.5	5		
	Oct/Nov 91		a	seep	b		
SP2-17						Kpr	Wildlife
	Jul-87	8.53	210	<<1	7		
	Oct-87		b				
	Oct-89			dry			
	Jun-90						
	Oct/Nov-90						
	Jun-91	7.98	164	2	6		
	Oct/Nov 91		a	<.25	4		
SP2-18						Kpr	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.72	211	2.5	3		
	Oct/Nov 91		a	seep	a		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
SP2-19						Colluvium/alluvium	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91		a	seep	3		
	Oct/Nov 91		a	seep	a		
	Jun-92	8.06	473	0.5	6		
	Oct-92			dry			
SP2-20						Colluvium/alluvium	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91		a	seep	15		
	Oct/Nov 91			dry			
	Jun-92	7.25	266	1	6		
	Oct-92			dry			
SP2-21						TKfn	Wildlife
	Jul-87	8.58	320	7	5		
	Oct-87		b				
	Oct-89			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-92	8.61	383	2	7		
	Oct-92			dry			
SP2-21a						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91		a	5	4		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	8.45	383	1	5		
SP2-21b						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.25	3		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP2-22						Kpr	None
	Jul-87	8.21	350	1	5		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	4	7		
	Oct/Nov-90						
	Jun-91	7.72	347	30	3		
	Oct/Nov 91			dry			
	Jun-92	7.81	402	1	4		
	Oct-92	a	a	seep	4		
SP2-22a						Kpr	None
	Jun-90	7.66	304	5	3		
	Oct/Nov-90						
	Jun-91		a	seep	5		
	Oct/Nov 91			dry			
	Jun-92	8.16	387	0.5	5		
	Oct-92	a	a	seep	5		
SP2-23						Kpr	Wildlife
	Jul-87	8.84	290	5	5		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91		a	0.5	2		
	Jun-92	8.42	305	1	5		
	Oct-92	a	a	seep	4		
SP2-24						Kpr	Wildlife
	Jul-87	7.93	310	5	3.5		
	Oct-87		a	seep	a		
	Oct-89	8.17	360	dry			
	Jun-90	8.12	276	10	4		
	Oct/Nov-90	8.1	351	1	4.5		
	Jun-91	7.58	295	<1	4		
	Oct/Nov 91	8.04	413	0.25	3		
	Jun-93	7.21	588	15	5		
SP2-24a						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	8.01	216	5	5		
	Oct/Nov-90			dry			
	Jun-91			seep	a		
	Oct/Nov 91			dry			
	Jun-93	8.76	222	8	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP2-24b						Kpr	Wildlife
	Jun-90	8.17	222	2	5		
	Oct/Nov-90			dry			
	Jun-91			seep	a		
	Oct/Nov 91			dry			
	Jun-93	8.89	242	5	6		
	Sep/Oct 93	8.29	279	1	5		
SP2-25						TKfn	None
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91	8.1	750	2	4		
SP2-26						TKfn	None
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.16	297	1	6		
	Oct/Nov-90		b	b			
	Jun-91	7.57	446	0.25	4		
	Oct/Nov 91		a	0.05	11		
SP2-27						Kpr	Developed
	Jul-87	7.46	440	4	3		
	Oct-87	7.6	380	1	4		
	Oct-89	8.02	410	<<1	4.4		
	Jun-90	7.7	360	3	4		
	Oct/Nov-90		b	b			
	Jun-91	7.91	401	5	3		
	Oct/Nov 91	7.83	482	3	3		
SP2-28						Kpr	Wildlife
	Jul-87	7.78	400	2	4		
	Oct-87	8.01	380	<1	4		
	Oct-89	8.36	328	<<1	3.8		
	Jun-90	7.79	390	2.5	5		
	Oct/Nov-90	8.16	435	seep	7		
	Jun-91	7.36	460	1	4		
	Oct/Nov 91	8.15	490	<1	4		
SP2-29						Kpr	Wildlife
	Jul-87	7.57	410	2	4		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	8.54	380	2	9		
	Oct/Nov-90						
	Jun-91	7.36	474	1	2		
	Oct/Nov 91	7.86	527	1	4		
SP2-30						Kpr	Wildlife
	Jul-87	8.01	370	1	4		
	Oct-87	8.05	380	<<1	4		
	Oct-89	8.41	413	<1	1.1		
	Jun-90	7.9	428	<1	5		
	Oct/Nov-90						
	Jun-91	7.5	439	2	3		
	Oct/Nov 91	7.89	514	<1	4		
SP2-30a						Kpr	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	7.94	359	<1	5		
	Oct/Nov-90						
	Jun-91	7.13	491	5	3		
	Oct/Nov 91	8.15	528	<1	5		
SP2-31						Kpr	Wildlife
	Jul-87	7.73	390	2	6		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90	7.76	419	5	4		
	Oct/Nov-90		b	b			
	Jun-91	7.28	524	1	3		
	Oct/Nov 91			dry			
SP2-32						Kpr	Wildlife
	Jul-87	7.56	410	2	4		
	Oct-87	8.28	350	<1	4		
	Oct-89		a	seep	a		
	Jun-90	8.41	392	5	10		
	Oct/Nov-90		b	b			
	Jun-91	7.26	495	7	4		
	Oct/Nov 91	8.23	525	2	5		
SP2-32a						Kpr	Wildlife
	Jun-90		a	1	5		
	Oct/Nov-90		b	b			
	Jun-91	7.34	476	1.5	3		
	Oct/Nov 91			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP2-32b						Kpr	Wildlife
	Jun-90	8.16	409	seep	a		
	Oct/Nov-90		b	b			
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-93	8.66	346	25	6		
	Sep/Oct 93	8.16	309	1	4		
SP2-33						Kpr	Wildlife
	Jul-87	7.85	410	2	4		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	7.91	421	seep	a		
	Oct/Nov-90		b	b			
	Jun-91	7.45	513	5	3		
	Oct/Nov 91	8.01	508	<1	4		
SP2-33a						Kpr	Wildlife
	Jul-87	7.66	450	4	4		
	Oct-87	7.8	430	1	5		
	Oct-89	8.29	421	<<1	2.2		
	Jun-90	7.69	432	15	5		
	Oct/Nov-90	8.19	466	0.5	4		
	Jun-91	7.09	513	15	4		
	Oct/Nov 91						
	Jun-93			dry			
SP2-34						Kpr	Wildlife
	Jul-87	7.85	320	2	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.04	267	7	6		
	Oct/Nov-90		b	b			
	Jun-91	7.61	249	5	4		
	Oct/Nov 91		451	0.5	7		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP2-34a	Jun-91	7.8	221	0.5	4	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.04	327	<1/8	6		
SP2-35						Kpr	Wildlife
	Jul-87	7.79	360	5	6		
	Oct-87	7.87	340	<1	5		
	Oct-89	8.21	350	<<1	5.6		
	Jun-90	8.02	279	15	5		
	Oct/Nov-90						
	Jun-91	7.72	249	4	3		
	Oct/Nov 91	8.13	443	0.5	5		
SP2-36						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	5	15		
	Oct/Nov-90						
	Jun-91	8.1	389	5	3		
	Oct/Nov 91			dry			
SP2-36a						TKfn	Wildlife
	Jun-90	8.18	319	1	8		
	Oct/Nov-90						
	Jun-91	8.21	271	1.5	3		
	Oct/Nov 91	7.96	361	0.5	4		
	Jun-93	a	a	seep	a		
SP2-36bw						TKfn	Wildlife
	Jun-90	7.86	333	3	4		
	Oct/Nov-90						
	Jun-91	7.49	319	2	2		
	Oct/Nov 91	8.22	417	0.25	8		
	Jun-93	8.6	307	10	6		
SP2-36bm	Jun-91					TKfn	Wildlife
	Oct/Nov 91	7.7	466	0.5	5		
SP2-36be	Jun-91					TKfn	Wildlife
	Oct/Nov 91	7.88	420	1	5		
SP2-37						TKfn	Wildlife
	Jul-87	7.5	390	6	5		
	Oct-87			dry			
	Oct-89	8.3	377	<<1	8.9		
	Jun-90	7.95	306	5	15		
	Oct/Nov-90						
	Jun-91	7.33	263	7	2		
	Oct/Nov 91	7.72	343	1	5		
SP2-37a	Jun-91					TKfn	Wildlife
	Oct/Nov 91	7.9	434	0.25	5		
SP2-38						TKfn	Wildlife
	Jul-87	7.76	410	5	4		
	Oct-87			dry			
	Oct-89		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	7.81	321	10	6		
	Oct/Nov-90						
	Jun-91	7.7	310	3	5		
	Oct/Nov 91						
SP2-38a	Jun-91	7.75	297	<1	4	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.79	304	2	6		
SP2-38b	Jun-91	7.92	260	1	4	TKfn	Wildlife
	Oct/Nov 91		a	<1	5		
	Jun-93	8.32	359	15	6		
SP2-38c	Jun-91		a	seep	a	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.66	301	10	6		
SP2-39						TKfn	Wildlife
	Jul-87	8.01	370	4	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP2-40						TKfn	Wildlife & Livestock
	Jul-87	7.56	440	3	5		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP2-40a						TKfn	Wildlife & Livestock
	Jun-90	7.75	361	7	5		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
	Jun-93	8.22	342	<1/8	6		
SP2-40b						TKfn	Wildlife & Livestock
	Jun-90		a	<1	5		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91			dry			
SP2-40c	Jun-91		a	0.5	3	TKfn	Wildlife
	Oct/Nov 91						
	Jun-93	7.98	402	7	6		
SP2-40d	Sep/Oct 93	7.35	493	<.25	9	TKfn	Wildlife
	Jun-91	7.81	421	15	3		
	Oct/Nov 91						
SP2-40e	Sep/Oct 93	7.2	523	<.25	5	Kpr	Wildlife
	Jun-91		a	1	4		
	Oct/Nov 91						
SP2-41						TKfn	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jul-87	7.64	440	3	6		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90		a	1	6		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP2-42						Kpr	Wildlife
	Oct-89		a	<<1	3.1		
	Jun-90	7.89	310	5	4		
	Oct/Nov-90	8.38	343	0.25	3		
	Jun-91	7.16	368	15	2		
	Oct/Nov 91	8.4	371	<1	4		
SP2-43						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	8.1	380	1	5		
	Oct/Nov-90	8.56	294	0.5	6		
	Jun-91	7.35	421	5	3		
	Oct/Nov 91			dry			
	Jun-93	8.7	350	20	5		
SP2-43a						Kpr	Wildlife
	Jun-90	8.53	435	3	7		
	Oct/Nov-90	8.58	353	0.5	8		
	Jun-91	7.88	414	0.75	3		
	Oct/Nov 91	8.34	437	0.5	6		
	Jun-93	8.34	384	20	5		
	Sep/Oct 93	7.86	358	1	5		
SP2-44						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	7.96	380	1	5		
	Oct/Nov-90		b	b			
	Jun-91	7.23	467	2	3		
	Oct/Nov 91	8.25	530	1	5		
	Jun-93	8.17	451	15	5		
	Sep/Oct 93	a	a	seep			
SP2-44a						Kpr	Wildlife
	Jun-90	8.17	461	<1	5		
	Oct/Nov-90		b	b			
	Jun-91	7.19	453	10	4		
	Oct/Nov 91			dry			
	Jun-93			dry			
SP2-44a2						Kpr	Wildlife
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			
	Jun-93	8.31	414	10	5		
	Sep/Oct 93	a	a	seep			
SP2-44a3						Kpr	Wildlife
	Jun-91	7.48	570	0.5	4		
	Oct/Nov 91			dry			
	Jun-93	8.17	420	10	6		
	Sep/Oct 93			dry			
SP2-44a4						Kpr	Wildlife
	Jun-91	7.05	518	1	4		
	Oct/Nov 91			dry			
	Jun-93	8.2	416	10	6		
	Sep/Oct 93	a	a	seep			
SP2-44b						Kpr	Wildlife
	Jun-90	7.49	459	1	5		
	Oct/Nov-90		b	b			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-91	7.61	507	0.5	4		
	Oct/Nov 91						
	Jun-93	8.02	449	6	6		
	Sep/Oct 93	a	a	seep			
SP3-2						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.8	420	10	6		
SP3-3						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.5	7		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-4						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	6		
	Jun-92	7.72	255	seep	8		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-5						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP3-6						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	2		
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-7						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.61	420	1	6		
	Jun-92	7.67	447	0.5	6		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP3-8						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.55	410	0.5	6		
	Jun-92	8.98	129	<1/8	15		
	Oct-92			dry			
	Jun-93	8.23	391	1	6		
	Sep/Oct 93			dry			
SP3-9						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.25	5		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP3-10						Alluvium/valley floor	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-91						
	Oct/Nov 91			2	2		
	Jun-92	7.97	423	1/8	8		
	Oct-92	7.73	572	<.25	1		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-10a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92			dry			
	Sep/Oct 93			dry			
SP3-10b						Alluvium/valley floor	Wildlife & Livestock
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	dry			
	Oct-92			dry			
	Sep/Oct 93			dry			
SP3-11						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91			0.5			
	Jun-92	8.35	358	1/8	13		
	Oct-92	a	a	seep	5		
	Jun-93	8.48	276	10	5		
	Sep/Oct 93	8.42	381	<.25	6		
SP3-12						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.25	5		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	10		
	Jun-93	8.08	404	0.5	7		
	Sep/Oct 93			dry			
SP3-13						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.33	500	5	5		
	Jun-92	7.58	481	<1/8	4		
	Oct-92	7.9	620	2	5		
	Jun-93	7.97	417	5	6		
	Sep/Oct 93			dry			
SP3-13a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.08	288	3	2		
	Oct-92	7.66	687	0.5	5		
	Jun-93	8.4	190	10	5		
	Sep/Oct 93	7.64	530	7	5		
SP3-13b	Jun-91			dry		Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
SP3-14	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91	7.29	470	3	6		
SP3-15	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	seep	3		
SP3-16	Jun-91					TKfn	Wildlife
	Oct/Nov 91		a	seep	6		
	Jun-92		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-92			dry			
	Jun-93	a	a	seep	a		
SP3-16a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	8.43	328	8	6		
SP3-16b	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92	8.05	424	1/4	10		
	Oct-92	a	a	seep	a		
	Jun-93	8.54	377	12	6		
SP3-17						Kc	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-93	8.2	430	10	6		
	Sep/Oct 93			dry			
SP5-1						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	8.27	468	seep	a		
	Jun-92	8.13	316	seep	2		
	Oct-92	8	513	<.25	5		
	Sep/Oct 93			dry			
SP5-1a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	7.72	487	<.25	4		
	Jun-93	8	316	12	3		
	Sep/Oct 93			dry			
SP5-2	Jun-91					Kbh	Wildlife
	Oct/Nov 91	8.03	460	6	5		
	Jun-93	8.31	428	10	5		
SP5-3	Jun-91					Kbh	Wildlife
	Oct/Nov 91	8.08	465	5	4		
	Jun-93	7.99	438	8	6		
SP5-4	Jun-91					Kpr	Wildlife
	Oct/Nov 91	7.99	400	4	3		
	Jun-93	a	a	seep	a		
SP5-5						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	8.06	430	0.5	5		
	Jun-93	8.02	482	2	6		
	Sep/Oct 93			dry			
SP6-1						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.31	400	3	5		
	Jun-92	7.91	98	<1/8	5		
	Oct-92			dry			
	Jun-93			dry			
	Sep/Oct 93	a	a	seep			
SP6-1a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-93	8.35	404	4	5		
SP6-2						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.15	410	1	5		
	Jun-92	7.81	393	1	3		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-92	7.94	532	1	5		
	Jun-93	7.95	346	12	3		
	Sep/Oct 93	8.12	378	3	5		
SP6-3						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.27	340	5	2		
	Jun-92	7.83	351	seep	6		
	Oct-92	8.17	490	<.25	5		
	Jun-93	8.39	211	10	4		
	Sep/Oct 93	8.3	330	4	5		
SP6-3a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.68	322	7	6		
	Oct-92	a	a	seep	5		
	Jun-93	8.6	359	2	6		
	Sep/Oct 93	8.2	322	2	4		
SP6-4						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.09	480	1	6		
	Jun-92		a	dry			
	Oct-92	8.27	531	0.5	5		
	Jun-93	8.71	346	6	12		
	Sep/Oct 93	8.43	401	4	9		
SP6-5						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.1	1		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8.57	375	5	4		
	Sep/Oct 93			dry			
SP6-6	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	seep	5		
SP6-7	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	seep	4		
SP6-8	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	0.1	0		
SP6-9	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	0.1	2		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
SP6-10	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91	7	320	0.1	3		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	8.08	393	4	6		
SP6-11						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.01	250	seep	3		
	Jun-92	8.08	426	0.5	13		
	Oct-92			dry			
	Jun-93	8.53	351	9	6		
	Sep/Oct 93	8.18	412	3	7		
SP6-11a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-92	7.91	542	seep	a		
	Oct-92			dry			
	Jun-93	8.45	352	14	6		
SP6-11b	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92	7.88	401	seep	a		
	Oct-92	8.1	515	<.25	7		
	Jun-93	8.22	355	60	3		
SP6-12	Jun-91					Kpr	Wildlife
	Oct/Nov 91	7.82	490	1	1		
	Jun-92	7.82	481	4	6		
	Oct-92	8.16	274	<.25	5		
	Jun-93	8.39	165	3	5		
SP6-13	Jun-91					Kbh	Wildlife
	Oct/Nov 91	8.14	260	2	2		
	Jun-92		a	seep	a		
	Oct-92	8.38	391	2	3		
SP6-13a	Jun-91					Kbh	Wildlife
	Oct/Nov 91						
	Jun-92		a	dry			
	Oct-92	8.08	374	1.75	5.5		
	Jun-93	8.12	418	15	5		
SP6-13b	Jun-91					Kbh	Wildlife
	Oct/Nov 91						
	Jun-92	8.01	280	1	7		
	Oct-92	8.07	427	<.25	12		
	Jun-93	7.94	255	3	5		
SP6-13c	Jun-91					Kbh	Wildlife
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8.27	192	2	5		
SP6-13d						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	7.9	381	<.25	5		
	Jun-93	8.27	262	2	5		
	Sep/Oct 93	7.81	265	2	6		
SP6-14						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	7.96	425	seep	7		
	Jun-92		a	dry			
	Oct-92	8.17	565	<.25	6.5		
	Jun-93	8.79	318	5	5		
	Sep/Oct 93	8.13	266	3	5		
SP6-15						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	8.11	280	seep	7		
	Jun-92		a	seep	a		
	Oct-92	7.94	570	<.25	5.5		
	Jun-93	7.52	170	2	6		
	Sep/Oct 93	8.38	273	2	5		
SP6-15a						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.66	541	<1/8	7		
	Oct-92	a	a	seep	a		
	Jun-93			dry			
	Sep/Oct 93	8.42	269	4	7		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP6-15b						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.87	532	4	6		
	Oct-92	8.18	701	<.25	5.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	8.46	270	1	6		
SP6-16						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	7.95	415	seep	7		
	Jun-92		a	dry			
	Oct-92	8.17	560	<.25	6		
	Jun-93	8.98	352	4	4		
	Sep/Oct 93	8.51	389	3	6		
SP7-1						Kpr	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	8.08	390	<.25	3		
	Jun-93	8.76	408	<1/8	10		
	Sep/Oct 93	a	a	seep			
SP7-2						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8.45	499	2	6		
	Sep/Oct 93	a	a	seep			
SP7-3						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	8.34	704	<1/8	8		
	Oct-92	8.41	899	1	5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			

Table 1 Summary of spring and seep results, 1980-95.

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
Notes:	a = no representative sample to measure parameter						
	b = ice prevents measurement						
UJV 1	1993	a	a	Seep	a		
	1994	7.85	445	1	5		
	1995			Dry			
UJV 2	1993	a	a	Seep	a		
	1994			Dry			
	1995			Dry			
UJV 3	1993			Dry			
	1994	7.55	566	4	4		
	1995			Dry			
UJV 3A	1993	7.86	430	0.5	5		
	1994	8.27	461	1	6		
	1995	7.82	358	0.5	4		
UJV 4	1993	a	a	Seep	a		
	1994	7.49	606	5	4		
	1995			Damp			
UJV 4A	1993	a	a	0.25	4		
	1994	a	a	Seep	a		
	1995	7.44	392	0.25	3		
UJV 5	1993	a	a	Seep	a		
	1994			Dry			
	1995			Damp			
UJV 6	1993	a	a	Seep	a		
	1994			Dry			
	1995	a	a	Seep	2		
UJV 6A	1993	a	a	Seep	a		
	1994	7.93	612	1	4		
	1995	a	a	Seep	4		
UJV 7	1993	a	a	Seep	a		
	1994	8.14	515	1.5	4		
	1995			Dry			
UJV 7A	1993	7.57	430	2	5		
	1994	8.11	527	8	4		
	1995	7.36	411	3	5		
UJV 8	1993			Dry			
	1994	7.9	547	9	4		
	1995			Dry			
UJV 8A	1993	7.89	476	1	6		
	1994	7.82	555	10	4		
	1995	7.78	391	1	5		
UJV 8B	1993	7.76	426	1	6		
	1994	7.99	545	2	4		
	1995	7.33	438	10	6		
UJV 8C	1993	7.82	430	4	4		
	1994	7.84	550	4	4		
	1995	a	a	Seep	4		
UJV 9	1993	a	a	Seep	a		
	1994	8.15	572	2	4		
	1995	7.7	361	0.25	2		
UJV 9A	1993	7.93	444	0.25	7		
	1994	8.27	563	1	4		
	1995	7.41	432	5	5		
UJV 10	1993	7.77	484	0.05	4		
	1994	7.82	562	1	5		
	1995	7.47	430	0.5	6		
UJV 11	1993	8.07	445	0.03	4		
	1994	7.86	524	0.5	5		
	1995	7.73	453	1	6		
UJV 12	1993	7.47	602	1	5		
	1994						
	1995	7.79	533	3	4		
UJV 13	1993	7.53	820	<1	5		
	1994	7.76		3	6		
	1995	7.32	516	2	6		
UJV 14	1993	7.72	539	<1	5		
	1994	a	a	Seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995	7.59	533	1	5		
UJV 15	1993	7.84	548	<1	5		
	1994	7.77	794	5	5		
	1995	7.38	534	1	5		
UJV 16	1993	a	a	Seep	a		
	1994	7.8	652	5	5		
	1995	7.15	536	1	5		
UJV 17	1993	7.6	553	<1	5		
	1994	7.9	595	5	5		
	1995	7.96	635	2	4		
UJV 17A	1993						
	1994	7.94	591	2	6		
	1995	7.71	495	1	4		
UJV 20	1993	7.96	562	2	4		
	1994			Dry			
	1995	7.26	505	4	6		
UJV 21	1993	7.87	563	2	4		
	1994	a	a	Seep	a		
	1995	7.85	488	1	5		
UJV 22	1993	7.52	743	Seep	4		
	1994	7.65	615	1	a		
	1995	7.86	473	1	5		
UJV 23	1993	8.02	486	Seep	4		
	1994			Dry	8		
	1995	7.51	450	1	4		
UJV 24	1993	7.83	683	Seep	4		
	1994			Dry			
	1995	8.01	621	2	5		
UJV 25	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	7.45	513	0.5	4		
UJV 26	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	7.31	530	0.25	4		
UJV 27	1993	a	a	Seep	a		
	1994	7.57	540	2	4		
	1995	7.74	555	1	4		
UJV 28	1993	7.61	560	1	4		
	1994	a	a	Seep	a		
	1995	7.4	607	0.25	6		
UJV 29	1993	7.7	444	1	4		
	1994	7.6	559	<.3	4		
	1995	7.7	535	<.3	5		
UJV 30	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	7.82	464	0.5	5		
UJV 31	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	7.99	624	<.3	5		
UJV 32	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	7.8	552	<.3	5		
UJV 33	1993	a	a	Seep			
	1994	a	a	Seep	a		
	1995	8.02	703	0.25	5		
UJV 34	1993	7.67	485	<.25	4		
	1994	7.6	630	<.3	6		
	1995	7.99	578	<.3	4		
UJV 35	1993	a	a	Seep			
	1994			Dry			
	1995	7.54	594	8	5		
UJV 36	1993	7.89	493	5	4		
	1994	7.54	648	5	4		
	1995	7.27	499	2	6		
UJV 50	1993	a	a	Seep			
	1994	7.88	575	0.5	6		
	1995	7.45	506	1	5		
UJV 52	1993	a	a	Seep			
	1994	7.84	610	3	6		
	1995	7.82	512	1	3		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
UJV 53	1993	a	a	Seep	a		
	1994	8.06	467	0.5	15		
	1995	7.8	773	2	5		
UJV 54	1993	a	a	Seep	a		
	1994	7.85	593	0.5	8		
	1995	7.86	457	1	3		
UJV 55	1993	7.92	556	2			
	1994	7.93	502	1	8		
	1995	7.44	437	2	4		
UJV 55A	1993						
	1994	7.94	501	1	9		
	1995	7.35	433	2	6		
UJV 56	1993	8.24	475	3			
	1994	8.09	487	0.5	16		
	1995	7.84	597	5	2		
UJV 57	1993	8.22	538	2	9		
	1994	8.16	485	1	7		
	1995	7.45	435	2	4		
UJV 58	1993	7.78	493	2	6		
	1994	8.3	587	1	6		
	1995	7.95	458	2	2		
UJV 59	1993	7.98	533	1	10		
	1994	8.09	700	<.3	10		
	1995	7.87	514	4	2		
UJV 60	1993	8.15	519	1.5	10		
	1994	7.82	529	2	8		
	1995	7.38	665	2	4		
UJV 61	1993	8.17	453	1	8		
	1994	7.79	509	2	5		
	1995	7.76	633	1	2		
UJV 62	1993	a	a	Seep	a		
	1994	7.74	523	3	5		
	1995	7.95	485	1	2		
UJV 63	1993	7.56	483	1	6		
	1994	7.74	534	0.5	6		
	1995	7.35	431	0.5	4		
UJV 64	1993	8.03	547	3	8		
	1994	7.77	521	0.5	6		
	1995	7.16	450	0.5	5		
UJV 65	1993	a	a	Seep	a		
	1994	7.71	565	0.5	7		
	1995	7.74	449	1.5	3		
UJV 66	1993	a	a	Seep	a		
	1994	7.72	492	2	8		
	1995	7.76	430	8	3		
UJV 66A	1993						
	1994	a	a	Seep	a		
	1995	7.83	430	10	2		
UJV 67	1993	a	a	Seep	a		
	1994			Dry			
	1995	7.28	441	0.5	6		
UJV 68	1993	a	a	Seep	a		
	1994			Dry			
	1995	7.6	524	3	3		
UJV 69	1993	a	a	Seep	a		
	1994	8.32	469	0.5	8		
	1995	7.59	440	2	3		
UJV 70	1993	8.13	499	3	12		
	1994	8.32	469	0.5	8		
	1995	7.59	440	2	3		
UJV 71	1993	7.99	485	3	10		
	1994			Dry			
	1995	7.72	443	2	3		
UJV 72	1993	a	a	Seep	a		
	1994	8.22	491	0.5	8		
	1995	7.82	435				
UJV 80	1993	a	a	Seep	a		
	1994	7.47	922	1	18		
	1995	7.67	585				
UJV 81	1993	a	a	Seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	7.91	642	<.3	13		
	1995	7.81	574				
UJV 81A	1993						
	1994	7.99	456	1			
	1995	7.25	613				
UJV 82	1993	a	a	Seep	a		
	1994			Dry	11		
	1995	7.36	438				
UJV 83	1993	a	a	Seep	a		
	1994			Dry			
	1995	7.6	424				
UJV 100	1993	7.09	470	Seep	10		
	1994	7.47	300	2	4		
	1995	a	a	Seep	a		
UJV 100A	1993						
	1994						
	1995	a	a	Seep	a		
UJV 100B	1993						
	1994						
	1995	a	a	Seep	a		
UJV 100C	1993						
	1994						
	1995	a	a	Seep	a		
UJV 101	1993	7.18	581	Seep	9		
	1994	a	a	Seep	a		
	1995	7.34	467	<.3	5.9		
UJV 102	1993	7.27	496	Seep	10		
	1994	7.75	320	<.3	8		
	1995						
UJV 102A	1993						
	1994	7.54	325	1	6		
	1995	7.64	500	<.3	5.3		
UJV 103	1993	7.92	368	1	4		
	1994			Dry			
	1995			Ice			
UJV 104	1993	7.89	408	0.25	3		
	1994			1.5	8		
	1995	7.51	481	0.5	5		
UJV 105	1993	8.06	454	2	4		
	1994			0.5	6		
	1995	7.6	504	0.25	5		
UJV 105A	1993						
	1994						
	1995	8.33	457	0.25	5		
UJV 106	1993	7.66	462	Seep	12		
	1994			Seep			
	1995	8.13	558	0.25	5		
UJV 106A	1993						
	1994						
	1995	8.92	489	0.25	5.5		
UJV 106B	1993						
	1994						
	1995	8.17	605	<.3	5.5		
UJV 107	1993	7.65	404	Seep	3		
	1994						
	1995						
UJV 108	1993	7.78	443	1	4		
	1994	8.22	375				
	1995	7.48	405	0.25	4.3		
UJV 109	1993	7.91	473	1	8		
	1994						
	1995	8.07	497	0.75	4		
UJV 109A	1993						
	1994						
	1995	a	a	Seep	a		
UJV 150	1993	7.75	415	0.25	4		
	1994	7.77	290	1	3		
	1995	8.57	538	0.5	6		
UJV 151	1993	8.03	411	0.25	4		
	1994	7.45	300	1	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995	8.23	677	1.5	5		
UJV 152	1993	7.71	517	0.25	6		
	1994	8.21	568	0.5	7		
	1995	7.96	566	0.5	5.5		
UJV 153	1993	8.07	523	0.25	6		
	1994	8.21	568	1	7		
	1995	8.22	565	<.3	6		
UJV 154	1993	7.31	665	Seep	6		
	1994			Dry			
	1995	7.65	481	<.3	6		
UJV 155	1993	7.62	494	Seep	6		
	1994			Dry			
	1995	7.3	460	Seep	1		
UJV 200	1993	7.42	478	1	6		
	1994						
	1995						
UJV 201	1993	7.74	574	1	5		
	1994						
	1995						
UJV 202	1993	8.18	434	5	3		
	1994			3	6		
	1995	7.97	607	<.3	4.5		
UJV 203	1993	8.14	429	1	4		
	1994			5	6		
	1995	8.85	529	<.3	4		
UJV 204	1993	8.08	387	3	7		
	1994	6.87	427	0.5	6		
	1995	7.45	461	<.3	5		
UJV 205	1993	8	430	7	4		
	1994	7.02	507	2	6		
	1995	7.66	467	1.5	4.5		
UJV 206	1993	a	a	Seep	5		
	1994	7.18	491	0.5	8		
	1995	7.32	462	Seep	5		
UJV 207	1993	8.13	448	5	5		
	1994	8.09	553	2	5		
	1995	7.15	504	1.5	6		
UJV 208	1993	7.93	456	6	7		
	1994	8.18	602	5	4		
	1995	7.46	503	3	6		
UJV 209	1993	8.37	401	4	5		
	1994	8.48	528	5	3		
	1995	7.73	509	1.5	6		
UJV 209A	1993	8.32	407	4	7		
	1994	7.04	458	4	7		
	1995	7.43	466	<.3	4.5		
UJV 210	1993	a	a	Seep	a		
	1994	a	a	a	a		
	1995	7.82	428	<.3	5		
UJV 211	1993	a	a	Seep	a		
	1994	a	a	a	a		
	1995	a	a	Seep	a		
UJV 212	1993	7.98	486	1	6		
	1994	7.9	663	2	5		
	1995	7.24	549	0.25	6		
UJV 8B	21-Jun-95	8.35	342				
UJV 8C	21-Jun-95	8.33	380				
UJV 11	21-Jun-95	8.45	333	3	7		
UJV 13	21-Jun-95	7.66	274	3	6		
UJV 14	21-Jun-95	7.6	350	Seep	12		
UJV 17A	21-Jun-95	8.79	400	<1	5		
UJV 3A	21-Jun-95	8.85	330				
UJV 21	21-Jun-95	7.82	333	<1	6		
UJV 22	21-Jun-95	7.8	360	<1	11		
UJV 24	21-Jun-95	8.95	320	Seep	9		
UJV 25	21-Jun-95	9.21	255	Seep	7		
UJV 26	21-Jun-95	8.79	310	Seep			
UJV 27	21-Jun-95	8.43	340	Seep	5		
UJV 28	21-Jun-95	7.7	380	Seep	6		
UJV 35	21-Jun-95	7.69	385	<1	17		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
UJV 36	21-Jun-95	7.85	372	5	6		
UJV 50	21-Jun-95			dr			
UJV 52	21-Jun-95	8.27	356	0.5	7		
UJV 53	21-Jun-95	8.01	310	Seep	7		
UJV 54	21-Jun-95	7.92	341	Seep	8		
UJV 55	21-Jun-95	7.59	320	Seep	15		
UJV 55A	21-Jun-95	8.75	360	3	10		
UJV 56	21-Jun-95	8.33	387	10	7		
UJV 57	21-Jun-95	7.91	310	Seep	12		
UJV 58	21-Jun-95	8.57	437	2	10		
UJV 59	21-Jun-95	8.07	408	2	10		
UJV 60	21-Jun-95	8.03	322	Seep	14		
UJV 61	21-Jun-95	7.66	344	Seep	14		
UJV 62	21-Jun-95	8.07	347	Seep	11		
UJV 63	21-Jun-95	7.94	344	Seep	10		
UJV 64	21-Jun-95			1	7		
UJV 65	21-Jun-95	8.18	308	Seep	16		
UJV 66A	21-Jun-95	7.62	331	1	18		
UJV 68	21-Jun-95	8.04	285	1	5		
UJV 70	21-Jun-95	7.91	360	1	9		
UJV 71	21-Jun-95	7.93	292	Seep	8		
UJV 72	21-Jun-95	7.95	363	Seep	8		
UJV 207	21-Jun-95	8.09	302	3	7		
UJV 208	21-Jun-95	8.45	308	5	4		
UJV 209	21-Jun-95	9.33	365	3	6		
UJV 209A	21-Jun-95	9.33	313	25	4		
UJV 210	21-Jun-95	8.91	322	Seep	7		
UJV 211	21-Jun-95	7.67	320	Seep	7		
UJV 212	21-Jun-95	8.11	342	1	5		
RR1	Sep/Oct 93	7.12	449	0.25	6		
RR2	1993	7.1	468	0.5	2		
	1994	7.46	473	20	2		
	1995	7.85	527	2	3		
RR 2A	1993						
	1994	7.51	481	2	4		
	1995	8.01	543	1	2.5		
RR 2B	1993						
	1994						
	1995	8.04	555	3	5		
RR 3	1993	6.85	451	<.25	8		
	1994	7.17	475	1	3		
	1995			Ice			
RR 3A	1993						
	1994						
	1995	7.88	463	0.5	4.5		
RR 4	1993						
	1994	7.23	551	1	7		
	1995			Dry			
RR 4A	1993						
	1994	6.92	422	15	5		
	1995	7.52	663	5	4		
RR 5	1993						
	1994	7.35	405	2	3.5		
	1995			Dry			
RR 5A	1993						
	1994	6.97	415	8	3		
	1995	8.29	349	2	5.5		
RR 6	1993						
	1994	7	414	<.3	6.5		
	1995	7.78	359	2	5		
RR 6A	1993						
	1994	7	414	2	4		
	1995	7.97	270	<.3	5		
RR 7	1993						
	1994	7.18	357	1.5	4		
	1995	7.58	343	0.25	4.5		
RR 7A	1993						
	1994						
	1995	a	a	Seep	a		
RR 8	1993						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	a	a	Seep	a		
	1995	8.25	375	0.5	7		
RR 8A	1993						
	1994						
	1995	a	a	Seep	a		
RR 9	1993						
	1994	7.24	432	15	4		
	1995	7.68	377	5	5.5		
RR 10	1993						
	1994	7.23	427	15	4.5		
	1995	7.52	521	2	6		
RR 11	1993						
	1994	7.28	476	10	5		
	1995	7.55	510	5	5		
RR 12	1993						
	1994	7.35	476	18	4.5		
	1995	7.61	379	5	5		
RR 13	1993						
	1994	7.31	435	1.5	5		
	1995	7.94	483	0.25	4.5		
RR 14	1993						
	1994	6.99	405	1.5	4		
	1995	7.84	375	7	4.5		
RR 14A	1993						
	1994						
	1995	7.98	532	0.25	5.5		
RR 14B	1993						
	1994						
	1995	7.67	356	1	5		
RR 14C	1993						
	1994						
	1995	7.51	518	0.5	4.5		
RR 15	1993						
	1994	7.06	495	20	2		
	1995	7.8	467	10	4		
RR 16	1993						
	1994	7.09	489	10	2.5		
	1995	7.68	320	0.5	3.5		
RR 17	1993						
	1994						
	1995	a	a	<.3	4		
RR 18	1993						
	1994						
	1995	a	a	Seep	a		
RR 19	1993						
	1994						
	1995			Dry			
RR 20	1993						
	1994						
	1995			Dry			
RR 21	1993						
	1994	8.02	400				
	1995	7.7	334	0.5	4		
RR 22	1993						
	1994						
	1995			Dry			
RR 23	1993						
	1994	8.08	511				
	1995	a	a	Seep	a		
RR 23A	1993						
	1994						
	1995	7.57	378	5	5.5		
RR 24	1993						
	1994						
	1995	7.57	545	0.25	4.5		
RR 25	1993						
	1994						
	1995	7.71	513	0.25	4.5		
RR 26	1993						
	1994						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995	a	a	Seep	a		
RR 27	1993						
	1994	7.73	395				
	1995			Dry			
RR 28	1993						
	1994	7.43	379				
	1995	8.11	403	<.3	3.5		
MF 1	1993	7.96	395	3	4		
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 2	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 3	1993	7.72	436	6	5		
	1994	7.76	500	10	6		
	1995	a	a	Seep	a		
MF 4	1993	7.95	341	Seep	4		
	1994	7.77	334	10	6		
	1995	a	a	Dry	a		
MF 4A	1993						
	1994	7.76	341	10	4.5		
	1995	8.39	285	3	0		
MF 5	1993	8.99	388	Seep	5		
	1994	8.37	381	15	4		
	1995	8.28	316	1	1		
MF 5A	1993	a	a	Seep			
	1994	7.84	441	0.5	4		
	1995	8.08	303	0.25	2		
MF 6	1993	8.4	405	Seep	4		
	1994	7.85	464	8	3		
	1995	7.84	396	1	5		
MF 7	1993	7.78	460	20	4		
	1994	7.79	504	10	6		
	1995	a	a	a	a		
MF 8	1993	7.75	431	17	4		
	1994	7.64	437	9	6		
	1995	a	a	a	a		
MF 9	1993	8.29	362	5	2		
	1994	8.31	412	10	3.5		
	1995	8	322	7	3		
MF 10	1993	7.95	324	0.5	3		
	1994	8.16	356	0.25	5		
	1995	8.4	309	10	2.5		
MF 11	1993	a	a	Seep	a		
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 12	1993	7.95	341	0.5	2		
	1994	8.13	409	1	5		
	1995	7.98	309	0.25	3		
MF 13	1993	7.62	332	0.5	2		
	1994	8.42	409	1	2.5		
	1995	7.9	351	1	2		
MF 14	1993	7.97	336	0.5	2		
	1994	8.4	399	1	4		
	1995	8.21	287	0.5	3		
MF 14A	1993						
	1994						
	1995	8.29	318	1	2.5		
MF 15	1993	7.98	335	0.5	2		
	1994	8.13	345	0.25	6		
	1995	7.95	403	0.5	5.5		
MF 15A	1993						
	1994	7.79	465	20	4		
	1995	8.18	338	0.25	5		
MF 15B	1993						
	1994	7.9	488	15	2.5		
	1995	a	a	a	a		
MF 16	1993	7.76	371	5	3		
	1994	a	a	a	a		
	1995	7.94	355	0.5	5.5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
MF 17	1993	7.71	392	8	3		
	1994	a	a	a	a		
	1995	8.24	349	0.5	2		
MF 17A	1993						
	1994						
	1995	8.26	273	0.25	6		
MF 18	1993	7.78	403	5	3		
	1994	a	a	a	a		
	1995	7.9	343	1.5	2		
MF 18A	1993						
	1994						
	1995	8.29	294	6	4		
MF 18B	1993						
	1994						
	1995	7.99	275	1	8		
MF 18C	1993						
	1994						
	1995	7.41	437	2	6		
MF 19	1993	7.8	429	2	3		
	1994	8.26	412	3	6		
	1995						
MF 19A	1993						
	1994	7.79	466	0.25	4		
	1995	7.78	327	1	4		
MF 19B	1993						
	1994	8.07	391	0.25	7.5		
	1995	8.37	283	0.5	4		
MF 19C	1993						
	1994	8.16	408	1	5		
	1995	a	a	Seep	a		
MF 19D	1993						
	1994	8.09	477	2	4		
	1995	a	a	Seep	a		
MF 19E	1993						
	1994	8.01	494	0.5	4.5		
	1995	a	a	Dry	a		
MF 19F	1993						
	1994	7.98	519	0.25	6		
	1995	a	a	Dry	a		
MF 19G	1993						
	1994	a	a	Seep	a		
	1995	a	a	Dry	a		
MF 19H	1993						
	1994	7.81	539	1.5	5		
	1995	a	a	Dry	a		
MF 19I	1993						
	1994						
	1995	a	a	Dry	a		
MF 20	1993	8.09	437	0.25	3		
	1994	8.18	497	a	a		
	1995	8.25	354	2	5		
MF 21	1993	7.46	430	Seep	a		
	1994	7.87	436	1	6		
	1995	7.77	363	3	4		
MF 22	1993	7.52	436	0.25	3		
	1994	8.22	485	2	3.5		
	1995	8.17	351	3	3		
MF 23	1993	a	a	Seep			
	1994	8.26	453	1	4		
	1995	8.25	355	Seep	3		
MF 24A	1993	a	a	Seep			
	1994	7.95	462	0.5	5		
	1995	7.8	389	2	4		
MF 24B	1993						
	1994	7.71	480	0.25	5		
	1995						
MF 171	1993						
	1994	7.78	366	5	4		
	1995						
MF 172	1993						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	8.06	353	10	5		
	1995						
MF 173	1993						
	1994	8.04	392	10	4		
	1995	7.67	395	0.5	3		
MF 212	1993						
	1994	7.09	605	a	a		
	1995						
MF 214	1994			Dry			
	1995			Dry			
	1996	7.46	276	63.6	10		
MF 216	1994			Dry			
	1995	8.97	795	57.2	8		
	1996	7.31	342	63.6	11		
MF 214	1991			Dry			
	1992			Dry			
	1993	8.5	300	550	4.5		
MF 216	1991			Dry			
	1992			Dry			
	1993	8.5	300	570	4.5		
MF 214	1989			Dry			
	1990			Dry			
MF 216	1989	7.9	535	86	3		
	1990			Dry			
MF 213	1980						
	1981						
	1982	7	215	29			
MF 214	1980	7.74	424	2.56			
	1981						
	1982	8.28	390		12		
MF 215	1980	7.63	573.3	1.43			
	1981	7.76	644.1	0.01			
	1982	7.93	565	0.02			
LB 1	1993	7.95	478	1	6		
	1994			Dry			
	1995						
LB 2	1993	7.95	495	2	4		
	1994	8.12	375	5	7		
	1995						
LB 3	1993	7.89	400	0.25	3		
	1994	8.19	340	1	7		
	1995						
LB 4	1993	8.37	771	0.25	4		
	1994			Dry			
	1995						
LB 5	1993	7.73	425	1	7		
	1994						
	1995						
LB 5A	1993	a	a	Seep	a		
	1994						
	1995						
LB 6	1993	7.83	489	2	6		
	1994						
	1995						
LB 7	1993	7.97	413	1	7		
	1994	a	a	Seep	a		
	1995						
LB 7A	1993	8.05	390	0.5	6		
	1994	7.92	360	0.5			
	1995						
LB 7B	1993	8.09	408	0.5	8		
	1994	7.98	325	0.5			
	1995						
LB 8	1993	8.22	402	0.25	4		
	1994	8.06	290				
	1995						
LB 9	1993	8.17	480	0.5	4		
	1994	7.98	300				
	1995						
LB 9A	1993						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1994	7.95	300				
	1995						
LB 10	1980						
	1981	7.73	543.3	.69 (cfs)	9		
	1982	7.47	450	.71 (cfs)	8.3		
LB 11	1980						
	1981	8.1	558.6	.01 (cfs)	9.9		
	1982						
LB 12	1980						
	1981						
	1982	7.35	563.5	4.4			
LB 13	1980						
	1981						
	1982	7.95	290.5	1.5			
LB 14	1980	7.6	520				
	1981	8.3	620	.002 (cfs)	20		
	1982	7.45	333	22			
LB 15	1980	7.2	495				
	1981	7.65	547.8				
	1982	7.56	490.7	.66 (cfs)	16		
LB 16	1980	7.4	500				
	1981	8.76	559.2				
	1982	7.8	487.5	.01 (cfs)			
LB 16	1990	7.2	430	282			
	1993	7	561	291			
	1995	7.7	490	300			
EM 50	1993	7.06	392	0.25	4		
	1994						
	1995			Ice			
EM 51	1993	a	a	Seep	a		
	1994						
	1995			Ice			
EM 213	1993	8.19	435	5	5		
	1994	8.37	478	5	5		
	1995	8.35	387	1.5	2.5		
EM 214	1993	8.12	475	2	4		
	1994	8.37	555	2	3		
	1995	7.8	382	<.3	3		
EM 215	1993	a	a	Seep	a		
	1994	8.37	548	<.3	7		
	1995			Dry			
EM 216	1993	a	a	Seep	a		
	1994	8.32	450	<.3	15		
	1995	a	a	Seep	a		
EM 217	1993	a	a	Seep	a		
	1994	8.16	556	<.3	9		
	1995	a	a	Seep	a		
EM 218	1993	8.06	489	1	3		
	1994	a	a	Seep	a		
	1995			Dry			
EM 218A	1993						
	1994	7.91	412	1	5		
	1995						
EM 219	1993	8.14	335	7	4		
	1994	8.04	382	5	4		
	1995			Ice			
EM 220	1993	a	a	Seep	a		
	1994	8.05	388	<.3	4		
	1995			Ice			
EM 221	1993	a	a	Seep	a		
	1994						
	1995	7.46	479	Seep	3.7		
EM 221A	1993						
	1994	a	a	Seep	a		
	1995	a	a	Seep	a		
EM 222	1993	8.1	376	0.25	5		
	1994	7.88	459	0.5	4		
	1995			Ice			
EM 223	1993	8.11	376	<.25	4		
	1994	8	462	<.3	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	1995			Ice			
EM 224	1993	7.99	391	0.5	10		
	1994	8.39	457	0.5	12		
	1995			Dry			
EM 224Z	1993						
	1994	8.23	535	<.3	15		
	1995			Dry			
EM 225	1993	8.18	367	0.5	3		
	1994	8.07	452	0.5	6		
	1995						
EM 226	1993	7.8	393	2	5		
	1994	8.16	451	0.75	4		
	1995						
EM 227	1993	7.98	347	0.25	5		
	1994	8.13	452	0.25	6		
	1995						
EM 228	1993	8.21	310	0.25	4		
	1994	8.18	407	0.5	4		
	1995						
EM POND 1	1993			3	4		
	1994	8.24	556	6	5		
	1995	7.81	370	0.5	4		
UJV 1	Jun 24-27,96	8.04	438	5	4	TKn	Joe's Valley
UJV 2	Jun 24-27,96	7.61	410	<1	7	TKn	Joe's Valley
UJV 3	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 3A/4A	Jun 24-27,96	7.55	419	13	4	TKn	Joe's Valley
UJV 4	Jun 24-27,96			N/F		TKn	Joe's Valley
UJV 5	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 6	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 6A	Jun 24-27,96			Dry		TKn	Joe's Valley
UJV 7	Jun 24-27,96	8.08	418	28	3	TKn	Joe's Valley
UJV 7A	Jun 24-27,96	7.81	492	1	8	TKn	Joe's Valley
UJV 8	Jun 24-27,96	7.68	434	80	8	TKn	Joe's Valley
UJV 8A	Jun 24-27,96			Seep		TKn	Joe's Valley
UJV 8B	Jun 24-27,96	7.95	415	50	7	TKn	Joe's Valley
UJV 8C	Jun 24-27,96	7.5	432	5	8	TKn	Joe's Valley
UJV 9	Jun 24-27,96	7.62	473	70	7	TKn	Joe's Valley
UJV 9A	Jun 24-27,96			Seep		TKn	Joe's Valley
UJV 10	Jun 24-27,96	8.04	424	4	7	TKn	Joe's Valley
UJV 11	Jun 24-27,96	7.84	435	5	8	TKn	Joe's Valley
UJV 12	Jun 24-27,96	7.69	573	25	8	TKn	Joe's Valley
UJV 13	Jun 24-27,96	7.69	541	5	6	Alluvium/Fault	Joe's Valley
UJV 14	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 15	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 16	Jun 24-27,96	7.77	483	<1	7	Alluvium/Fault	Joe's Valley
UJV 17	Jun 24-27,96	7.85	494	<1	5	Alluvium/Fault	Joe's Valley
UJV 17A	Jun 24-27,96	7.71	487	3	5	Alluvium/Fault	Joe's Valley
UJV 20	Jun 24-27,96	7.75	474	2	11	Alluvium/Fault	Joe's Valley
UJV 21	Jun 24-27,96	7.54	434	<1	9	Alluvium/Fault	Joe's Valley
UJV 22	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 23	Jun 24-27,96			Seep		Alluvium/Fault	Joe's Valley
UJV 24	Jun 24-27,96			Seep		Alluvium/Fault	Joe's Valley
UJV 25	Jun 24-27,96	7.79	404	<1	16	Alluvium/Fault	Joe's Valley
UJV 26	Jun 24-27,96	7.87	367	4	11	Alluvium/Fault	Joe's Valley
UJV 27	Jun 24-27,96	7.7	438	<1	5	Alluvium/Fault	Joe's Valley
UJV 28	Jun 24-27,96	7.76	492	3	7	Alluvium/Fault	Joe's Valley
UJV 29	Jun 24-27,96	7.74	498	1	8	Alluvium/Fault	Joe's Valley
UJV 30	Jun 24-27,96	7.77	522	2	7	Alluvium/Fault	Joe's Valley
UJV 31	Jun 24-27,96	7.8	451	5	5	Alluvium/Fault	Joe's Valley
UJV 32	Jun 24-27,96	7.71	473	3	5	Alluvium/Fault	Joe's Valley
UJV 33	Jun 24-27,96	7.88	401	<1	12	Alluvium/Fault	Joe's Valley
UJV 34	Jun 24-27,96			Dry		Alluvium/Fault	Joe's Valley
UJV 35	Jun 24-27,96	7.76	403	8	10	Alluvium/Fault	Joe's Valley
UJV 36	Jun 24-27,96	7.74	475	2	7	TKn	Joe's Valley
UJV 50	Jun 24-27,96	8.13	508	1	7	Alluvium/Fault	Joe's Valley
UJV 52	Jun 24-27,96	8.1	480	1	15	Alluvium/Fault	Joe's Valley
UJV 53	Jun 24-27,96	8.06	397	3	5	Alluvium/Fault	Joe's Valley
UJV 54	Jun 24-27,96	8.05	421	2	7	Alluvium/Fault	Joe's Valley
UJV 55	Jun 24-27,96	8.01	403	4	8	Alluvium/Fault	Joe's Valley
UJV 55A	Jun 24-27,96	8.1	440	2	9	Alluvium/Fault	Joe's Valley

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
UJV 56	Jun 24-27,96	7.9	462	4	4	Alluvium/Fault	Joe's Valley
UJV 57	Jun 24-27,96	8.19	450	2	6	Alluvium/Fault	Joe's Valley
UJV 58	Jun 24-27,96	8.18	379	35	11	Alluvium/Fault	Joe's Valley
UJV 59	Jun 24-27,96	7.85	459	25	9	Alluvium/Fault	Joe's Valley
UJV 60	Jun 24-27,96	7.49	764	3	11	Alluvium/Fault	Joe's Valley
UJV 61	Jun 24-27,96	8.08	423	60	8	Alluvium/Fault	Joe's Valley
UJV 62	Jun 24-27,96	8	468	2	4	Alluvium/Fault	Joe's Valley
UJV 63	Jun 24-27,96	8.05	465	4	6	Alluvium/Fault	Joe's Valley
UJV 64	Jun 24-27,96	8.13	407	2	7	Alluvium/Fault	Joe's Valley
UJV 65	Jun 24-27,96	7.99	549	12	6	Alluvium/Fault	Joe's Valley
UJV 66	Jun 24-27,96	7.99	411	5	10	Alluvium/Fault	Joe's Valley
UJV 66A	Jun 24-27,96	7.8	466	18	12	Alluvium/Fault	Joe's Valley
UJV 67	Jun 24-27,96	7.94	610	10	9	Alluvium/Fault	Joe's Valley
UJV 68	Jun 24-27,96	8.06	441	8	7	Alluvium/Fault	Joe's Valley
UJV 69/70	Jun 24-27,96	8.18	405	60	11	Alluvium/Fault	Joe's Valley
UJV 71	Jun 24-27,96	8.15	435	10	9	Alluvium/Fault	Joe's Valley
UJV 72	Jun 24-27,96	7.95	439	3	7	Alluvium/Fault	Joe's Valley
UJV 80	Jun 24-27,96	7.67	532	5	5	Alluvium/Fault	Joe's Valley
UJV 81	Jun 24-27,96	7.73	596	2	7	Alluvium/Fault	Joe's Valley
UJV 81A	Jun 24-27,96	7.72	594	2	4	Alluvium/Fault	Joe's Valley
UJV 82	Jun 24-27,96	7.9	402	7	9	Alluvium/Fault	Joe's Valley
UJV 83	Jun 24-27,96	7.84	397	6	17	Alluvium/Fault	Joe's Valley
UJV 100	Jun 24-27,96						
UJV 100A	Jun 24-27,96	7.99	343	3	5	TKn	~300'
UJV 100B	Jun 24-27,96	7.83	402	4	5	KP	Flows to canyon mouth
UJV 100C	Jun 24-27,96	7.85	462	8	5	Kp	Flows to canyon mouth
UJV 101/102	Jun 24-27,96	8.12	430	20	6	Kc	Same spring
UJV 102A	Jun 24-27,96			N/F		Kc/Alluvium?	Disappears into alluvium
UJV 103	Jun 24-27,96	7.98	356	7	2	TKn	~100'
UJV 104	Jun 24-27,96	8.03	426	15	5	TKn	To stream
UJV 105	Jun 24-27,96	8.12	444	5	4	TKn	To stream
UJV 106	Jun 24-27,96	8.41	422	1	7	Kp	To stream
UJV 106A	Jun 24-27,96	8.03	455	2	5	Kp	~100'
UJV 106B	Jun 24-27,96	7.85	372	<1	6	Kp	~100'
UJV 107	Jun 24-27,96	7.91	460	4	5	TKn	To stream
UJV 108	Jun 24-27,96	7.75	488	10	5	TKn	To stream
UJV 109	Jun 24-27,96	8.09	505	10	5	Kp/Kc?	~200-300'
UJV 109A	Jun 24-27,96	8.04	516	<1	10	Kp	~50'
UJV 109B	Jun 24-27,96	8.05	479	10	4	Kp/Kc	~200-300'
UJV 150	Jun 24-27,96	8.05	451	7	7	Kp	~200-300'
UJV 151	Jun 24-27,96	7.85	491	10	6	Kp	~200-300'
UJV 151B	Jun 24-27,96	7.93	413	10	5	Kp?	~200-300'
UJV 152	Jun 24-27,96	7.95	531	18	5	Kc	To stream
UJV 153	Jun 24-27,96	8.02	459	5	6	Kc	To stream
UJV 154	Jun 24-27,96	8.04	416	<1	6	Kp	~100-200'
UJV 155	Jun 24-27,96	8.16	435	1	8	Kp	~100-200'
UJV 202	Jun 24-27,96	7.96	490	2	4	TKn	To stream
UJV 203	Jun 24-27,96	8.01	573	1	6	TKn/Kp	To stream
UJV 204	Jun 24-27,96	8.09	397	15	5	Kp	~300-400'
UJV 205	Jun 24-27,96	8.16	517	15	5	Kp	To cliff base
UJV 206	Jun 24-27,96	8.1	432	1		Kp	~200-300'
UJV 207	Jun 24-27,96	7.93	459	20	4	Kp	To stream
UJV 208	Jun 24-27,96	7.87	458	45	4	Kc	To stream
UJV 209	Jun 24-27,96			Dry		Kp?	To stream
UJV 209A	Jun 24-27,96	8.06	441	15	6	Kp	To stream
UJV 210	Jun 24-27,96			Dry		Kc	
UJV 211	Jun 24-27,96	7.88	460	2	6	Kc	To stream
UJV 212	Jun 24-27,96	7.84	492	3	5	Kc	To stream
EM POND	Jun 24-27,96	8.27	403	20	3	TKn	~200-300'
EM 50	Jun 24-27,96	7.67	311	10	3	TKn	To stream
EM 51	Jun 24-27,96	7.7	316	20	3	TKn	To stream
EM 213	Jun 24-27,96	7.91	433	23	5	Kp	To stream
EM 214	Jun 24-27,96	8.18	397	8	4	Kp	To stream
EM 215	Jun 24-27,96			N/F		Kp	~50'
EM 216	Jun 24-27,96	8.18	482	3	6	Kp	~100'
EM 217	Jun 24-27,96			Seep		Kp	~100'
EM 218	Jun 24-27,96			Dry		Kp	~100'
EM 219	Jun 24-27,96	8.25	361	15	3	TKn	Unknown
EM 220	Jun 24-27,96	7.93	411	1	5	TKn	Unknown
EM 221	Jun 24-27,96	8	390	8	5	Base of Tf	<50'

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
EM 221A	Jun 24-27,96	8.05	317	1	5	Base of Tf	~100'
EM 221B	Jun 24-27,96	7.92	281	6	4	Base of Tf	~100'
EM 222	Jun 24-27,96	8.17	481	2	7	TKn	~100'
EM 223	Jun 24-27,96	8.19	406	1	10	TKn	~100'
EM 224	Jun 24-27,96	8.19	412	3	7	TKn	~100'
EM 224Z	Jun 24-27,96	8	386	12	3	TKn	~100'
EM 225	Jun 24-27,96					TKn	Same as EM-228
EM 226	Jun 24-27,96					TKn	Same as EM-228
EM 227	Jun 24-27,96					TKn	Same as EM-228
EM 228	Jun 24-27,96	7.72	357	3	3	TKn	~300-500'
MF 1	Jun 24-27,96	7.71	310	10	6	Base of TKn	To stream
MF 2	Jun 24-27,96			N/F		Base of Kc?	To stream
MF 3	Jun 24-27,96	7.95	470	50	7	Kb	To stream
MF 4	Jun 24-27,96	7.96	466	1	3	Kp	To stream
MF 4A	Jun 24-27,96			Seep		Kp	To stream
MF 5	Jun 24-27,96	7.77	281	30	4	Kp	Unknown
MF 5A	Jun 24-27,96	7.95	297	7	4	Kp	Unknown
MF 6	Jun 24-27,96	8.35	343	8	4	TKn	To stream
MF 7	Jun 24-27,96	7.6	489	30	4	Kb	To stream
MF 7A	Jun 24-27,96	7.72	350	2		Kb	To stream
MF 8	Jun 24-27,96						No spring where marked
MF 8A	Jun 24-27,96	7.66	382	1	6	Kb	To stream
MF 9	Jun 24-27,96	8.13	310	7	4	TKn	To stream
MF 10	Jun 24-27,96	8.33	291	10	5	TKn	To stream
MF 11	Jun 24-27,96	8.31	289	<1	4	TKn	~100-200'
MF 12	Jun 24-27,96	8.36	336	1	4	TKn	~100-200'
MF 13	Jun 24-27,96	8.31	360	1	4	TKn	~100-200'
MF 14	Jun 24-27,96	8.28	351	1	5	TKn	~100-200'
MF 14A	Jun 24-27,96	8.03	334	2	6	TKn	~100-200'
MF 14B	Jun 24-27,96	8.29	317	4	9	TKn	~100-200'
MF 15	Jun 24-27,96	8.31	341	1	5	TKn	To stream?
MF 15A	Jun 24-27,96	8.08	365	3	5	TKn	To stream
MF 15B	Jun 24-27,96	8.04	393	3	4	TKn	To stream
MF 16	Jun 24-27,96	7.98	419	7	4	TKn	To stream
MF 17	Jun 24-27,96	8.23	384	2	10	TKn	To stream
MF 17A	Jun 24-27,96	8.14	395	15	5	TKn	To stream
MF 17X	Jun 24-27,96	8.14	478	<1	6	TKn	Unknown
MF 18	Jun 24-27,96	8.23	328	2	5	TKn	To stream
MF 18A	Jun 24-27,96	8.28	414	12	9	TKn	~200-300'
MF 18B	Jun 24-27,96	8.23	389	6	5	TKn	~200-300'
MF 18C	Jun 24-27,96	7.99	517	12	4	TKn	To stream
MF 18D	Jun 24-27,96			N/F			Unknown
MF 19A	Jun 24-27,96	8.27	352	1	4	TKn	To stream?
MF 19B	Jun 24-27,96	8.33	393	1	5	TKn	To stream?
MF 19C	Jun 24-27,96	7.73	355	4	4	TKn	To stream?
MF 19D	Jun 24-27,96	7.85	408	1	4	TKn	~100-200'
MF 19E	Jun 24-27,96	7.78	405	5	4	TKn	~100-200'
MF 19F	Jun 24-27,96	7.8	447	3	6	TKn	~100-200'
MF 19G	Jun 24-27,96	7.79	410	<1	7	TKn	~100-200'
MF 19H	Jun 24-27,96	7.76	450	10	4	TKn	~500'
MF 19I	Jun 24-27,96	8.06	395	2	3	TKn	~500'
MF 19J	Jun 24-27,96	7.89	408	3	3	TKn	Unknown
MF 19K	Jun 24-27,96	7.93	374	15	4	TKn	~200-300'
MF 20	Jun 24-27,96	7.92	414	15	4	Kp	Unknown
MF 21	Jun 24-27,96	8.02	428	5	4	TKn/Kp	To stream
MF 22	Jun 24-27,96	7.93	422	25	4	TKn/Kp	~100'
MF 23	Jun 24-27,96	8.02	381	15	4	TKn/Kp	To stream
MF 24	Jun 24-27,96			N/F		Kc	Unknown
MF 24A	Jun 24-27,96			N/F		Kc	Unknown
MF 24B	Jun 24-27,96			N/F		Kc	Unknown
RR 2	Jun 24-27,96	7.74	413	8	3	TKn	To stream
RR 2A	Jun 24-27,96	8.36	370	15	2	TKn	To stream
RR 2B	Jun 24-27,96	8.05	317	12	3	TKn	To stream
RR 2C	Jun 24-27,96	7.65	418	3	1	TKn	Unknown
RR 3	Jun 24-27,96	7.64	470	20	4	TKn/Kp	To stream
RR 3A	Jun 24-27,96	8.08	480	15	4	TKn/Kp	To stream
RR 3B	Jun 24-27,96	7.54	478	12	4	TKn/Kp	To stream
RR 4	Jun 24-27,96	7.5	480	30	4	TKn	To stream
RR 4A	Jun 24-27,96	8.62	466	15	5	TKn	To stream
RR 5	Jun 24-27,96	7.79	347	2	3	TKn	~50-100'

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
RR 5A	Jun 24-27,96	7.66	426	5	10	TKn	To stream
RR 6	Jun 24-27,96	7.71	359	10	4	TKn	To stream
RR 6A	Jun 24-27,96	7.82	312	1	4	TKn	To stream
RR 7	Jun 24-27,96	7.56	353	3	4	TKn	To stream
RR 7A	Jun 24-27,96	7.84	328	1	8	TKn	To stream
RR 8	Jun 24-27,96	7.8	395	3	4	TKn	To stream
RR 8A	Jun 24-27,96			N/F		TKn	Unknown
RR 9	Jun 24-27,96	7.56	368	10	4	TKn	To stream
RR 10	Jun 24-27,96	7.73	386	18	4	TKn	To stream
RR 11	Jun 24-27,96	7.59	418	12	4	TKn	To stream
RR 12	Jun 24-27,96	7.49	388	25	4	TKn	To stream
RR 13	Jun 24-27,96	7.53	355	5	5	TKn	~100-200'
RR 14	Jun 24-27,96	8.21	363	20	3	TKn	To stream
RR 14A	Jun 24-27,96	8.08	367	3	6	TKn	To stream
RR 14B	Jun 24-27,96	7.75	707	12	4	TKn	To stream
RR 14C	Jun 24-27,96	7.68	391	3	3	TKn	To stream
RR 15	Jun 24-27,96	7.9	313	50	3	TKn	To stream
RR 16	Jun 24-27,96	7.88	344	40	4	TKn	To stream
RR 17	Jun 24-27,96			Seep		TKn	~100-200'
RR 18	Jun 24-27,96	7.85	348	5	3	TKn	~50'
RR 19	Jun 24-27,96	7.44	321	1	4	TKn	~50'
RR 20	Jun 24-27,96	7.89	333	4	4	TKn	~50'
RR 21	Jun 24-27,96			Seep		TKn	~20'
RR 22	Jun 24-27,96	7.8	337	2	4	TKn	~20'
RR 23	Jun 24-27,96	7.86	403	3	4	TKn	~20'
RR 23A	Jun 24-27,96	7.84	375	40	3	TKn	~20'
RR 24	Jun 24-27,96	7.5	365	10	4	TKn	~50'
RR 25	Jun 24-27,96	7.83	404	1	3	TKn	~50'
RR 26	Jun 24-27,96	7.93	335	<1	6	TKn	~20'
RR 27	Jun 24-27,96	7.8	302	4	2	TKn	~100'
RR 28	Jun 24-27,96	7.91	319	4	3	TKn	To stream
RR 29	Jun 24-27,96	7.78	338	1	4	TKn	~50'
SP 2-1	Jun 24-27,96	8.14	392	31	3	TKn	To stream
SP 1-33	Jun 24-27,96	8.07	395	25	8	TKn	Unknown
SP 1-47	Jun 24-27,96	7.89	419	4	3	TKn	Unknown
LB 1	Jun 24-27,96					Kc	Unknown
LB 2	Jun 24-27,96	7.78	415			Kc	Unknown
LB 3	Jun 24-27,96	7.79	393			Kb	Unknown
LB 4	Jun 24-27,96					Kb	Unknown
LB 5	Jun 24-27,96	7.67	440	15	7	Kp	To stream
LB 5A	Jun 24-27,96	7.98	436	15	7	Kb	To stream
LB 6	Jun 24-27,96			Dry		Kp	~20'
LB 7	Jun 24-27,96			Seep		Kc	~200-300'
LB 7A	Jun 24-27,96			Seep		Kc	~200-300'
LB 7B	Jun 24-27,96	7.77	498	1	9	Kc	~200-300'
LB 8	Jun 24-27,96	7.92	428			Kp	Unknown
LB 9	Jun 24-27,96					Kp	Unknown
LB 9A	Jun 24-27,96					Kc	Unknown
SP-1	Jun-85			seep		Ksp over Masuk Shale of Mancos Shale	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-2	Jun-85			seep		Ksp over Masuk Shale of Mancos Shale	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-3	Jun-85	8.12	730	4	17	Ksp	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-4	Jun-85	7.86	660	6	10	Colluvium at head of landslide in Kbh	Wildlife
	Oct-85			seep			
	Sep/Oct 93			seep			
SP-5	Jun-85			seep		Colluvium at head of landslide in Kbh	None
	Oct-85			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Sep/Oct 93			seep			
SP-6	Jun-85	7.67	590	5	4.5	Kbh	Wildlife
	Oct-85			dry			
	Jun-93			seep			
	Sep/Oct 93			dry			
SP-7	Jun-85	8.36	440	10	10	Kc	Wildlife
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	8.31	379	4	6		
	Oct/Nov 90						
	Jun-91			dry	a		
	Oct/Nov 91			dry	a		
SP-8	Jun-85	7.95	280	20	3.5	Kc	Wildlife
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	8.21	194	5	4		
	Oct/Nov 90						
	Jun-91	8.07	176	20	2		
	Oct/Nov 91	7.63	428	2	3		
SP-9	Jun-85			seep		Kc/Kbh interface	None
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	8.35	306	5	4		
	Oct/Nov 90						
	Jun-91		seep	seep	4		
	Oct/Nov 91			0.5	4		
SP-10	Jun-85	7.9	220	40	10	Kc	Wildlife
	Oct-85			seep			
	Oct-89			dry			
	Jun-90	7.62	244	5	3		
	Oct/Nov 90						
	Jun-91		seep	seep	5		
	Oct/Nov 91	8.19	354	1	4		
SP-11	Jun-85		a	seep	a	Kc	None
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	7.87	126	1	10		
	Oct/Nov 90						
	Jun-91	7.32	202	2.5	4		
	Oct/Nov 91		a	0.1	5		
SP-12	Jun-85	7.66	250	15	3	Kpr	Wildlife
	Oct-85		a	seep	a		
	Oct-89			dry			
	Jun-90	8	112	5	3		
	Oct/Nov 90						
	Jun-91		seep	seep	5		
	Oct/Nov 91						
SP-13	Jun-85	8.57	100	3	7	Kpr	Wildlife
	Oct-85			dry			
	Oct-89		a	seep	a		
	Jun-90	7.91	187	3	6		
	Oct/Nov 90						
	Jun-91		seep	seep	6		
	Oct/Nov 91		a	0.1	6		
SP-14	Jun-85	8.1	150	25	5.5	Kpr	Wildlife
	Oct-85	7.74	340	1	6		
	Oct-89	7.8	380	1	6		
	Jun-90	7.77	150	10	4		
	Oct/Nov 90						
	Jun-91	8.38	301	1.5	6		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct/Nov 91	7.87	360	0.1	5		
SP-14a	Jun-90	7.89	280	1.5	4	Kpr	Wildlife
	Oct/Nov 90						
	Jun-91	7.56	259	2	5		
	Oct/Nov 91						
	Jun-93	8.27	0.55	8	3		
	Sep/Oct 93	8.4	301	3	4		
SP-14b	Jun-90	7.74	306	1.5	4	Kpr	Wildlife
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91						
SP-15	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP-16	Sep/Oct 93	a	a	seep		Kbh	Wildlife
	Jun-85	8.34	560	1	14.5		
	Oct-85			dry			
	Jun-93	8.35	462	1/5	8		
SP-17	Jun-85	7.71	460	2	10	Kbh	Wildlife
	Oct-85			dry			
	Jun-93	8.48	407	3	10		
	Sep/Oct 93			dry			
SP-18	Jun-85	7.42	500	10	7	Ksp	Wildlife
	Oct-85	8.15	450	2	3		
	Jun-93	8.5	447	<1/8	8		
	Sep/Oct 93	a	a	seep			
SP-19	Jun-85	7.6	620	5	6.5	Kbh	None
	Oct-85	8.27	530	1	3.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP-20	Jun-85		a	seep	a	Ksp	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-21	Jun-85	8.53	820	2	13.5	Ksp	Wildlife
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-22	Jun-85	8.05	230	4	3.5	Kbh	None
	Oct-85	7.32	350	1	3.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-22a	Jun-85					Kbh/Tufa deposits	Wildlife
	Oct-85						
	Jun-93	7.96	472	0.5	4		
	Sep/Oct 93	a	a	seep			
SP-23	Jun-85	8.02	550	5	6	Kbh	None
	Oct-85	8.08	670	2	3.5		
	Jun-93	8.19	498	0.5	10		
	Sep/Oct 93	a	a	seep			
SP-24	Jun-85	7.35	790	2	6	Kbh	Wildlife
	Oct-85			dry			
	Jun-93	8.54	555	10	8		
	Sep/Oct 93	a	a	seep			
SP-25	Jun-85	6.8	820	<1	10	Ksp	None

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-25a	Jun-85					Ksp	None
	Oct-85						
	Sep/Oct 93			dry			
SP-26	Jun-85		a	seep	a	Ksp	None
	Oct-85		a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-27	Jun-85		a	seep	a	Ksp	None
	Oct-85		a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-28	Jun-85		a	seep	a	Ksp	None
	Oct-85			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-29	Jun-85		a	seep	a	Ksp	None
	Oct-85			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP-30	Jun-85	8.1	1150	1	16.5	Kbh	None
	Oct-85	8.19		<1	4		
	Sep/Oct 93		1060	dry			
SP-31	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-32	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Sep/Oct 93			dry			
SP-33	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-34	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-35	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-36	Jun-85	8.39	890	2	16	Kbh	Wildlife
	Oct-85	7.85	950	1	4		
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-37	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-38	Jun-85	8.22	1180	<1	9	Kbh	Wildlife
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-39	Jun-85		a	seep	a	Kbh	None

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-85			dry			
	Jun-93	8.64	718	2	8		
	Sep/Oct 93			dry			
SP-40	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-41	Jun-85		a	seep	a	Kbh	None
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-42	Jun-85		a	seep	a	Kbh	Wildlife
	Oct-85			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP-43						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-44						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-45						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-46						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov 90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-47						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-47a	Jun-85						Developed
	Oct-85						
	Jun-91	7.81	368	2	5		
	Oct/Nov 91	7.67	345	0.1	6		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct/Nov-90						
	Sep/Oct 93	a	a	seep			
SP-48						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91	7.68	342	dry			
	Oct/Nov 91	7.04		dry			
SP-48a						Kbh	None
	Jun-85						
	Oct-85						
	Jun-90	8.19	602	2	6		
	Oct/Nov-90						
	Jun-91	7.84	362	dry			
	Oct/Nov 91			dry			
SP-48b						Kbh	None
	Jun-90	7.59	642	1.5	6		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-49						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			
SP-50						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91	7.61	381	2.5	6		
	Oct/Nov 91			dry			
SP-51						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-52						Kbh	Wildlife
	Jun-85	7.99	600	1	12		
	Oct-85	8	540	1	7		
	Oct-89	8.3	392	<<1	6.7		
	Jun-90	8.6	545	<1	11		
	Oct/Nov-90			dry			
	Jun-91	8.12	337	0.25	5		
	Oct/Nov 91	8.06	602	0.5	6		
SP-53						Kbh	Wildlife
	Jun-85	7.31	490	8	5.5		
	Oct-85	7.95	470	5	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-89			dry			
	Jun-90	7.91	506	<1	6		
	Oct/Nov-90	8.18	236	4	5		
	Jun-91	7.42	536	dry			
	Oct/Nov 91			dry			
SP-54						Kbh	Wildlife
	Jun-85	7.35	500	15	5.5		
	Oct-85	8.07	500	5	5.5		
	Oct-89	8.47	352	<<1	2.2		
	Jun-90	8.23	536	2	5		
	Oct/Nov-90			dry			
	Jun-91	7.5	333	3	4		
	Oct/Nov 91	8.44	550	5	4		
SP-55						Kbh	Wildlife
	Jun-85	7.36	480	10	5.5		
	Oct-85	7.59	530	10	5.5		
	Oct-89		a	seep	a		
	Jun-90	7.97	466	5	6		
	Oct/Nov-90			dry			
	Jun-91	7.95	314	8	4		
	Oct/Nov 91		a	seep	a		
SP-56						Kbh	Wildlife
	Jun-85	7.61	490	15	5.5		
	Oct-85	7.9	470	15	6.5		
	Oct-89		a	seep	a		
	Jun-90	7.99	536	5	6		
	Oct/Nov-90			dry			
	Jun-91	7.83	512	3	4		
	Oct/Nov 91	8.36	483	1	7		
SP-57						Kbh	Wildlife
	Jun-85	7.35	480	6	5.5		
	Oct-85	7.56	470	4.5	4.5		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90		b	b			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-57a						Kbh	Wildlife
	Jun-85						
	Oct-85						
	Oct-89						
	Jun-90						
	Oct/Nov-90						
	Jun-91	7.24	331	1	4		
	Oct/Nov 91						
SP-58						Kbh	Wildlife
	Jun-85	7.4	500	10	5		
	Oct-85	7.7	500	5	9		
	Oct-89	7.88	470	4	5.6		
	Jun-90	7.79	437	20	5		
	Oct/Nov-90	8.27	466	6	5		
	Jun-91	7.46	318	15	4		
	Oct/Nov 91	7.95	481	5	5		
SP-59						Kbh	Wildlife
	Jun-85	7.43	690	1	7		
	Oct-85	7.86	520	1	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
SP-60						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91						
SP-61						Kpr	Wildlife
	Jun-85	7.36	450	15	2		
	Oct-85	8.16	450	1	9		
	Oct-89			dry			
	Jun-90	8.28	362	3	4		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91						
SP-62						Kpr	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91						
SP-63						Kpr	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.49	458	0.75	2		
	Oct/Nov 91						
SP-64						Kpr	Wildlife
	Jun-85	7.33	440	10	3		
	Oct-85			dry			
	Oct-89			dry			
	Jun-90	7.81	376	2	5		
	Oct/Nov-90						
	Jun-91	7.6	451	0.5	2		
	Oct/Nov 91						
	Jun-93	8.34	1180	5	5		
SP-65						Kpr	Wildlife
	Jun-85	7.43	430	15	5		
	Oct-85	8.18	500	<1	3.5		
	Jun-93	8.3	1170	5	6		
SP-66						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
SP-67						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
SP-68						Kc	None
	Jun-85		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-85			dry			
	Jun-93	8.16	444	10	6		
SP-69						Kc	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	8.1	473	10	5		
SP-70						Kpr	Wildlife
	Jun-85	7.17	550	15	3.5		
	Oct-85		a	seep	a		
	Jun-93	8.33	430	10	6		
SP-71						Kc	None
	Jun-85		a	seep	a		
	Oct-85		a	seep	a		
	Jun-93	8.08	468	2	5		
SP-72						Kpr	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	8.27	445	0.5	7		
SP-73						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	8.26	417	10	5		
SP-74						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-75						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-76						Kbh	Wildlife
	Jun-85	7.48	960	1	10		
	Oct-85	8.35	850	1	5		
	Jun-93			dry			
SP-77						Kbh	None
	Jun-85		a	seep	a		
	Oct-85			dry			
SP-78						Ksp	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-79						Ksp	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93			dry			
SP-80						Ksp	None
	Jun-85		a	seep	a		
	Oct-85			dry			
	Jun-93	a	a	seep	a		
SP1-1						Alluvium/valley floor	Wildlife
	Jul-87	7.71	360	<<1	2.9		
	Oct-87	7.24	440	3	7		
	Oct-89		a	seep	a		
	Jun-90	8.16	437	<1	7		
	Oct/Non-90	7.43	418	seep	8		
	Jun-91	7.6	1740	0.5	9		
	Oct/Nov 91	8.1	384	dry			
	Jun-92	7.38	247	seep	a		
	Oct-92			dry			
SP1-2						Alluvium/valley floor	Developed
	Jul-87	7.81	280	2	4		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.61	214	2.5	9		
	Oct/Nov-90		b	b			
	Jun-91		a	0.5	5		
	Oct/Nov 91	8.05	341	b	b		
	Jun-92		a	seep	a		
	Oct-92	7.98	517	semi-frozen	0		
	Jun-93			b			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-2a	Jul-87	7.8	280	5	4	Alluvium/valley floor	Wildlife
	Oct-87	7.97	320	1	7		
	Oct-89	8.68	292	<<1	2.9		
	Jun-90	7.87	202	3	3		
	Oct/Nov 91	8.1	291	1	2		
	Jun-91	8.17	314	7	2		
	Jun-92						
	Oct-92						
	Oct/Nov 90	8.21	264	seep	1		
	Sep/Oct 93	8.34	298	5	4		
SP1-2b	Jun-91	7.56	219	2	3	Alluvium/valley floor	None
	Oct/Nov 91			dry			
	Jun-92						
	Oct-92						
SP1-3						Kpr	Developed
	Jul-87	7.61	190	<1	2		
	Oct-87	7.61	250	<1	2		
	Oct-89	7.7	280	<<1	2.8		
	Jun-90	8.1	164	3	3		
	Oct/Nov-90	7.88	249	b	2		
	Jun-91	7.49	304	0.5	5		
	Oct/Nov 91		b	b	b		
	Jun-92						
	Oct-92						
SP1-3a	Jun-91	7.8	191	0.5	3	Alluvium/valley floor	None
	Oct/Nov 91			dry			
	Sep/Oct 93	7.7	275	1	4		
SP1-4						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.37	257	<1	3		
	Oct/Nov-90			dry			
	Jun-91	7.56	326	5	6		
	Oct/Nov 91	8.3	456	2	5		
	Jun-92						
	Oct-92						
SP1-4a	Jun-91	8.26	376	1	12	Kbh	Wildlife
	Oct/Nov 91		a	seep	a		
	Jun-92	8.16	564	seep	a		
	Oct-92			dry			
	Jun-93	8.63	214	25	5		
	Sep/Oct 93	8.19	344	2	6		
SP1-4a1	Jun-92		a	seep	a	Kbh	None
	Oct-92	a	a	seep	a		
	Sep/Oct 93	a	a	seep	a		
SP1-4b	Jun-91					Kpr	None
	Oct/Nov 91		a				
	Jun-93	7.83	244	15	5		
	Sep/Oct 93	8.52	351	6	6		
SP1-4b1	Jun-92		a	seep	a	Kbh	None
	Oct-92	a	a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.92	305	3	6		
SP1-4c	Jun-92		a	seep	a	Kbh	None
	Oct-92	8.21	517	7	7		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	8.21	362	4	5		
SP1-5						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-89			dry			
	Jun-90	7.97	169	<1	4		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91		a	0.25	8		
SP1-6						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.14	346	<1	4		
	Oct/Nov-90		a	seep	a		
	Jun-91	8.26	150	15	5		
	Oct/Nov 91	8.14	316	1.5	5		
SP1-7						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	7.72	348	<1	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.8	282	0.25	5		
	Oct/Nov 91	8.24	498	0.5	8		
SP1-8						TKfn	Wildlife
	Jul-87	7.54	420	<<1	11		
	Oct-87			dry			
	Oct-89	7.99	282	<<1	5.6		
	Jun-90	7.22	197	1	10		
	Oct/Nov-90		a	seep	6		
	Jun-91	8.05	299	15	3		
	Oct/Nov 91			dry	a		
SP1-9						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90	7.84	260	1.5	4		
	Oct/Nov-90		a	seep	8		
	Jun-91	7.59	164	7	3		
	Oct/Nov 91		a	1	7		
SP1-10						TKfn/Kpr	Wildlife
	Jul-87		a	seep			
	Oct-87		a	seep			
	Oct-89			dry			
	Jun-90	7.87	311	2	4		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91		a	0.5	2		
SP1-10a	Oct-89			b		Kpr	Wildlife
	Jun-90		a	dry			
	Jun-91	7.91	259	dry			
	Oct/Nov 91	8.2	458	0.5	7		
	Jun-93	8.33	329	5	3		
	Sep/Oct 93	8.42	290	2	5		
SP1-10b	Jun-90	7.92	281	4		TKfn/Kpr	Wildlife
	Oct/Nov-90			4			
	Jun-91	7.73	320	25	3		
	Oct/Nov 91			dry			
	Jun-93	8.02	404	<1/8	5		
	Sep/Oct 93	8.29	293	1	7		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-11						TKfn	Developed
	Jul-87	7.76	360	3	4		
	Oct-87			dry			
	Oct-89			b			
	Jun-90	7.69	352	5	4		
	Oct/Nov-90			dry			
	Jun-91	8.07	365	0.5	4		
	Oct/Nov 91		a	1	4		
SP1-12						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89	8.09	340	<<1	3.3		
	Jun-90	7.88	350	10	5		
	Oct/Nov-90			dry			
	Jun-91	7.37	320	30	3		
	Oct/Nov 91		b	b	b		
SP1-13						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90		a	3	6		
	Oct/Nov-90		a	seep	a		
	Jun-91		a	seep	a		
	Oct/Nov 91		a	seep	a		
	Jun-92						
	Oct-92						
SP1-13a						TKfn	Wildlife
	Jun-90	8.13	420	2	5		
	Oct/Nov-90			5	6		
	Jun-91	7.22	a	seep	a		
	Oct/Nov 91						
	Jun-93	8.26	362	<1/8	10		
	Sep/Oct 93	8.59	280	4	6		
SP1-13b						TKfn	Wildlife
	Jun-90	7.83	539	5	3		
	Oct/Nov-90			1	5		
	Jun-91		156	5	4		
	Oct/Nov 91						
SP1-13bb	Oct-92	8.35	484	2.5	8	TKfn	Wildlife
	Jun-93	7.97	363	5	4		
	Sep/Oct 93	8.52	363	5	6		
SP1-13c	Jun-92		a	<1/8	10	TKfn	Wildlife
	Oct-92	a	a	seep	8		
	Jun-93	8.23	398	1	6		
	Sep/Oct 93	a	a	seep			
SP1-13d	Oct-92	7.84	560	1	12	TKfn	Developed
	Jun-93	8.14	411	1	10		
	Sep/Oct 93	8.53	488	5	6		
SP1-14						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90		a	10	4		
	Oct/Nov-90		a	seep	a		
	Jun-91			dry			
	Oct/Nov 91			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-15						TKfn	Wildlife
	Jul-87	7.4	380	<<1	5		
	Oct-87		a	dry			
	Oct-89	8.16	326	<<1	2.2		
	Jun-90	8.19	352	10	6		
	Oct/Nov-90			dry			
	Jun-91	7.42	251	30	4		
	Oct/Nov 91			dry			
SP1-16						TKfn	Wildlife
	Jul-87	8.8	280	<<1	11		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.68	364	20	5		
	Oct/Nov-90	8.34	350	0.25	5		
	Jun-91	7.32	338	10	4		
	Oct/Nov 91			dry			
SP1-16a						TKfn	Wildlife
	Jun-90	7.68	360	15	5		
	Oct/Nov-90	8.14	330	seep	5		
	Jun-91	7.58	316	5	3		
	Oct/Nov 91			dry			
	Jun-93	8.03	583	15	4		
	Sep/Oct 93	8.32	298	2	5		
SP1-17						TKfn	Wildlife
	Jul-87	7.85	390	10	5		
	Oct-87	7.85	410	2	4		
	Oct-89			dry			
	Jun-90	7.9	354	40	5		
	Oct/Nov-90			dry			
	Jun-91	7.8	332	0.5	5		
	Oct/Nov 91	8.27	321	0.5	4		
SP1-17a						TKfn	Wildlife
	Jun-90	7.82	340	10	5		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91	8.44	381	15	1		
	Sep/Oct 93			dry			
SP1-18						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	7.72	350	50	5		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.41	287	7	3		
	Oct/Nov 91			dry			
SP1-18a						TKfn	Wildlife
	Jun-91						
	Oct/Nov 91	8.28	275	3	5		
	Jun-93	8.93	258	10	6		
	Sep/Oct 93	8.36	276	1	5		
SP1-19						TKfn	Wildlife & Livestock
	Jul-87	8.05	400	<<1	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.95	304	30	4		
	Oct/Nov-90	8.39	139	0.25	50		
	Jun-91	8.17	341	10	4		
	Oct/Nov 91			dry			
SP1-20						TKfn	Wildlife & Livestock
	Jul-87	8.01	360	<1	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-87	8.27	350	<1	8		
	Oct-89			b			
	Jun-90	7.95	304	10	4		
	Oct/Nov-90	8.41	223	0.25	5		
	Jun-91	8.03	250	5	4		
	Oct/Nov 91			dry			
SP1-21						TKfn	Wildlife & Livestock
	Jul-87	7.9	370	<1	4		
	Oct-87			dry			
	Oct-89			b			
	Jun-90	8	174	15	4		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.86	214	1	4		
	Oct/Nov 91			dry			
SP1-21a						TKfn	Wildlife & Livestock
	Jun-90	8	174	10	6		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.28	274	2	3		
	Oct/Nov 91			dry			
	Sep/Oct 93	8.26	305	2	6		
SP1-21b						TKfn	Wildlife & Livestock
	Jun-90	7.88	236	5	4		
	Oct/Nov-90			dry			
	Jun-91	7.36	265	2	4		
	Oct/Nov 91			dry			
	Jun-93	8.62	315	5	5		
	Sep/Oct 93	8.34	338	3	6		
SP1-22						TKfn	Wildlife & Livestock
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90		a	5	4		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91	8.18	311	1	4		
	Jun-93	7.17	556	1	4		
SP1-23						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.03	369	7	5		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.57	297	5	4		
	Oct/Nov 91	8.22	313	0.25	4		
SP1-24						TKfn	Wildlife & Livestock
	Jul-87	7.86	310	<1	5		
	Oct-87		a	seep	a		
	Oct-89	8.22	389	<<1	3.3		
	Jun-90	7.89	311	5	5		
	Oct/Nov-90	8.09	368	seep	5.5		
	Jun-91	7.48	295	2.5	4		
	Oct/Nov 91		a	0.5	5		
SP1-25						TKfn	Wildlife
	Jul-87	7.76	490	3	3.6		
	Oct-87	7.81	330	2	7		
	Oct-89	7.8	294	<1	4.4		
	Jun-90	8.03	268	3	3		
	Oct/Nov-90	8.05	356	0.5	4		
	Jun-91	7.92	130	10	2		
	Oct/Nov 91	8.34	332	1	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-26						TKfn	Wildlife
	Jul-87	7.74	430	2	3.7		
	Oct-87	7.78	340	2	7		
	Oct-89	7.97	282	<1	4.4		
	Jun-90	7.78	277	3	3		
	Oct/Nov-90	8.36	288	0.5	4		
	Jun-91	7.83	310	10	2		
	Oct/Nov 91	8.82	308	0.5	4		
SP1-27						TKfn	Wildlife
	Jul-87	7.69	450	<1	2.8		
	Oct-87			dry			
	Oct-89	8.17	282	<<1	5		
	Jun-90	8.06	320	2	2		
	Oct/Nov-90	8.54	298	0.5	3		
	Jun-91	7.34	473	4	2		
	Oct/Nov 91	7.82	438	0.5	4		
SP1-28						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.82	390	8	8		
	Oct/Nov 91						
SP1-28a	Jun-91	8.03	308	5	5	Kc	Wildlife
	Oct/Nov 91			dry			
SP1-28b	Jun-91		269	3	5	Kc	Wildlife
	Oct/Nov 91	8.05	492	0.25	7		
SP1-28c	Jun-91	7.9				Kc	Wildlife
	Oct/Nov 91	8.46	412	3	6		
SP1-29						TKfn	Wildlife
	Jul-87	7.63	470	<<1	3		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	7.81	403	2	4		
	Oct/Nov-90		b	b			
	Jun-91	7.55	694	1	2		
	Oct/Nov 91			dry			
	Jun-93	7.98	315	3	5		
SP1-29a						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90		b	b			
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			
SP1-29b						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90		b	b			
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP1-30						TKfn	Wildlife
	Jul-87	7.47	440	<1	3.1		
	Oct-87			dry			
	Oct-89	8.49	992	<<1	6.8		
	Jun-90	7.01	326	10.5	4		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP1-30a						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.8	394	10	3		
	Oct/Nov 91		a	seep	a		
	Jun-93	8.12	350	2	5		
SP1-30b						TKfn	Wildlife
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91		a	<<1	5		
	Oct/Nov 91		a	seep	a		
SP1-31						TKfn	Wildlife
	Jul-87	7.59	430	<1	3.3		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	7.56	326	5	7		
	Oct/Nov-90						
	Jun-91	7.81	361	10	4		
	Oct/Nov 91	8	560	1	3		
SP1-31a	Jun-91	7.76	350	4	3	TKfn	Wildlife
	Oct/Nov 91						
	Jun-93	8.12	350	2	5		
SP1-32						Kpr	Wildlife
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89						
	Jun-90	7.33	374	5	4		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91			dry			
	Jun-93	8.71	388	1	6		
SP1-32a						Kpr	Wildlife
	Jun-90	7.66	383	10	4		
	Oct/Nov-90			dry			
	Jun-91						
	Oct/Nov 91	8.2	466	seep	a		
	Jun-93	7.75	407	1	4		
SP1-33						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	8.27	390	<1	7		
	Oct-89	7.03	410	<1	5.5		
	Jun-90	7.74	468	2	16		
	Oct/Nov-90	7.99	498	3	7		
	Jun-91	7.63	1770	<<1	4		
	Oct/Nov 91	8.19	415	seep	a		
	Jun-92		a	dry			
	Oct-92	8.04	529	<.25	5.5		
SP1-34						Alluvium/valley floor	Wildlife
	Jul-87	8.16	480	<<1	4		
	Oct-87	8.14	460	15	8		
	Oct-89	7.63	550	<<1	10.8		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	8.24	850	8	14		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.53	1890	1	5		
	Oct/Nov 91	8.09	601	0.5	3		
	Jun-92		a	dry			
	Oct-92		a	seep	a		
SP1-35						Alluvium/valley floor	Wildlife
	Jul-87	8.26	470	1	11		
	Oct-87	8.3	480	4	7		
	Oct-89	8.02	375	<<1	14.5		
	Jun-90	8.55	383	15	6		
	Oct/Nov-90	7.75	417	0.5	7		
	Jun-91	7.83	1870	5	7		
	Oct/Nov 91	8.23	390	1	2		
	Jun-92		a	seep	a		
	Oct-92	8.09	542	0.5	5		
SP1-36						Alluvium/valley floor	Wildlife
	Jul-87	7.51	490	<<1	4		
	Oct-87	7.65	500	3	8		
	Oct-89	7.59	390	<<1	9.3		
	Jun-90	7.74	731	3	7		
	Oct/Nov-90	8.08	499	1	7		
	Jun-91	7.74	1810	<<1	7		
	Oct/Nov 91	8.12	482	1	0		
	Jun-92		a	seep	a		
	Oct-92	8.22	481	<.25	5.5		
SP1-37						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	7.67	450	4	5		
	Oct-89	7.29	325	<<1	5.6		
	Jun-90	8.19	461	2	15		
	Oct/Nov-90	8.11	411	2	7		
	Jun-91	7.77	1770	<<1	7		
	Oct/Nov 91	8.51	401	7	5		
	Jun-92		a	dry			
	Oct-92	8.31	538	0.5	4		
SP1-37a						Alluvium/valley floor	Wildlife
	Jul-87	7.42	500	<1	4.2		
	Oct-87	7.56	490	3	7		
	Oct-89	7.13	363	<1	6.5		
	Jun-90	8.44	880	1	16		
	Oct/Nov-90		a	seep	a		
	Jun-91		a	<<1	6		
	Oct/Nov 91	8.04	609	3	4		
	Jun-92		a	seep	a		
	Oct-92	8.12	546	0.5	5		
SP1-37b						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	7.7	591	0.5	5.5		
	Jun-93	8.2	449	0.25	11		
	Sep/Oct 93	7.66	461	5	7		
SP1-38						Alluvium/valley floor	Wildlife
	Jul-87	7.29	480	<<1	4.2		
	Oct-87	7.24	470	2	7		
	Oct-89	7.22	360	<<1	7.4		
	Jun-90	7.97	1159	6	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.87	1830	<<1	10		
	Oct/Nov 91	8.34	427	7	3		
	Jun-92		a	seep	a		
	Oct-92	8.25	534	0.25	3		
SP1-38a						Alluvium/valley floor	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-91	7.52	12500	1	6		
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92	8.16	587	0.25	5.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.55	414	0.5	12		
SP1-39						Alluvium/valley floor	Wildlife
	Jul-87	8.17	460	<1	4.1		
	Oct-87	7.48	450	3	7		
	Oct-89	6.69	360	<<1	9		
	Jun-90	8.05	409	4	10		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.53	1870	1	4		
	Oct/Nov 91	7.8	398	4	7		
	Jun-92		a	seep	a		
	Oct-92	8.14	511	<.25	5.5		
SP1-40	Jul-87	7.17	530	<<1	4.4	Alluvium/valley floor	Wildlife
	Oct-87	7.17	690	10	7		
	Oct-89	7.27	310	<1	6.8		
	Jun-90	8.49	1100	1	12		
	Oct/Nov-90	8.24	423	0.5	0.5		
	Jun-91	8.25	1710	2	11		
	Oct/Nov 91	8.32	499	0.5	6		
	Jun-92	7.98	433	1.5	16		
	Oct-92	7.81	537	<.25	3		
SP1-40a						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	7.78	490	5	7		
	Oct-89	6.85	350	<<1	5.4		
	Jun-90	8.27	624	5	13		
	Oct/Nov-90						
	Jun-91	8.31	1650	1	11		
	Oct/Nov 91	8.18	417	5	3		
	Jun-92	7.86	399	0.5	13		
	Oct-92	a	a	seep	a		
SP1-41						Alluvium/valley floor	Wildlife
	Jul-87		a	seep	a		
	Oct-87	7.63	450	2	7		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90		a	seep	a		
	Jun-91			1	11		
	Oct/Nov 91	8.63	406	0.5	6		
	Jun-92		a	seep	a		
	Oct-92	a	a	dry	a		
SP1-41a						Alluvium/valley floor	Wildlife
	Oct/Nov-90	8.35	363	0.5	9		
	Jun-91	7.43	1680	6	4		
	Oct/Nov 91	8.42	403	seep	0		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8	399	3	5		
	Sep/Oct 93	8.12	469	0.5	7		
SP1-42						Alluvium/valley floor	Wildlife
	Jul-87	7.43	490	1	3.3		
	Oct-87	8.15	420	<1	10		
	Oct-89			dry			
	Jun-90	8.23	412	1	8		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.57	1680	3	5		
	Oct/Nov 91	8.45	426	1	3		
	Jun-92	8.56	379	0.25	8		
	Oct-92	a	a	seep	a		
SP1-42a						Alluvium/valley floor	Wildlife
	Jun-91						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct/Nov 91		a	seep	3		
	Jun-92		a	seep	a		
	Oct-92	8	577	<.25	5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP1-43						Alluvium/valley floor	Wildlife
	Jul-87	7.49	470	<1	3.3		
	Oct-87	7.46	460	1	7		
	Oct-89			dry			
	Jun-90	7.68	385	10	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.71	420	4	7		
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92	7.77	560	<.25	5.5		
SP1-43a						TKfn	Wildlife
	Jun-91						
	Oct/Nov 91			seep	a		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
	Jun-93	7.79	461	2	4		
	Sep/Oct 93	7.71	483	0.25	7		
SP1-44						Alluvium/valley floor	Wildlife
	Jul-87	7.8	490	3	12		
	Oct-87	7.76	480	5	7		
	Oct-89			dry			
	Jun-90	7.72	669	2	14		
	Oct/Nov-90	7.55	458	3	7		
	Jun-91	7.75	1680	4	4		
	Oct/Nov 91	7.14	510	0.25	6		
	Jun-92		a	seep	a		
	Oct-92	8.23	533	1	5.5		
SP1-45						Alluvium/valley floor	Wildlife
	Oct-89	6.92	315	<<1	6.1		
	Jun-90	8.01	864	5	11		
	Oct/Nov-90	8.35	383	2	7		
	Jun-91	8.28	1860	<<1	9		
	Oct/Nov 91	7.8	461	seep	6		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
SP1-45a						Alluvium/valley floor	Wildlife
	Jun-91	7.21	1760	1	4		
	Oct/Nov 91		a	dry			
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.84	550	2	9		
SP1-46						Alluvium/valley floor	Wildlife
	Oct-89	6.94	340	<<1	9		
	Jun-90	8.15	834	7	15		
	Oct/Nov-90	8.38	395	2	12		
	Jun-91	8.38	1590	1.5	10		
	Oct/Nov 91	8.04	651	seep	3		
	Jun-92		a	seep	a		
	Oct-92	7.88	538	1	3		
SP1-47						Alluvium/valley floor	Wildlife
	Oct-89	7.61	305	<<1	6.8		
	Jun-90	8	347	4	11		
	Oct/Nov-90	8.47	443	0.5	9		
	Jun-91	7.46	1690	0.5	4		
	Oct/Nov 91	8.21	398	seep	3		
	Jun-92		a	seep	a		
	Oct-92	7.69	524	<.25	5		
SP1-48						Kpr	Wildlife
	Oct-89	8.01	380	<<1	4.1		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	7.98	312	1.5	4		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.71	354	4	2		
	Oct/Nov 91		a	seep	2		
SP1-48a	Jun-91	7.29	310	15	4	Kpr	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.13	383	5	5		
SP1-49						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	7.86	288	5	5		
	Oct/Nov-90						
	Jun-91	7.45	342	15	3		
	Oct/Nov 91			dry			
	Jun-93	8.23	385	8	5		
SP1-49a	Jun-91	8.2	317	2	3	Kpr	Wildlife
	Oct/Nov 91			dry			
	Jun-93	7.75	441	1.5	4		
SP1-50						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	8.24	299	2.5	6		
	Oct/Nov-90						
	Jun-91	7.96	320	6	5		
	Oct/Nov 91		a	seep	a		
	Jun-93	8.02	427	1	5		
SP1-50a	Jun-91	7.78	354	7	3	Kpr	Wildlife
	Oct/Nov 91			dry			
SP1-51						Kpr	Wildlife
	Oct-89	8.79	350	<<1	7.9		
	Jun-90	7.98	242	5	4		
	Oct/Nov-90						
	Jun-91	8.29	322	5	3		
	Oct/Nov 91			dry			
	Jun-93	7.58	556	1	4		
SP1-51a	Jun-91	8.39	348	14	2	Kpr	Wildlife
	Oct/Nov 91	8.05	382	seep	a		
	Jun-93	7.74	465	5	5		
SP1-51b	Jun-91	7.82	325	2	2	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8	371	8	5		
SP1-51c	Jun-91					TKfn	Wildlife
	Oct/Nov 91		a	seep	a		
	Jun-93	8.88	231	8	5		
SP1-52						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	7.2	305	10	4		
	Oct/Nov-90						
	Jun-91	7.99	372	15	2		
	Oct/Nov 91	8.07	418	1	3		
SP1-53						Alluvium/valley floor	Wildlife
	Oct-89	7.65	310	<<1	7.5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	8.33	367	1	6		
	Oct/Nov-90	8.35	402	seep	a		
	Jun-91			dry			
	Oct/Nov 91	8.25	198	3	1		
1-53aa	Jun-93					Alluvium/valley floor	Wildlife
1-53b						Alluvium/valley floor	Wildlife
SP1-53a	Oct-89	7.9				Alluvium/valley floor	Wildlife
	Jun-90	8.15		<1	10		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-93	8.74	427	1	3		
1-53aa						Alluvium/valley floor	Wildlife
SP1-53b	Jun-93	8.3	395	5	4	Alluvium/valley floor	Wildlife
SP1-53c	Jun-93	8.16	390	10	3	Alluvium/valley floor	Wildlife
SP1-54						Kpr	Wildlife
	Oct-89	7.9	642	<<1	4.9		
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-93	a	a	seep	a		
SP1-55	Jun-91	7.5	427	5	4		
	Oct/Nov 91						
SP2-1						TKfn	Wildlife
	Jul-87	7.72	430	4	5		
	Oct-87			dry			
	Oct-89	8.25	474	1.5	10		
	Jun-90	8.33	380	10	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.98	1650	8	7		
	Oct/Nov 91	8.25	420	3	5		
	Jun-92	8.12	411	3	15		
	Oct-92	8	610	0.5	5.5		
SP2-2						TKfn	None
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90	8.32	406	15	7		
	Oct/Nov-90			dry			
	Jun-91	7.29	1770	<1	5		
	Oct/Nov 91	8.18	450	2	4		
	Jun-92	7.99	401	5	11		
	Oct-92	8.01	590	1	3		
SP2-2a						TKfn	None
	Jun-90	7.44	423	5	13		
	Oct/Nov 90	8.31	385	0.5	4		
	Jun-91	8.54	391	20	2		
	Oct/Nov 91	7.68	486	2	4		
	Jun-92		a	dry			
	Oct-92			dry			
SP2-3						Colluvium over limestone	Wildlife
	Jul-87	8.15	380	5	14		
	Oct-87			dry			
	Oct-89	8.28	458	<<1	5.5		
	Jun-90	8.06	408	1	8		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.45	1670	8	5		
	Oct/Nov 91	7.6	530	3	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-92	7.78	389	2	7		
	Oct-92	8.07	553	<.25	5.5		
SP2-3a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	0.5	5		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
	Jun-93	7.84	432	4	5		
SP2-3b	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-92	8.01	397	2	8		
	Oct-92	a	a	seep	a		
	Jun-93	7.95	408	2	5		
SP2-4						Alluvium/valley floor	Wildlife
	Jul-87	8.17	400	10	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.25	379	6	9		
	Oct/Nov-90			dry			
	Jun-91	7.4	1660	13	4		
	Oct/Nov 91		a	seep	a		
	Jun-92		a	dry			
	Oct-92			dry			
SP2-5						TKfn	Wildlife
	Jul-87	7.56	410	2	5		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.59	428	<1	4		
	Oct/Nov-90			dry			
	Jun-91	7.52	1910	1	7		
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92			dry			
SP2-6						TKfn	Wildlife
	Jul-87	7.7	410	5	5		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.24	426	3	7		
	Oct/Nov-90		a	seep	a		
	Jun-91	7.53	1680	7	4		
	Oct/Nov 91		a	seep	a		
	Jun-92		a	seep	a		
	Oct-92	8.07	565	1	4		
SP2-7						TKfn	Wildlife
	Jul-87	8.19	410	4	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.1	353	<1	15		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-92		a	seep	a		
	Oct-92			dry			
SP2-8						TKfn	None
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.8	333	1	12		
	Oct/Nov-90	7.61	419	1	6		
	Jun-91	7.98	1570	3	11		
	Oct/Nov 91	8.14	341	seep	7		
	Jun-92		a	dry			
	Oct-92	7.63	600	<.25	5.5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP2-9						TKfn	Developed
	Jul-87	7.56	250	5	5		
	Oct-87	7.76	270	1	4		
	Oct-89	8.37	234	<<1	4.4		
	Jun-90	7.55	350	2	4		
	Oct/Nov-90	7.48	301	seep	a		
	Jun-91	7.06	560	3	4		
	Oct/Nov 91		b	b	b		
	Jun-93	8.06	293	8	3		
SP2-9a	Jun-91	6.72	260	0.5	5	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.27	270	10	5		
SP2-10						TKfn	Wildlife
	Jul-87	8.71	300	2	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90			dry			
	Jun-91	7.87	225				
	Oct/Nov 91			dry			
SP2-11						Kpr	None
	Jul-87	8.11	270	<<1	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.52	266	1	6		
	Oct/Nov-90			dry			
	Jun-91	8.48	226	10	4		
	Oct/Nov 91			dry			
SP2-12						Kpr	None
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	7.8	387	<1	6		
	Oct/Nov-90			dry			
	Jun-91		a	seep	a		
	Oct/Nov 91		a	seep	a		
SP2-13	Jul-87	7.94	230			Kpr	Wildlife
	Jun-90	8.38	135				
	Oct/Nov 90						
	Jun-91	7.31	153	3	4		
	Oct/Nov 91		a	seep	a		
	Jun-93	8.3	236	5	6		
SP2-14	Jul-87	8.24	200			Kpr	Wildlife
	Jun-90		a				
	Oct/Nov 90						
	Jun-91	7.41	286	1	5	Kpr	Wildlife
	Oct/Nov 91		a	1	1		
	Jun-93	8.49	220	3	5		
SP2-15						Kpr	Wildlife
	Jul-87	8.6	210	2	8		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.34	162	2	9		
	Oct/Nov-90						
	Jun-91	7.74	178	1	5		
	Oct/Nov 91		a	0.5	4		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-92	7.97	387	0.25	4		
SP2-15a						Kpr	Wildlife
	Jun-91		a	seep	4		
	Oct/Nov 91			dry			
	Oct-92	a	a	seep	7		
	Jun-93	8.17	226	2	5		
	Sep/Oct 93	7.84	289	1	6		
SP2-15b						Kpr	Wildlife
	Jun-91		a	seep	5		
	Oct/Nov 91			dry			
	Oct-92			b			
	Jun-93	8.06	278	4	6		
	Sep/Oct 93	8.53	363	1	7		
SP2-16						Kpr	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91		a	0.5	5		
	Oct/Nov 91		a	seep	b		
SP2-17						Kpr	Wildlife
	Jul-87	8.53	210	<<1	7		
	Oct-87		b				
	Oct-89			dry			
	Jun-90						
	Oct/Nov-90						
	Jun-91	7.98	164	2	6		
	Oct/Nov 91		a	<.25	4		
SP2-18						Kpr	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91	7.72	211	2.5	3		
	Oct/Nov 91		a	seep	a		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
SP2-19						Colluvium/alluvium	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91		a	seep	3		
	Oct/Nov 91		a	seep	a		
	Jun-92	8.06	473	0.5	6		
	Oct-92			dry			
SP2-20						Colluvium/alluvium	None
	Jul-87		a	seep	a		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91		a	seep	15		
	Oct/Nov 91			dry			
	Jun-92	7.25	266	1	6		
	Oct-92			dry			
SP2-21						TKfn	Wildlife
	Jul-87	8.58	320	7	5		
	Oct-87		b				
	Oct-89			dry			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-92	8.61	383	2	7		
	Oct-92			dry			
SP2-21a						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91		a	5	4		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	8.45	383	1	5		
SP2-21b						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.25	3		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP2-22						Kpr	None
	Jul-87	8.21	350	1	5		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	4	7		
	Oct/Nov-90						
	Jun-91	7.72	347	30	3		
	Oct/Nov 91			dry			
	Jun-92	7.81	402	1	4		
	Oct-92	a	a	seep	4		
SP2-22a						Kpr	None
	Jun-90	7.66	304	5	3		
	Oct/Nov-90						
	Jun-91		a	seep	5		
	Oct/Nov 91			dry			
	Jun-92	8.16	387	0.5	5		
	Oct-92	a	a	seep	5		
SP2-23						Kpr	Wildlife
	Jul-87	8.84	290	5	5		
	Oct-87		b				
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90						
	Jun-91			dry			
	Oct/Nov 91		a	0.5	2		
	Jun-92	8.42	305	1	5		
	Oct-92	a	a	seep	4		
SP2-24						Kpr	Wildlife
	Jul-87	7.93	310	5	3.5		
	Oct-87		a	seep	a		
	Oct-89	8.17	360	dry			
	Jun-90	8.12	276	10	4		
	Oct/Nov-90	8.1	351	1	4.5		
	Jun-91	7.58	295	<1	4		
	Oct/Nov 91	8.04	413	0.25	3		
	Jun-93	7.21	588	15	5		
SP2-24a						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	8.01	216	5	5		
	Oct/Nov-90			dry			
	Jun-91			seep	a		
	Oct/Nov 91			dry			
	Jun-93	8.76	222	8	5		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP2-24b						Kpr	Wildlife
	Jun-90	8.17	222	2	5		
	Oct/Nov-90			dry			
	Jun-91			seep	a		
	Oct/Nov 91			dry			
	Jun-93	8.89	242	5	6		
	Sep/Oct 93	8.29	279	1	5		
SP2-25						TKfn	None
	Jul-87		a	seep	a		
	Oct-87		a	seep	a		
	Oct-89			dry			
	Jun-90		a	seep	a		
	Oct/Nov-90			dry			
	Jun-91			dry			
	Oct/Nov 91	8.1	750	2	4		
SP2-26						TKfn	None
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.16	297	1	6		
	Oct/Nov-90		b	b			
	Jun-91	7.57	446	0.25	4		
	Oct/Nov 91		a	0.05	11		
SP2-27						Kpr	Developed
	Jul-87	7.46	440	4	3		
	Oct-87	7.6	380	1	4		
	Oct-89	8.02	410	<<1	4.4		
	Jun-90	7.7	360	3	4		
	Oct/Nov-90		b	b			
	Jun-91	7.91	401	5	3		
	Oct/Nov 91	7.83	482	3	3		
SP2-28						Kpr	Wildlife
	Jul-87	7.78	400	2	4		
	Oct-87	8.01	380	<1	4		
	Oct-89	8.36	328	<<1	3.8		
	Jun-90	7.79	390	2.5	5		
	Oct/Nov-90	8.16	435	seep	7		
	Jun-91	7.36	460	1	4		
	Oct/Nov 91	8.15	490	<1	4		
SP2-29						Kpr	Wildlife
	Jul-87	7.57	410	2	4		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	8.54	380	2	9		
	Oct/Nov-90						
	Jun-91	7.36	474	1	2		
	Oct/Nov 91	7.86	527	1	4		
SP2-30						Kpr	Wildlife
	Jul-87	8.01	370	1	4		
	Oct-87	8.05	380	<<1	4		
	Oct-89	8.41	413	<1	1.1		
	Jun-90	7.9	428	<1	5		
	Oct/Nov-90						
	Jun-91	7.5	439	2	3		
	Oct/Nov 91	7.89	514	<1	4		
SP2-30a						Kpr	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	7.94	359	<1	5		
	Oct/Nov-90						
	Jun-91	7.13	491	5	3		
	Oct/Nov 91	8.15	528	<1	5		
SP2-31						Kpr	Wildlife
	Jul-87	7.73	390	2	6		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90	7.76	419	5	4		
	Oct/Nov-90		b	b			
	Jun-91	7.28	524	1	3		
	Oct/Nov 91			dry			
SP2-32						Kpr	Wildlife
	Jul-87	7.56	410	2	4		
	Oct-87	8.28	350	<1	4		
	Oct-89		a	seep	a		
	Jun-90	8.41	392	5	10		
	Oct/Nov-90		b	b			
	Jun-91	7.26	495	7	4		
	Oct/Nov 91	8.23	525	2	5		
SP2-32a						Kpr	Wildlife
	Jun-90		a	1	5		
	Oct/Nov-90		b	b			
	Jun-91	7.34	476	1.5	3		
	Oct/Nov 91			dry			
	Jun-93			dry			
	Sep/Oct 93			dry			
SP2-32b						Kpr	Wildlife
	Jun-90	8.16	409	seep	a		
	Oct/Nov-90		b	b			
	Jun-91			dry			
	Oct/Nov 91			dry			
	Jun-93	8.66	346	25	6		
	Sep/Oct 93	8.16	309	1	4		
SP2-33						Kpr	Wildlife
	Jul-87	7.85	410	2	4		
	Oct-87			dry			
	Oct-89		a	seep	a		
	Jun-90	7.91	421	seep	a		
	Oct/Nov-90		b	b			
	Jun-91	7.45	513	5	3		
	Oct/Nov 91	8.01	508	<1	4		
SP2-33a						Kpr	Wildlife
	Jul-87	7.66	450	4	4		
	Oct-87	7.8	430	1	5		
	Oct-89	8.29	421	<<1	2.2		
	Jun-90	7.69	432	15	5		
	Oct/Nov-90	8.19	466	0.5	4		
	Jun-91	7.09	513	15	4		
	Oct/Nov 91						
	Jun-93			dry			
SP2-34						Kpr	Wildlife
	Jul-87	7.85	320	2	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90	8.04	267	7	6		
	Oct/Nov-90		b	b			
	Jun-91	7.61	249	5	4		
	Oct/Nov 91		451	0.5	7		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP2-34a	Jun-91	7.8	221	0.5	4	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.04	327	<1/8	6		
SP2-35						Kpr	Wildlife
	Jul-87	7.79	360	5	6		
	Oct-87	7.87	340	<1	5		
	Oct-89	8.21	350	<<1	5.6		
	Jun-90	8.02	279	15	5		
	Oct/Nov-90						
	Jun-91	7.72	249	4	3		
	Oct/Nov 91	8.13	443	0.5	5		
SP2-36						TKfn	Wildlife
	Jul-87		a	seep	a		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	5	15		
	Oct/Nov-90						
	Jun-91	8.1	389	5	3		
	Oct/Nov 91			dry			
SP2-36a						TKfn	Wildlife
	Jun-90	8.18	319	1	8		
	Oct/Nov-90						
	Jun-91	8.21	271	1.5	3		
	Oct/Nov 91	7.96	361	0.5	4		
	Jun-93	a	a	seep	a		
SP2-36bw						TKfn	Wildlife
	Jun-90	7.86	333	3	4		
	Oct/Nov-90						
	Jun-91	7.49	319	2	2		
	Oct/Nov 91	8.22	417	0.25	8		
	Jun-93	8.6	307	10	6		
SP2-36bm	Jun-91					TKfn	Wildlife
	Oct/Nov 91	7.7	466	0.5	5		
SP2-36be	Jun-91					TKfn	Wildlife
	Oct/Nov 91	7.88	420	1	5		
SP2-37						TKfn	Wildlife
	Jul-87	7.5	390	6	5		
	Oct-87			dry			
	Oct-89	8.3	377	<<1	8.9		
	Jun-90	7.95	306	5	15		
	Oct/Nov-90						
	Jun-91	7.33	263	7	2		
	Oct/Nov 91	7.72	343	1	5		
SP2-37a	Jun-91					TKfn	Wildlife
	Oct/Nov 91	7.9	434	0.25	5		
SP2-38						TKfn	Wildlife
	Jul-87	7.76	410	5	4		
	Oct-87			dry			
	Oct-89		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-90	7.81	321	10	6		
	Oct/Nov-90						
	Jun-91	7.7	310	3	5		
	Oct/Nov 91						
SP2-38a	Jun-91	7.75	297	<1	4	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.79	304	2	6		
SP2-38b	Jun-91	7.92	260	1	4	TKfn	Wildlife
	Oct/Nov 91		a	<1	5		
	Jun-93	8.32	359	15	6		
SP2-38c	Jun-91		a	seep	a	TKfn	Wildlife
	Oct/Nov 91			dry			
	Jun-93	8.66	301	10	6		
SP2-39						TKfn	Wildlife
	Jul-87	8.01	370	4	6		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP2-40						TKfn	Wildlife & Livestock
	Jul-87	7.56	440	3	5		
	Oct-87			dry			
	Oct-89			dry			
	Jun-90		a	dry			
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP2-40a						TKfn	Wildlife & Livestock
	Jun-90	7.75	361	7	5		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
	Jun-93	8.22	342	<1/8	6		
SP2-40b						TKfn	Wildlife & Livestock
	Jun-90		a	<1	5		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91			dry			
SP2-40c	Jun-91		a	0.5	3	TKfn	Wildlife
	Oct/Nov 91						
	Jun-93	7.98	402	7	6		
SP2-40d	Sep/Oct 93	7.35	493	<.25	9	TKfn	Wildlife
	Jun-91	7.81	421	15	3		
	Oct/Nov 91						
SP2-40e	Sep/Oct 93	7.2	523	<.25	5	Kpr	Wildlife
	Jun-91		a	1	4		
	Oct/Nov 91						
SP2-41						TKfn	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jul-87	7.64	440	3	6		
	Oct-87		a	seep	a		
	Oct-89		a	seep	a		
	Jun-90		a	1	6		
	Oct/Nov-90						
	Jun-91						
	Oct/Nov 91						
SP2-42						Kpr	Wildlife
	Oct-89		a	<<1	3.1		
	Jun-90	7.89	310	5	4		
	Oct/Nov-90	8.38	343	0.25	3		
	Jun-91	7.16	368	15	2		
	Oct/Nov 91	8.4	371	<1	4		
SP2-43						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	8.1	380	1	5		
	Oct/Nov-90	8.56	294	0.5	6		
	Jun-91	7.35	421	5	3		
	Oct/Nov 91			dry			
	Jun-93	8.7	350	20	5		
SP2-43a						Kpr	Wildlife
	Jun-90	8.53	435	3	7		
	Oct/Nov-90	8.58	353	0.5	8		
	Jun-91	7.88	414	0.75	3		
	Oct/Nov 91	8.34	437	0.5	6		
	Jun-93	8.34	384	20	5		
	Sep/Oct 93	7.86	358	1	5		
SP2-44						Kpr	Wildlife
	Oct-89		a	seep	a		
	Jun-90	7.96	380	1	5		
	Oct/Nov-90		b	b			
	Jun-91	7.23	467	2	3		
	Oct/Nov 91	8.25	530	1	5		
	Jun-93	8.17	451	15	5		
	Sep/Oct 93	a	a	seep			
SP2-44a						Kpr	Wildlife
	Jun-90	8.17	461	<1	5		
	Oct/Nov-90		b	b			
	Jun-91	7.19	453	10	4		
	Oct/Nov 91			dry			
	Jun-93			dry			
SP2-44a2						Kpr	Wildlife
	Jun-91		a	seep	a		
	Oct/Nov 91			dry			
	Jun-93	8.31	414	10	5		
	Sep/Oct 93	a	a	seep			
SP2-44a3						Kpr	Wildlife
	Jun-91	7.48	570	0.5	4		
	Oct/Nov 91			dry			
	Jun-93	8.17	420	10	6		
	Sep/Oct 93			dry			
SP2-44a4						Kpr	Wildlife
	Jun-91	7.05	518	1	4		
	Oct/Nov 91			dry			
	Jun-93	8.2	416	10	6		
	Sep/Oct 93	a	a	seep			
SP2-44b						Kpr	Wildlife
	Jun-90	7.49	459	1	5		
	Oct/Nov-90		b	b			

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-91	7.61	507	0.5	4		
	Oct/Nov 91						
	Jun-93	8.02	449	6	6		
	Sep/Oct 93	a	a	seep			
SP3-2						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	7.8	420	10	6		
SP3-3						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.5	7		
	Jun-92		a	dry			
	Oct-92	a	a	seep	a		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-4						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	6		
	Jun-92	7.72	255	seep	8		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-5						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP3-6						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	2		
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-7						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.61	420	1	6		
	Jun-92	7.67	447	0.5	6		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP3-8						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.55	410	0.5	6		
	Jun-92	8.98	129	<1/8	15		
	Oct-92			dry			
	Jun-93	8.23	391	1	6		
	Sep/Oct 93			dry			
SP3-9						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.25	5		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			
SP3-10						Alluvium/valley floor	Wildlife

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-91						
	Oct/Nov 91			2	2		
	Jun-92	7.97	423	1/8	8		
	Oct-92	7.73	572	<.25	1		
	Jun-93	a	a	seep	a		
	Sep/Oct 93			dry			
SP3-10a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92			dry			
	Sep/Oct 93			dry			
SP3-10b						Alluvium/valley floor	Wildlife & Livestock
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	dry			
	Oct-92			dry			
	Sep/Oct 93			dry			
SP3-11						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91			0.5			
	Jun-92	8.35	358	1/8	13		
	Oct-92	a	a	seep	5		
	Jun-93	8.48	276	10	5		
	Sep/Oct 93	8.42	381	<.25	6		
SP3-12						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.25	5		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	10		
	Jun-93	8.08	404	0.5	7		
	Sep/Oct 93			dry			
SP3-13						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.33	500	5	5		
	Jun-92	7.58	481	<1/8	4		
	Oct-92	7.9	620	2	5		
	Jun-93	7.97	417	5	6		
	Sep/Oct 93			dry			
SP3-13a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.08	288	3	2		
	Oct-92	7.66	687	0.5	5		
	Jun-93	8.4	190	10	5		
	Sep/Oct 93	7.64	530	7	5		
SP3-13b	Jun-91			dry		Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	a	a	seep	a		
SP3-14	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91	7.29	470	3	6		
SP3-15	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	seep	3		
SP3-16	Jun-91					TKfn	Wildlife
	Oct/Nov 91		a	seep	6		
	Jun-92		a	seep	a		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-92			dry			
	Jun-93	a	a	seep	a		
SP3-16a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92			dry			
	Jun-93	8.43	328	8	6		
SP3-16b	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92	8.05	424	1/4	10		
	Oct-92	a	a	seep	a		
	Jun-93	8.54	377	12	6		
SP3-17						Kc	Wildlife
	Jun-91						
	Oct/Nov 91		a	seep	a		
	Jun-93	8.2	430	10	6		
	Sep/Oct 93			dry			
SP5-1						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	8.27	468	seep	a		
	Jun-92	8.13	316	seep	2		
	Oct-92	8	513	<.25	5		
	Sep/Oct 93			dry			
SP5-1a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	7.72	487	<.25	4		
	Jun-93	8	316	12	3		
	Sep/Oct 93			dry			
SP5-2	Jun-91					Kbh	Wildlife
	Oct/Nov 91	8.03	460	6	5		
	Jun-93	8.31	428	10	5		
SP5-3	Jun-91					Kbh	Wildlife
	Oct/Nov 91	8.08	465	5	4		
	Jun-93	7.99	438	8	6		
SP5-4	Jun-91					Kpr	Wildlife
	Oct/Nov 91	7.99	400	4	3		
	Jun-93	a	a	seep	a		
SP5-5						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	8.06	430	0.5	5		
	Jun-93	8.02	482	2	6		
	Sep/Oct 93			dry			
SP6-1						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.31	400	3	5		
	Jun-92	7.91	98	<1/8	5		
	Oct-92			dry			
	Jun-93			dry			
	Sep/Oct 93	a	a	seep			
SP6-1a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-93	8.35	404	4	5		
SP6-2						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.15	410	1	5		
	Jun-92	7.81	393	1	3		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Oct-92	7.94	532	1	5		
	Jun-93	7.95	346	12	3		
	Sep/Oct 93	8.12	378	3	5		
SP6-3						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.27	340	5	2		
	Jun-92	7.83	351	seep	6		
	Oct-92	8.17	490	<.25	5		
	Jun-93	8.39	211	10	4		
	Sep/Oct 93	8.3	330	4	5		
SP6-3a						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.68	322	7	6		
	Oct-92	a	a	seep	5		
	Jun-93	8.6	359	2	6		
	Sep/Oct 93	8.2	322	2	4		
SP6-4						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.09	480	1	6		
	Jun-92		a	dry			
	Oct-92	8.27	531	0.5	5		
	Jun-93	8.71	346	6	12		
	Sep/Oct 93	8.43	401	4	9		
SP6-5						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91		a	0.1	1		
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8.57	375	5	4		
	Sep/Oct 93			dry			
SP6-6	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	seep	5		
SP6-7	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	seep	4		
SP6-8	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	0.1	0		
SP6-9	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91		a	0.1	2		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	a	a	seep	a		
SP6-10	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91	7	320	0.1	3		
	Jun-92		a	dry			
	Oct-92			dry			
	Jun-93	8.08	393	4	6		
SP6-11						Alluvium/valley floor	Wildlife
	Jun-91						
	Oct/Nov 91	7.01	250	seep	3		
	Jun-92	8.08	426	0.5	13		
	Oct-92			dry			
	Jun-93	8.53	351	9	6		
	Sep/Oct 93	8.18	412	3	7		
SP6-11a	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
	Jun-92	7.91	542	seep	a		
	Oct-92			dry			
	Jun-93	8.45	352	14	6		
SP6-11b	Jun-91					Alluvium/valley floor	Wildlife
	Oct/Nov 91						
	Jun-92	7.88	401	seep	a		
	Oct-92	8.1	515	<.25	7		
	Jun-93	8.22	355	60	3		
SP6-12	Jun-91					Kpr	Wildlife
	Oct/Nov 91	7.82	490	1	1		
	Jun-92	7.82	481	4	6		
	Oct-92	8.16	274	<.25	5		
	Jun-93	8.39	165	3	5		
SP6-13	Jun-91					Kbh	Wildlife
	Oct/Nov 91	8.14	260	2	2		
	Jun-92		a	seep	a		
	Oct-92	8.38	391	2	3		
SP6-13a	Jun-91					Kbh	Wildlife
	Oct/Nov 91						
	Jun-92		a	dry			
	Oct-92	8.08	374	1.75	5.5		
	Jun-93	8.12	418	15	5		
SP6-13b	Jun-91					Kbh	Wildlife
	Oct/Nov 91						
	Jun-92	8.01	280	1	7		
	Oct-92	8.07	427	<.25	12		
	Jun-93	7.94	255	3	5		
SP6-13c	Jun-91					Kbh	Wildlife
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8.27	192	2	5		
SP6-13d						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	7.9	381	<.25	5		
	Jun-93	8.27	262	2	5		
	Sep/Oct 93	7.81	265	2	6		
SP6-14						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	7.96	425	seep	7		
	Jun-92		a	dry			
	Oct-92	8.17	565	<.25	6.5		
	Jun-93	8.79	318	5	5		
	Sep/Oct 93	8.13	266	3	5		
SP6-15						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	8.11	280	seep	7		
	Jun-92		a	seep	a		
	Oct-92	7.94	570	<.25	5.5		
	Jun-93	7.52	170	2	6		
	Sep/Oct 93	8.38	273	2	5		
SP6-15a						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.66	541	<1/8	7		
	Oct-92	a	a	seep	a		
	Jun-93			dry			
	Sep/Oct 93	8.42	269	4	7		

Seep/Spring	Date	pH	Cond. (umhos/cm @ 25°C)	Flow (gpm)	Temp. (C°)	Formation	Use/Remarks
SP6-15b						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	7.87	532	4	6		
	Oct-92	8.18	701	<.25	5.5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	8.46	270	1	6		
SP6-16						Kc	Wildlife
	Jun-91						
	Oct/Nov 91	7.95	415	seep	7		
	Jun-92		a	dry			
	Oct-92	8.17	560	<.25	6		
	Jun-93	8.98	352	4	4		
	Sep/Oct 93	8.51	389	3	6		
SP7-1						Kpr	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	8.08	390	<.25	3		
	Jun-93	8.76	408	<1/8	10		
	Sep/Oct 93	a	a	seep			
SP7-2						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92		a	seep	a		
	Oct-92	a	a	seep	a		
	Jun-93	8.45	499	2	6		
	Sep/Oct 93	a	a	seep			
SP7-3						Kbh	Wildlife
	Jun-91						
	Oct/Nov 91						
	Jun-92	8.34	704	<1/8	8		
	Oct-92	8.41	899	1	5		
	Jun-93	a	a	seep	a		
	Sep/Oct 93	a	a	seep			

PH

PETERSEN HYDROLOGIC, LLC

27 March 2012

Mr. Dave Shaver
Genwal Resources, Inc.
P.O. Box 1077
Price, Utah 84501

Dave,

At your request, we have produced this Annual Hydrologic Monitoring Report for the Crandall Canyon Mine for the year 2011. This report is based on hydrologic monitoring information collected during 2011 and submitted to the Utah Division of Oil, Gas and Mining.

Other than the permitted discharge of mine water to Crandall Creek, there are no indications that significant mining-related impacts to the hydrologic balance in the mine permit area have occurred.

Please feel free to contact me should you have any questions in this regard.

Sincerely,

LICENSED PROFESSIONAL GEOLOGIST
ERIK CARL PETERSEN
STATE OF UTAH

Erik C. Petersen, P.G.
Principal Hydrogeologist
Utah PG No. 5373615-2250

2695 N. 600 E. LEHI, UTAH 84043 (801) 766-4006

Summary of Hydrologic Monitoring at the

Genwal Resources, Inc.

Crandall Canyon Mine During 2011

Introduction

Hydrologic monitoring at the Genwal Resources, Inc. Crandall Canyon Mine was carried out in 2011 in accordance with the hydrologic monitoring plan as approved by the Utah Division of Oil, Gas and Mining (DOGM). Hydrologic monitoring locations are shown on Figure 1. All 2011 hydrologic monitoring data have been entered into the DOGM on-line electronic hydrology database. The purpose of this document is to present and summarize the results of the 2011 hydrologic monitoring.

Including this introduction, this report contains the following sections:

- Introduction
- Methods of Study
- Climate
- Presentation of Data
- Spring Monitoring Summary
- Stream Monitoring Summary
- Conclusions

Active mining operations at the Crandall Canyon Mine ceased during 2007. No coal mining occurred in the Crandall Canyon Mine during 2011.

Methods of Study

The specific methods of study used to collect the 2011 hydrologic monitoring data are described below.

Discharge Measurements

Discharge measurements for springs were performed using a calibrated container and a stopwatch. Generally, spring discharge measurements were performed by damming and diverting the spring discharge through a pipe. Using an appropriately sized container, time-to-fill measurements were typically performed at least 3 times at each location. An average time-to-fill value was used to calculate the reported discharge measurement. At some spring locations with large discharge rates, spring discharge measurements were performed using a 90° v-notch weir, or using cross-sectional area – current velocity techniques. Discharge measurements at Indian Creek, upper Crandall Creek, and lower Crandall Creek were performed using the existing, permanently installed 3-foot Parshall flumes, or using a current-velocity meter and wading rod. Discharge measurements during high-flow periods in Blind Canyon Creek were performed using the existing 12-inch Parshall Flume. Discharge measurements at other stream monitoring stations were performed using a portable 3-inch Parshall flume, current-velocity meter and wading rod, portable 90-degree v-notch weir, or a stopwatch and calibrated container as appropriate. Discharge measurements and calculations were performed using standard U.S. Bureau of Reclamation methods.

Discharge Temperature Measurements

Temperature measurements were performed using a Taylor brand electronic digital thermometer. Discharge temperature measurements at springs were performed as close to the spring discharge locations as possible. Stream temperature measurements were performed, where possible, in a shaded, actively flowing portion of the stream.

Specific Conductance Measurements

Specific conductance measurements were performed using an Extech brand model EC400 conductivity meter with automatic temperature compensation. The instrument was regularly calibrated using NIST traceable conductivity standard solutions.

pH Measurements

pH Measurements were performed using an Oakton model pH Testr 30 with automatic temperature compensation. The instruments were regularly calibrated using NIST traceable pH standard solutions.

Dissolved Oxygen Measurements

Dissolved oxygen measurements were performed using a YSI brand Model 55 dissolved oxygen meter. The meter was routinely calibrated using atmospheric oxygen calibration methods.

Water Quality Laboratory Measurements

Water quality laboratory analyses were performed by SGS Laboratories of Huntington, Utah, which is a NELAC certified water analysis laboratories. Information regarding laboratory standard analytical methods and procedures used and laboratory detection limits has been entered into the DOGM on-line database.

Climate

A plot of the Palmer Hydrologic Drought Index for Utah Region 4 (which includes the Crandall Canyon Mine permit area) is presented in Figure 2. The PHDI is a monthly value generated by the National Climatic Data Center that indicates wet and dry spells. The PHDI is calculated from several hydrologic parameters including precipitation, temperature, evapotranspiration, soil water recharge, soil water loss, and runoff. Consequently, it is a useful tool for evaluating the relationship between climate and groundwater and surface water discharge data. The PHDI is useful for determining whether variations in spring and stream discharge rates are the result of climatic variability or whether they are the result of other factors.

It is apparent in Figure 2 that, beginning in late 2004, the region transitioned from the previous 3-year period of drought into a period of wetness. During 2005 the region experienced a period of continuous severe to extreme wetness. Climatic conditions during 2006 were not as wet as in 2005, with generally mild to moderately wet conditions occurring throughout the year. Beginning in early 2007, the region entered a period of drought that persisted throughout the year. During 2008 the climatic conditions, as indicated by the PHDI, were mildly wet in the first half of the year, and mildly dry in the second half of 2008. During 2009, the region continued to experience dry climatic conditions, with mild to moderate drought conditions prevailing through most of the yearWith the exception of a brief, mildly wet period during early 2008, generally dryer than normal climatic conditions prevailed in the region for the three-year period beginning in early 2007 and continuing through the end of 2009 (Figure 2). Beginning in April 2010, the region began experiencing mildly wetter than normal climatic conditions, which prevailed for 8 of the remaining 9 months of 2010. During 2011 the region experienced a period of continuous severe to extreme wetness. Snow accumulations in the mountainous Wasatch Plateau areas during the wintertime of 2010-2011 were great. The melt-off of the winter snowpack was delayed appreciably due to the large snow accumulations, additional snow accumulations resulting from late-season snowstorms, and cool springtime temperatures. When the melt-off of the winter snowpack occurred during the springtime and early summer months, discharge rates in streams in the region were high.

Presentation of Data

The results of the 2011 hydrologic monitoring, including discharge measurements, laboratory water quality parameters, and field water quality data are presented in tabular form in Table 1. Hydrologic monitoring locations are shown on Figure 1. A plot of the Palmer Hydrologic Drought Index (PHDI) for Utah Region 4 is presented in Figure 2. A compilation of historic discharge and water quality data for springs and streams is presented in Table 2. Time series plots of specific conductance, pH, and discharge for each of the regular water-monitoring sites, together with plots of the PHDI for Utah Region 4 are included at the end of this report.

Operational monitoring of eight spring sites (LB-5A, LB-7, LB-7A, LB-7B, LB-7C, LB-12, SP-79, and Little Bear Spring) and six stream sites (Little Bear Creek, Section 4 Creek, Section 5 Creek, Section 5 Creek U. R. Fork, Section 5 Creek U. L. Fork, and IBC-1) associated with the South Crandall Lease area began in 2005 and continued in 2011. Also commencing in 2005 and continuing in 2011 was operational monitoring of two spring sites (SP-18 and SP-22) and one stream monitoring site (Shingle Creek) in the Shingle Canyon drainage (Figure 1).

During the 1st quarter of 2011, heavy snow-cover prohibited access to the high-elevation spring and stream monitoring sites on East Mountain and in upper Joes Valley. Some of the stream-monitoring sites in the Huntington Canyon drainage were accessed during the 1st quarter, while others were inaccessible due to substantial snow and ice cover. Little Bear Spring (which is monitored at an access/diversion point in the spring discharge pipeline in

Huntington Canyon) was also monitored in the 1st quarter. UPDES discharge monitoring was also performed during each of the months of the 1st quarter of 2011.

During the 2nd quarter of 2011, deep snow cover was continuously present in the mountainous areas of the Wasatch Plateau throughout the quarter. Additionally, very high stream flows with swift currents persisted in Huntington Creek in the 2nd quarter. While several attempts were made to access some monitoring sites in late June 2011, reasonable and safe access was not possible. Accordingly, after consultation with the Division, these sites were not accessed and monitored during the 2nd quarter (see Table 1).

All of the regular above-ground monitoring stations were accessed and monitored during the 3rd and 4th quarters of 2011.

The Crandall Canyon Mine remained closed and sealed throughout 2011. Accordingly, the in-mine monitoring wells could not be accessed during 2011.

Spring Monitoring Summary

In accordance with the approved monitoring plan, 23 springs were monitored for discharge and field water-quality parameters during 2011. Of these, eight springs are also monitored for laboratory water quality parameters. Additionally, Little Bear Spring is monitored for field water quality parameters and also for laboratory water quality parameters, but is not monitored for discharge. As part of a Division-requested field investigation of groundwater systems in the mine area, laboratory chemical analysis was performed on four spring monitoring sites during the 4th quarter of 2011 for which laboratory chemical analysis is not called for in the regular water monitoring plan. These springs include SP1-3, SP1-19, SP1-22, and SP1-24.

A summary of the 2011 monitoring results for springs in the Crandall Canyon Mine permit and adjacent area is presented below.

East Mountain Springs

As specified in the water monitoring plan, eight springs on East Mountain were monitored during 2011. These include SP2-24, SP2-9, SP-47A, SP1-3, SP1-19, SP1-22, SP1-9, and SP1-24.

The water quality at these springs, as indicated by field measurements of specific conductance and pH, is similar to that monitored during previous years (see attached plots). The solute compositions of springs SP1-9, SP2-9, and SP2-24, which are monitored for laboratory water quality parameters as specified in the MRP, likewise are similar to previous years (Tables 1 and 2). The laboratory water quality parameters measured at sites SP1-3, SP1-19, SP1-22, and SP1-24 during the 4th quarter of 2011 were generally similar to those measured during previous monitoring activities and also similar to solute compositions monitored at similar nearby springs.

The peak discharge rates measured at the springs on East Mountain during 2011 were generally similar to those measured in the previous few years (see attached graphs and Table

1). It is noteworthy that the peak discharges measured several of the monitored springs on East Mountain were not appreciably greater than those measured in previous years, although the climate was very wet during 2011. This occurrence is likely due to the fact that the East Mountain springs were not first accessed until late July – which is approximately a month later than when they are typically first accessed during the year (i.e., we likely missed the peak). It is readily apparent that appreciable recharge to the groundwater systems that support the springs on East Mountain occurred based on the elevated baseflow discharge rates that were measured at the springs during the 4th quarter 2011 (see attached plots and Table 2).

Upper Joes Valley Springs

As specified in the monitoring plan, three springs in Upper Joes Valley were monitored during 2011. These include SP1-33, SP1-47, and SP2-1. These springs were monitored during the 3rd and 4th quarters of 2011, but were not monitored during the 1st or 2nd quarters due to the presence of heavy snow pack, mud, and runoff waters in upper Joes Valley during those times.

Water quality at the Upper Joes Valley springs, as indicated by field measurements of specific conductance and pH, was similar to that monitored during previous years (see attached plots). The solute composition of spring SP1-33, which is monitored quarterly for laboratory water quality parameters during 2011 as specified in the MRP, is likewise similar to that of previous years (Tables 1 and 2).

Discharge rates measured at springs SP1-47, SP1-33 and SP2-1 during 2011 were similar to or greater than those measured in recent years and were generally consistent with the prevailing climatic conditions in the region. As discussed previously, these springs were not first accessed during 2011 until late July. Accordingly, it is possible that these springs were first accessed during 2011 after the passage of the snowmelt discharge peak.

Crandall Canyon Springs

As specified in the water monitoring plan, three springs were monitored in Crandall Canyon during 2011. These include SP-30, SP-36, and SP-58. These springs were monitored in the 2nd, 3rd, and 4th quarters of 2011, but were inaccessible in the1st quarter due to the above-normal snowpack and winter-like conditions in Crandall Canyon above the mine.

Discharge rates measured at SP-30 during 2011 were similar to those measured at the spring in 2009 and 2010. It was previously noted during 2009 that while the discharges measured at the designated spring monitoring point were somewhat lower than in previous years, the discharge from adjacent seepage areas at the spring complex (about 5 feet distant) was noticeably increased relative to those observed in recent years. This suggests the probability that the decline in discharge from the designated point source observed during 2009 is likely attributable to near-surface changes in the spring complex discharge mechanism (likely infilling of near-surface fracture openings with calcium carbonate deposition), and not to overall changes in the discharge rate from the groundwater system. As an example, during the 1st quarter monitoring event performed on 25 March 2010, a discharge of 0.029 gpm was measured at the designated monitoring point at SP-30. However, on that same day at a discrete discharge location only about 5 feet east of the designated monitoring point at SP-30, a discharge of 0.17 gpm was measured (which is more than five times the reported discharge). As noted during previous years, it is estimated that the discharge measured at the designated monitoring point at the spring complex typically has only constituted roughly 20% of the total discharge from the spring complex.

Discharge rates measured at SP-36 on 26 June 2011 were greater than those measured in recent years and are generally consistent with the prevailing wet climatic conditions in the region. Both peak and baseflow discharge rates measured at SP-58 during 2011 were greater than those measured in any of the previous 10 years (Table 2), demonstrating the response of the groundwater system that supports the spring to climatic variability (the very wet year).

It has been noted that the specific conductance at springs SP-36 and SP-58 have gradually increased somewhat over the past decade (see Tables 1 and 2 and the attached plots). Discharge in Crandall Creek above the mine surface facilities also shows a similar trend. During 2003 it was noted that the concentration of some solute species in discharge from spring SP-58 had increased somewhat relative to that of previous years (Table 2). It was suspected that the observed variability in solute composition may be related to long-term climatic variability. Water quality and discharge rates at springs SP-58, SP-36, and at UPF-1 will continue to be monitored during 2012 to further evaluate hydrologic conditions in the Crandall Canyon area.

South Crandall Area Springs

As part of the permit revision that included the South Crandall Lease area, eight springs were added to the water monitoring program in 2005. These include, Little Bear Spring, LB-5A, LB-7, LB-7A, LB-7B, LB-7C, LB-12, and SP-79 (Figure 1). Little Bear Spring is located near the mouth of Little Bear Canyon and is developed and piped to adjacent municipalities for use as municipal water. Spring LB-12 seeps from the Blackhawk Formation near the bottom of Little Bear Canyon. Spring LB-5A discharges from the Blackhawk Formation on the south-facing slope of Little Bear Canyon. Springs LB-7, LB-7A, LB-7B, LB-7C discharge near the contact of the Blackhawk Formation with the overlying Castlegate Sandstone in the upper portions of Little Bear Canyon. Spring SP-79 discharges in the canyon bottom near the mouth of an unnamed stream drainage (Section 4 Creek) immediately north of Little Bear Canyon. Spring discharge rates are measured quarterly at all of these springs with the exception of Little Bear Spring. Discharge measurements at Little Bear Spring are not practical due to the developed nature of the spring for municipal use. Average monthly discharge at Little Bear Spring is determined monthly by the Castle Valley Special Service District using a totalizing flow meter. While Discharge rates at Little Bear Spring typically range from about 200 to 400 gpm, discharges from the other springs in the South Crandall Lease area are generally meager. Discharges measured at LB-5A and LB-7 have typically been between about 1 and 3 gpm. Discharges at LB-12, LB-7A, LB-7B, and LB-7C are typically less than 1 gpm (Table 1). Discharge at SP-79 is usually less than about 1.5 gpm. Discharges measured at the South Crandall Area springs in 2011 were generally greater than those measured in previous years in response to the prevailing wet climatic conditions during 2011 (Table 2). The discharge from the designated spring LB-5A monitoring point has gradually decreased in recent years (Table 2). This condition is likely a response to the prevailing climatic conditions the region has experienced in the past several years. It has also been observed that at least three additional seepage locations have recently (within about the last one or two years) emerged along the base of the adjacent sandstone ledge and substantial tufa deposit from which LB-5A discharges. It is readily apparent from the lack of vegetation or tufa deposition at these new seepage sites that they have only recently formed. It is likely that these new discharge locations have formed as a result of the infilling of fracture openings in the sandstone bedrock outcrop and/or tufa mound at the spring, which forces some groundwater which previously discharged at the designated monitoring point to now discharge at other adjacent locations (following paths of lesser resistance to groundwater flow). (The discharge from the new seepage locations is not included in the reported discharge rates for the spring). During the 25 October 2011 monitoring event, the discharge rates from four adjacent discrete seepage areas was measured. The discharge rates from these four seepage points ranged from about 0.05 gpm to 0.877 gpm and totaled 2.03 gpm. Thus, if these new seepage locations were to be included in the LB-5A discharge measurement, a discharge of 2.92 gpm would be determined (which is substantially greater than at any time in the past 8 years).

Laboratory water quality measurements and field parameters are performed at Little Bear Spring, SP-79 and at spring LB-5A. Discharge measurements and field water quality measurements only are performed at the other five springs. Recent discharge measurements and field water quality parameters for these springs are plotted on the attached sheets. It is apparent in these plots and in Table 1 that field water quality parameters measured at these springs during 2011 (other than a modest increase in specific conductance at LB-12, which seeps at less than about 0.2 gpm) are very similar to those measured in previous years and at other springs in the local area.

Shingle Canyon Area Springs

Springs SP-18 and SP-22 were added to the water monitoring plan in conjunction with recent permit amendments. SP-18 discharges from the hillside above the upper Left Fork of Shingle Canyon (Figure 1). SP-22 discharges from the bottom of the stream channel in the upper Right Fork of Shingle Canyon (Figure 1). Monitoring at both springs is for field water quality parameters and discharge rate. Discharge from both springs has historically been meager (Table 2). During 2011, the discharge rates measured at these two springs were greater than those measured during 2009 and 2010, which is a reflection of the prevailing wet climatic conditions the region experienced.

Based on field water quality measurements, it is apparent that water quality at these springs is similar to other springs monitored in the Crandall Canyon Mine area. Appreciable changes in field water quality parameters were not noted during 2011.

Stream Monitoring Summary

In accordance with the approved hydrologic monitoring plan, 12 stream sites were monitored for flow and water quality during 2011. These include Indian Creek in Upper Joes Valley, Horse Canyon Creek, Blind Canyon Creek, Shingle Creek, a creek in an unnamed drainage in Section 4 in Huntington Canyon, Little Bear Canyon Creek, and six sites in the Crandall Creek drainage.

Indian Creek

Discharge rate and field water quality measurements were performed on Indian Creek during the 3rd and 4th quarters of 2011. Located in Upper Joes Valley, the site was not accessible during the 1st or 2nd quarters because of the heavy winter snow pack, mud, and surface runoff in Upper Joes Valley. Discharge measured at Indian Creek during 2011 ranged from 1,993 gpm in July to 1,184 gpm in October (Table 1). The discharges that occurred during 2011 were similar to those measured in previous years (Table 2). As discussed previously, it seems likely that the July 20th monitoring at Indian Creek occurred after the 2011 peak discharge in the creek had passed. It is noteworthy, however, that the 4th quarter baseflow discharge measurement in Indian Creek was appreciably greater than any other baseflow measurement in the past 10 years, which is reflective of the very wet conditions in the region during 2011.

Water quality in Indian Creek during 2011, as indicated by field measurements of specific conductance and pH, was similar to that monitored during previous years (see attached plots). The solute composition of Indian Creek monitored during 2011 was similar to that measured in previous years (Table 2). There are no changes in discharge rates or to water quality that would suggest that any mining-related impacts have occurred in Indian Creek.

Horse Canyon Creek

Horse Canyon Creek, which is monitored near the confluence with Huntington Creek (Figure 1), was monitored during the 1^{st}, 2^{nd}, 3^{rd}, and 4^{th} quarters of 2011. In response to the prevailing climatic conditions, both peak and baseflow discharge rates in Horse Canyon Creek monitored during 2011 were appreciably greater those that measured in previous years, ranging from 2,718 gpm during late June to 101 gpm in late September (Table 1).

Water quality in Horse Canyon Creek during 2011, as indicated by field measurements of specific conductance and pH, was similar to that monitored during previous years (see attached plots). The solute composition of Horse Canyon Creek monitored during 2011 was also generally similar to that measured in previous years (Table 2).

Blind Canyon Creek

Blind Canyon Creek, which is monitored near the confluence with Huntington Creek (Figure 1), was monitored during the 1^{st}, 2^{nd}, 3^{rd}, and 4^{th} quarters of 2011. Discharge in Blind Canyon Creek monitored during 2011 ranged from 1,687 gpm during June to 62.4 gpm in November (Table 1). The springtime discharge rate measured in 2011 was considerably greater than that measured in the recent years, which is reflective of the prevailing wet conditions in 2011.

Water quality in Blind Canyon Creek, as indicated by field measurements of specific conductance and pH, was similar to that monitored during previous years (see attached plots). The solute composition of Blind Canyon Creek monitored during 2011 was likewise similar to that measured in previous years (Table 2).

Shingle Canyon Creek

Monitoring in Shingle Creek, a small drainage just above Crandall Canyon (Figure 1), was added to the monitoring plan in conjunction with recent permit amendments. Shingle Creek is monitored a short distance above the mouth of the canyon for discharge and field water quality parameters. Both peak and baseflow discharge rates measured during 2011 were greater than in recent years. Discharge ranged from 61 gpm in June to 4.78 gpm in mid-September 2011, which is reflective of the prevailing wet climatic conditions in the area during 2011.

Water quality monitored in Shingle Creek during 2011, as indicated by measurements of specific conductance, was similar to that measured during 2010. It is notable that the specific conductance of water in the creek has been somewhat variable over the past several years. This condition is likely attributable to the substantial variability in the discharge rate in the stream (i.e. greater and lesser contributions of higher TDS and lower TDS waters under differing flow regimes).

Little Bear Canyon Creek

Monitoring in Little Bear Canyon Creek, a small drainage about 1¼ miles below Crandall Canyon (Figure 1), has been added to the monitoring plan in conjunction with recent permit amendments. Little Bear Canyon Creek is monitored a short distance above the confluence with Huntington Creek. Discharge measured in the creek during 2011 ranged from 4.46 gpm in late August to 5.5 gpm in late October. It is noteworthy that during both the August 2011 and October 2011 monitoring events, there was no flow at the designated monitoring site. However, discharge was occurring in the stream channel approximately 60 to 75 feet higher in the drainage during both monitoring events – at which point the monitoring of the creek was performed at those times.

Section 4 Creek

Monitoring in Section 4 Creek, a small drainage about ¾ mile below Crandall Canyon (Figure 1), has been added to the monitoring plan in conjunction with recent permit amendments. Section 4 Creek is monitored near the confluence with Huntington Creek. Discharge at Section 4 Creek is typically small. During 2011 the discharge from the stream ranged from 2.29 gpm in August to 6.53 gpm in November, which is similar to that measured in previous years.

Water quality in Section 4 Creek during 2011 was similar to that measured during previous years and is generally similar to that at other streams in the Crandall Canyon Mine area, although TDS concentrations are somewhat greater in the creek than are most other nearby creeks (Table 2).

Crandall Canyon Drainage

Crandall Canyon Creek Upper Flume (UPF-1)

The upper flume in Crandall Canyon Creek is located above the mine surface facilities in Crandall Canyon. This station was monitored during all four quarters of 2011. The discharge measured at the upper flume ranged from 8,089 gpm in June to 276 gpm in March. Both the high-flow and baseflow discharge rates at the upper flume in Crandall Canyon Creek were greater than those measured during previous years (see attached plots).

Water quality at the upper flume in Crandall Creek during 2011, as indicated by field measurements of specific conductance and pH, was generally similar to that monitored during 2010 (see Table 2 and attached plots). It was observed in 2003 that TDS and sulfate concentrations measured at the upper flume were somewhat elevated relative to previous years. Sulfate concentrations measured during 2011 during the high spring runoff event were lower than during the baseflow monitoring events. This supports the conclusion that the elevated sulfate concentrations in upper Crandall Creek (and other streams and springs in the area) are likely related to discharge rate variability. Continued monitoring and analysis of laboratory water quality information will be performed in the future.

Crandall Canyon Creek Lower Flume (LOF-1)

The lower flume in Crandall Canyon Creek is located immediately below the Crandall Canyon #1 Mine discharge. The lower flume site was monitored during all four quarters of 2010. Stream flow measured at the lower flume is a composite of Crandall Canyon Creek water originating above the mine area and mine discharge water (UPDES 002).

Discharge rates at LOF-1 ranged from 8,576 gpm during June to 994 gpm during March. Both peak and baseflow discharge rates monitored during 2011were greater than those measured during previous years.

The permitted discharge of mine water into Crandall Canyon Creek results in increased discharge rates in lower Crandall Creek when the mine is discharging relative to the non-discharging condition. This is particularly evident during baseflow conditions and during drought periods when the relative contribution of water in Crandall Creek above the mine discharge point is small. During 2008, groundwaters from the closed Crandall Canyon Mine began to discharge from the mine portals which were subsequently discharged to the creek. The quality of the initial water emerging from the mine was of poorer quality than that commonly discharged when the mine was in operation. Subsequent to the initial outflows from the sealed mine, the quality of the discharge water (in terms of dissolved solids) has gradually improved and is now similar to that observed in previous years. Currently, Genwal Resources, Inc. is operating an iron treatment facility at the Crandall Canyon Mine to treat total iron concentrations in mine discharge water prior to its discharge into Crandall Creek.

IBC-1

IBC-1 was added to the Crandall Canyon Mine monitoring plan in conjunction with recent permit amendments. IBC-1 is monitored quarterly for discharge and field and laboratory water quality parameters. The drainage that is monitored at IBC-1 is a tributary to Crandall

Creek and is located adjacent to the mine surface facilities, immediately south of the existing UPF-1 monitoring site (Figure 1).

Discharge rates monitored at IBC-1 during 2011 ranged from 30 gpm in June to 2.07 gpm in September, which are somewhat elevated relative to recent years, which reflects the wet climatic conditions in the region during 2011.

Water quality monitored in the drainage during 2011 was similar to that measured in previous years (Table 2) and generally similar to that in other streams in the Crandall Canyon Mine area.

Section 5 Creek

Section 5 Creek is a tributary of Crandall Creek located on the north-facing slope of Crandall Canyon adjacent to the lower mine facilities (Figure 1). Monitoring at Section 5 Creek occurs about 400 feet above the mouth of the canyon, and at the upper left and right forks. It is noteworthy that discharge in the creek infiltrates rapidly below the lower monitoring site and generally does not persist in the stream bed to the confluence with Crandall Creek. Monitoring at the main (lower) stream site (Section 5 Creek) is for discharge and field and laboratory water quality parameters. At the upper forks, monitoring is for discharge and field water quality parameters only.

Discharge measured at Section 5 Creek during 2011 ranged from 63.4 gpm in June to 4.29 gpm in September. Both the peak and baseflow discharge rates measured during 2011 are considerably greater than average, reflecting the wet climatic conditions that prevailed during 2011.

Discharge measured at the upper forks during 2011 ranged from 10.9 gpm to 1.64 gpm in the upper right fork, and from 26.1 gpm to 2.52 gpm in the upper left fork. These discharge rates are considerably greater than average for the drainage, which is consistent with the wet climatic conditions that existed in the area during 2011.

Water quality monitored during 2011 in Section 5 Canyon was generally similar to that measured in previous years and is similar to that monitored at other streams in the Crandall Canyon Mine area (Table 2).

In-Mine monitoring Summary

All of the in-mine monitoring sites are now inaccessible due the closure of the Crandall Canyon Mine. Consequently, no monitoring of any of these underground sites could be performed during 2011.

Detailed information and analysis regarding the Crandall Canyon Mine discharge water has been provided previously to the Division during. Accordingly, information in this regard is not presented here.

Conclusions

- Discharge rates measured at streams and springs in the mine permit area during 2011 were generally greater than those measured during previous years. The observed discharge rates are reflective of the prevailing wet climatic conditions in the area during 2011. There are no indications that adverse impacts to groundwater or surface-water discharge rates that could be attributed to mining-related activities have occurred.

- No major changes to important water quality parameters were observed in springs or streams, during 2011. Some spring and stream waters continued to experience moderately increased solute and TDS concentrations. These conditions may be largely attributable to the effects of long-term climatic variability in the region. Continued monitoring of spring and stream discharge rates and water quality will occur during 2012.

- Genwal Resources, Inc. continued to operate an iron treatment facility during 2011 that is successfully removing iron from Crandall Canyon Mine discharge waters prior to their discharge to Crandall Creek.

- Other than the effects of the permitted mine water discharges to Crandall Canyon Creek, there is no indication that any significant mining-related impacts to the hydrologic balance in the mine permit and adjacent area occurred during 2011.

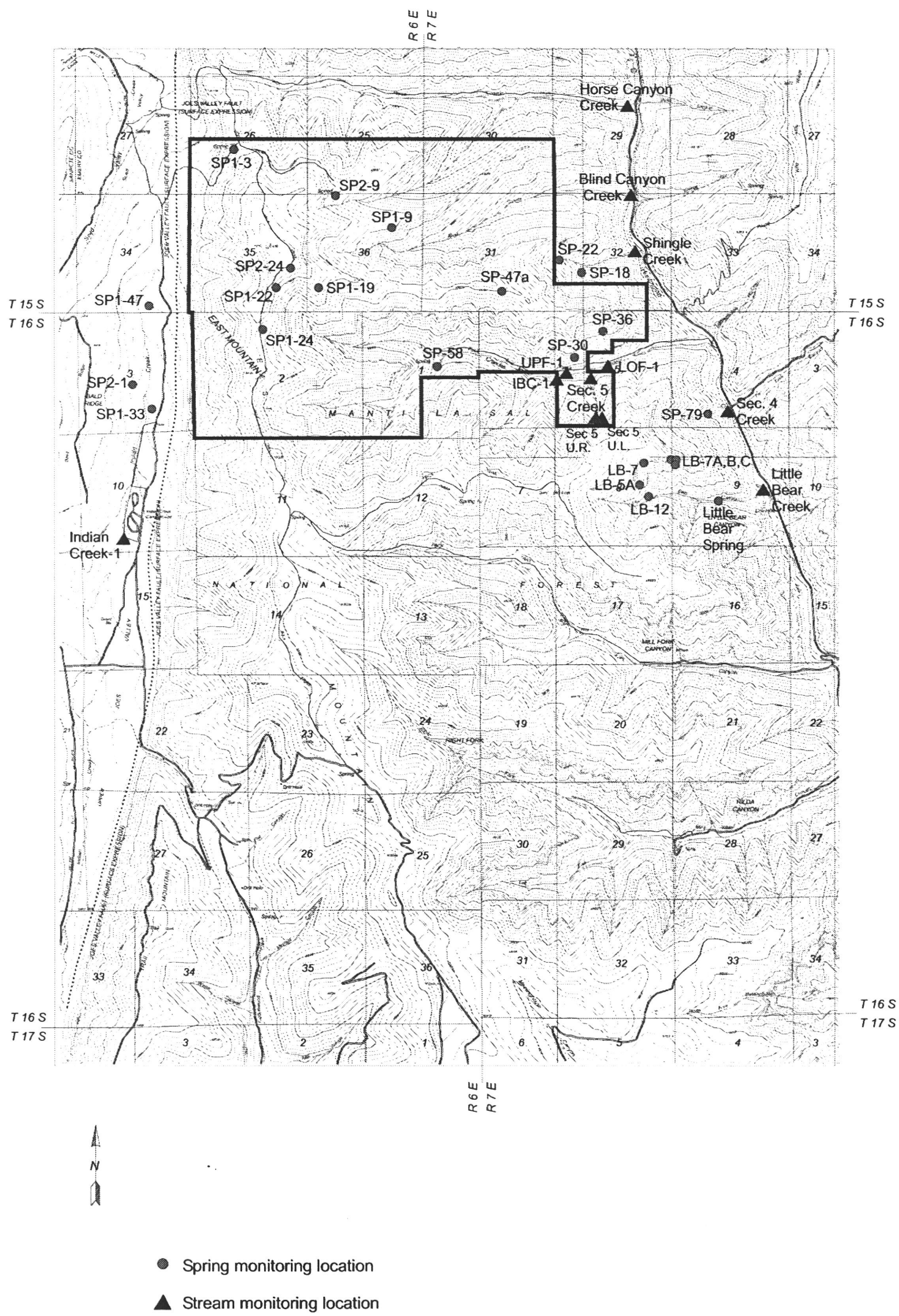
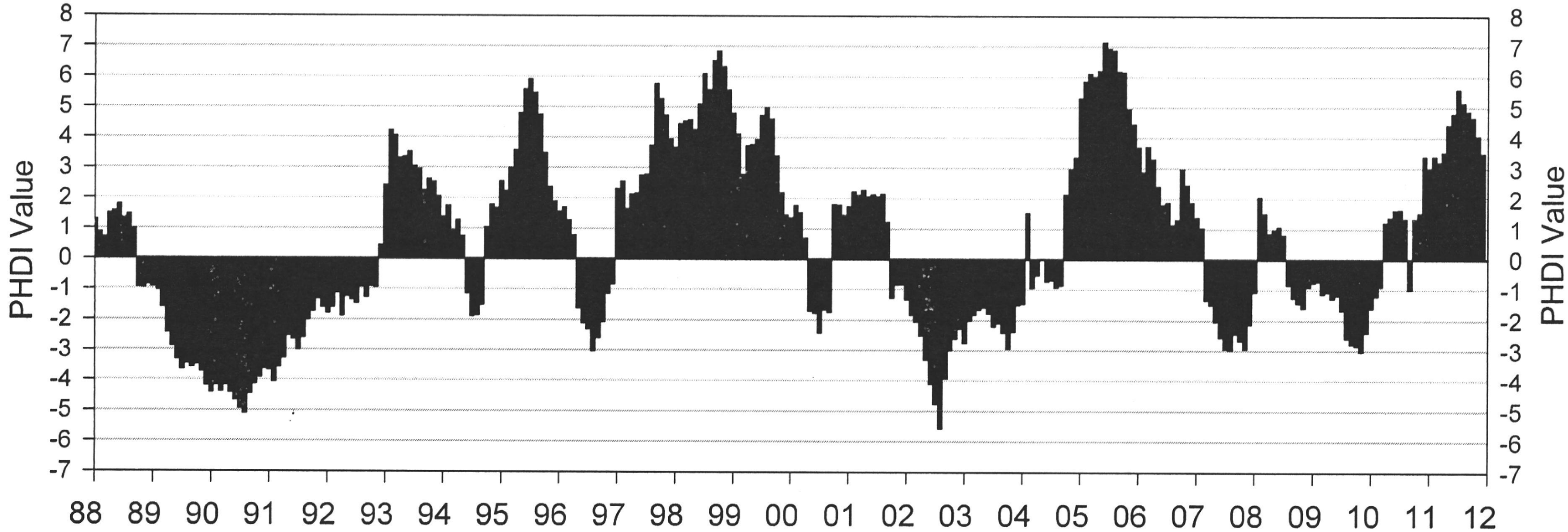


Figure 1 Hydrologic monitoring locations



-1 to -2	Mild Drought	1 to 2	Mild Wet Spell
-2 to -3	Moderate Drought	2 to 3	Moderate Wet Spell
-3 to -4	Severe Drought	3 to 4	Severe Wet Spell
-4 to -5	Extreme Drought	4 to 5	Extreme Wet Spell

Figure 2 Plot of Palmer Hydrologic Drought Index for Utah Region 4.

Table 1 Results of hydrologic monitoring at GENWAL's Crandall Canyon Mine permit area during 2011.

	Date	Monitored	Flow (gpm)	T (°C)	pH (S.U.)	Cond (μs/cm)	TDS (mg/l)	TSS (mg/l)	Set Sol (mg/l)	DO (mg/l)	O&G (mg/l)	Tot Alk (mg/l)	Hard. (mg/l)	HCO_3 (CaCO3)	CO_3 (CaCO3)	SO_4 (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Anions (meq/l)	Cations (meq/l)	Fe(d) (mg/l)	Fe(T) (mg/l)	Mn(d) (mg/l)	Mn(T) (mg/l)
Springs																											
SP-30	3/29/2011	Inaccessible																									
SP-30	6/26/2011	Yes	0.054	12	7.87	827																					
SP-30	9/20/2011	Yes	0.046	12.5	7.92	914																					
SP-30	11/16/2011	Yes	0.036	6.6	8.03	848																					
SP-36	3/29/2011	Yes																									
SP-36	6/26/2011	Yes	1.32	8.3	7.88	646	405					308	371	308	< 5.	62	9	66.5	49.79	7.85	1	7.71	7.78	< .03	< .05	< .002	< .002
SP-36	9/20/2011	Yes	1.08	11.1	7.83	691	409					322	377	322	< 5.	58	8	67.86	50.41	8.47	1.47	7.86	7.94	< .03	< .05	< .002	< .002
SP-36	11/16/2011	Yes	1.21	9.7	7.84	671	399					313	374	313	< 5.	58	7	67.14	50.14	8.54	1.26	7.68	7.88	< .03	< .05	< .002	< .002
SP-58	3/29/2011	Inaccessible																									
SP-58	6/26/2011	Yes	53.4	5.3	7.56	827	613					282	517	282	< 5.	227	3	117.1	54.5	6.18	1.78	10.46	10.64	< .03	< .05	< .002	< .002
SP-58	9/20/2011	Yes	36.3	5.6	7.51	873	615					293	494	293	< 5.	206	3	111.6	52.35	6.66	2.15	10.21	10.22	< .03	< .05	< .002	< .002
SP-58	10/26/2011	Yes	31.5	5.7	7.58	863	530					291	509	291	< 5.	199	3	114.6	54.02	6.21	2.09	10.04	10.49	< .03	< .05	< .002	< .002
SP2-24	3/29/2011	Inaccessible																									
SP2-24	6/26/2011	Inaccessible																									
SP2-24	7/20/2011	Yes	7	7.1	7.78	405	214					158	181	158	< 5.	5	5	50.46	13.27	1.68	8.01	3.4	3.89	< .03	< .05	< .002	< .002
SP2-24	10/4/2011	Yes	2.44	4.4	8.19	382	239					169	192	169	< 5.	5	5	52.46	14.78	1.85	6.02	3.62	4.07	< .03	< .05	< .002	< .002
SP2-9	3/29/2011	Inaccessible																									
SP2-9	6/26/2011	Inaccessible																									
SP2-9	7/20/2011	Yes	6.73	4.7	7.71	273	186					142	156	142	< 5.	4	< 1.	48.41	8.48	1.45	0.71	2.95	3.19	< .03	0.12	< .002	< .002
SP2-9	10/3/2011	Yes	1.38	5.9	7.87	299	195					152	165	152	< 5.	7	< 1.	50.63	9.34	1.78	0.93	3.21	3.4	< .03	< .05	< .002	< .002
SP-47A	3/29/2011	Inaccessible																									
SP-47A	6/26/2011	Inaccessible																									
SP-47A	7/20/2011	Yes	1.28	6.4	7.45	394																					
SP-47A	10/3/2011	Yes	0.31	7.9	7.46	411																					
SP1-3	3/29/2011	Inaccessible																									
SP1-3	6/26/2011	Inaccessible																									
SP1-3	7/20/2011	Yes	0.523	7.7	7.88	251																					
SP1-3	10/3/2011	Yes	0.41	4.9	7.95	301	206					136	154	136	< 5.	10	3	47.08	8.83	3.68	0.73	3.01	3.25	< .03	0.19	< .002	< .002
SP1-19	3/29/2011	Inaccessible																									
SP1-19	6/26/2011	Inaccessible																									
SP1-19	7/20/2011	Yes	41.3	5	7.74	395																					
SP1-19	10/4/2011	Yes	3.78	7.1	7.92	483	288					245	252	245	< 5.	25	< 1.	69.96	18.89	8.52	0.8	5.44	5.44	< .03	0.1	< .002	0.005
SP1-22	3/29/2011	Inaccessible																									
SP1-22	6/26/2011	Inaccessible																									
SP1-22	7/20/2011	Yes	8.38	4.5	7.96	290																					
SP1-22	10/4/2011	Yes	1.14	6.6	8.16	343	217					175	190	175	< 5.	4	3	50.91	15.26	1.75	0.95	3.66	3.9	< .03	< .05	< .002	0.003
SP1-33	3/29/2011	Inaccessible																									
SP1-33	6/26/2011	Inaccessible																									
SP1-33	7/21/2011	Yes	3.66	5	7.57	516	332					245	300	245	< 5.	44	2	79.1	24.96	6.13	1.12	5.86	6.3	< .03	0.15	< .002	0.009
SP1-33	10/4/2011	Yes	3.07	5.8	7.61	567	335					268	305	268	< 5.	44	2	79.91	25.54	7.52	1.26	6.34	6.24	< .03	< .05	< .002	0.003
SP1-47	3/29/2011	Inaccessible																									
SP1-47	6/26/2011	Inaccessible																									
SP1-47	7/21/2011	Yes	11	25.6	8.18	455																					

	Date	Monitored	Flow (gpm)	T (°C)	pH (S.U.)	Cond (µs/cm)	TDS (mg/l)	TSS (mg/l)	Set Sol (mg/l)	DO (mg/l)	O&G (mg/l)	Tot Alk (mg/l)	Hard. (mg/l)	HCO_3 (CaCO3)	CO_3 (CaCO3)	SO_4 (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Anions (meq/l)	Cations (meq/l)	Fe(d) (mg/l)	Fe(T) (mg/l)	Mn(d) (mg/l)	Mn(T) (mg/l)
SP1-47	10/4/2011	Yes	28	8.9	8.25	562																					
SP2-1	3/29/2011	Inaccessible																									
SP2-1	6/26/2011	Inaccessible																									
SP2-1	7/21/2011	Yes	17.8	5.1	7.69	493																					
SP2-1	10/4/2011	Yes	3.42	6.4	7.65	547																					
SP1-9	3/29/2011	Inaccessible																									
SP1-9	6/26/2011	Inaccessible																									
SP1-9	7/20/2011	Yes	5.54	4.6	7.63	291	186					146	169	146	< 5.	11	< 1.	46.02	13.02	1.91	0.91	3.17	3.47	< .03	< .05	< .002	< .002
SP1-9	10/3/2011	Yes	1.01	6.1	7.74	339	206					166	187	166	< 5.	12	< 1.	50.59	14.78	2.49	1.18	3.58	3.88	< .03	0.06	< .002	< .002
SP1-24	3/29/2011	Inaccessible	No Access																								
SP1-24	6/26/2011	Inaccessible	No Access																								
SP1-24	7/20/2011	Yes	0.987	7.1	7.78	405																					
SP1-24	10/4/2011	Yes	0.121	10.4	8.12	454	280					240	255	240	< 5.	13	1	67.62	20.88	2.31	0.5	5.11	5.21	< .03	0.17	< .002	0.007
LB-5A	3/29/2011	Inaccessible																									
LB-5A	6/26/2011	Inaccessible																									
LB-5A	8/30/2011	Yes	0.94	9.4	7.72	802	509					315	441	315	< 5.	125	6	88.79	53.35	8.1	1.65	9.06	9.21	< .03	< .05	< .002	< .002
LB-5A	10/25/2011	Yes	0.89	9	7.58	771	485					305	444	305	< 5.	124	6	88.43	54.21	7.99	1.62	8.84	9.26	< .03	< .05	< .002	< .002
LB-7	3/29/2011	Inaccessible																									
LB-7	6/26/2011	Inaccessible																									
LB-7	8/30/2011	Yes	2.43	8.7	7.88	565																					
LB-7	10/25/2011	Yes	2.46	8.7	7.75	565																					
LB-7A	3/29/2011	Inaccessible																									
LB-7A	6/26/2011	Inaccessible																									
LB-7A	8/30/2011	Yes	0.457	11.9	8.73	484																					
LB-7A	10/25/2011	Yes	0.495	7.7	8.46	472																					
LB-7B	3/29/2011	Inaccessible																									
LB-7B	6/26/2011	Inaccessible																									
LB-7B	8/30/2011	Yes	0.129	10.6	8.36	458																					
LB-7B	10/25/2011	Yes	0.163	10.7	8.27	446																					
LB-7C	3/29/2011	Inaccessible																									
LB-7C	6/26/2011	Inaccessible																									
LB-7C	8/30/2011	Yes	0.357	19.1	8.68	466																					
LB-7C	10/25/2011	Yes	0.413	12.5	8.66	440																					
LB-12	3/29/2011	Inaccessible																									
LB-12	6/26/2011	Inaccessible																									
LB-12	8/30/2011	Yes	0.137	10.7	7.97	1190																					
LB-12	10/25/2011	Yes	0.185	8.4	7.79	1191																					
LITTLE BEAR SPG	3/29/2011	Yes	---	8.3	7.7	569	351					284	322	284	< 5.	40	4	68.08	36.85	6.21	1.45	6.61	6.74	< .03	< .05	< .002	< .002
LITTLE BEAR SPG	6/20/2011	Yes	---	8.8	7.62	568	323					271	202	271	< 5.	41	4	65.88	35.86	7.35	1.5	4.45	4.69	< .03	< .05	< .002	0.002
LITTLE BEAR SPG	9/20/2011	Yes	---	8.8	7.57	583	344					276	304	276	< 5.	39	3	64.45	34.71	7.33	1.51	6.42	6.43	< .03	< .05	< .002	< .002
LITTLE BEAR SPG	12/27/2011	Yes	---	8.3	7.67	569	302					276	313	276	<5	38	3	65.55	36.19	7.32	1.51	6.41	6.60	<.03	<.05	<.002	<.002
SP-18	3/29/2011	Inaccessible																									
SP-18	6/24/2011	Yes	0.084	6.6	8.17	797																					
SP-18	9/14/2011	Yes	0.017	8.3	8.19	946																					
SP-18	10/14/2011	Yes	0.015	5.3	8.15	956																					

	Date	Monitored	Flow (gpm)	T (°C)	pH (S.U.)	Cond (µs/cm)	TDS (mg/l)	TSS (mg/l)	Set Sol (mg/l)	DO (mg/l)	O&G (mg/l)	Tot Alk (mg/l)	Hard. (mg/l)	HCO_3 (CaCO3)	CO_3 (CaCO3)	SO_4 (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Anions (meq/l)	Cations (meq/l)	Fe(d) (mg/l)	Fe(T) (mg/l)	Mn(d) (mg/l)	Mn(T) (mg/l)
SP-22	3/29/2011	Inaccessible																									
SP-22	6/24/2011	Yes	0.661	8.2	7.97	670																					
SP-22	9/14/2011	Yes	0.049	9.2	7.92	713																					
SP-22	10/14/2011	Yes	0.101	6.7	7.85	660																					
SP-79	3/29/2011	Inaccessible	No Access																								
SP-79	6/26/2011	Inaccessible	No Access																								
SP-79	8/30/2011	Yes	0.7	10	8.16	940	602					334	511	333	< 5.	189	13	78.82	76.35	16.32	5.26	10.99	11.06	< .03	0.12	0.007	0.013
SP-79	11/16/2011	Yes	1.2	3.4	8.07	939	633					346	535	346	< 5.	200	13	80.06	81.46	18.12	4.86	11.45	11.61	< .03	< .05	< .002	0.004
Streams																											
UPF-1	3/29/2011	Yes	276	0.9	8.33	802	593	6	< .1	10.3	< 5.	243	488	243	< 5.	265	3	104.9	54.8	6.71	1.97	10.46	10.08	< .03	< .05	< .002	< .002
UPF-1	6/22/2011	Yes	8089	8.5	8.71	584	428	36	< .1	8.83	< 5.	244	338	233	12	105	2	88.83	28.21	9.11	1.37	7.11	7.18	< .03	0.4	< .002	0.013
UPF-1	9/20/2011	Yes	539	8.2	8.46	824	576	8	< .1	8.67	< 5.	224	453	224	< 5.	253	2	100.2	49.33	7.39	1.95	9.82	9.43	< .03	< .05	< .002	0.003
UPF-1	11/16/2011	Yes	433	0.8	8.57	867	609	< 5.	< .1	10.8	< 5.	250	471	250	< 5.	239	3	104.6	50.98	7.28	1.74	10.05	9.77	< .03	< .05	< .002	< .002
LOF-1	3/29/2011	Yes	994	7.2	8.44	949	618	< 5.	< .1	8.76	< 5.	319	489	319	< 5.	204	21	101.3	57.26	28.47	5.74	11.22	11.15	< .03	< .05	0.045	0.049
LOF-1	6/22/2011	Yes	8576	10.3	8.68	601	402	26	< .1	8.2	< 5.	260	333	240	20	106	3	86.53	28.38	9.56	1.48	7.47	7.11	< .03	0.37	0.003	0.015
LOF-1	9/20/2011	Yes	1333	9.8	8.33	914	613	< 5.	< .1	7.9	< 5.	309	452	309	< 5.	197	11	94.33	52.68	22.5	5.16	10.58	10.15	< .03	0.11	0.029	0.049
LOF-1	12/26/2011	Yes	1031	5.2	8.57	911	623	6	< .1	9.43	< 5.	312	469	312	< 5.	186	12	96.35	55.36	23.58	5.46	10.44	10.53	< .03	< .05	0.026	0.05
HORSE CANYON	3/29/2011	Yes	171	1.6	8.74	628	352	< 5.	< .1	10.3	< 5.	300	356	300	< 5.	58	7	67.35	45.68	7.51	1.3	7.39	7.48	< .03	< .05	< .002	0.004
HORSE CANYON	6/22/2011	Yes	2718	8.4	8.75	378	225	16	< .1	8.49	< 5.	247	234	235	13	12	2	57.18	22.22	3.4	0.84	5.26	4.85	0.06	0.27	0.006	0.014
HORSE CANYON	9/20/2011	Yes	101	5.7	8.58	584	338	11	< .1	9.38	< 5.	278	309	267	12	49	4	58.39	39.71	8.18	1.47	6.71	6.57	< .03	0.08	0.003	0.007
HORSE CANYON	11/16/2011	Yes	116	0.2	8.73	633	358	< 5.	< .1	10.8	< 5.	302	338	298	< 5.	52	4	67.95	40.96	7.31	1.3	7.23	7.11	< .03	< .05	< .002	0.005
BCF	3/29/2011	Yes	89	0.8	8.71	632	352	6	< .1	10.2	< 5.	291	332	291	< 5.	42	20	62.23	42.8	15.01	1.38	7.26	7.32	< .03	0.07	< .002	0.006
BCF	6/22/2011	Yes	1687	8.2	8.72	441	258	19	< .1	8.37	< 5.	227	269	227	< 5.	21	2	67.32	24.6	3.22	0.87	5.35	5.55	< .03	0.19	0.004	0.021
BCF	9/20/2011	Yes	80.4	6.8	8.6	539	315	< 5.	< .1	9.11	< 5.	266	292	260	6	35	3	54.28	37.97	5.05	1.42	6.14	6.09	< .03	< .05	0.003	0.005
BCF	11/16/2011	Yes	62.4	0.2	8.76	602	332	< 5.	< .1	10.73	< 5.	297	337	291	6	39	3	64.67	42.68	5.1	1.3	6.83	6.99	< .03	< .05	< .002	0.004
INDIAN CREEK	3/29/2011	Inaccessible																									
INDIAN CREEK	6/26/2011	Inaccessible																									
INDIAN CREEK	7/21/2011	Yes	1993	14.7	8.3	476	296	7	< .1	7.65	< 5.	274	290	274	< 5.	12	1	81.14	21.34	6.12	0.6	5.77	6.09	< .03	0.12	0.008	0.016
INDIAN CREEK	10/4/2011	Yes	1184	8.5	8.3	521	316	< 5.	< .1	8.76	< 5.	275	291	269	6	10	3	79.17	22.59	5.11	1.63	5.8	6.07	< .03	0.09	0.007	0.01
LITTLE BEAR CRK	3/29/2011	Inaccessible																									
LITTLE BEAR CRK	6/26/2011	Inaccessible																									
LITTLE BEAR CRK	8/30/2011	Yes	4.46	14	8.65	607	359	17	< .1	7.06	< 5.	287	327	258	29	56	7	60.46	42.8	8.75	2.01	7.09	6.97	< .03	0.15	< .002	0.009
LITTLE BEAR CRK	10/25/2011	Yes	5.5	6.5	8.54	644	399	< 5.	< .1	9.15	< 5.	295	372	295	< 5.	57	7	68.52	48.91	9.31	2.06	7.29	7.9	< .03	< .05	< .002	0.004
IBC-1	3/29/2011	Inaccessible																									
IBC-1	6/22/2011	Yes	30	8.9	8.67	502	314	< 5.	< .1	8.43	< 5.	258	307	250	8	38	5	63.37	36.01	7.39	1.42	6.07	6.48	< .03	< .05	< .002	< .002
IBC-1	9/20/2011	Yes	2.07	7.8	8.3	607	364	8	< .1	8.25	< 5.	270	331	270	< 5.	59	7	60.98	43.4	9.28	1.86	6.82	7.06	< .03	< .05	< .002	< .002
IBC-1	11/16/2011	Yes	3.43	0.7	8.58	632	395	14	< .1	10.3	< 5.	276	353	276	< 5.	69	6	63.62	47.23	9.78	1.67	7.13	7.53	< .03	< .05	< .002	< .002
SECTION 4 CREEK	3/29/2011	Inaccessible																									
SECTION 4 CREEK	6/26/2011	Inaccessible																									
SECTION 4 CREEK	8/30/2011	Yes	2.29	12.2	8.57	847	516	30	< .1	7.27	< 5.	342	450	323	20	129	12	69.05	67.34	15.03	3.96	9.88	9.74	< .03	0.54	0.002	0.077
SECTION 4 CREEK	11/16/2011	Yes	6.53	1.4	8.65	912	573	10	< .1	10.4	< 5.	352	500	350	< 5.	140	12	76	75.22	16.46	3.46	10.3	10.78	< .03	0.2	< .002	0.04
SECTION 5 CREEK	3/29/2011	Inaccessible																									
SECTION 5 CREEK	6/22/2011	Yes	63.4	15.9	8.7	512	360	< 5.	< .1	7.15	< 5.	248	302	238	11	44	5	56.55	39.02	7.05	1.4	6.02	6.37	< .03	< .05	< .002	< .002
SECTION 5 CREEK	9/20/2011	Yes	4.29	8.4	8.59	569	356	15	< .1	8.38	< 5.	261	313	257	< 5.	55	6	51.18	45.07	8.21	1.92	6.54	6.67	< .03	< .05	< .002	0.003
SECTION 5 CREEK	10/26/2011	Yes	5.14	0.7	8.66	580	326	< 5.	< .1	10.7	< 5.	257	324	257	< 5.	59	6	53.48	46.19	7.76	1.52	6.52	6.85	< .03	< .05	< .002	< .002
UPR RF SEC 5 CR	3/29/2011	Inaccessible																									

	Date	Monitored	Flow (gpm)	T (°C)	pH (S.U.)	Cond (µs/cm)	TDS (mg/l)	TSS (mg/l)	Set Sol (mg/l)	DO (mg/l)	O&G (mg/l)	Tot Alk (mg/l)	Hard. (mg/l)	HCO_3 (CaCO3)	CO_3 (CaCO3)	SO_4 (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Anions (meq/l)	Cations (meq/l)	Fe(d) (mg/l)	Fe(T) (mg/l)	Mn(d) (mg/l)	Mn(T) (mg/l)
UPR RF SEC 5 CR	6/26/2011	Yes	10.9	12.1	8.6	551				8.37																	
UPR RF SEC 5 CR	9/20/2011	Yes	1.64	7.7	8.5	574				8.28																	
UPR RF SEC 5 CR	10/26/2011	Yes	2.07	0.2	8.62	590				10.45																	
UPR LF SEC 5 CR	3/29/2011	Inaccessible																									
UPR LF SEC 5 CR	6/26/2011	Yes	26.1	9	8.63	457				8.33																	
UPR LF SEC 5 CR	9/20/2011	Yes	2.52	6.9	8.52	488				8.49																	
UPR LF SEC 5 CR	10/26/2011	Yes	2.88	1.3	8.59	484				10.56																	
SHINGLE CREEK	3/29/2011	Inaccessible																									
SHINGLE CREEK	6/24/2011	Yes	61	12.2	8.49	760				8.41																	
SHINGLE CREEK	9/14/2011	Yes	4.78	9.3	8.49	848				8.3																	
SHINGLE CREEK	10/14/2011	Yes	8.43	4.8	8.52	846				8.91																	

In-Mine Monitoring Wells

DH-1	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
DH-1	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
DH-1	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
DH-1	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
DH-2	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
DH-2	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
DH-2	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
DH-2	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-1	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-1	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-1	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-1	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-2	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-2	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-2	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-2	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-3	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-3	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-3	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-3	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-4	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-4	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-4	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-4	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-5	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-5	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-5	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-5	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-6	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-6	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-6	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-6	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)
MW-6A	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)

Site	Date	Monitored	Flow (gpm)	T (°C)	pH (S.U.)	Cond (µs/cm)	TDS (mg/l)	TSS (mg/l)	Set Sol (mg/l)	DO (mg/l)	O&G (mg/l)	Tot Alk (mg/l)	Hard. (mg/l)	HCO_3 (CaCO3)	CO_3 (CaCO3)	SO_4 (mg/l)	Cl (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Anions (meq/l)	Cations (meq/l)	Fe(d) (mg/l)	Fe(T) (mg/l)	Mn(d) (mg/l)	Mn(T) (mg/l)
MW-6A	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-6A	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-6A	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-7	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-7	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-7	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-7	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-8	3/29/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-8	6/26/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-8	9/20/2011	Inaccessible (Crandall Canyon Mine is closed)																									
MW-8	11/16/2011	Inaccessible (Crandall Canyon Mine is closed)																									

Table 2 Solute compositions and discharge rates of streams, springs and wells in the Genwal permit area.

summer's table revised for annual report 2011.xls March 2012

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Streams																		
LOF-1 (Crandall Creek)	11-Mar-1988	76.3	3.00	8.24	743	384	64.0	36.5	10.6	3.3	289	0	91.0	5.8		<0.05	<0.01	
LOF-1 (Crandall Creek)	31-May-1988	350.1	3.60	8.14	528	252	64.0	21.9	4.7	2.8	269	0	18.0	4.1		<0.05	0.02	
LOF-1 (Crandall Creek)	30-Sep-1988	58.3	9.90	7.68	483	256	60.0	25.5	6.9	1.6	267	16	38.1	5.6		<0.05	<0.01	
LOF-1 (Crandall Creek)	2-Nov-1988	62.8	6.80	8.40	670	330	60.0	42.6	8.6	2.5	298	0	73.3	4.2	<0.05		<0.01	
LOF-1 (Crandall Creek)	31-Mar-1989					298	56.5	29.4	5.8	1.4	259	7	0.0	20.0		0.03	<0.01	
LOF-1 (Crandall Creek)	22-Jun-1989					198	56.3	23.1	3.9	0.7	248	<1	28.0	25.0	<0.02	<0.02	<0.01	
LOF-1 (Crandall Creek)	28-Sep-1989					32	57.6	32.2	5.3	0.4	314	<1	25.0	10.0	<0.02	<0.02	<0.01	
LOF-1 (Crandall Creek)	18-Dec-1989					326	68.7	29.2	5.4	0.1	294	<1	40.0	10.0	0.06		<0.01	
LOF-1 (Crandall Creek)	30-Jan-1990					291	60.7	28.4	1.0	0.4	292	<1	33.0	10.0	<0.02	<0.02	<0.01	
LOF-1 (Crandall Creek)	18-Jan-1990	4.5	3.10	7.20	450													
LOF-1 (Crandall Creek)	30-Jan-1990					291	60.7	28.4	1.0	0.4	292	<1	33.0	10.0	<0.02	<0.02	<0.01	
LOF-1 (Crandall Creek)	13-Apr-1990					225	66.0	28.0	3.3	4.6	274	<1	35.0	20.0		<0.02	0.02	
LOF-1 (Crandall Creek)	14-Apr-1990	430.9	3.20	7.20	448													
LOF-1 (Crandall Creek)	23-Jul-1990	502.7	3.30	7.20	448													
LOF-1 (Crandall Creek)	24-Jul-1990					254	61.8	21.6	3.4	0.0	270	<1	28.0	10.0		<0.02	0.02	
LOF-1 (Crandall Creek)	11-Oct-1990	103.2	4.80	7.60	300													
LOF-1 (Crandall Creek)	12-Oct-1990					189	70.5	30.5	5.6	0.0	363	<1	22.0	5.0	<0.02	<0.02	<0.01	
LOF-1 (Crandall Creek)	12-Jan-1991	148.1	2.80	8.46	300													
LOF-1 (Crandall Creek)	14-Jan-1991					323	86.7	39.7	9.3	0.6	346	<1	43.0	70.0	0.03	0.03	0.39	
LOF-1 (Crandall Creek)	4-Apr-1991	148.1	1.40	8.00	330	318	69.0	28.1	5.0	0.5	252	<1	47.0	15.0	<0.02	<0.02	<0.01	
LOF-1 (Crandall Creek)	21-Jul-1991	538.6	4.90	7.20	500													
LOF-1 (Crandall Creek)	11-Oct-1991	237.8	7.00	8.26	600	298	74.6	24.9	4.1	0.0	270	<1	52.0	15.0		0.09		
LOF-1 (Crandall Creek)	8-Mar-1992	44.9	3.33	7.60	400	564	99.7	28.9	75.1	1.0	326	0	58.0	125.0	0.00	0.00	0.00	
LOF-1 (Crandall Creek)	18-Jun-1992	116.7	17.33	8.24	513	265	71.5	19.0	3.1	0.0	228	5	30.0	20.0	0.00		0.00	
LOF-1 (Crandall Creek)	30-Sep-1992	134.6	16.1	8.2	550	357	91.2	24.1	3.1	0.0	406	0	50.0	10.0	0.44		0.06	
LOF-1 (Crandall Creek)	16-Dec-1992	224.4	0.6	7.9	620	254	93.4	35.5	10.3	1.3	301	0	100.0	15.0	0.10	0.05	0.00	
LOF-1 (Crandall Creek)	4-Mar-1993	234.0	1.0	7.8	490	615	68.8	27.9	94.1	0.0	311	0	60.0	164.0	0.12	0.00	0.00	
LOF-1 (Crandall Creek)	3-Jun-1993	6500.0	12.0	8.1	300	244	57.8	20.2	4.8	0.6	248	0	19.0	4.9	0.28	<0.5	<0.03	
LOF-1 (Crandall Creek)	1-Jul-1993	290.0	10.0	8.1	540	249	57.7	21.3	5.7	0.1	253	0	24.0	5.3	<0.05	0.05	<0.03	
LOF-1 (Crandall Creek)	25-Oct-1993	380.0	7.0	7.2	440	368	59.0	32.0	9.0	<2	281	<1	50.0	28.0	<0.2	<0.2	0.10	
LOF-1 (Crandall Creek)	9-Feb-1994	220.0	29.4	7.3	506	265	46.0	35.0	4.5	1.7	296	0	29.0	4.1	0.00		0.00	
LOF-1 (Crandall Creek)	15-Jul-1994	30.0	57.2	7.6	610	301	46.0	30.0	21.0	1.9	246	0	46.0	31.0	0.09	0.21	<.02	
LOF-1 (Crandall Creek)	6-Sep-1994	40.0	46.4	7.6	848	308	42.0	31.0	25.0	2.4	241	0	44.0	40.0	0.13	<.05	<.02	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
LOF-1 (Crandall Creek)	22-Nov-1994	125.0	28.4	6.7		450	65.0	40.0	38.0	<5	290	0	50.0	68.0	<.2	<.2	<.2	
LOF-1 (Crandall Creek)	10-Mar-1995	184.0	0.0	7.9	480	700	70.0	55.0	113.0	3.0	260	20	75.0	230.0	0.10	<0.1	<0.1	
LOF-1 (Crandall Creek)	16-May-1995	535.0	7.0	8.2	380	310	60.0	31.0	10.0	2.0	240	240	42.0	15.0	0.40	<0.1	<0.1	
LOF-1 (Crandall Creek)	10-Aug-1995	636.0	12.0	8.4	534	290	55.0	25.0	10.0	1.0	249	14	34.0	14.0	0.1<	<0.1	<0.1	
LOF-1 (Crandall Creek)	28-Nov-1995	71.6	10.0	8.8	546	390	61.0	37.0	19.0	4.0	240	15	82.0	21.0	0.1<	<0.1	<0.1	
LOF-1 (Crandall Creek)	26-Mar-1996	150.0	1.0	8.1	640	328	57.0	35.0	6.0	1.1	350	<2	28.0	10.0	0.18	<.03		<.04
LOF-1 (Crandall Creek)	26-Jun-1996					266	56.0	24.0	8.0	2.0	254	18	29.0	11.0	<.1	<.1		<0.1
LOF-1 (Crandall Creek)	16-Aug-1996	15.0	15.0	7.3	605	327	53.0	37.0	17.0	4.0	246	16	45.0	17.0	<.1	<.2		<0.1
LOF-1 (Crandall Creek)	24-Oct-1996	2.5	0.0	8.3	686	377	61.0	41.0	17.0	3.0	318	<5	62.0	20.0	<.1	<.1		<0.1
LOF-1 (Crandall Creek)	25-Mar-1997	11.3	10.0	8.7	670	422	61.0	37.5	14.8	2.0	300	<1	62.1	23.0	<0.02	0.03		<0.05
LOF-1 (Crandall Creek)	5-May-1997	224.4	6.0	8.6	724	330	52.2	31.8	8.7	1.7	267	<1	44.9	9.5	0.07	<0.02		<0.05
LOF-1 (Crandall Creek)	20-Aug-1997	673.2	8.0	8.0	620	370	68.0	36.0	15.0	4.0	353	<5	59.0	9.0	0.10	<0.1	<0.1	
LOF-1 (Crandall Creek)	7-Oct-1997	507.1	7.0	8.0	569	370	71.0	38.0	18.0	4.0	368	<5	100.0	7.6	0.30	<0.1	<0.1	
LOF-1 (Crandall Creek)	8-Sep-1998			8.2	655	405	71.0	37.0	16.0	4.0	366	<5	66.0	10.0	0.50	<0.1	<0.1	
LOF-1 (Crandall Creek)	4-Mar-1999	399.0	3.0	8.2	454	435	79.0	43.0	19.0	2.0	334	<5	101.0	31.0	<0.1	<0.1	<0.1	
LOF-1 (Crandall Creek)	10-Jun-1999	4406.0				292	83.0	29.0	7.0	2.0	294	<5	33.0	4.0	0.1	<0.1	<0.1	
LOF-1 (Crandall Creek)	15-Sep-1999	502.0	7.3	8.6	500	410	71.1	38.7	10.5	2.0	318	<1	70.0	12.0	0.12	<0.02	0.01	
LOF-1 (Crandall Creek)	4-Nov-1999	336.0	10.0	8.5	592	450	50.7	46.5	31.2	5.9	325	<1	88.0	29.0	0.08	<0.02	<0.01	
LOF-1 (Crandall Creek)	20-Jun-2000	1135	10.6	8.33	539	333	60	30	7	2	275	<5	56	8	<0.1	<0.1	<0.1	<0.1
LOF-1 (Crandall Creek)	14-Sep-2000	1210	11.2	7.99	708	413	63	37	30	6	344	<5	93	12	<0.1	<0.1	<0.1	<0.1
LOF-1 (Crandall Creek)	9-Dec-2000	1135	9	8.15	717	401	63	37	30	6	345	<5	95	12	<0.1	<0.1	<0.1	<0.1
LOF-1 (Crandall Creek)	13-Mar-2001	1819	10	7.5	747	488	49	32	67	6	353	<5	98	30	0.2	<0.1	<0.1	<0.1
LOF-1 (Crandall Creek)	1-May-2001	1436	10.9	7.8	678	398	57	35	40	8	331	<5	88	20	<0.1	<0.1	<0.1	<0.1
LOF-1 (Crandall Creek)	9-Sep-2001	276	8.5	8.18	637	479	73	40	16	2	314	<5	128	21.2	<0.1	<0.1	<0.05	<0.05
LOF-1 (Crandall Creek)	29-Oct-2001	221	4.7	8.27	696	485	79	43	15	2	328	<5	124.8	17.7	<0.1	<0.1	<0.05	<0.05
LOF-1 (Crandall Creek)	21-Mar-2002	1283	9.5	8.15	710	385	58	35	44	7	336	<5.	106	19	<0.1	<0.1	<0.05	<0.05
LOF-1 (Crandall Creek)	8-Jun-2002	1308	12.7	8.49	797	522	75	44	35	6	304	<5.	184	13	<0.1	<0.1	<0.05	<0.05
LOF-1 (Crandall Creek)	27-Sep-2002	972	11.5	8.05	708	442	62	40	36	7	318	<5.	126	14	0.1	<0.1	<0.05	<0.05
LOF-1 (Crandall Creek)	19-Nov-2002	614	9.9	7.94	708	441	62	37	29	7	319	<5	121	13	<0.1	<0.1	<0.05	<0.05
LOF-1 (Crandall Creek)	23-Mar-2003	884	10.4	8.06	722	425	63.9	38.8	33	6.45	296	<5.	112	21	0.056	<0.005	0.007	0.006
LOF-1 (Crandall Creek)	13-Jun-2003	2,810	10.8	8.07	715	509	79.2	40.2	24.4	4.8	249	<5.	162	8	0.042	<0.005	<0.005	<0.005
LOF-1 (Crandall Creek)	23-Sep-2003	499	11.4	7.92	766	506	79.2	47	37.6	6.8	405	<5.	132	12	0.095	<0.005	0.011	0.007
LOF-1 (Crandall Creek)	9-Dec-2003	1177	10.0	8.29	847	493	75.5	44.3	42.4	7.09	415	<5	121	17	0.049	0.006	0.01	0.005
LOF-1 (Crandall Creek)	31-Mar-2004	296	4.6	8.21	976	667	97.2	53.1	39.3	2.65	342	< 5.	189	69	0.088	< .03	0.051	0.049
LOF-1 (Crandall Creek)	17-Jun-2004	2910	9.8	8.19	796	515	90.1	41.5	22.4	3.86	260	< 5.	180	8	0.08	< .03	0.009	0.005
LOF-1 (Crandall Creek)	20-Sep-2004	801	10.7	8.25	740	513	87.5	49.6	36.9	6.54	339	< 5.	139	10	0.06	< .03	0.008	0.007
LOF-1 (Crandall Creek)	6-Nov-2004	190	3.3	7.93	744	596	94.9	48.3	24.6	2.5			193	24	0.11	< .03	0.024	0.02

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
LOF-1 (Crandall Creek)	28-Mar-2005	1150	10.8	8.13	749	575	80.3	44.8	43.9	6.97	405	< 5.	137	19	0.11	< .03	0.009	0.006
LOF-1 (Crandall Creek)	31-May-2005	6730	8.5	8.26	536	408	86.7	27.8	9.84	1.56	280	< 5.	103	4	1	< .03	0.04	0.002
LOF-1 (Crandall Creek)	25-Aug-2005	884	11.9	8.27	763	542	89.3	48.5	30.3	5.82	349	< 5.	182	10	0.08	< .03	0.009	0.009
LOF-1 (Crandall Creek)	28-Dec-2005	555	8.4	8.29	832	545	84.2	51.7	33.2	6.46	335	15	180	15	0.09	< .03	0.009	0.005
LOF-1 (Crandall Creek)	6-Mar-2006	737	9.3	8.27	878	587	87.1	53.6	42.5	7.12	352	< 5.	173	26	< .05	< .03	0.008	0.007
LOF-1 (Crandall Creek)	25-Jun-2006	1460	10.8	8.24	738	536	93.6	46.5	17.3	3.42	293	8.3	180	8	0.08	< .03	0.006	0.004
LOF-1 (Crandall Creek)	22-Sep-2006	495	4.7	8.05	797	583	100.24	48.72	17.95	2.44	299	< 5.	204	20	0.07	< .03	0.014	0.014
LOF-1 (Crandall Creek)	13-Nov-2006	1030	7.9	8.19	820	567	90.95	53.18	29.4	5.55	356	< 5.	185	12	0.07	< .03	0.005	0.005
LOF-1 (Crandall Creek)	15-Mar-2007	738	8.6	8.32	872	588	85.3	52.81	33.67	7.21	337	< 10.	150	20.3	0.055	< .005	0.007	< .005
LOF-1 (Crandall Creek)	18-Jun-2007	570	10.2	8.25	818	585	111.3	50.12	13.61	2.6	269	< 10.	228	10.3	0.058	< .01	0.009	0.003
LOF-1 (Crandall Creek)	18-Sep-2007	210	7.9	8.32	845	607	108.8	57.77	18.6	2.27	295	< 10.	220	19.5	0.063	< .01	0.012	0.011
LOF-1 (Crandall Creek)	5-Dec-2007	152	3	8.29	704	578	98.33	53.19	14.8	2.18	316	< 10.	196	17.4	0.057	< .01	0.015	0.015
LOF-1 (Crandall Creek)	26-Mar-2008	472	7.9	8.13	1108	823	134.4	70.72	34.47	7.33	388	< 10.	328	28.6	0.465	< .01	0.072	0.067
LOF-1 (Crandall Creek)	29-May-2008	2346	7.3	8.2	699	575	110.2	44.01	13.36	2.76	300	< 10.	210	5.87	0.136	< .01	0.026	0.023
LOF-1 (Crandall Creek)	4-Sep-2008	659	9.5	8.44	960	731	115.8	60.59	22.33	5.72	362	< 10.	254	11.6	0.358	< .01	0.076	0.076
LOF-1 (Crandall Creek)	23-Dec-2008	769	7.8	8.15	1025	722	116.3	61.44	28.62	7.23	391	< 10.	260	16.3	1.438	< .01	0.122	0.09
LOF-1 (Crandall Creek)	24-Mar-2009	533	7.7	8.27	954	681	113.5	60.04	28.04	6.66	399	< 10.	237	14.1	1.432	< .01	0.095	0.072
LOF-1 (Crandall Creek)	24-Jun-2009	1077	10.9	8.15	795	569	101.1	45.92	15.55	3.48	301	< 10.	168	6.17	0.679	< .01	0.039	0.022
LOF-1 (Crandall Creek)	10-Sep-2009	546	10.1	8.46	895	624	102.6	57.23	25.85	6.25	374	< 10.	198	10.16	1.585	0.018	0.085	0.076
LOF-1 (Crandall Creek)	3-Nov-2009	936	7.4	8.22	936	673	115.5	56.66	22.43	5.52	399	<10.	237.5	12.35	1.479	< .01	0.076	0.05
LOF-1 (Crandall Creek)	25-Mar-2010	739	8	8.31	920	623	104.2	58.1	32.21	6.5	366	< 10.	202	24.2	0.503	< .01	0.078	0.066
LOF-1 (Crandall Creek)	24-Jun-2010	1868	11.7	8.65	768	570	91.11	43.54	16.12	3.25	296	< 10.	186	5.74	0.106	< .01	0.03	0.013
LOF-1 (Crandall Creek)	9-Sep-2010	904	9.7	8.17	916	571	99.44	54.59	26.87	6.09	391	< 5.	185	14	0.6	< .03	0.064	0.062
LOF-1 (Crandall Creek)	2-Dec-2010	760	6.3	8.06	935	629	98.35	54.09	26.27	5.57	382	23	193	14	0.38	< .03	0.058	0.048
LOF-1 (Crandall Creek)	29-Mar-2011	994	7.2	8.44	949	618	101.33	57.26	28.47	5.74	319	< 5.	204	21	< .05	< .03	0.049	0.045
LOF-1 (Crandall Creek)	22-Jun-2011	8576	10.3	8.68	601	402	86.53	28.38	9.56	1.48	240	20	106	3	0.37	< .03	0.015	0.003
LOF-1 (Crandall Creek)	20-Sep-2011	1333	9.8	8.33	914	613	94.33	52.68	22.5	5.16	309	< 5.	197	11	0.11	< .03	0.049	0.029
LOF-1 (Crandall Creek)	26-Dec-2011	1031	5.2	8.57	911	623	96.35	55.36	23.58	5.46	312	< 5.	186	12	< .05	< .03	0.05	0.026
UPF-1 (Crandall Creek)	11-Mar-1988	112.2	1.6	8.6	755	296	58.0	17.0	4.3	1.6	284	0	35.1	4.4		<0.05	0.01	
UPF-1 (Crandall Creek)	31-May-1988	561.0	3.5	8.2	463	276	62.0	21.9	4.8	5.0	264	0	16.2	5.7		<0.05	0.01	
UPF-1 (Crandall Creek)	30-Sep-1988	67.3	9.8	7.7	430	232	56.0	28.0	5.3	1.2	235	24	27.1	8.0		<0.05		<0.01
UPF-1 (Crandall Creek)	2-Nov-1988	80.8	6.7	8.4	478	252	50.0	30.4	4.1	1.1	246	0	32.2	3.4	<0.05		<0.01	
UPF-1 (Crandall Creek)	31-Mar-1989					198	53.3	30.7	3.8	0.9	272	25	30.0	15.0		<0.02	<0.01	
UPF-1 (Crandall Creek)	22-Jun-1989					198	50.5	22.1	2.8	1.1	228	<1	25.0	5.0	<0.02	<0.02	<0.01	
UPF-1 (Crandall Creek)	28-Sep-1989					265	52.9	27.6	3.7	0.1	273	<1	20.0	10.0	<0.02	<0.02	<0.01	
UPF-1 (Crandall Creek)	18-Dec-1989					289	60.2	24.2	1.2	0.0	224	<1	45.0	15.0	<0.02		<0.01	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
UPF-1 (Crandall Creek)	29-Jan-1990					282	67.7	26.3	0.9	0.2	266	<1	50.0	10.0		<0.02	<0.01	
UPF-1 (Crandall Creek)	18-Jan-1990	3.5	2.9	7.0	400													
UPF-1 (Crandall Creek)	30-Jan-1990					282	67.7	26.3	0.9	0.2	266	<1	50.0	10.0		<0.02	<0.01	
UPF-1 (Crandall Creek)	13-Apr-1990					185	89.9	24.6	4.9	4.5	325	<1	40.0	20.0		<0.02		<0.01
UPF-1 (Crandall Creek)	14-Apr-1990	430.9	3.0	7.0	400													
UPF-1 (Crandall Creek)	23-Jul-1990	430.9	3.2	7.1	410													
UPF-1 (Crandall Creek)	24-Jul-1990					247	62.2	21.3	2.8	0.0	251	<1	32.0	15.0		<0.02	0.03	
UPF-1 (Crandall Creek)	11-Oct-1990	170.5	5.2	7.5	300													
UPF-1 (Crandall Creek)	12-Oct-1990					261	63.4	22.4	2.0	0.0	279	<1	25.0	10.0	<0.02	<0.02	0.02	
UPF-1 (Crandall Creek)	12-Jan-1991		3.2	8.5	300													
UPF-1 (Crandall Creek)	14-Jan-1991					300	76.6	33.1	4.9	0.1	323	<1	27.0	45.0	0.09	0.11	0.24	
UPF-1 (Crandall Creek)	4-Apr-1991	368.0	1.4	8.0	400	290	67.9	24.8	2.9	0.0	252	<1	33.0	25.0	<0.02	<0.02	<0.01	
UPF-1 (Crandall Creek)	21-Jul-1991	852.7	5.1	7.0	500	234	56.5	22.9	2.8	1.8	261	<1	23.0	5.0	<0.02	<0.02	0.05	
UPF-1 (Crandall Creek)	11-Oct-1991	273.8	8.0	8.5	600	262	67.7	25.9	3.0	0.0	263	<1	36.0	10.0		0.05		
UPF-1 (Crandall Creek)	8-Mar-1992	67.3	1.1	7.5	300	320	72.2	22.2	3.2	0.0	274	0	32.0	20.0	0.00		0.00	
UPF-1 (Crandall Creek)	18-Jun-1992	161.6	16.8	8.2	517	250	53.5	26.8	1.4	0.0	217	5	27.0	10.0	0.00		0.00	
UPF-1 (Crandall Creek)	30-Sep-1992	94.3	13.3	8.2	600	288	63.9	23.7	1.3	0.0	224	0	28.0	20.0	0.13		0.00	
UPF-1 (Crandall Creek)	4-Mar-1993	68.7	0.8	7.9	440	611	56.7	25.7	3.2	1.4	306	0	60.0	3.3	1.20	0.14	0.00	
UPF-1 (Crandall Creek)	3-Jun-1993	5386.0	3.0	8.2	300	245	60.3	18.0	3.0	0.2	244	0	18.0	3.9	0.34	<0.05	<0.03	
UPF-1 (Crandall Creek)	1-Jul-1993	129.0	9.4	8.1	427	231	54.8	20.0	23.1	<0.10	247	0	26.0	2.3	<0.05	<0.05	<0.03	
UPF-1 (Crandall Creek)	25-Oct-1993	147.0	6.0	7.9	440	297	56.0	28.0	4.0	<2.0	194	<1	28.0	6.0	<0.20	<0.20	<0.10	
UPF-1 (Crandall Creek)	9-Feb-1994	168.0	32.0	7.2		409	55.0	44.0	39.0	1.7	312	3						
UPF-1 (Crandall Creek)	15-Jul-1994	70.0	55.4	7.6	430	228	44.0	26.0	4.1	1.1	227	0						
UPF-1 (Crandall Creek)	6-Sep-1994	50.0	41.0	7.6	613	225	41.0	25.0	5.0	<10	241	0						
UPF-1 (Crandall Creek)	22-Nov-1994	125.0	28.4	6.8		280	58.0	30.0	<5	<5	260	<1						
UPF-1 (Crandall Creek)	10-Mar-1995	180.0	0.6	7.9	450	280	55.0	30.0	6.0	2.0	245	10	25.0	6.0	<0.1	<0.1	<0.1	
UPF-1 (Crandall Creek)	16-May-1995	522.0	8.0	8.0	490	260	60.0	31.0	5.0	1.0	250	20	38.0	10.0	0.30	<0.1	<0.1	
UPF-1 (Crandall Creek)	10-Aug-1995	254.0	11.0	8.9	467	230	56.0	23.0	5.0	<1	248	13	27.0	55.0	<0.1	<0.1	<0.1	
UPF-1 (Crandall Creek)	28-Nov-1995	47.7	6.0	9.2	432	290	62.0	27.0	5.0	<1	250	15	31.0	20.0	<0.1	<0.1	<0.1	
UPF-1 (Crandall Creek)	26-Mar-1996	150.0	1.0	8.0	580	322	61.0	30.0	4.0	<.3	314	<2	38.0	5.0	0.19	<.03		<.04
UPF-1 (Crandall Creek)	26-Jun-1996					266	52.0	21.0	4.0	<1	240	13	24.0	4.0	<0.1	<0.1		<0.1
UPF-1 (Crandall Creek)	16-Aug-1996	15.0	14.0	8.3	499	261	55.0	29.0	5.0	<1	232	25	29.0	7.0	<0.1	<0.1		<0.1
UPF-1 (Crandall Creek)	24-Oct-1996	2.0	3.0	8.2	564	312	60.0	34.0	6.0	1.0	326	<5	38.0	7.0	<0.1	<0.1		<0.1
UPF-1 (Crandall Creek)	25-Mar-1997	11.2	3.0	8.4	730	370	59.9	35.0	4.7	1.6	293	<1	50.6	3.9	<0.005		<0.05	
UPF-1 (Crandall Creek)	5-May-1997	47.0	6.0	9.0	656	314	59.9	35.0	4.7	1.6	293	<1	50.6	3.9	<0.02	<0.02	<0.05	
UPF-1 (Crandall Creek)	20-Aug-1997	673.2	8.0	7.7	502	310		31.0	5.0	1.0	301	<5	48.0	4.0	270.00	<0.1		<0.1
UPF-1 (Crandall Creek)	1-Oct-1997	507.1	6.0	7.9	641	320	68.0	32.0	5.0	<1	352	<5	48.0	4.0	<0.1	<0.1	<0.1	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
UPF-1 (Crandall Creek)	8-Sep-1998			8.4	548	337	70.0	33.0	4.0	1.0	321	<5	50.0	3.0	0.60	<0.1	<0.1	
UPF-1 (Crandall Creek)	4-Mar-1999	367.0	3.0	8.1	380	344	71.0	37.0	5.0	2.0	356	<5	79.0	4.0	<0.1	<0.1	<0.1	
UPF-1 (Crandall Creek)	10-Jun-1999	4173.0				256	64.0	21.0	3.0	<1	272	<5	21.0	1.0	0.1	<0.1	<0.1	
UPF-1 (Crandall Creek)	15-Sep-1999	467.0	7.2	8.0	480	370	62.1	35.2	4.4	1.4	283	<1	57.0	7.0	0.09	<0.02	0.01	
UPF-1 (Crandall Creek)	4-Nov-1999	305.0	12.0	7.9	479	340	61.0	40.6	4.2	1.7	313	<1	63.0	7.0	0.05	<0.02	<0.01	
UPF-1 (Crandall Creek)	20-Jun-2000	950	8.7	8.31	479	304	59	27	3	<1	270	<5	45	2	<0.1	<0.1	<0.1	<0.1
UPF-1 (Crandall Creek)	14-Sep-2000	321	9.2	8.06	557	325	60	34	5	2	281	<5	76	3	<0.1	<0.1	<0.1	<0.1
UPF-1 (Crandall Creek)	9-Dec-2000	350	-0.3	8.26	590	333	66	36	4	1	324	<5	73	2	<0.1	<0.1	<0.1	<0.1
UPF-1 (Crandall Creek)	13-Mar-2001	234	3.6	7.8	583	383	62	37	4	1	311	<5	84	2	<0.1	<0.1	<0.1	<0.1
UPF-1 (Crandall Creek)	1-May-2001	383	10.8	7.9	567	336	63	38	4	1	303	<5	81	3	<0.1	<0.1	<0.1	<0.1
UPF-1 (Crandall Creek)	9-Sep-2001	367	9.3	8.36	549	419	69	37	5	1	284	<5	124	3.1	<0.1	<0.1	<0.05	<0.05
UPF-1 (Crandall Creek)	29-Oct-2001	262	3.7	8.39	592	406	71	39	5	2	306	<5	98.9	3	<0.1	<0.1	<0.05	<0.05
UPF-1 (Crandall Creek)	21-Mar-2002	182	1.2	8.23	533	302	68	38	5	<1.	306	<5.	102	3	<0.1	<0.1	<0.05	<0.05
UPF-1 (Crandall Creek)	8-Jun-2002	539	14.3	8.15	901	678	111	60	6	2	245	<5.	341	2	<0.1	<0.1	<0.05	<0.05
UPF-1 (Crandall Creek)	27-Sep-2002	124	7.3	8.21	575	377	67	39	6	1	270	<5.	114	2	<0.1	<0.1	<0.05	<0.05
UPF-1 (Crandall Creek)	19-Nov-2002	117	0.5	8.01	604	419	68	36	4	1	309	<5	118	3	<0.1	<0.1	<0.05	<0.05
UPF-1 (Crandall Creek)	23-Mar-2003	121	2.8	8.15	619	390	73.9	40.5	4.9	1.48	289	5	109	3	0.013	<0.005	<0.005	<0.005
UPF-1 (Crandall Creek)	13-Jun-2003	1,230	9.1	8.39	717	530	98.2	41.2	4.9	1.33	238	6	213	2	0.023	<0.005	<0.005	<0.005
UPF-1 (Crandall Creek)	23-Sep-2003	138	9.0	8.15	680	478	89.2	47.7	4.6	1.71	293	<5.	178	2	0.153	<0.005	<0.005	<0.005
UPF-1 (Crandall Creek)	9-Dec-2003	86	0.4	8.38	697	478	91.8	48	4.61	1.64	321	<5	164	3	<0.02	<0.005	<0.005	<0.005
UPF-1 (Crandall Creek)	31-Mar-2004	117	3.9	8.39	758	546	95.3	49.2	4.77	1.66	304	<5	197	3	<0.05	<0.03	<0.002	<0.002
UPF-1 (Crandall Creek)	17-Jun-2004	1010	8.4	8.48	733	482	97.7	39.2	6.19	1.41	201	< 5.	212	3	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	20-Sep-2004	393	5.5	8.58	667	523	95.7	49.4	4.76	1.67	222	< 5.	204	2	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	6-Nov-2004	134	1	8.06	669	530	93.5	45.8	4.68	1.55			195	2	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	28-Mar-2005	72	0.9	8.1	636	587	99	49.2	4.28	1.2	284	< 5.	253	2	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	31-May-2005	6450	8	8.15	509	391	88.3	28.4	8.21	1.12	266	6	98	2	1.72	< .03	0.044	< .002
UPF-1 (Crandall Creek)	25-Aug-2005	220	11.3	8.26	696	528	97.7	47.8	5.68	1.68	246	< 5.	217	2	< .05	< .03	0.002	< .002
UPF-1 (Crandall Creek)	27-Dec-2005	117	0.6	8.19	744	484	96.5	45.5	5.71	1.79	296	< 5.	182	3	< .05	< .03	0.002	< .002
UPF-1 (Crandall Creek)	6-Mar-2006	152	0.8	8.33	766	538	101	49.1	5.61	1.74	290	< 5.	192	4	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	25-Jun-2006	868	10.8	8.33	689	508	98.1	42.2	6.45	1.56	254	< 5.	190	3	< .05	< .03	0.002	< .002
UPF-1 (Crandall Creek)	22-Sep-2006	200	3.1	8.24	735	548	101.45	47.06	5.26	1.83	282	< 5.	217	3	< .05	< .03	0.002	0.002
UPF-1 (Crandall Creek)	13-Nov-2006	210	0.4	8.33	726	532	100.42	48.83	5.46	1.46	289	< 5.	204	3	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	15-Mar-2007	109	1.6	8.34	712	494	92.43	46.21	5.4	2.06	293	< 10.	136	3.12	0.014	< .005	< .005	< .005
UPF-1 (Crandall Creek)	18-Jun-2007	513	11.8	8.29	809	577	115.2	48.93	6.86	1.78	251	< 10.	249	1.87	0.018	< .01	0.002	0.001
UPF-1 (Crandall Creek)	18-Sep-2007	170	7.1	8.49	758	550	106.2	54.42	6.57	1.84	278	< 10.	215	3.21	0.059	< .01	0.003	0.001
UPF-1 (Crandall Creek)	4-Dec-2007	134	0.8	8.25	572	518	86.2	48.52	5.73	1.61	306	< 10.	176	2.57	0.047	< .01	0.003	0.002
UPF-1 (Crandall Creek)	26-Mar-2008	143	1.4	8.95	652	511	95.53	47.97	5.71	1.9	301	< 10.	198	2.83	0.465	< .01	0.072	< .001

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
UPF-1 (Crandall Creek)	29-May-2008	1264	6.9	8.31	635	506	106.4	38.49	8.49	1.62	266	< 10.	192	2.06	0.08	< .01	0.003	< .001
UPF-1 (Crandall Creek)	4-Sep-2008	252	8.8	8.33	776	593	100.3	48.82	6.18	1.88	263	< 10.	232	3.26	0.031	< .01	0.004	0.003
UPF-1 (Crandall Creek)	23-Dec-2008	258	0.5	8.27	537	555	103.4	48.7	6.19	1.8	302	< 10.	218	2.51	0.031	< .01	0.002	0.001
UPF-1 (Crandall Creek)	24-Mar-2009	143	1	8.33	774	563	103.3	51.28	6.38	1.91	299	< 10.	205	2.88	0.021	< .01	0.001	0.001
UPF-1 (Crandall Creek)	24-Jun-2009	674	10.9	8.25	711	513	98.67	39.99	8.27	1.73	190	< 10.	240	2.43	0.048	0.03	0.002	< .001
UPF-1 (Crandall Creek)	10-Sep-2009	200	9.6	8.58	755	549	94.91	49.84	7.07	1.97	254	< 10.	236	3.46	0.016	< .01	0.003	0.002
UPF-1 (Crandall Creek)	3-Nov-2009	268	1.8	8.2	822	577	112.8	48.54	5.76	1.74	297	<10	247.5	4.19	0.012	< .01	0.002	0.002
UPF-1 (Crandall Creek)	25-Mar-2010	208	1	8.26	776	540	103.4	52.33	6.58	1.86	297	< 10.	192	3.34	< .01	< .01	0.001	0.001
UPF-1 (Crandall Creek)	24-Jun-2010	1227	11.8	8.66	800	527	96.1	39.57	9.46	1.69	245	< 10.	192.4	2.12	0.053	< .01	0.003	< .001
UPF-1 (Crandall Creek)	9-Sep-2010	305	7.8	8.43	786	549	98.53	50.13	7.01	1.96	263	< 5.	227	3	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	2-Dec-2010	234	1	8.2	848	595	104.16	50.48	6.68	1.78	302	< 5.	229	3	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	29-Mar-2011	276	0.9	8.33	802	593	104.89	54.8	6.71	1.97	243	< 5.	265	3	< .05	< .03	< .002	< .002
UPF-1 (Crandall Creek)	22-Jun-2011	8089	8.5	8.71	584	428	88.83	28.21	9.11	1.37	233	12	105	2	0.4	< .03	0.013	< .002
UPF-1 (Crandall Creek)	20-Sep-2011	539	8.2	8.46	824	576	100.21	49.33	7.39	1.95	224	< 5.	253	2	< .05	< .03	0.003	< .002
UPF-1 (Crandall Creek)	16-Nov-2011	433	0.8	8.57	867	609	104.56	50.98	7.28	1.74	250	< 5.	239	3	< .05	< .03	< .002	< .002
Blind Canyon Flume	12-Jan-1991		4.2	8.6	300													
Blind Canyon Flume	14-Jan-1991					293	58.2	40.7	4.6	0.2	325	<1	23.0	55.0	0.38	0.34	0.26	
Blind Canyon Flume	4-Apr-1991		0.9	8.5	200	257	52.3	21.0	1.3	1.6	207	<1	23.0	20.0	0.05	<0.02	<0.01	
Blind Canyon Flume	21-Jul-1991	368.0	10.5		600	253	56.6	26.9	11.9	2.2	279	<1	9.0	10.0	<0.02	0.06	0.17	
Blind Canyon Flume	11-Oct-1991	67.3	7.0	8.5	600	279	71.4	22.8	3.9	0.0	318	<1	10.0	15.0		0.11		
Blind Canyon Flume	8-Mar-1992	Frozen	0.0	7.4	400	315	85.4	25.9	3.1	0.0	312	0	22.0	20.0		0.00	0.05	
Blind Canyon Flume	18-Jun-1992	80.8	10.1	8.4	624	241	69.4	21.9	0.3	0.0	259	6	7.0	30.0		0.00	0.00	
Blind Canyon Flume	30-Sep-1992	0.0																
Blind Canyon Flume	16-Dec-1992	0.0																
Blind Canyon Flume	3-Jun-1993	1.0	4.5	8.4	300	234	52.5	19.3	1.8	<0.10	246	0	11.0	3.1	0.53	0.06	<0.03	
Blind Canyon Flume	1-Jul-1993	1.0	10.1	7.8	517	245	49.2	21.6	21.2	<0.10	257	0	18.0	3.6	1.35	0.06	<0.03	
Blind Canyon Flume	25-Oct-1993	0.0																
Blind Canyon Flume	15-Jul-1994	dry																
Blind Canyon Flume	6-Sep-1994	dry																
Blind Canyon Flume	16-May-1995	147.0	9.0	8.4	610	300	61.0	33.0	4.0	2.0	265	25	24.0	5.0	1.00	<0.01	<0.1	
Blind Canyon Flume	9-Aug-1995	0.0																
Blind Canyon Flume	28-Nov-1995	0.0																
Blind Canyon Flume	5-May-1997	0.0																
Blind Canyon Flume	15-Aug-1997	0.0																
Blind Canyon Flume	9-Oct-1997	0.0																
Blind Canyon Flume	8-Sep-1998			8.4	497	296	50.0	37.0	4.0	1.0	281	13	24.0	4.0	0.10	<0.01	<0.1	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Blind Canyon Flume	15-Sep-1999	26.0	10.0	8.1	580	450	54.1	61.2	10.2	2.0	378	9	56.0	11.0	0.04	<0.02	<0.01	
Blind Canyon Flume	4-Nov-1999	1.0	11.0	8.2	517	380	51.2	64.1	9.6	2.0	389	<1	55.0	11.0	0.06	<0.02	<0.01	
Blind Canyon Flume	20-Jun-2000	173	13.9	8.61	482	290	51	32	2	1	289	<5	29	2	0.1	<0.1	<0.1	<0.1
Blind Canyon Flume	14-Sep-2000	54	10.1	8.27	514	303	49	37	4	2	312	<5	25	3	0.1	<0.1	<0.1	<0.1
Blind Canyon Flume	8-Dec-2000	10	-0.4	8.4	511	337	56	38	4	1	356	<5	30	3	0.3	<0.1	<0.1	<0.1
Blind Canyon Flume	14-Mar-2001	50	0	8.3	500	337	54	40	5	1	354	<5	34	3	<0.1	<0.1	<0.1	<0.1
Blind Canyon Flume	2-May-2001	488	3.3	8.6	422	261	54	28	2	<1	267	11	21	2	0.4	<0.1	<0.1	<0.1
Blind Canyon Flume	9-Sep-2001	24.8	7.6	8.43	458	324	50	35	4	1	312	<5	28	3.2	<0.1	<0.1	<0.05	<0.05
Blind Canyon Flume	29-Oct-2001	39.9	3.4	8.54	511	347	55	38	4	1	332	<5	31.7	3.2	<0.1	<0.1	<0.05	<0.05
Blind Canyon Flume	21-Mar-2002	30	0.1	8.42	452	245	53	37	5	1	324	<5.	34	3	0.3	<0.1	<0.05	<0.05
Blind Canyon Flume	8-Jun-2002	95	17.6	8.24	445	262	46	32	5	1	278	<5.	30	2	0.2	<0.1	<0.05	<0.05
Blind Canyon Flume	27-Sep-2002	9.3	6.3	8.46	514	296	50	41	6	2	309	7	36	3	0.1	<0.1	<0.05	<0.05
Blind Canyon Flume	19-Nov-2002	17.4	0.0	8.19	510	315	59	40	4	1	348	<5	40	3	<0.1	<0.1	<0.05	<0.05
Blind Canyon Flume	23-Mar-2003	60	0.5	8.41	494	307	55.9	38.4	4.29	1.25	321	6	42	3	0.155	<0.005	0.008	<0.005
Blind Canyon Flume	13-Jun-2003	231	11.9	8.45	427	273	56.8	28.4	5.42	1.07	244	11	30	2	0.182	<0.005	0.012	0.012
Blind Canyon Flume	22-Sep-2003	18.8	7.0	8.14	492	339	58.7	42	3.89	1.99	327	6	35	3	0.15	<0.005	<0.005	<0.005
Blind Canyon Flume	9-Dec-2003	21.5	0.4	8.61	535	306	62.1	39.6	4.09	1.59	343	<5	42	3	0.116	<0.005	<0.005	<0.005
Blind Canyon Flume	31-Mar-2004	105	2.1	8.65	504	331	61.5	35.1	3.65	1.33	318	< 5.	41	3	0.129	< .03	0.012	< .002
Blind Canyon Flume	17-Jun-2004	280	9.2	8.62	425	231	53.6	26.1	2.43	1	207	< 5.	30	2	0.39	< .03	0.02	< .005
Blind Canyon Flume	20-Sep-2004	26.1	6	8.31	419	278	55.8	39.7	3.48	1.79	244	14	38	3	0.05	< .03	< .002	< .002
Blind Canyon Flume	6-Nov-2004	38.4	0.1	8.28	486	324	63.1	38.4	3.59	1.44			42	3	0.07	< .03	0.003	< .002
Blind Canyon Flume	28-Mar-2005	132	1.4	8.53	438	368	62.3	38.5	3.81	0.91	327	6	37	3	0.1	< .03	0.002	< .002
Blind Canyon Flume	31-May-2005	1930	10.7	8.29	366	245	63.5	22.1	2.26	0.7	237	16	18	2	0.59	< .03	0.018	0.003
Blind Canyon Flume	25-Aug-2005	80.4	13.6	8.39	465	273	50.3	35.1	3.53	1.45	274	13	34	2	0.16	< .03	0.008	< .002
Blind Canyon Flume	28-Dec-2005	32.7	0.5	8.42	567	287	62.8	38.5	4.13	1.43	343	8	34	4	< .05	< .03	0.003	0.002
Blind Canyon Flume	6-Mar-2006	62	0.5	8.49	551	323	63.9	40.7	4.91	1.48	337	< 5.	33	4	0.17	< .03	0.007	0.003
Blind Canyon Flume	25-Jun-2006	287	14.5	8.66	491	265	54.6	34.8	3.3	1.23	277	13.3	31	3	0.42	< .03	0.016	0.002
Blind Canyon Flume	22-Sep-2006	90	3.9	8.38	495	301	57.89	37.29	4.12	1.58	326	< 5.	32	4	0.1	< .03	0.004	0.003
Blind Canyon Flume	13-Nov-2006	80.4	0.1	8.59	516	316	60.89	39.46	4.5	1.18	333	< 5.	36	4	0.18	< .03	0.007	0.003
Blind Canyon Flume	15-Mar-2007	85.2	0.7	8.6	524	314	55.34	36.92	4.4	1.41	304	40	31.3	3.87	0.201	0.012	0.009	< .005
Blind Canyon Flume	18-Jun-2007	95	12.4	8.51	466	300	57.72	37.48	7.48	1.79	290	< 10.	52.1	3.43	0.242	< .01	0.017	< .001
Blind Canyon Flume	17-Sep-2007	9.68	9.3	8.51	492	300	48.15	42.49	5.16	1.94	311	< 10.	22.3	3.25	0.094	< .01	0.004	< .001
Blind Canyon Flume	5-Dec-2007	104	0.8	8.4	437	341	60.64	42.88	4.73	1.51	365	< 10.	34.8	3.41	0.106	< .01	0.007	0.003
Blind Canyon Flume	26-Mar-2008	163	0.9	8.35	457	354	63.07	41.89	6.84	1.51	329	< 10.	40.3	5.45	1.236	< .01	0.041	0.004
Blind Canyon Flume	29-May-2008	723	8.6	8.43	423	259	63.51	27.06	2.83	1.07	277	20	24.8	2.19	0.236	< .01	0.014	0.005
Blind Canyon Flume	4-Sep-2008	31.9	8.8	8.53	493	301	53.12	35.88	3.8	1.69	300	< 10.	30.5	2.91	0.107	< .01	0.006	0.003
Blind Canyon Flume	23-Dec-2008	46.5	0.1	8.42	402	332	64.27	38.91	4.5	1.41	349	< 10.	35.1	3.01	0.191	0.016	0.009	0.002

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Blind Canyon Flume	24-Mar-2009	89.7	0.7	8.71	544	331	63.39	39.53	4.52	1.36	329	< 10.	36.4	12.1	0.942	< .01	0.016	0.001
Blind Canyon Flume	24-Jun-2009	155	15	8.47	458	280	53.54	30.13	3.23	1.25	302	< 10.	32.6	2.09	0.0927	< .01	0.024	< .001
Blind Canyon Flume	9-Sep-2009	31.4	11.5	7.84	465	285	45.13	37.73	4.36	1.82	284	< 10.	28.2	2.94	0.113	< .01	0.005	< .001
Blind Canyon Flume	3-Nov-2009	38.4	0.5	8.61	542	343	65.98	40.24	4.08	1.46	341	17	38.4	3.32	0.212	< .01	0.006	< .001
Blind Canyon Flume	25-Mar-2010	42.2	0.7	8.41	574	331	67.57	42.11	5.05	1.38	334	< 10.	39.4	3.63	0.074	< .01	0.003	< .001
Blind Canyon Flume	24-Jun-2010	121	15.6	8.67	443	275	52.22	28.18	2.76	1.24	261	< 10.	30.9	1.59	0.313	< .01	0.016	< .001
Blind Canyon Flume	9-Sep-2010	24.8	7.9	8.51	488	271	46.49	40.09	4.33	1.83	296	< 5.	32	3	< .05	< .03	0.003	< .002
Blind Canyon Flume	16-Dec-2010	16.5	0.1	8.62	611	352	60.38	43.79	4.95	1.46	328	58	49	4	0.08	< .03	0.005	< .002
Blind Canyon Flume	29-Mar-2011	89	0.8	8.71	632	352	62.23	42.8	15.01	1.38	291	< 5.	42	20	0.07	< .03	0.006	< .002
Blind Canyon Flume	22-Jun-2011	1687	8.2	8.72	441	258	67.32	24.6	3.22	0.87	227	< 5.	21	2	0.19	< .03	0.021	0.004
Blind Canyon Flume	20-Sep-2011	80.4	6.8	8.6	539	315	54.28	37.97	5.05	1.42	260	6	35	3	< .05	< .03	0.005	0.003
Blind Canyon Flume	16-Nov-2011	62.4	0.2	8.76	602	332	64.67	42.68	5.1	1.3	291	6	39	3	< .05	< .03	0.004	< .002
Horse Canyon Creek	22-Nov-1994	6.0	-2.0	6.8		340	65.0	40.0	7.0	<5	290	0	50.0	8.0	2.00	<.2	<.2	
Horse Canyon Creek	16-May-1995	387.0	9.0	8.3	440	290	58.0	30.0	5.0	1.0	240	30	21.0	1.0	0.70	<0.1	<0.1	
Horse Canyon Creek	9-Aug-1995	72.0	10.0	8.1	765	280	50.0	33.0	7.0	1.0	274	17	25.0	6.0	0.20	<0.1	<0.1	
Horse Canyon Creek	28-Nov-1995	15.9	9.0	8.9	436	280	62.0	35.0	6.0	1.0	280	25	30.0	7.0	0.10	<0.1	<0.1	
Horse Canyon Creek	26-Mar-1996	280.0	1.0	7.9	340	128	57.0	35.0	6.0	1.1	350	<2	28.0	10.0	0.18	<.03		<.04
Horse Canyon Creek	13-Jun-1996					203	45.0	16.0	3.0	<1	212	12	<1	5.0	<.1	<0.1		<0.1
Horse Canyon Creek	12-Aug-1996	7.0	14.0	8.0	509	270	41.0	36.0	6.0	1.0	245	17	30.0	7.0	<.1	<0.1		<0.1
Horse Canyon Creek	24-Oct-1996	3.0	0.0	8.9	584	301	55.0	37.0	6.0	1.0	331	<5	16.0	7.0	<.1	<0.1		<0.1
Horse Canyon Creek	25-Mar-1997	12.6	3.0	8.6	789	410	59.1	41.2	6.1	1.5	344	<1	34.8	6.1	0.23	<0.2		0.02
Horse Canyon Creek	5-May-1997	64.0	5.0	8.7	608	284	57.1	30.4	4.3	1.0	279	4	21.6	3.9	0.21	<0.02		0.01
Horse Canyon Creek	20-Aug-1997	60.0	9.0	7.8	438	270	45.0	27.0	4.0	<1	<10	<5	17.0	<0.1	<0.1		<0.1	
Horse Canyon Creek	7-Oct-1997	179.5	7.0	8.0	473	260	63.0	30.0	4.0	<1	321	<5	16.0	5.0	0.20	<0.1	<0.1	
Horse Canyon Creek	8-Sep-1998			8.5	557	346	62.0	38.0	7.0	2.0	276	31	43.0	5.0	0.50	<0.1	<0.1	
Horse Canyon Creek	10-Jun-1999	337.0				229	57.0	22.0	3.0	<1	250	<5	13.0	2.0	0.2	<0.1	<0.1	
Horse Canyon Creek	15-Sep-1999	860.0	7.0	8.1	400	410	61.5	42.3	8.6	1.9	320	<1	58.0	8.0	0.11	<0.02	0.02	
Horse Canyon Creek	4-Nov-1999	352.0	10.0	8.3	502	400	55.4	46.4	8.4	2.2	353	<1	60.0	8.0	0.17	<0.02	0.01	
Horse Canyon Creek	20-Jun-2000	235	15.9	8.33	522	321	56	32	5	1	303	<5	43	3	0.1	<0.1	<0.1	<0.1
Horse Canyon Creek	14-Sep-2000	80	11.6	8.21	675	422	64	44	13	3	308	12	108	5	<0.1	<0.1	<0.1	<0.1
Horse Canyon Creek	8-Dec-2000	75	0	8.4	622	399	67	42	10	2	339	<5	96	4	0.2	<0.1	<0.1	<0.1
Horse Canyon Creek	14-Mar-2001	102	0.7	8.2	594	415	65	43	9	2	340	<5	88	5	<0.1	<0.1	<0.1	<0.1
Horse Canyon Creek	2-May-2001	970	3.2	8.5	372	238	49	22	2	<1	217	8	22	2	0.6	<0.1	<0.1	<0.1
Horse Canyon Creek	9-Sep-2001	68	10	8.42	674	527	75	49	15	3	330	<5	170	6.9	<0.1	<0.1	<0.05	<0.05
Horse Canyon Creek	29-Oct-2001	69.3	4.3	8.49	719	516	80	50	14	2	361	<5	150.8	5.7	0.1	<0.1	<0.05	<0.05
Horse Canyon Creek	21-Mar-2002	85.7	1.3	8.41	537	363	69	43	11	2	318	<5.	112	5	0.3	<0.1	<0.05	<0.05

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Horse Canyon Creek	8-Jun-2002	104	18.9	8.34	586	376	61	39	11	2	279	8	96	4	0.5	<0.1	<0.05	<0.05
Horse Canyon Creek	27-Sep-2002	47.2	7.7	8.44	727	481	75	52	17	3	318	10	155	6	0.1	<0.1	<0.05	<0.05
Horse Canyon Creek	19-Nov-2002	52.9	0.6	8.23	696	474	71	46	13	3	338	<5	145	5	<0.1	<0.1	<0.05	<0.05
Horse Canyon Creek	23-Mar-2003	145	2.2	8.45	539	343	58.9	36.4	8.06	1.61	257	6	78	4	0.219	0.005	0.013	<0.004
Horse Canyon Creek	13-Jun-2003	198	12.6	8.45	457	311	56.1	28.3	5.56	1.33	246	8	51	3	0.311	<0.005	0.022	<0.005
Horse Canyon Creek	22-Sep-2003	37.7	7.5	8.19	698	504	82.3	58.2	15	3.47	348	<5.	153	6	0.141	<0.005	0.006	<0.005
Horse Canyon Creek	9-Dec-2003	33	0.5	8.55	688	442	74.6	48	11.1	2.56	356	<5	121	5	0.039	<0.005	<0.005	<0.005
Horse Canyon Creek	31-Mar-2004	218	4.1	8.65	515	334	63.1	33.8	5.77	1.41	266	< 5.	56	4	0.21	< .03	0.014	< .005
Horse Canyon Creek	17-Jun-2004	183	9.3	8.53	457	260	54.4	28.1	5.12	1.36	212	< 5.	45	3	0.76	< .03	0.041	< .002
Horse Canyon Creek	20-Sep-2004	38.7	6.4	8.39	559	442	74.9	52.9	12.1	2.89	262	16	133	5	0.09	< .03	< .002	< .002
Horse Canyon Creek	6-Nov-2004	48	0.2	8.27	554	430	74.7	47.2	10.3	2.22			107	4	0.08	< .03	0.004	< .002
Horse Canyon Creek	28-Mar-2005	138	1.9	8.59	492	384	66.1	38.1	6.71	1.09	308	21	61	5	0.21	< .03	0.008	0.002
Horse Canyon Creek	31-May-2005	1860	10.4	8.31	314	184	51.7	17.9	2.58	0.57	207	5	11	2	1.39	< .03	0.042	0.008
Horse Canyon Creek	25-Aug-2005	61	13.9	8.47	576	351	60.1	43.2	10.3	2.21	293	13	91	5	0.37	< .03	0.016	< .002
Horse Canyon Creek	28-Dec-2005	31	1.3	8.45	633	358	71.4	42.5	9.34	2.09	330	14	80	5	0.17	< .03	0.01	0.002
Horse Canyon Creek	6-Mar-2006	99	1.4	8.58	602	365	70.2	42.6	8.71	1.8	322	15	67	5	0.11	< .03	0.007	0.004
Horse Canyon Creek	25-Jun-2006	337	13.8	8.69	501	302	57.3	34.9	4.9	1.16	287	< 5.	28	4	0.2	< .03	0.017	0.004
Horse Canyon Creek	22-Sep-2006	107	3.1	8.34	553	364	65.05	39.89	8.13	1.92	323	< 5.	63	5	0.08	< .03	0.006	0.004
Horse Canyon Creek	13-Nov-2006	109	0.2	8.56	551	357	69.07	41.8	7.54	1.38	324	< 5.	59	5	0.12	< .03	0.006	0.004
Horse Canyon Creek	15-Mar-2007	148	1	8.61	543	337	61.35	35.98	6.92	1.62	300	30	48.5	5.29	0.176	< .005	0.01	< .005
Horse Canyon Creek	18-Jun-2007	75.9	12.8	8.32	518	269	55.58	34.61	3.41	1.56	285	< 10.	29.3	2.02	0.571	< .01	0.021	< .001
Horse Canyon Creek	17-Sep-2007	37.1	7.5	8.58	702	476	76.02	56.83	0.98	2.89	341	< 10.	122	5.54	0.062	< .01	0.004	< .001
Horse Canyon Creek	5-Dec-2007	46	0.8	8.44	497	406	65.94	47.05	10.41	2.09	347	< 10.	102	4.7	0.081	< .01	0.009	0.005
Horse Canyon Creek	26-Mar-2008	212	1.6	8.35	485	363	60.69	40.88	7.49	1.4	317	17	62.3	6.3	0.31	< .01	0.02	0.004
Horse Canyon Creek	29-May-2008	1332	9.1	8.48	387	225	56.03	24.45	3.7	0.96	251	27	16.7	2.72	0.247	< .01	0.015	0.004
Horse Canyon Creek	4-Sep-2008	53.7	7.5	8.82	606	393	62.83	44.07	9	1.92	311	< 10.	76.6	4.46	0.094	< .01	0.008	0.004
Horse Canyon Creek	23-Dec-2008	50.4	0.4	8.35	617	387	69.94	41.34	8.62	1.78	340	< 10.	81.3	4.4	0.081	< .01	0.006	0.002
Horse Canyon Creek	24-Mar-2009	113	1.4	8.73	568	356	67.46	38.5	7.04	1.43	319	< 10.	56	4.4	0.068	< .01	0.004	0.001
Horse Canyon Creek	18-Jun-2009	287	10	8.5	455	273	58.25	26.24	4.5	1	262	20	28.7	3	0.216	< .01	0.015	0.003
Horse Canyon Creek	9-Sep-2009	26.7	10.9	8.17	636	417	63.23	50.73	13.37	2.84	294	17	120.8	5.66	0.103	< .01	0.006	< .001
Horse Canyon Creek	3-Nov-2009	47.5	0.6	8.63	632	429	76.33	44.74	8.78	1.94	341	<10	93.2	5.5	0.025	< .01	0.003	0.001
Horse Canyon Creek	25-Mar-2010	80.3	0.9	8.37	609	367	69.28	42.4	7.66	1.6	319	< 10.	73	4.91	0.04	< .01	0.003	0.001
Horse Canyon Creek	24-Jun-2010	92.3	16.4	8.67	419	295	55.66	30.06	5.72	1.44	263	27	46.9	2.79	0.248	< .01	0.016	< .001
Horse Canyon Creek	9-Sep-2010	19.5	8.6	8.34	703	441	70.65	53.31	12.91	2.91	321	< 5.	128	6	0.12	< .03	0.007	< .002
Horse Canyon Creek	16-Dec-2010	48.4	0.7	8.56	720	411	69.2	46.75	10.09	1.95	329	62	97	6	< .05	< .03	0.004	< .002
Horse Canyon Creek	29-Mar-2011	171	1.6	8.74	628	352	67.35	45.68	7.51	1.3	300	< 5.	58	7	< .05	< .03	0.004	< .002
Horse Canyon Creek	22-Jun-2011	2718	8.4	8.75	378	225	57.18	22.22	3.4	0.84	235	13	12	2	0.27	0.06	0.014	0.006

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Horse Canyon Creek	20-Sep-2011	101	5.7	8.58	584	338	58.39	39.71	8.18	1.47	267	12	49	4	0.08	< .03	0.007	0.003
Horse Canyon Creek	16-Nov-2011	116	0.2	8.73	633	358	67.95	40.96	7.31	1.3	298	< 5.	52	4	< .05	< .03	0.005	< .002
Indian Creek	26-Jun-1996					290	67.0	19.0	3.0	<1	302	9	5.0	2.0		<0.1	<0.1	
Indian Creek	16-Aug-1996	673.2	12.0	7.4	465	260	68.0	22.0	3.0	<1	293	9	4.0	4.0		<0.1	<0.1	
Indian Creek	24-Oct-1996	1570.8	3.0	8.4	724	262	67.0	22.0	3.0	1.0	334	<5	6.0	5.0		<0.1	<0.1	
Indian Creek	1-Jul-1997	4936.8	13.9	7.4	425	260	71.0	19.0	3.0	1.0	310		7.0	2.0		<0.1	<0.1	
Indian Creek	20-Aug-1997	4488.0	12.0	7.8	423	250	72.0	21.0	3.0	<1	<10	<5	5.0	2.0		<0.1	<0.1	
Indian Creek	10-Oct-1997	3927.0	7.0	8.3	483	240	74.0	21.0	3.0	<1	318	<5	6.0	4.0	<0.1	<0.1	<0.1	
Indian Creek	25-Jun-1998	1257.0				235	72.0	19.0	3.0	<1	307	<5	6.0	5.0	0.30	<0.1	<0.1	
Indian Creek	26-Sep-1998	1122.0				321	62.0	22.0	7.0	3.0	211	<5	78.0	<1	11.00	<0.1	<0.1	
Indian Creek	21-May-1999	1571.0	11.0	7.5	395													
Indian Creek	15-Sep-1999	1282.0	4.0	8.2	380	290	73.5	21.9	2.9	1.1	320	7	11.0	<1	0.2	<0.02	0.03	
Indian Creek	4-Nov-1999	708.0	10.0	8.4	380	270	57.2	23.0	2.6	0.9	299	<1	12.0	6.0	0.12	<0.02	<0.01	
Indian Creek	21-Jun-2000	1250	8	8.49	466	281	70	19	2	<1	318	<5	5	1	0.1	<0.1	<0.1	<0.1
Indian Creek	13-Sep-2000	634	13.8	8.01	390	238	60	20	3	<1	291	<5	7	2	0.1	<0.1	<0.1	<0.1
Indian Creek	17-Jun-2001	1184	14.4	8.35	459	256	66	19	3	<1	311	<5	6	1	0.1	<0.1	<0.1	<0.1
Indian Creek	9-Sep-2001	634	8.4	8.29	417	287	65	20	4	<1	326	<5	7	2.1	<0.1	<0.1	<0.05	<0.05
Indian Creek	28-Oct-2001	580	7.6	7.81	454	268	66	21	4	<1	315	<5	7.4	2	<0.1	<0.1	<0.05	<0.05
Indian Creek	6-Jun-2002	734	15	8.26	461	272	65	21	4	<1.	303	<5.	5	2	0.1	<0.1	<0.05	<0.05
Indian Creek	26-Sep-2002	321	12.9	8.23	431	249	60	21	4	<1.	287	<5.	7	1	<0.1	<0.1	<0.05	<0.05
Indian Creek	10-Oct-2002	247	8.2	8.43	457	256	70	21	4	<1	305	<5	9	2	<0.1	<0.1	<0.05	<0.05
Indian Creek	9-Jun-2003	1,130	7.7	8.08	388	286	78	19.6	4.66	0.515	313	6	14	1	0.095	<0.005	0.012	0.008
Indian Creek	21-Sep-2003	274	8.9	8.05	441	296	67.8	22	3.06	0.538	326	<5.	8	2	0.073	<0.005	0.009	0.006
Indian Creek	21-Oct-2003	263	9.4	7.98	478	288	69.5	22.1	2.79	0.741	318	<5	9	2	0.353	<0.005	0.02	<0.005
Indian Creek	14-Jun-2004	753	12	8.3	487	288	71.6	20.3	5.31	0.57	263	< 5.	14	2	0.11	< .03	0.012	0.006
Indian Creek	9-Sep-2004	327	11.5	8.26	435	253	68.6	21	3.59	0.73	250	< 5.	10	3	0.16	< .03	0.015	0.008
Indian Creek	17-Oct-2004	320	5.3	8.38	464	256	69.2	19.9	3.61	0.79			11	2	0.17	< .03	0.017	0.01
Indian Creek	19-Jun-2005	1800	12	8.26	435	332	77.5	20.1	6.14	0.71	316	< 5.	14	1	0.31	< .03	0.022	< .002
Indian Creek	25-Aug-2005	705	11.7	8.3	461	275	74.8	21.1	3.98	0.57	319	< 5.	9	2	0.14	< .03	0.016	0.008
Indian Creek	12-Oct-2005	570	6.4	8.25	420	293	70.8	20.9	3.92	0.76	317	< 5.	9	2	0.12	< .03	0.016	0.003
Indian Creek	20-Jun-2006	1460	12.7	8.39	462	297	74.8	20.1	4.75	0.56	302	< 5.	12	2	0.2	< .03	0.018	0.004
Indian Creek	21-Sep-2006	644	7.1	8.2	462	272	74.88	21.27	4.02	0.9	318	< 5.	9	3	0.12	0.04	0.012	0.008
Indian Creek	21-Oct-2006	705	5.4	8.47	457	276	75.78	21.12	3.79	0.89	304	16.7	9	3	0.13	< .03	0.014	0.009
Indian Creek	17-Jun-2007	584	10.1	8.43	449	241	72.51	20.92	2.99	0.56	321	< 10.	4.93	1.5	0.143	< .01	0.016	< .001
Indian Creek	9-Aug-2007	360	12.8	8.17	428	259	61.13	19.44	3.11	0.69	289	< 10.	6.91	1.7	0.112	< .01	0.01	< .001
Indian Creek	23-Oct-2007	419	8.6	8.18	409	279	68.67	21.1	3.58	0.94	302	< 10.	13.6	1.94	0.076	< .01	0.009	0.004

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Indian Creek	19-Jun-2008	1798	14	8.28	464	288	74.34	18.67	7.1	0.68	311	< 10.	13.3	1.48	0.11	< .01	0.011	0.007
Indian Creek	27-Aug-2008	445	12.6	8.34	437	276	62	20.4	3.52	0.64	289	< 10.	11.2	2.12	0.243	< .01	0.018	0.009
Indian Creek	9-Oct-2008	472	7.8	8.29	455	308	64.68	21.08	3.89	0.79	305	< 10.	10.9	1.89	0.051	< .01	0.006	0.001
Indian Creek	8-Jun-2009	1421	10.9	8.32	461	283	78.11	19.2	5.16	0.52	311	< 10.	11.5	1.6	0.099	< .01	0.01	0.003
Indian Creek	9-Sep-2009	406	12.5	7.79	449	260	64.39	21.56	4.19	0.87	289	< 10.	10.4	1.81	0.09	< .01	0.009	0.001
Indian Creek	8-Oct-2009	406	5.4	8.43	458	277	65.95	21.41	3.9	0.83	321	<10.	11.7	2.07	0.062	< .01	0.008	<.001
Indian Creek	24-Jun-2010	1404	11.2	8.2	468	293	73.56	19.64	4.3	0.56	319	< 10.	9.19	1.36	0.065	< .01	0.009	0.002
Indian Creek	8-Sep-2010	539	10.7	8.26	440	243	67.24	21.76	3.71	0.87	293	< 5.	11	2	0.09	< .03	0.006	0.005
Indian Creek	20-Oct-2010	503	9.7	8.35	464	267	63.04	19.99	4.2	0.87	297	< 5.	12	2	< .05	< .03	0.004	< .002
Indian Creek	21-Jul-2011	1993	14.7	8.3	476	296	81.14	21.34	6.12	0.6	274	< 5.	12	1	0.12	< .03	0.016	0.008
Indian Creek	4-Oct-2011	1184	8.5	8.3	521	316	79.17	22.59	5.11	1.63	269	6	10	3	0.09	< .03	0.01	0.007
IBC-1	31-May-2005	74.8	8.2	8.25	439	331	61	36.1	6.48	1.3	278	17	37	5	< .05	< .03	< .002	<0.002
IBC-1	25-Aug-2005	0.8	9.8	8.37	534	342	59.9	43.5	8.28	1.69	337	< 5.	59	7	< .05	< .03	< .002	<0.002
IBC-1	27-Dec-2005	0																
IBC-1	6-Mar-2006	0																
IBC-1	25-Jun-2006	33	9.9	8.37	544	349	59.6	44.5	7.27	1.62	302	36.7	45	6	< .05	< .03	< .002	< .002
IBC-1	22-Sep-2006	3.81	3.1	8.34	542	361	56.35	43.78	8.68	2.18	317	< 5.	58	7	0.07	< .03	0.003	< .002
IBC-1	13-Nov-2006	3.53	0.5	8.32	564	354	59.16	45.99	8.37	1.53	319	< 5.	67	6	0.14	< .03	0.003	< .002
IBC-1	15-Mar-2007	0																
IBC-1	18-Jun-2007	4.48	12.2	8.38	505	300	53.79	37.97	7.16	1.74	302	< 10.	44	1.87	0.029	< .01	0.001	< .001
IBC-1	18-Sep-2007	0																
IBC-1	4-Dec-2007	1.25	0.7	8.03	471	371	58.93	47.69	9.01	1.53	323	< 10.	91.4	5.71	0.107	< .01	0.008	< .001
IBC-1	26-Mar-2008	0																
IBC-1	29-May-2008	60.5	2.3	8.39	357	241	48.31	28.68	5.37	1.17	244	< 10.	30.1	3.13	0.037	< .01	0.001	< .001
IBC-1	4-Sep-2008	0																
IBC-1	23-Dec-2008	0																
IBC-1	24-Mar-2009	0																
IBC-1	24-Jun-2009	5.56	9.9	8.38	495	307	54.14	34.68	6.81	1.57	278	< 10.	45.6	3.34	0.011	< .01	< .001	< .001
IBC-1	10-Sep-2009	0																
IBC-1	3-Nov-2009	0																
IBC-1	24-Jun-2010	4.59	7.7	8.48	531	341	56.01	36.99	6.9	1.53	304	< 10.	56.3	3.11	0.037	< .01	0.001	< .001
IBC-1	9-Sep-2010	0																
IBC-1	2-Dec-2010	0																
IBC-1	22-Jun-2011	30	8.9	8.67	502	314	63.37	36.01	7.39	1.42	250	8	38	5	< .05	< .03	< .002	< .002
IBC-1	20-Sep-2011	2.07	7.8	8.3	607	364	60.98	43.4	9.28	1.86	270	< 5.	59	7	< .05	< .03	< .002	< .002
IBC-1	16-Nov-2011	3.43	0.7	8.58	632	395	63.62	47.23	9.78	1.67	276	< 5.	69	6	< .05	< .03	< .002	< .002

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Little Bear Creek	21-Jun-2005	20																
Little Bear Creek	27-Jul-2005	6.98	13.3	8.52	507	326	61.8	44.5	8.98	2.25	322	<5	53	7	0.17	<0.03	0.018	<0.002
Little Bear Creek	5-Sep-2005	6.98	10.5	8.44	551	370	58.6	40.9	7.83	3.96	317	25	54	11	0.22	< .03	0.009	<0.002
Little Bear Creek	28-Dec-2005	0																
Little Bear Creek	6-Mar-2006	0																
Little Bear Creek	24-Jun-2006	27.1	12.5	8.48	604	358	61.5	46.6	7.79	1.92	321	28.3	59	7	0.24	< .03	0.012	< .002
Little Bear Creek	21-Sep-2006	12	6.8	8.54	565	363	62.86	42.18	8.4	2.07	349	< 5.	46	7	< .05	< .03	< .002	< .002
Little Bear Creek	13-Nov-2006	4.92	1.3	8.45	605	387	66.98	45.24	8.27	1.73	356	20	53	8	0.22	< .03	0.008	< .002
Little Bear Creek	15-Mar-2007	11.2	2.5	8.58	598	373	66.45	42.55	8	1.81	326	37	59.3	9.35	0.456	< .005	0.025	< .005
Little Bear Creek	19-Jun-2007	2.56	14.3	8.65	554	320	52.19	41.6	8	2	313	< 10.	46.6	6.24	0.198	< .01	0.011	< .001
Little Bear Creek	18-Sep-2007	3.73	9.6	8.68	541	338	56.28	44.89	9.29	1.92	311	< 10.	46.3	7.01	0.042	< .01	0.002	0.001
Little Bear Creek	5-Dec-2007	0																
Little Bear Creek	26-Mar-2008	0																
Little Bear Creek	25-Jul-2008	11.2	13.6	8.46	543	331	55.75	37.95	7.7	1.9	388	< 10.	44.8	6.78	3.513	< .01	0.15	< .001
Little Bear Creek	3-Sep-2008	2.88	9.7	8.44	542	353	56.6	40.2	7.49	1.86	312	< 10.	50.7	7.39	0.135	< .01	0.006	< .001
Little Bear Creek	20-Oct-2008	0.04	6.6	8.4	564	374	59.11	41.86	8.47	2.27	328	< 10.	48.6	6.72	0.371	< .01	0.016	< .001
Little Bear Creek	24-Mar-2009	0																
Little Bear Creek	24-Jun-2009	0																
Little Bear Creek	3-Sep-2009	0																
Little Bear Creek	3-Nov-2009	0																
Little Bear Creek	23-Jun-2010	0																
Little Bear Creek	26-Aug-2010	0																
Little Bear Creek	13-Oct-2010	0																
Little Bear Creek	30-Aug-2011	4.46	14	8.65	607	359	60.46	42.8	8.75	2.01	258	29	56	7	0.15	< .03	0.009	< .002
Little Bear Creek	25-Oct-2011	5.5	6.5	8.54	644	399	68.52	48.91	9.31	2.06	295	< 5.	57	7	< .05	< .03	0.004	< .002
Section 4 Creek	21-Jun-2005	0																
Section 4 Creek	27-Jul-2005	1.03	11.4	8.31	876	576	77.9	75.3	15.6	4.31	447	4	151	15	0.28	<0.03	0.03	<0.002
Section 4 Creek	5-Sep-2005	2.46	9.5	8.3	773	580	75.3	76	3.95	3.95	447	< 5.	132	11	0.24	< .03	0.033	<0.002
Section 4 Creek	28-Dec-2005	5.67	1.3	8.44	815	497	70.1	69.5	13.5	3.67	389	24	133	12	0.79	< .03	0.084	<0.002
Section 4 Creek	6-Mar-2006	6.15	1.5	8.44	798	531	71.8	69.7	14.1	3.59	393	< 5.	134	12	0.64	< .03	0.074	< .002
Section 4 Creek	27-Jun-2006	3.57	10.5	8.42	825	509	72.8	73.2	13.6	3.69	391	< 5.	144	14	0.66	< .03	0.059	0.002
Section 4 Creek	22-Sep-2006	6.73	5.5	8.26	801	533	74	70.9	14.3	4.2	417	< 5.	132	12	0.6	< .03	0.079	0.002
Section 4 Creek	13-Nov-2006	6.48	2.2	8.27	826	564	78.02	73.78	14.96	3.53	417	15	146	14	0.15	< .03	0.014	< .002
Section 4 Creek	15-Mar-2007	7.48	1.6	8.43	780	521	66.82	63.21	13.46	3.43	361	53	147	15.4	1.381	< .005	0.15	< .005
Section 4 Creek	19-Jun-2007	0.88	10.7	8.52	829	539	77.4	71.85	14.62	4.26	433	< 10.	92.9	11.5	0.316	< .01	0.033	< .001

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Section 4 Creek	18-Sep-2007	1.73	9.3	8.57	792	529	70.96	73.71	15	3.66	404	33	110	11.9	0.257	< .01	0.029	< .001
Section 4 Creek	5-Dec-2007	4.69	1.5	8.49	636	529	64.77	70.2	13.98	3.38	406	< 10.	142	10.9	0.449	0.019	0.056	0.001
Section 4 Creek	26-Mar-2008	9.1	1.8	8.36	712	567	73.57	68.85	14.64	3.7	382	< 10.	153	11.7	0.245	< .01	0.032	0.001
Section 4 Creek	25-Jul-2008	3.85	12	8.36	801	530	71.14	66.74	15.07	3.86	405	< 10.	127	12.4	0.496	< .01	0.061	0.001
Section 4 Creek	4-Sep-2008	1.94	8.7	8.46	804	561	68.17	68.62	13.73	3.75	413	< 10.	116	10.8	0.309	< .01	0.042	0.002
Section 4 Creek	23-Dec-2008	5.83	0.8	8.45	771	524	71.4	66.77	14.23	3.33	404	< 10.	141	10.7	0.753	< .01	0.106	< .001
Section 4 Creek	24-Mar-2009	6.81	1.8	8.59	812	541	74.1	70.42	15.12	3.52	402	< 10.	140	10.7	0.141	< .01	0.021	< .001
Section 4 Creek	24-Jun-2009	2.78	10.6	8.35	791	527	71.76	64.88	13.71	3.66	435	< 10.	124	12	0.669	< .01	0.095	< .001
Section 4 Creek	9-Sep-2009	1.18	10.8	7.79	778	511	69.02	69.38	14.58	3.92	396	17	123.4	10.86	0.53	0.041	0.081	0.002
Section 4 Creek	3-Nov-2009	4.97	3.6	8.49	819	563	80.21	69.36	12.68	3.37	422	<10	143.6	11.76	0.091	< .01	0.012	< .001
Section 4 Creek	25-Mar-2010	6.25	1.8	8.54	814	544	73.41	70.72	14.61	3.38	388	27	144.4	10.84	0.283	< .01	0.039	< .001
Section 4 Creek	24-Jun-2010	1.34	10.5	8.33	814	524	69.32	67.01	13.96	3.61	397	20	134	10.7	2.229	< .01	0.297	< .001
Section 4 Creek	10-Sep-2010	2.71	7.9	8.26	822	504	70.87	69.92	13.67	3.57	415	< 5.	121	12	0.51	< .03	0.071	0.004
Section 4 Creek	2-Dec-2010	4.84	0.7	8.27	899	566	75.71	72.47	15.1	3.23	418	25	144	13	0.18	< .03	0.03	< .002
Section 4 Creek	30-Aug-2011	2.29	12.2	8.57	847	516	69.05	67.34	15.03	3.96	323	20	129	12	0.54	< .03	0.077	0.002
Section 4 Creek	16-Nov-2011	6.53	1.4	8.65	912	573	76	75.22	16.46	3.46	350	< 5.	140	12	0.2	< .03	0.04	< .002
Section 5 Creek	21-Jun-2005	19.8	17.4	8.48	501	320	50.8	41.3	7.61	1.63	254	23	51	5	< .05	< .03	< .002	<0.002
Section 5 Creek	25-Aug-2005	1.53	11.7	8.79	455	252	43.5	39.8	7.12	1.48	276	< 5.	53	5	< .05	< .03	0.003	0.002
Section 5 Creek	2-Nov-2005	8.93	0.7	8.07	378	261	40.1	36	6.58	1.39	254	< 5.	47	5	< .05	< .03	< .002	<0.002
Section 5 Creek	27-Jun-2006	10.6	16.8	8.63	517	318	47.9	45.9	7.72	1.53	285	13.3	50	7	< .05	< .03	< .002	< .002
Section 5 Creek	22-Sep-2006	9	4.3	8.25	452	282	43.65	36.72	6.38	1.44	261	< 5.	45	5	< .05	< .03	< .002	< .002
Section 5 Creek	5-Nov-2006	7.14	0	8.37	504	308	49.29	43.11	7.147	1.28	283	< 5.	55	6	0.08	< .03	0.003	< .002
Section 5 Creek	18-Jun-2007	0.67	11.1	8.38	516	314	49.42	44.37	8.13	1.82	291	< 10.	53.7	5.31	0.027	0.011	0.004	0.001
Section 5 Creek	18-Sep-2007	0.35	11.4	8.55	521	329	44.76	47.33	10.52	1.72	285	17	57.8	6.77	0.094	< .01	0.005	0.002
Section 5 Creek	4-Dec-2007	1.15	0.5	8.44	617	547	71.62	75.15	12.7	2.7	419	40	105	11.1	0.012	< .01	0.005	0.005
Section 5 Creek	3-Jun-2008	49.9	8.5	8.26	353	258	46.45	27.96	4.71	1.16	223	17	28.1	3.58	0.017	< .01	0.001	< .001
Section 5 Creek	4-Sep-2008	0																
Section 5 Creek	22-Oct-2008	0.71	0.6	8.41	586	399	53.1	49.39	9.14	1.73	328	< 10.	73.8	7.33	0.017	< .01	0.002	0.002
Section 5 Creek	18-Jun-2009	5.81	9	8.44	485	303	50.65	34.91	6.91	1.47	257	< 10.	51.1	4.91	0.01	< .01	0.001	0.001
Section 5 Creek	10-Sep-2009	0																
Section 5 Creek	3-Nov-2009	0.67	0.6	8.42	633	408	60.7	48.62	8.67	1.51	330	<10.	89.5	8.35	0.011	< .01	0.001	<.001
Section 5 Creek	24-Jun-2010	0.16	11.6	8.6	547	336	52.19	42.47	9.14	1.59	310	< 10.	66.4	5.29	0.106	< .01	0.03	0.001
Section 5 Creek	10-Sep-2010	0																
Section 5 Creek	18-Nov-2010	1.4	0.9	8.33	605	371	56.54	46.63	7.92	1.42	306	< 5.	81	7	< .05	< .03	< .002	< .002
Section 5 Creek	22-Jun-2011	63.4	15.9	8.7	512	360	56.55	39.02	7.05	1.4	238	11	44	5	< .05	< .03	< .002	< .002
Section 5 Creek	20-Sep-2011	4.29	8.4	8.59	569	356	51.18	45.07	8.21	1.92	257	< 5.	55	6	< .05	< .03	0.003	< .002

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Section 5 Creek	26-Oct-2011	5.14	0.7	8.66	580	326	53.48	46.19	7.76	1.52	257	< 5.	59	6	< .05	< .03	< .002	< .002
Section 5 Creek U. L. Fork	21-Jun-2005	13.4	11	8.25	437													
Section 5 Creek U. L. Fork	25-Aug-2005	2.12	10	8.68	396													
Section 5 Creek U. L. Fork	2-Nov-2005	3.73	1.4	8.55	379													
Section 5 Creek U. L. Fork	27-Jun-2006	6.17	10.3	8.54	447													
Section 5 Creek U. L. Fork	23-Sep-2006	3.06	3.1	8.39	518													
Section 5 Creek U. L. Fork	9-Nov-2006	2.7	0	8.13	450													
Section 5 Creek U. L. Fork	18-Jun-2007	1.2	8.8	8.2	429													
Section 5 Creek U. L. Fork	18-Sep-2007	1.06	6.5	8.27	427													
Section 5 Creek U. L. Fork	4-Dec-2007	1.15	0.6	8.27	410													
Section 5 Creek U. L. Fork	3-Jun-2008	24.3	3.1	8.13	302													
Section 5 Creek U. L. Fork	4-Sep-2008	0.94	7.2	8.42	429													
Section 5 Creek U. L. Fork	22-Oct-2008	1.29	0.4	8.49	453													
Section 5 Creek U. L. Fork	18-Jun-2009	3.2	8	8.32	439													
Section 5 Creek U. L. Fork	10-Sep-2009	0.24	9.9	8.25	454													
Section 5 Creek U. L. Fork	13-Oct-2009	1.64	3.8	8.58	459													
Section 5 Creek U. L. Fork	24-Jun-2010	0.73	8.4	8.56	484													
Section 5 Creek U. L. Fork	11-Sep-2010	0.36	5.2	8.55	469													
Section 5 Creek U. L. Fork	18-Nov-2010	0.612	1.2	8.41	499													
Section 5 Creek U. L. Fork	26-Jun-2011	26.1	9	8.63	457													
Section 5 Creek U. L. Fork	20-Sep-2011	2.52	6.9	8.52	488													
Section 5 Creek U. L. Fork	26-Oct-2011	2.88	1.3	8.59	484													
Section 5 Creek U. R. Fork	21-Jun-2005	5.04	16.6	8.27	567													
Section 5 Creek U. R. Fork	25-Aug-2005	0.55	11.2	8.66	494													
Section 5 Creek U. R. Fork	2-Nov-2005	2.4	0.2	8.54	428													
Section 5 Creek U. R. Fork	27-Jun-2006	2.4	15.5	8.52	555													
Section 5 Creek U. R. Fork	23-Sep-2006	4.08	2.6	8.52	416													
Section 5 Creek U. R. Fork	5-Nov-2006	1.7	0.2	8.04	538													
Section 5 Creek U. R. Fork	18-Jun-2007	0.72	9.5	8.25	567													
Section 5 Creek U. R. Fork	18-Sep-2007	0.29	8.5	8.1	573													
Section 5 Creek U. R. Fork	4-Dec-2007	0.041	0.5	8.36	534													
Section 5 Creek U. R. Fork	3-Jun-2008	20	4.1	8.18	374													
Section 5 Creek U. R. Fork	4-Sep-2008	0.083	11.1	8.49	578													
Section 5 Creek U. R. Fork	22-Oct-2008	0.27	0	8.47	582													
Section 5 Creek U. R. Fork	18-Jun-2009	2.43	8.6	8.43	540													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		μS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Section 5 Creek U. R. Fork	10-Sep-2009	0																
Section 5 Creek U. R. Fork	13-Oct-2009	1.12	3.7	8.59	571													
Section 5 Creek U. R. Fork	24-Jun-2010	0.45	10.3	8.65	569													
Section 5 Creek U. R. Fork	11-Sep-2010	0																
Section 5 Creek U. R. Fork	18-Nov-2010	0.811	0.9	8.25	601													
Section 5 Creek U. R. Fork	26-Jun-2011	10.9	12.1	8.6	551													
Section 5 Creek U. R. Fork	20-Sep-2011	1.64	7.7	8.5	574													
Section 5 Creek U. R. Fork	26-Oct-2011	2.07	0.2	8.62	590													
Shingle Creek	20-Jun-2005	20.2	12.1	8.06	609													
Shingle Creek	23-Sep-2005	6.33	8.2	8.23	703													
Shingle Creek	25-Oct-2005	12.7	3.4	8.18	663													
Shingle Creek	25-Jun-2006	11	17.1	8.54	705													
Shingle Creek	23-Sep-2006	4.51	4.7	8.39	701													
Shingle Creek	5-Nov-2006	5.77	0.8	8.32	703													
Shingle Creek	23-Jun-2007	0																
Shingle Creek	17-Sep-2007	0																
Shingle Creek	26-Oct-2007	0.73	2.3	8.21	672													
Shingle Creek	29-May-2008	35.9	8.7	8.36	602													
Shingle Creek	28-Aug-2008	0																
Shingle Creek	16-Oct-2008	1.56	1.4	8.43	794													
Shingle Creek	3-Jun-2009	6.49	10.6	8.31	721													
Shingle Creek	2-Sep-2009	0																
Shingle Creek	8-Oct-2009	0.685	2.8	8.45	1028													
Shingle Creek	19-Jun-2010	0.71	16.4	8.58	921													
Shingle Creek	8-Sep-2010	0																
Shingle Creek	18-Oct-2010	0.439	4.6	7.96	951													
Shingle Creek	24-Jun-2011	61	12.2	8.49	760													
Shingle Creek	14-Sep-2011	4.78	9.3	8.49	848													
Shingle Creek	14-Oct-2011	8.43	4.8	8.52	846													
Springs																		
SP1-33	7-Nov-1995	1.8	9.0	7.5	479	330	71.0	23.0	5.0	1.0	335	<5	17.0	6.0	0.30	<0.1	<0.1	
SP1-33	21-Jun-1996					298	70.0	23.0	5.0	<1	321	<5	14.0	4.0		<0.1		<0.1
SP1-33	16-Aug-1996	0.5	7.0	7.8	480	295	72.0	23.0	4.0	1.0	316	<5	17.0	7.0		<0.1		<0.1
SP1-33	24-Oct-1996	1.0	5.0	8.1	733													
SP1-33	20-Aug-1997	3.0	7.0	8.2	502	290		22.0	5.0	<1	321	<5	17.0	3.0		<0.1		<0.1

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-33	10-Oct-1997	3.0	6.0	8.3	501	290	82.0	24.0	5.0	1.0	315	<5	18.0	5.0	3.60	<0.1	0.10	
SP1-33	25-Jun-1998			8.7	463	255	70.0	23.0	5.0	<1								
SP1-33	21-May-1999			8.1		215	68.0	17.0	5.0	2.0	245	<5	2.0	<1	0.5	<0.1	<0.1	
SP1-33	15-Sep-1999	1.2	4.0	7.6	550	350	85.8	25.1		2.3	366	<1	11.0	7.0	0.61	<0.02	0.09	
SP1-33	4-Nov-1999	1.5	13.0	7.5	395	290	65.7	24.4	3.9	1.1	329	<1	21.0	7.0	0.39	<0.02	<0.01	
SP1-33	23-Jun-2000	2.9	4.3	7.76	504	280	70	22	4	<1	318	<5	16	2	1.8	<0.1	<0.1	0.1
SP1-33	13-Sep-2000	2.47	5.5	7.92	492	267	66	22	5	1	311	<5	19	3	<0.1	<0.1	<0.1	<0.1
SP1-33	17-Jun-2001	3.19	5.4	7.42	474	269	67	22	5	<1	318	<5	20	2	0.1	<0.1	<0.1	<0.1
SP1-33	9-Sep-2001	3.08	6.4	7.58	445	324	68	22	5	<1	321	<5	20	2.9	<0.1	<0.1	<0.05	<0.05
SP1-33	28-Oct-2001	2.31	6.4	6.88	483	284	68	23	5	1	319	<5	20	2.3	0.2	<0.1	<0.05	<0.05
SP1-33	6-Jun-2002	1.63	5.4	7.43	488	302	68	23	6	<1.	314	<5.	19	3	0.2	<0.1	<0.05	<0.05
SP1-33	26-Sep-2002	1.29	5.9	7.79	468	272	66	22	6	<1.	309	<5.	17	2	<0.1	<0.1	<0.05	<0.05
SP1-33	10-Oct-2002	1.40	5.7	7.83	473	258	70	23	5	1	309	<5	17	2	<0.1	<0.1	<0.05	<0.05
SP1-33	9-Jun-2003	1.90	4.3	7.71	336	288	71.9	22.4	4.03	0.979	316	<5.	17	2	0.052	<0.005	<0.005	<0.005
SP1-33	21-Sep-2003	2.38	5.4	7.38	491	325	73.6	24	4.51	0.909	325	<5.	29	2	0.167	0.02	0.006	0.006
SP1-33	22-Oct-2003	2.22	5.7	7.87	518	308	74.9	24	4.19	1.09	320	<5	28	2	0.359	<0.005	0.011	<0.005
SP1-33	14-Jun-2004	2.51	4.6	7.57	505	281	73.7	23.2	4.18	1	267	< 5.	20	2	0.42	< .03	0.018	< .005
SP1-33	17-Sep-2004	2.78	5.5	7.94	461	290	76.9	24.2	4.3	1.08	265	< 5.	20	2	< .05	< .03	< .005	< .002
SP1-33	17-Oct-2004	2.9	2.7	8.34	437	287	72.7	22.6	4.49	1.08			23	2	0.19	< .03	0.01	0.004
SP1-33	19-Jun-2005	5.04	4.6	7.63	469	354	75.4	24.6	9.84	1.07	312	< 5.	34	2	< .05	< .03	0.004	0.002
SP1-33	25-Aug-2005	3.29	5.4	7.65	448	312	73.2	22.4	4.76	0.93	315	< 5.	24	2	0.2	< .03	0.009	0.005
SP1-33	12-Oct-2005	2.99	5.3	7.85	444	307	74	23.3	4.82	1.08	306	< 5.	25	2	< .05	< .03	0.003	0.002
SP1-33	20-Jun-2006	3.33	4.4	7.59	483	311	74.5	23.5	4.23	0.98	297	< 5.	26	3	0.09	< .03	0.005	< .002
SP1-33	21-Sep-2006	3	5.2	7.51	494	299	76.07	23.4	5.183	1.14	316	< 5.	28	3	0.05	< .03	0.003	0.003
SP1-33	21-Oct-2006	3.02	5.1	7.35	491	291	77	24.47	5.79	1.24	315	< 5.	28	3	0.08	< .03	0.004	0.002
SP1-33	17-Jun-2007	1.66	4	7.81	499	285	73.53	23.87	4.67	1.05	311	< 10.	30.5	1.83	0.078	< .01	0.002	< .001
SP1-33	9-Aug-2007	1.88	5.1	7.59	514	320	73.38	22.3	4.59	1.05	311	< 10.	32.1	2	0.017	< .01	0.002	0.002
SP1-33	23-Oct-2007	2.6	5.2	7	454	341	82.96	24.72	7.03	1.99	317	< 10.	47.3	2.21	0.131	< .01	0.008	0.002
SP1-33	19-Jun-2008	3.5	5.5	7.42	458	315	77.37	23.24	5.05	1.09	311	< 10.	31.7	1.99	0.135	< .01	0.008	0.002
SP1-33	27-Aug-2008	2.77	5.4	7.52	503	312	69.33	22.55	4.62	1	304	< 10.	34.8	2.44	0.098	< .01	0.005	< .001
SP1-33	9-Oct-2008	2.68	6	7	502	345	75.28	23.74	5.47	1.12	311	< 10.	32	1.87	0.049	< .01	0.003	0.001
SP1-33	8-Jun-2009	3.33	4.6	7.49	494	307	78.26	23.69	5.85	1	302	< 10.	34.8	2.08	0.057	< .01	0.003	0.001
SP1-33	9-Sep-2009	2.34	5.5	7.46	517	311	74.81	24.19	5.69	1.13	302	< 10.	38.9	1.88	0.059	< .01	0.007	0.003
SP1-33	7-Oct-2009	2.44	5.7	7.43	514	309	78.44	25.49	6.11	1.22	319	<10	39.8	2.35	0.093	< .01	0.006	0.003
SP1-33	25-Jun-2010	3.01	4.9	7.56	556	315	78.78	24.1	5.99	1.06	318	< 10.	43.1	1.65	0.062	< .01	0.005	0.001
SP1-33	8-Sep-2010	2.26	5.4	7.35	531	319	79.23	25.13	6.13	1.14	312	< 5.	43	2	< .05	< .03	0.003	0.003
SP1-33	20-Oct-2010	2.1	5.9	7.4	539	320	75.11	22.87	6.75	1.2	316	< 5.	44	2	0.3	< .03	0.011	< .002

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-33	21-Jul-2011	3.66	5	7.57	516	332	79.1	24.96	6.13	1.12	245	< 5.	44	2	0.15	< .03	0.009	< .002
SP1-33	4-Oct-2011	3.07	5.8	7.61	567	335	79.91	25.54	7.52	1.26	268	< 5.	44	2	< .05	< .03	0.003	< .002
SP1-47	23-Jul-1990	no flow																
SP1-47	19-Aug-1990	no flow																
SP1-47	26-Sep-1990	no flow																
SP1-47	18-Jun-1991	no flow																
SP1-47	12-Jun-1992					262	91.9	21.2	2.3	1.0	332	0	9.5	3.5		0.50	0.03	
SP1-47	21-Jun-1996					272	69.0	19.0	3.0	<1	307	<5	4.0	3.0	0.80	<0.1	<0.1	
SP1-47	24-Oct-1996	1.0	3.0	8.1	571	283	70.0	21.0	3.0	1.0	330	<5	4.0	5.0	1.40	<0.1	<0.1	
SP1-47	30-Jun-1997	3.0	18.0	7.1	427	290	76.0	17.0	2.0	1.0	310	<5	7.0	1.0	0.10	<0.1	<0.1	
SP1-47	20-Aug-1997	4.0	8.0	7.2	488	270	77.0	20.0	3.0	2.0	334	<5	17.0	5.0	0.30	<0.1	<0.1	
SP1-47	10-Oct-1997	3.0	9.0	8.3	509													
SP1-47	25-Jun-1998			7.7	473	256	75.0	18.0	3.0	<1	340	<5	6.0	4.0	0.60	<0.1	<0.1	
SP1-47	8-Sep-1998			8.2	532	330	79.0	24.0	3.0	4.0	330	<5	3.0	6.0	0.30	<0.1	<0.1	
SP1-47	15-Sep-1999	2.1	5.0	7.8	490	350	89.0	19.3	2.9	0.9	343	<1	9.0	6.0	0.89	<0.02	<0.1	
SP1-47	4-Nov-1999	1.8	12.0	8.2	372	270	76.4	21.1	2.0	0.8	306	<1	13.0	6.0	1.12	<0.02	0.04	
SP1-47	21-Jun-2000	3.68	25.3	8.08	384													
SP1-47	13-Sep-2000	7.32	15.4	8.16	445													
SP1-47	17-Jun-2001	4.05	20.4	8.38	385													
SP1-47	9-Sep-2001	6.38	15.9	8.21	378													
SP1-47	28-Oct-2001	9.02	12.3	8.29	443													
SP1-47	6-Jun-2002	3.93	24.9	8.13	378													
SP1-47	25-Sep-2002	4.71	11.8	8.29	420													
SP1-47	10-Oct-2002	6.82	10.6	8.59	369													
SP1-47	9-Jun-2003	2.61	17.9	8.23	394													
SP1-47	21-Sep-2003	3.87	15.6	7.85	425													
SP1-47	21-Oct-2003	4.54	13.1	7.90	471													
SP1-47	14-Jun-2004	3.7	3.2	7.94	357													
SP1-47	17-Sep-2004	3.9	19.3	8.12	449													
SP1-47	17-Oct-2004	10.3	2.7	8.34	437													
SP1-47	19-Jun-2005	7	16.8	8.25	459													
SP1-47	25-Aug-2005	12	16.1	8.33	447													
SP1-47	12-Oct-2005	11.9	8.3	8.25	443													
SP1-47	20-Jun-2006	7.7	19.1	8.28	463													
SP1-47	21-Sep-2006	16	7.1	8.19	481													
SP1-47	21-Nov-2006	80.7	6.8	7.99	428													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-47	17-Jun-2007	2.88	13.3	8.44	444													
SP1-47	9-Aug-2007	5.86	19.4	8.13	442													
SP1-47	23-Oct-2007	26.5	11.3	7.97	403													
SP1-47	19-Jun-2008	5.14	26.8	8.19	442													
SP1-47	27-Aug-2008	3.97	22.8	8.15	410													
SP1-47	9-Oct-2008	9.64	9.6	8.19	455													
SP1-47	8-Jun-2009	10.1	17	8.18	453													
SP1-47	9-Sep-2009	6.3	17.2	8.14	436													
SP1-47	8-Oct-2009	9.93	8.7	8.29	472													
SP1-47	25-Jun-2010	5.81	13.5	8.14	488													
SP1-47	8-Sep-2010	5.21	15.1	8.04	423													
SP1-47	19-Oct-2010	7.58	15.7	8.16	453													
SP1-47	21-Jul-2011	11	25.6	8.18	455													
SP1-47	4-Oct-2011	28	8.9	8.25	562													
SP2-24	10-Oct-1991	0.4	6.0	8.3	500	227	65.1	13.6	2.1	0.0	248	<1	5.0	10.0		0.06		
SP2-24	18-Jun-1992	2.0	5.4	7.7	265	186	63.0	6.0	1.0	0.0	190	0	5.0	20.0		0.02	0.06	
SP2-24	29-Sep-1992	0.5	7.8	7.9	300	208	94.5	20.4	0.5	0.0	204	0	80.0	20.0		0.00	0.10	
SP2-24	3-Jun-1993	8.0	2.0	8.0	200	184	37.9	86.0	0.3	3.7	272	0	4.0	3.1	0.29	<0.05	<0.03	
SP2-24	1-Jul-1993	7.8	12.0	7.8	200	186	41.1	9.9	1.4	6.7	158	0	4.0	3.6	<0.05	0.17	<0.03	
SP2-24	25-Oct-1993	1.5	6.0	7.8	290	219	48.0	15.0	1.0	3.0	179	<1	5.0	7.0	<0.2	<0.2	<0.1	
SP2-24	2-Jun-1994	5.0	42.8	8.2	280	214	40.3	9.9	1.2	8.5	168	5	<10	7.0	0.10	0.05	<0.1	
SP2-24	12-Sep-1994	3.0	41.0	7.5	402	184	52.0	15.0	1.3	5.5	195	0	7.3	7.8	<.05	<0.05	<0.02	
SP2-24	9-Sep-1995	dry																
SP2-24	25-Jun-1996					177	39.0	11.0	1.0	5.0	171	3	2.0	2.0		<0.1		<0.1
SP2-24	12-Aug-1996	1.0	10.0	7.9	380	217	50.0	16.0	2.0	1.0	207	13	10.0	4.0		<0.1		<0.1
SP2-24	13-Oct-1996	1.0	4.0	8.5	840	216	62.0	14.0	3.0	1.0	254	<5	11.0	3.0		<0.1		<0.1
SP2-24	7-Aug-1997	dry																
SP2-24	9-Oct-1997	dry																
SP2-24	15-Sep-1999	2.0	13.0	8.4	300	220	43.8	15.0	2.0	0.7	197	<1	10.0	6.0	1.7	<0.02	0.04	
SP2-24	4-Nov-1999	dry																
SP2-24	22-Jun-2000	2.05	4.5	8.07	331	304	49	13	<1	<1	212	<5	3	2	<0.1	<0.1	<0.1	<0.1
SP2-24	12-Sep-2000	0.233	8.4	8.13	320	190	44	14	2	<1	211	<5	3	1	0.5	<0.1	<0.1	<0.1
SP2-24	23-Jun-2001	2.52	4.4	7.55	379	207	50	17	3	2	225	<5	6	4.5	0.1	<0.1	<0.1	<0.1
SP2-24	8-Sep-2001	2.09	4.5	7.99	347	252	50	14	2	5	217	<5	6	5.1	<0.1	<0.1	<0.05	<0.05
SP2-24	27-Oct-2001	1.13	5.4	7.04	349	192	50	15	2	5	204	<5	5.1	4.6	<0.1	<0.1	<0.05	<0.05
SP2-24	7-Jun-2002	6.59	3.6	8.05	355	241	48	14	3	1	189	<5.	6	5	0.5	<0.1	<0.05	<0.05

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP2-24	25-Sep-2002	1.23	5.4	8.16	353	203	49	15	3	5	200	<5.	6	5	<0.1	<0.1	<0.05	<0.05
SP2-24	10-Oct-2002	1.08	5.5	8.53	384	207	52	16	3	4	201	<5	6	4	<0.1	<0.1	<0.05	<0.05
SP2-24	14-Jun-2003	9.68	3.1	7.82	322	211	49.5	12.4	1.34	7.54	174	<5.	5	3	0.021	<0.005	<0.005	<0.005
SP2-24	20-Sep-2003	1.78	5.4	7.56	365	254	53.5	15.8	1.34	4.57	207	<5.	6	4	<0.02	0.05	<0.005	<0.005
SP2-24	22-Oct-2003	1.27	5.0	7.96	383	226	53.7	15.7	1.69	4.51	217	<5	6	4	<0.02	0.012	<0.005	<0.005
SP2-24	14-Jun-2004	11.6	3.2	7.94	357	214	47.1	12.1	1.38	7.69	143	< 5.	6	3	0.05	< .03	< .002	< .002
SP2-24	10-Sep-2004	2.22	4.2	8.03	313	203	55.6	15.7	1.6	4.93	163	< 5.	7	4	< .05	< .03	< .002	< .002
SP2-24	19-Jun-2005	27	3	7.92	288	206	47.2	12	1.75	8.24	162	< 5.	5	4	0.18	< .03	0.003	< .002
SP2-24	26-Aug-2005	3.26	3.8	7.89	342	222	50.5	13.9	1.49	5.38	196	< 5.	6	5	< .05	< .03	< .002	< .002
SP2-24	12-Oct-2005	1.73	4.3	7.98	329	225	52.6	15.5	1.83	4.87	194	< 5.	6	4	0.05	< .03	< .002	< .002
SP2-24	20-Jun-2006	9.4	3	8.03	328	231	46.6	12.1	1.33	8.24	166	< 5.	6	5	< .05	< .03	< .002	< .002
SP2-24	29-Aug-2006	2.64	4.1	7.88	374	198	52.8	14.96	1.62	5.36	188	< 5.	7	5	0.12	< .03	0.002	< .002
SP2-24	12-Oct-2006	1.52	4.4	7.86	363	236	53.29	15.18	1.71	5.23	190	< 5.	7	5	< .05	< .03	< .002	< .002
SP2-24	17-Jun-2007	4.55	8.11	349	349	228	52.65	13.87	1.75	5.75	193	< 10.	4.25	3.51	0.602	0.032	0.018	0.001
SP2-24	13-Sep-2007	1.78	7.69	389	389	229	56.48	17.54	2.17	4.35	204	< 10.	5.15	4.08	< .01	< .01	< .001	< .001
SP2-24	15-Oct-2007	0.96	8.07	343	343	242	55.8	16.74	2.13	4.46	201	< 10.	5.51	4.25	0.011	< .01	< .001	< .001
SP2-24	8-Jul-2008	6.25	3.1	7.68	383	224	52.18	13.46	1.58	8.48	182	< 10.	5.27	5.83	0.062	< .01	0.003	< .001
SP2-24	26-Aug-2008	2.82	4	7.75	389	246	50.33	14.41	1.42	5.78	193	< 10.	6.27	5.7	< .01	< .01	< .001	< .001
SP2-24	8-Oct-2008	1.53	4	8	383	238	51.81	15.15	1.77	5.52	194	< 10.	5.5	5.16	< .01	< .01	< .001	< .001
SP2-24	11-Jun-2009	11.2	3.2	7.87	355	225	50.32	12.12	1.46	9.57	171	< 10.	5.58	6.21	0.083	< .01	< .001	< .001
SP2-24	31-Aug-2009	2.42	4.2	7.9	380	240	51.43	15.16	1.79	5.95	188	< 10.	5.57	5.61	0.091	< .01	0.005	< .001
SP2-24	7-Oct-2009	1.29	4.9	8.14	380	229	52.49	15.78	1.86	5.88	199	<10	5.72	6.83	0.077	< .01	0.003	0.003
SP2-24	25-Jun-2010	8.36	3.4	7.92	392	230	49.53	13.12	1.57	9.21	188	< 10.	5.87	5.81	0.017	< .01	< .001	< .001
SP2-24	25-Aug-2010	2.67	4.1	7.96	384	214	53.53	14.9	1.57	6.21	198	< 5.	6	6	< .05	< .03	< .002	< .002
SP2-24	11-Oct-2010	1.28	5	7.93	377	255	53.15	15.39	1.88	5.82	196	< 5.	6	7	< .05	< .03	< .002	< .002
SP2-24	20-Jul-2011	7	7.1	7.78	405	214	50.46	13.27	1.68	8.01	158	< 5.	5	5	< .05	< .03	< .002	< .002
SP2-24	4-Oct-2011	2.44	4.4	8.19	382	239	52.46	14.78	1.85	6.02	169	< 5.	5	5	< .05	< .03	< .002	< .002
SP-47a	14-Jun-1991	2.0	5.0	7.5	400													
SP-47a	28-Jun-1991						47.7	16.4	5.2	0.7	212	0	21.4	3.1		0.08	<0.01	
SP-47a	21-Jul-1991	0.0	6.4		400	214	54.5	14.6	4.3	3.0	208	<1	17.0	10.0		<0.02		
SP-47a	24-Aug-1991	0.2	8.0	7.2	400													
SP-47a	27-Aug-1991					231	60.1	18.1	4.4	2.3	235	<1	24.0	15.0	0.11		0.02	
SP-47a	21-Sep-1991	0.1	8.0	7.5	400													
SP-47a	24-Sep-1991					281	54.1	9.0	5.7	0.0	190	<1	18.0	10.0		0.13	0.01	
SP-47a	18-Jun-1992	<0.1	9.7	7.1	402	202	63.7	7.8	2.7	0.0	185	0	8.0	30.0		0.00	0.00	
SP-47a	29-Sep-1992	0.1	8.9	8.0	310	224	50.3	27.1	5.3	0.0	209	0	26.0	15.0		0.26	0.09	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-47a	4-Jun-1993	<1	8.1	8.0	475	302	49.0	16.8	4.3	1.1	219	0	3.0	25.9	0.28	0.08	<0.03	
SP-47a	1-Jul-1993	1.2	10.0	7.9	140	216	47.0	14.7	5.2	<1.1	241	0	27.0	5.7	0.14	0.06	<0.03	
SP-47a	25-Oct-1993	1.2	4.0	7.9	310	236	46.0	17.0	3.0	<2	154	<1	22.0	9.0	1.20	0.20	<0.1	
SP-47a	2-Jun-1994	<1	4.0	7.8	380	329	68.7	19.5	5.0	1.8	313	<1	53.5	8.0	0.03	<0.1	<0.1	
SP-47a	12-Sep-1994	dry																
SP-47a	9-Aug-1995	0.5	10.0	8.1	280	250	50.0	17.0	6.0	2.0	226	<5	24.0	8.0	<0.1	<0.1	<0.1	
SP-47a	25-Jun-1996					284	65.0	19.0	6.0	1.0	303	<5	18.0	8.0		<0.1		<0.1
SP-47a	12-Aug-1996	1.5	10.0	7.7	473	150	46.0	9.0	2.0	1.0	177	0	6.0	2.0		<0.1		<0.1
SP-47a	13-Oct-1996	0.3	8.0	7.5	250	193	48.0	15.0	6.0	2.0	209	<5	24.0	9.0		<0.1		<0.1
SP-47a	7-Aug-1997	3.0	8.3	7.5	349			16.0	5.0	2.0	212	<5	7.0	7.0		<0.1		
SP-47a	9-Oct-1997	<0.10	1.0	7.7	752													
SP-47a	21-May-1999	0.7	10.0	7.1	450	273	62.0	20.0	6.0	2.0	274	<5	23.0	6.0	0.3	<0.1	<0.1	
SP-47a	15-Sep-1999	2.5	10.0	7.5	410	240	52.5	18.0	7.3	2.1	215	<1	28.0	10.0	0.53	<0.02	0.01	
SP-47a	4-Nov-1999	dry																
SP-47a	22-Jun-2000	dry																
SP-47a	11-Sep-2000	dry																
SP-47a	23-Jun-2001	1.47	7	7.05	351													
SP-47a	8-Sep-2001	0.276	9	7.54	437													
SP-47a	27-Oct-2001	0.211	7.4	8.3	372													
SP-47a	7-Jun-2002	1.01	6.3	7.06	337													
SP-47a	25-Sep-2002	0.101	9.2	7.72	321													
SP-47a	10-Oct-2002	0.102	7.5	7.63	346													
SP-47a	14-Jun-2003	1.51	5.4	7.38	333													
SP-47a	20-Sep-2003	0.112	8.8	7.59	336													
SP-47a	22-Oct-2003	0.169	8.5	7.28	346													
SP-47a	14-Jun-2004	1.03	5.5	7.26	361													
SP-47a	10-Sep-2004	0.17	8.5	7.54	324													
SP-47a	19-Jun-2005	1.81	5.4	7.41	392													
SP-47a	26-Aug-2005	0.36	8.1	7.39	366													
SP-47a	12-Oct-2005	0.19	7.1	7.43	347													
SP-47a	20-Jun-2006	1.22	5.8	7.82	413													
SP-47a	29-Aug-2006	0.33	8.4	7.69	378													
SP-47a	12-Oct-2006	0.24	7	7.62	383													
SP-47a	17-Jun-2007	0.71	6.2	7.48	368													
SP-47a	13-Sep-2007	0.13	9.5	7.48	354													
SP-47a	15-Oct-2007	0.19	7.5	7.4	325													
SP-47a	8-Jul-2008	1.03	6.2	7.17	380													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^+	K^+	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-47a	26-Aug-2008	0.41	8.3	7.24	358													
SP-47a	8-Oct-2008	0.24	7.6	7.28	365													
SP-47a	10-Jun-2009	1.61	5.7	7.11	363													
SP-47a	31-Aug-2009	0.24	8.6	7.17	348													
SP-47a	7-Oct-2009	0.21	7.7	7.51	357													
SP-47a	25-Jun-2010	0.98	6.3	7.49	437													
SP-47a	25-Aug-2010	0.224	9.8	7.39	337													
SP-47a	11-Oct-2010	0.152	8.6	7.24	342													
SP-47A	20-Jul-2011	1.28	6.4	7.45	394													
SP-47A	3-Oct-2011	0.31	7.9	7.46	411													
SP1-19	5-Jul-1987	<1.	6	8.05	400													
SP1-19	5-Oct-1987	0																
SP1-19	5-Oct-1989	0																
SP1-19	2-Jun-1994	20	4	8.2	320	193					218	7	<10.	<2.	0.025	<0.01	<0.01	
SP1-19	12-Aug-1996	0																
SP1-19	13-Oct-1996	0.3	6	7.53	180	190					235	<5.	11	3	<0.1	<0.1	<0.1	
SP1-19	7-Aug-1997	0																
SP1-19	9-Oct-1997	0																
SP1-19	11-Mar-1998	0																
SP1-19	25-Sep-1998	1.5	7			167					175	<5.	2	<1.	0.8	<0.1	<0.1	
SP1-19	15-Sep-1999			8.2	500	330					264	<1.	52	6	0.69	<0.02	<0.01	
SP1-19	15-Sep-1999	0																
SP1-19	4-Nov-1999	1	9.4	7.78	403	360					301	<1.	68	9	0.19	<0.02	<0.01	
SP1-19	22-Jun-2000	18.8	6.4	8.28	417													
SP1-19	12-Sep-2000	1.35	7.2	8.27	456													
SP1-19	23-Jun-2001	29.4	6	7.96	390													
SP1-19	8-Sep-2001	1.62	6.46	8.25	453													
SP1-19	27-Oct-2001	1.3	5	7.31	434													
SP1-19	7-Jun-2002	50.2	5.1	8.37	394													
SP1-19	25-Sep-2002	1.4	6.5	8.25	425													
SP1-19	10-Oct-2002	1.75	5.4	8.54	419													
SP1-19	14-Jun-2003	97	4.2	7.78	388													
SP1-19	20-Sep-2003	3.35	7.0	7.71	451													
SP1-19	22-Oct-2003	2.21	6.8	7.81	483													
SP1-19	14-Jun-2004	102	4.2	7.68	408													
SP1-19	10-Sep-2004	2.8	7.5	7.81	395													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-19	19-Jun-2005	153	3.9	7.91	346													
SP1-19	26-Aug-2005	6.8	6.4	7.83	423													
SP1-19	12-Oct-2005	3.03	6.2	8.12	412													
SP1-19	20-Jun-2006	105	4.3	7.95	402													
SP1-19	29-Aug-2006	2.45	6.6	7.98	445													
SP1-19	12-Oct-2006	2.97	6.1	7.89	451													
SP1-19	17-Jun-2007	32	4.3	7.85	432													
SP1-19	13-Sep-2007	1.64	7.6	7.89	462													
SP1-19	15-Oct-2007	1.53	6.5	7.85	437													
SP1-19	8-Jul-2008	59.4	4.7	7.44	397													
SP1-19	26-Aug-2008	5.01	6.8	7.71	462													
SP1-19	8-Oct-2008	2.88	6.6	7.69	465													
SP1-19	11-Jun-2009	75.6	4.2	7.48	388													
SP1-19	31-Aug-2009	2.72	6.7	7.58	449													
SP1-19	7-Oct-2009	2.05	6.5	7.86	462													
SP1-19	25-Jun-2010	55	4.9	7.88	472													
SP1-19	25-Aug-2010	4.03	6.9	7.88	432													
SP1-19	11-Oct-2010	3.1	7.2	7.7	459													
SP1-19	20-Jul-2011	41.3	5	7.74	395													
SP1-19	4-Oct-2011	3.78	7.1	7.92	483	288	69.96	18.89	8.52	0.8	245	< 5.	25	< 1.	0.1	< .03	0.005	< .002
SP1-22	9-Aug-1995	1.0	7.0	8.5	211	220	46.0	11.0	3.0	7.5	177	5	5.0	6.0	<0.1	<0.1	<0.1	
SP1-22	28-Nov-1995	dry																
SP1-22	7-Aug-1997	1.1	8.0	7.5	293	200		14.0	2.0	6.0	186	<5	5.0	6.0		<0.1	<0.1	
SP1-22	9-Oct-1997	1.0	8.0	7.8	585													
SP1-22	15-Sep-1999	3.6	13.0	8.1	380		48.8	16.9	2.3	0.8	217	<1	11.0	7.0	1.27	<0.02	0.03	
SP1-22	4-Nov-1999	3.0	9.6	7.3	245	220	53.0	18.4	1.4	2.8	220	<1	11.0	8.0	2.66	<0.02	0.07	
SP1-22	22-Jun-2000	3.53	5.1	8.24	304													
SP1-22	12-Sep-2000	0.545	7.5	8.24	347													
SP1-22	23-Jun-2001	3.26	4.8	7.75	265													
SP1-22	8-Sep-2001	0.638	7.7	8.21	312													
SP1-22	27-Oct-2001	0.268	7.4	7.24	326													
SP1-22	7-Jun-2002	5.04	4.8	8.4	279													
SP1-22	25-Sep-2002	0.283	8.8	8.19	311													
SP1-22	10-Oct-2002	0.282	7.5	8.54	323													
SP1-22	14-Jun-2003	7.39	4.2	7.90	261													
SP1-22	20-Sep-2003	0.749	7.5	7.70	332													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-22	22-Oct-2003	0.487	8.4	7.89	348													
SP1-22	14-Jun-2004	10.7	4.3	7.94	295													
SP1-22	10-Sep-2004	0.86	7.1	8.02	298													
SP1-22	19-Jun-2005	37	3.8	7.92	221													
SP1-22	26-Aug-2005	1.75	5.9	7.97	316													
SP1-22	12-Oct-2005	0.82	6.2	8.02	301													
SP1-22	20-Jun-2006	9.8	9.8	8.01	298													
SP1-22	29-Aug-2006	1.18	6.7	7.93	334													
SP1-22	12-Oct-2006	0.72	6.1	7.72	335													
SP1-22	17-Jun-2007	4.38	4.7	8.06	311													
SP1-22	13-Sep-2007	0.68	8.2	7.63	348													
SP1-22	15-Oct-2007	0.345	7.5	8.12	316													
SP1-22	8-Jul-2008	6.61	4.5	7.74	302													
SP1-22	26-Aug-2008	1.22	6.9	7.72	329													
SP1-22	8-Oct-2008	0.75	6.7	7.99	326													
SP1-22	11-Jun-2009	13.1	4.1	7.79	244													
SP1-22	31-Aug-2009	0.97	7.4	7.95	321													
SP1-22	7-Oct-2009	0.508	7.1	8.19	315													
SP1-22	25-Jun-2010	8.2	4.7	7.92	292													
SP1-22	25-Aug-2010	1.02	6.7	7.91	323													
SP1-22	11-Oct-2010	0.679	7.3	8.03	331													
SP1-22	20-Jul-2011	8.38	4.5	7.96	290													
SP1-22	4-Oct-2011	1.14	6.6	8.16	343	217	50.91	15.26	1.75	0.95	175	< 5.	4	3	< .05	< .03	0.003	< .002
SP1-24	7-Aug-1997	dry																
SP1-24	9-Oct-1997	dry																
SP1-24	25-Sep-1998					313	60.0	21.0	3.0	<1	289	<5	19.0	2.0	<0.1	<0.1	<0.1	
SP1-24	15-Sep-1999	dry																
SP1-24	4-Nov-1999	0.7	8.6	7.4	328	310	62.6	28.1	2.6	3.7	287	<1	23.0	8.0	0.04	<0.02	<0.01	
SP1-24	12-Sep-2000	0.612	6.9	8.08	399													
SP1-24	23-Jun-2001	0.798	8	7.64	401													
SP1-24	8-Sep-2001	0.122	12.7	8.08	395													
SP1-24	27-Oct-2001	0.119	7.6	7.17	399													
SP1-24	7-Jun-2002	0.773	7.5	8.09	389													
SP1-24	25-Sep-2002	0.098	12.6	8.01	387													
SP1-24	10-Oct-2002	0.156	8.9	8.26	402													
SP1-24	14-Jun-2003	1.24	5.6	7.66	382													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-24	20-Sep-2003	0.200	11.0	7.75	415													
SP1-24	22-Oct-2003	0.146	10.8	7.71	434													
SP1-24	14-Jun-2004	1.45	5.3	7.74	415													
SP1-24	10-Sep-2004	0.15	13.4	7.98	395													
SP1-24	19-Jun-2005	3.75	4	7.87	341													
SP1-24	26-Aug-2005	0.255	11.5	7.89	415													
SP1-24	12-Oct-2005	0.17	7.6	7.98	386													
SP1-24	20-Jun-2006	1.08	6.2	7.97	399													
SP1-24	29-Aug-2006	0.13	12.8	7.98	419													
SP1-24	12-Oct-2006	0.19	7.1	7.96	413													
SP1-24	17-Jun-2007	0.46	8.7	8.06	417													
SP1-24	13-Sep-2007	0.21	11.9	7.67	432													
SP1-24	15-Dec-2007	0.24	9.2	7.94	399													
SP1-24	8-Jul-2008	0.96	6.9	7.77	420													
SP1-24	26-Aug-2008	0.16	13	7.8	430													
SP1-24	8-Oct-2008	0.16	10.2	7.97	417													
SP1-24	11-Jun-2009	2.11	4.1	7.64	386													
SP1-24	31-Jul-2009	0.103	13.3	7.97	427													
SP1-24	7-Oct-2009	0.149	7.1	8.04	410													
SP1-24	25-Jun-2010	1.51	5.8	7.95	432													
SP1-24	25-Aug-2010	0.136	13.4	7.91	433													
SP1-24	11-Oct-2010	0.133	8.8	7.98	426													
SP1-24	20-Jul-2011	0.987	7.1	7.78	405													
SP1-24	4-Oct-2011	0.121	10.4	8.12	454	280	67.62	20.88	2.31	0.5	240	< 5.	13	1	0.17	< .03	0.007	< .002
SP1-9	9-Aug-1995	7.0	8.2	8.2		170	43.0	6.0	3.0	<1	171	<5	6.0	4.0	<0.1	<0.1	<0.1	
SP1-9	7-Aug-1997	3.0	5.6	7.9	171	180	46.0	13.0	2.0	1.0	193	<5	12.0	3.0		<0.1	<0.1	
SP1-9	4-Oct-1997	3.0	1.0	7.9	328	160	53.0	13.0	3.0	2.0	179	<5	27.0	2.0	1.30	<0.1	<0.1	
SP1-9	25-Sep-1998					167	44.0	6.0	1.0	<1	175	<5	2.0	<1	0.80	<0.1	<0.1	
SP1-9	15-Sep-1999	dry																
SP1-9	4-Nov-1999	dry																
SP1-9	21-Jun-2000	3.39	4.2	7.76	271	181	42	12	2	<1	183	<5	11	<1	<0.1	<0.1	<0.1	<0.1
SP1-9	11-Sep-2000	0.698	5.8	7.48	324	193	45	13	2	1	201	<5	11	<1	<0.1	<0.1	<0.1	<0.1
SP1-9	23-Jun-2001	3.06	4.6	7.46	290	163	41	12	3	<1.	186	<5	10	1	0.1	<0.1	<0.1	<0.1
SP1-9	8-Sep-2001	0.822	6.8	8.11	322	222	46	14	2	<1	210	<5	13	1.3	0.9	<0.1	<0.05	<0.05
SP1-9	27-Oct-2001	0.566	6.9	8.29	288	168	46	14	3	<1	207	<5	12.6	1.2	0.4	<0.1	<0.05	<0.05
SP1-9	7-Jun-2002	3.85	5.1	7.73	289	189	41	13	3	<1.	183	<5.	11	<1.	<0.1	<0.1	<0.05	<0.05

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-9	25-Sep-2002	0.455	7.2	7.8	321	179	47	16	4	<1.	211	<5.	13	1	0.3	<0.1	<0.05	<0.05
SP1-9	10-Oct-2002	0.344	6.5	8.05	327	181	48	15	3	<1	215	<5	13	1	0.2	<0.1	<0.05	<0.05
SP1-9	14-Jun-2003	5.99	3.9	7.62	274	171	42.8	11.8	1.7	0.839	172	<5.	10	<1.	0.046	0.007	<0.005	<0.005
SP1-9	20-Sep-2003	0.696	6.4	7.77	333	232	48.6	15	1.66	0.929	215	<5.	13	<1.	0.051	<0.005	<0.005	<0.005
SP1-9	22-Oct-2003	0.594	6.6	7.35	350	206	49.5	14.9	1.97	1.97	213	<5	13	<1	<0.02	<0.005	<0.005	<0.005
SP1-9	14-Jun-2004	7.41	4	7.64	277	162	39.9	10.8	1.75	0.81	137	< 5.	9	< 1.	0.1	< .03	< .002	< .002
SP1-9	10-Sep-2004	0.73	6.1	7.94	301	167	49.6	14.5	1.97	1.08	167	< 5.	11	1	0.73	< .03	0.003	< .002
SP1-9	17-Oct-2004	0.71	5.9	7.81	330	188	49.4	14.1	2.15	1.12			13	1	1.65	< .03	0.01	0.002
SP1-9	19-Jun-2005	10.6	3.9	7.56	203	168	33.8	9.26	1.77	0.87	137	< 5.	7	< 1.	0.21	< .03	< .002	< .002
SP1-9	26-Aug-2005	1.07	5.6	7.77	296	195	49.8	14.5	2	1.1	195	< 5.	12	< 1.	0.09	< .03	< .002	< .002
SP1-9	12-Oct-2005	0.82	5.7	7.76	299	204	50.1	14.9	2.07	1.13	204	< 5.	12	1	2.81	< .03	0.017	< .002
SP1-9	20-Jun-2006	6.07	4.1	7.84	282	191	40.5	11.2	1.89	0.9	162	< 5.	10	2	0.14	0.08	< .002	< .002
SP1-9	29-Aug-2006	0.77	6.1	7.51	327	187	49.15	14.46	2.02	1.05	195	< 5.	12	2	0.08	< .03	< .002	< .002
SP1-9	12-Oct-2006	0.77	5.7	7.67	325	206	50.09	14.65	2.09	1.06	200	< 5.	12	2	3.07	< .03	0.025	0.008
SP1-9	17-Jun-2007	2.74	4.5	7.87	293	184	43.8	13.04	2.23	1	193	< 10.	9.02	0.93	0.026	0.01	< .001	< .001
SP1-9	13-Sep-2007	0.55	7.1	7.81	328	195	51.39	15.61	2.56	1.12	208	< 10.	11.1	1.2	0.607	< .01	0.007	< .001
SP1-9	15-Oct-2007	0.571	6.4	7.61	281	214	54.75	15.78	2.38	1.21	210	< 10.	12	1.17	0.318	< .01	0.006	< .001
SP1-9	8-Jul-2008	4.53	4.3	7.48	308	180	45.8	12.44	2.01	0.94	184	< 10.	9.41	0.91	0.037	0.037	< .001	< .001
SP1-9	27-Aug-2008	1.06	5.9	7.75	334	194	47.86	14.24	1.95	1.12	200	< 10.	12.1	1.43	0.123	< .01	0.002	< .001
SP1-9	8-Oct-2008	0.81	6	7	329	219	47.36	13.86	2.1	1.07	206	< 10.	11.2	1.06	0.024	< .01	< .001	< .001
SP1-9	10-Jun-2009	8.29	4.1	7.28	253	164	39.28	10.77	1.8	0.83	156	< 10.	9.03	0.98	0.037	0.017	< .001	< .001
SP1-9	31-Aug-2009	0.81	6.3	7.48	327	199	48.55	14.47	2.19	1.1	200	< 10.	11.5	1.09	0.174	< .01	0.003	0.001
SP1-9	7-Oct-2009	0.73	6.4	7.7	341	189	49.66	14.97	2.21	1.18	212	<10	12.1	1.41	0.453	< .01	0.004	< .001
SP1-9	25-Jun-2010	4.81	4.6	7.79	291	188	43.92	12.4	2.59	0.91	182	< 10.	11.1	0.68	0.125	< .01	0.002	< .001
SP1-9	25-Aug-2010	0.91	7.3	7.73	331	195	49.87	14.44	2.01	1.13	204	< 5.	12	1	0.07	< .03	< .002	< .002
SP1-9	11-Oct-2010	0.67	6.7	7.63	331	216	49.72	14.5	2.26	1.11	213	< 5.	13	1	0.07	< .03	< .002	< .002
SP1-9	20-Jul-2011	5.54	4.6	7.63	291	186	46.02	13.02	1.91	0.91	146	< 5.	11	< 1.	< .05	< .03	< .002	< .002
SP1-9	3-Oct-2011	1.01	6.1	7.74	339	206	50.59	14.78	2.49	1.18	166	< 5.	12	< 1.	0.06	< .03	< .002	< .002
SP2-1	21-Jun-1996					270	74.0	15.0	2.0	<1	307	<5	1.0	2.0		<0.1	<0.1	
SP2-1	24-Oct-1996	0.5	3.0	8.3	865	286	79.0	17.0	3.0	<1	359	<5	5.0	4.0		<0.1	<0.1	
SP2-1	20-Aug-1997	4.0	7.0	7.6	391	230		14.0	2.0	<1	264	<5	<5	3.0		<0.1		<0.1
SP2-1	10-Oct-1997	65.0	8.0	8.2	507													
SP2-1	25-Jun-1998			8.2	454	242	75.0	17.0	2.0	<1	326	<5	5.0	3.0	0.20	<0.1	<0.1	
SP2-1	8-Sep-1998			8.3	492	301	83.0	17.0	2.0	<1	345	<5	1.0	3.0	0.30	<0.1	<0.1	
SP2-1	21-May-1999	1.0	9.0	7.8	450	275	87.0	12.0	1.0	1.0	318	<5	2.0	<1	<0.1	<0.1	<0.1	
SP2-1	15-Sep-1999	0.4	8.0	7.4	460	310	81.8	18.2	1.5	0.4	325	<1	8.0	7.0	0.2	<0.02	0.03	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP2-1	4-Nov-1999	1.0	11.0	8.0	392	290	71.4	18.7	1.9	0.5	290	<1	8.0	6.0	0.28	<0.02	0.01	
SP2-1	22-Jun-2000	13.6	5.1	7.84	488	311	79	19	1	<1	363	<5	2	<1	<0.1	<0.1	<0.1	<0.1
SP2-1	13-Sep-2000	1.37	6.7	7.61	529													
SP2-1	17-Jun-2001	19.4	5	7.49	479													
SP2-1	9-Sep-2001	1.22	6.9	7.67	481													
SP2-1	28-Oct-2001	1.266	6.9	7.52	516													
SP2-1	6-Jun-2002	26.8	4.9	7.47	489													
SP2-1	25-Sep-2002	0.802	7.8	7.61	488													
SP2-1	10-Oct-2002	0.865	7.4	7.93	516													
SP2-1	9-Jun-2003	30.3	4.5	7.48	537													
SP2-1	21-Sep-2003	0.708	7.2	7.49	518													
SP2-1	22-Oct-2003	0.366	7.1	8.01	543													
SP2-1	14-Jun-2004	23.1	4.9	7.55	514													
SP2-1	17-Sep-2004	0.86	7	7.89	478													
SP2-1	17-Oct-2004	1.7	6.6	7.62	533													
SP2-1	19-Jun-2005	27	4.5	7.67	418													
SP2-1	25-Aug-2005	5.02	5.9	7.48	486													
SP2-1	12-Oct-2005	3.16	6.2	7.73	473													
SP2-1	20-Jun-2006	24	4.7	7.57	485													
SP2-1	21-Sep-2006	3.62	6.4	7.48	497													
SP2-1	21-Oct-2006	3.55	6.1	7.42	502													
SP2-1	17-Jun-2007	17.6	4.7	7.76	502													
SP2-1	9-Aug-2007	3.02	6.6	7.45	523													
SP2-1	23-Oct-2007	2.48	6.9	7.4	462													
SP2-1	19-Jun-2008	37.1	6.2	7.41	424													
SP2-1	27-Aug-2008	2.56	6.4	7.47	513													
SP2-1	9-Oct-2008	1.85	6.6	7.43	512													
SP2-1	8-Jun-2009	32.5	4.6	7.48	465													
SP2-1	9-Sep-2009	1.24	7	7.35	513													
SP2-1	8-Oct-2009	1.63	6.9	7.51	514													
SP2-1	25-Jun-2010	23.6	4.9	7.59	521													
SP2-1	8-Sep-2010	1.49	6.8	7.29	529													
SP2-1	19-Oct-2010	1.52	7.1	7.16	534													
SP2-1	21-Jul-2011	17.8	5.1	7.69	493													
SP2-1	4-Oct-2011	3.42	6.4	7.65	547													
SP2-9	10-Oct-1991	0.6	7.0	8.0	300	170	56.4	4.4	1.8	0.0	173	<1	4.0	10.0		0.16		

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP2-9	9-Aug-1995	dry																
SP2-9	7-Aug-1997	4.0	5.4	7.5	294	160		9.0	2.0	<1	172	<5	8.0	1.0		<0.1		
SP2-9	9-Oct-1997	<0.25	2.0	7.5	295	64	44.0	9.0	2.0	2.0	197	<5	10.0	2.0	0.70	<0.1	<0.1	
SP2-9	25-Sep-1998					198	50.0	9.0	2.0	<1	192	<5	6.0	<1	0.30	<0.1	<0.1	
SP2-9	15-Sep-1999	dry																
SP2-9	4-Nov-1999	0.5	10.0	7.1	272	180	58.8	10.3	0.8	5.8	190	<1	12.0	8.0	1.8	<0.02	0.03	
SP2-9	21-Jun-2000	5.9	3.9	7.96	277	170	45	8	<1	<1	177	<5	4	<1	0.3	<0.1	<0.1	<0.1
SP2-9	11-Sep-2000	0.903	5.8	7.55	299	181	46	9	2	<1	187	<5	6	<1	<0.1	<0.1	<0.1	<0.1
SP2-9	23-Jun-2001	5.83	4.5	7.42	248	147	44	7	2	<1	186	<5	3	<0.5	0.1	<0.1	<0.1	<0.1
SP2-9	8-Sep-2001	1.11	6.3	7.77	285	205	46	9	2	<1	190	<5	7	0.5	<0.1	<0.1	<0.05	<0.05
SP2-9	27-Oct-2001	0.257	6.6	7.62	288	172	48	9	2	<1	196	<5	6.8	0.8	<0.1	<0.1	<0.05	<0.05
SP2-9	7-Jun-2002	3.64	4.6	7.31	269	186	44	8	3	<1.	174	<5.	5	<1.	0.3	<0.1	<0.05	<0.05
SP2-9	25-Sep-2002	0.395	7.4	7.54	279	166	45	10	3	<1.	184	<5.	7	<1.	<0.1	<0.1	<0.05	<0.05
SP2-9	10-Oct-2002	0.361	6.2	7.97	291	163	48	10	3	<1	185	<5	7	1	<0.1	<0.1	<0.05	<0.05
SP2-9	14-Jun-2003	5.86	4.0	7.81	261	176	46.4	7.91	1.12	0.601	165	<5.	3	<1.	0.131	0.01	<0.005	<0.005
SP2-9	20-Sep-2002	0.629	6.0	7.62	292	212	48.7	9.77	1.19	0.654	188	<5.	6	<1.	0.783	<0.005	0.012	<0.005
SP2-9	22-Oct-2003	0.448	6.1	7.48	305	185	48.3	9.42	1.35	0.82	187	<5	7	<1	0.142	0.01	<0.005	<0.005
SP2-9	14-Jun-2004	6.55	4.1	7.55	291	177	49.6	8.01	1.21	0.64	146	< 5.	3	< 1.	0.15	< .03	< .005	< .002
SP2-9	10-Sep-2004	1.09	5.8	7.77	259	144	50.8	9.5	1.43	0.82	149	< 5.	6	< 1.	0.34	< .03	0.004	< .002
SP2-9	17-Oct-2004	0.64	5	7.74	294	166	49.8	9.01	1.52	0.93			10	< 1.	0.35	< .03	0.005	< .002
SP2-9	19-Jun-2005	8.57	4.2	7.48	262	202	53.8	9.32	1.49	0.64	174	< 5.	3	< 1.	0.52	< .03	0.01	< .002
SP2-9	26-Aug-2005	2.94	5.2	7.71	270	181	50.6	9.06	1.27	0.79	182	< 5.	7	< 1.	1.17	< .03	0.059	< .002
SP2-9	12-Oct-2005	0.86	5.5	7.78	252	187	43.5	9.26	2.38	0.88	168	< 5.	7	< 1.	0.36	0.04	0.012	0.002
SP2-9	20-Jun-2006	8.22	4.3	7.78	297	193	46.5	8.01	1.18	0.69	158	< 5.	5	2	0.15	< .03	< .002	< .002
SP2-9	29-Aug-2006	2.15	5.6	7.36	294	157	50.24	9.39	1.39	0.75	172	< 5.	8	2	0.05	< .03	< .002	< .002
SP2-9	12-Oct-2006	0.88	5.9	7.51	288	165	50.33	9.32	1.55	0.83	180	< 5.	8	2	0.17	< .03	0.004	< .002
SP2-9	17-Jun-2007	4.53	4.5	7.63	293	173	48.88	8.42	1.71	0.72	178	< 10.	3.39	0.79	1.156	0.031	0.031	< .001
SP2-9	13-Sep-2007	0.16	7.7	7.89	290	180	52.53	10.17	1.92	< .5	185	< 10.	6.38	0.88	0.313	< .01	0.005	< .001
SP2-9	15-Oct-2007	0.06	6.5	7.44	257	192	53.49	10.01	1.98	0.92	188	< 10.	6.67	0.88	0.649	< .01	0.012	0.001
SP2-9	8-Jul-2008	6.84	4.4	7.46	281	176	48.14	7.92	1.43	0.67	172	< 10.	3.45	0.75	0.118	< .01	0.002	0.001
SP2-9	27-Aug-2008	2.7	5	7.54	293	181	47.79	8.62	1.35	0.77	174	< 10.	7.28	1.3	0.04	< .01	< .001	< .001
SP2-9	8-Oct-2008	0.8	6	7.32	288	204	47.32	8.83	1.44	0.83	178	< 10.	6.84	0.89	0.174	< .01	0.002	0.002
SP2-9	10-Jun-2009	6.82	4.1	7.29	265	167	46.33	7.74	1.57	0.7	166	< 10.	3.53	0.9	0.543	0.012	0.009	0.001
SP2-9	31-Aug-2009	1.05	6	7.37	285	183	49.06	8.94	1.53	0.82	178	< 10.	6.94	1.06	0.299	< .01	0.009	< .001
SP2-9	7-Oct-2009	0.46	6.4	7.44	285	173	48.32	9.22	1.71	0.87	184	<10	7.19	1.2	0.429	< .01	0.012	< .001
SP2-9	25-Jun-2010	4.81	4.4	7.79	282	175	45.85	7.59	1.46	0.65	173	< 10.	3.86	0.55	0.165	< .01	0.003	< .001
SP2-9	25-Aug-2010	1.21	6.1	7.88	293	188	50.46	9.18	1.44	0.88	169	< 5.	7	< 1.	0.07	< .03	< .002	< .002

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP2-9	11-Oct-2010	0.305	7	7.42	287	194	49.58	9.24	1.69	0.85	178	< 5.	8	< 1.	0.28	< .03	0.009	< .002
SP2-9	20-Jul-2011	6.73	4.7	7.71	273	186	48.41	8.48	1.45	0.71	142	< 5.	4	< 1.	0.12	< .03	< .002	< .002
SP2-9	3-Oct-2011	1.38	5.9	7.87	299	195	50.63	9.34	1.78	0.93	152	< 5.	7	< 1.	< .05	< .03	< .002	< .002
SP1-3	9-Aug-1995	0.3	7.0	8.3	283		37.0	6.0	4.0	<1	152	<5	6.0	3.0	0.20	<0.1	<0.1	
SP1-3	12-Aug-1996	2.0	5.0	7.3	313	150	46.0	8.0	2.0	<1	180	0	7.0	3.0	<.1	<0.1	<0.1	
SP1-3	24-Oct-1996	1.2	6.0	7.5	150	290	48.0	8.0	2.0	<1	389	<5	<2	4.0	0.30		<0.1	
SP1-3	7-Aug-1997	11.5	4.8	7.9	271	140	41.0	7.0	3.0	<1	156	<5	8.0	3.0	1.30	<0.1	<0.1	
SP1-3	9-Oct-1997	1.0	3.0	8.1	367													
SP1-3	21-May-1999	3.0	10.0	6.8	400	261	73.0	14.0	1.0	<1	293	<5	10.0	<1	2.9	<0.1	0.1	
SP1-3	15-Sep-1999	0.5	13.0	7.6	290	220	43.6	9.1	4.0	0.7	174	<1	13.0	6.0	<0.05	<0.02	<0.01	
SP1-3	4-Nov-1999	0.3	8.0	7.3	245	180	50.7	9.3	2.5	0.8	179	<1	13.0	7.0	0.06	<0.02	<0.01	
SP1-3	21-Jun-2000	0.46	6.5	8.11	206													
SP1-3	11-Sep-2000	0.16	4	7.48	288													
SP1-3	23-Jun-2001	0.513	2.2	7.75	197													
SP1-3	8-Sep-2001	0.248	4.5	7.82	273													
SP1-3	27-Oct-2001	0.114	5.6	7.31	282													
SP1-3	7-Jun-2002	0.11	2.2	7.69	271													
SP1-3	25-Sep-2002	0.002	10.5	7.84	299													
SP1-3	10-Oct-2002	0.0291	3.8	8.19	277													
SP1-3	14-Jun-2003	0.573	5.3	7.88	190													
SP1-3	20-Sep-2003	0.167	4.6	7.94	267													
SP1-3	22-Oct-2003	0.124	4.4	7.74	287													
SP1-3	14-Jun-2004	0.547	5.6	7.83	230													
SP1-3	10-Sep-2004	0.41	5.2	8.07	245													
SP1-3	17-Oct-2004	0.37	3.4	7.93	271													
SP1-3	19-Jun-2005	0.58	6.2	7.8	215													
SP1-3	26-Aug-2005	0.45	7.8	7.99	267													
SP1-3	12-Oct-2005	0.39	3	8.05	236													
SP1-3	20-Jun-2006	0.53	6.7	7.98	293													
SP1-3	29-Aug-2006	0.34	6.4	7.71	270													
SP1-3	12-Oct-2006	0.38	3.5	7.88	293													
SP1-3	17-Jun-2007	0.17	5.2	7.94	291													
SP1-3	13-Sep-2007	0.32	5.9	7.97	292													
SP1-3	15-Oct-2007	0.3	3	7.68	233													
SP1-3	8-Jul-2008	0.497	8.1	7.5	280													
SP1-3	27-Aug-2008	0.4	6.2	7.77	305													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP1-3	8-Oct-2008	0.37	3.8	7.83	295													
SP1-3	10-Jun-2009	0.54	2.8	7.78	209													
SP1-3	31-Aug-2009	0.38	6.3	7.82	290													
SP1-3	7-Oct-2009	0.35	5.2	7.78	289													
SP1-3	25-Jun-2010	0.42	3.9	8.04	234													
SP1-3	25-Aug-2010	0.345	8.9	7.94	292													
SP1-3	11-Oct-2010	0.272	4.9	7.55	296													
SP1-3	20-Jul-2011	0.523	7.7	7.88	251													
SP1-3	3-Oct-2011	0.41	4.9	7.95	301	206	47.08	8.83	3.68	0.73	136	< 5.	10	3	0.19	< .03	< .002	< .002
SP-30	18-Jan-1990	no flow																
SP-30	14-Apr-1990	no flow																
SP-30	23-Jul-1990	no flow																
SP-30	9-Oct-1990	no flow																
SP-30	12-Jan-1991	no flow																
SP-30	4-Apr-1991	no flow																
SP-30	21-Jul-1991	no flow																
SP-30	10-Oct-1991	no flow																
SP-30	23-Jun-1993	dry																
SP-30	1-Jul-1993	dry																
SP-30	25-Oct-1993	dry																
SP-30	2-Jun-1994	dry																
SP-30	12-Sep-1994	dry																
SP-30	10-Mar-1995	dry																
SP-30	16-May-1995	dry																
SP-30	10-Aug-1995	dry																
SP-30	28-Nov-1995	dry																
SP-30	16-Aug-1996	dry																
SP-30	24-Oct-1996	dry																
SP-30	7-Aug-1997	dry																
SP-30	9-Oct-1997	dry																
SP-30	15-Sep-1999	dry																
SP-30	4-Nov-1999	dry																
SP-30	13-Sep-2000	0.053	13.4	8.16	820													
SP-30	9-Dec-2000	0.04	4.9	8	660													
SP-30	14-Mar-2001	0.055	2.5	7.7	744													
SP-30	23-Jun-2001	0.121	14.1	7.78	796													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		μS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-30	10-Sep-2001	0.049	13.9	7.75	769													
SP-30	29-Oct-2001	0.031	9.7	8.09	822													
SP-30	21-Mar-2002	0.0347	4.4	7.99	705													
SP-30	8-Jun-2002	0.035	11.4	7.48	755													
SP-30	27-Sep-2002	0.0414	10.8	7.94	788													
SP-30	19-Nov-2002	0.0373	4.6	7.90	741													
SP-30	23-Mar-2003	0.0407	5.4	7.81	789													
SP-30	13-Jun-2003	0.0353	11.2	7.97	804													
SP-30	26-Sep-2003	0.0325	12.5	7.78	804													
SP-30	5-Dec-2003	0.0295	4.3	7.98	772													
SP-30	31-Mar-2004	0.0248	7.8	8.1	808													
SP-30	18-Jun-2004	0.0252	11.1	8.08	857													
SP-30	20-Sep-2004	0.021	11	8.39	694													
SP-30	6-Nov-2004	0.204	7.1	7.93	791													
SP-30	28-Mar-2005	0.029	4.3	8.18	677													
SP-30	21-Jun-2005	0.032	11.4	7.7	829													
SP-30	23-Aug-2005	0.04	11.5	7.92	884													
SP-30	27-Dec-2005	0.069	3.7	7.93	796													
SP-30	6-Mar-2006	0.035	3.7	8.04	804													
SP-30	27-Jun-2006	0.086	12.1	7.78	870													
SP-30	22-Sep-2006	0.056	9.5	7.35	812													
SP-30	13-Nov-2006	0.07	7.2	7.44	804													
SP-30	15-Mar-2007	0.086	6	7.96	849													
SP-30	18-Jun-2007	0.050	11.5	7.8	852													
SP-30	12-Sep-2007	0.065	12.8	7.87	842													
SP-30	5-Dec-2007	0.090	6.9	7.65	781													
SP-30	26-Mar-2008	0.071	6.3	7.79	877													
SP-30	19-Jun-2008	0.091	12.3	7.58	833													
SP-30	9-Sep-2008	0.103	11.9	7.73	852													
SP-30	21-Dec-2008	0.189	3.7	7.98	863													
SP-30	24-Mar-2009	0.031	5.1	7.98	854													
SP-30	18-Jun-2009	0.041	10	7.83	874													
SP-30	10-Sep-2009	0.043	13.1	7.85	896													
SP-30	3-Nov-2009	0.032	7.9	8.08	899													
SP-30	25-Mar-2010	0.029	8.17	8.17	875													
SP-30	27-Jun-2010	0.04	12.4	7.89	938													
SP-30	10-Sep-2010	0.0371	12	7.95	960													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-30	2-Dec-2010	0.044	4.5	7.89	852													
SP-30	26-Jun-2011	0.0535	12	7.87	827													
SP-30	20-Sep-2011	0.0455	12.5	7.92	914													
SP-30	16-Nov-2011	0.0358	6.6	8.03	848													
SP-36	25-Sep-1988	<1	11.7	7.1	890	504	52.0	98.5	20.1	4.8	537	40	83.4	25.9	<0.05		0.02	
SP-36	30-Sep-1988	<1	12.5	7.0	914	512	52.0	98.5	20.0	4.8	532	18	85.3	24.9	<0.05		0.02	
SP-36	31-Oct-1988	<1	7.1	8.5	995	520	48.0	87.6	17.1	2.5	523	0	73.0	11.8	<0.05		<0.01	
SP-36	23-Jun-1989					463	50.9	85.6	16.7	1.9	444	33	120.0	15.0		0.34	<0.01	
SP-36	27-Jun-1990	0.1	6.3		600													
SP-36	28-Jun-1990					476	54.0	83.6	16.9	0.5	587	<1	25.0	20.0		<0.02	<0.01	
SP-36	19-Aug-1990	no flow																
SP-36	26-Sep-1990	no flow																
SP-36	18-Jun-1991	0.7	13.6	8.0	600													
SP-36	19-Jun-1991					482	53.8	79.4	15.0	2.9	459	<1	60.0	85.0		0.45	0.07	
SP-36	21-Jul-1991	0.1	6.4		1100	505	41.2	82.4	15.2	2.6	485	<1	64.0	10.0		<0.02	<0.01	
SP-36	24-Aug-1991	no flow																
SP-36	21-Sep-1991	no flow																
SP-36	18-Jun-1992	0.0	22.9	8.3	910	484	54.1	84.9	18.3	0.0	468	12	69.0	15.0		0.00	0.03	
SP-36	30-Sep-1992	dry																
SP-36	23-Jun-1993	dry																
SP-36	1-Jul-1993	dry																
SP-36	25-Oct-1993	dry																
SP-36	2-Jun-1994	<1	6.0	8.1	840	432	68.2	42.1	8.7	2.1	638	<1	52.4	12.5		0.10	<.01	
SP-36	12-Sep-1994	dry																
SP-36	10-Mar-1995	dry																
SP-36	16-May-1995	dry																
SP-36	9-Aug-1995	dry																
SP-36	28-Nov-1995	dry																
SP-36	10-Mar-1996	dry																
SP-36	16-May-1996	dry																
SP-36	9-Aug-1996	dry																
SP-36	28-Nov-1996	dry																
SP-36	7-Aug-1997	dry																
SP-36	10-Jun-1999	dry																
SP-36	15-Sep-1999	dry																
SP-36	4-Nov-1999	dry																

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-36	13-Sep-2000	0.023	16.4	7.72	664	364	60	46	8	<1	382	<5	43	7	<0.1	<0.1	<0.1	<0.1
SP-36	9-Dec-2000	0.875	8.2	8.1	613	345	59	44	7	1	374	<5	46	6	<0.1	<0.1	<0.1	<0.1
SP-36	14-Mar-2001	0.950	5.4	7.8	605	377	59	45	8	1	372	<5	52	7	<0.1	<0.1	<0.1	<0.1
SP-36	23-Jun-2001	0.800	9.3	7.88	505	355	61	46	8	1	381	<5	48	7.3	<0.1	<0.1	<0.1	<0.1
SP-36	10-Sep-2001	0.783	11.6	8.07	612	392	63	44	8	1	393	<5	54	8.3	<0.1	<0.1	<0.05	<0.05
SP-36	29-Oct-2001	0.744	11.7	8.03	601	408	63	47	8	1	375	<5	50.4	7.3	<0.1	<0.1	<0.05	<0.05
SP-36	21-Mar-2002	1.26	6.4	7.89	511	285	60	45	8	<1.	371	<5.	50	8	0.1	<0.1	<0.05	<0.05
SP-36	8-Jun-2002	1.03	8.9	7.86	631	373	60	46	9	1	368	<5.	49	8	0.1	<0.1	<0.05	<0.05
SP-36	27-Sep-2002	0.756	11.5	7.8	629	332	61	46	8	1	373	<5.	47	6	<0.1	<0.1	<0.05	<0.05
SP-36	19-Nov-2002	1.02	9.5	7.96	612	364	58	41	7	1	366	<5	48	6	<0.1	<0.1	<0.05	<0.05
SP-36	23-Mar-2003	1.28	6.9	7.94	615	364	58.5	44.6	7.46	0.98	360	<5.	50	8	0.04	<0.005	<0.005	<0.005
SP-36	13-Jun-2003	0.982	9.0	7.92	612	365	62.4	45	6.77	1.11	365	<5.	50	7	0.13	<0.005	0.007	<0.005
SP-36	26-Sep-2003	0.641	11.5	7.69	642	358	65.6	48.8	6.94	1.37	385	<5.	52	6	0.02	<0.005	<0.005	<0.005
SP-36	5-Dec-2003	0.810	9.3	7.98	636	387	63.3	46.9	7.58	1.38	377	<5	52	7	<0.02	<0.005	<0.005	<0.005
SP-36	31-Mar-2004	0.949	7.2	8.07	632	385	63.6	46.6	7.6	1.15	368	< 5.	54	8	< .05	< .03	< .002	< .002
SP-36	18-Jun-2004	0.84	9.8	7.82	643	370	59.7	44	6.99	1.14	313	< 5.	52	7	< .05	< .03	< .002	< .002
SP-36	20-Sep-2004	0.599	11.3	8.33	583	364	67.9	49.2	6.89	1.42	305	< 5.	50	6	< .05	< .03	< .002	< .002
SP-36	6-Nov-2004	0.74	10.7	7.62	618	372	63.5	45.6	7.12	1.32			49	6	< .05	< .03	< .002	< .002
SP-36	28-Mar-2005	1.00	7.9	7.83	551	406	61.9	45.7	7.59	0.81	361	< 5.	53	8	< .05	< .03	< .002	< .002
SP-36	21-Jun-2005	0.97	9.4	7.54	626	392	68.8	52.4	8.18	1.31	369	< 5.	57	7	< .05	< .03	< .002	< .002
SP-36	23-Sep-2005	0.41	11	7.88	673	378	66.7	50.5	7.32	1.28	372	< 5.	53	8	< .05	< .03	< .002	< .002
SP-36	27-Dec-2005	0.77	6.9	7.97	618	341	64.1	47.6	7.76	1.43	363	< 5.	51	7	< .05	< .03	< .002	< .002
SP-36	6-Mar-2006	0.96	6.2	7.98	616	371	64.2	49.1	7.79	1.15	355	< 5.	52	8	< .05	< .03	< .002	< .002
SP-36	27-Jun-2006	0.94	9.6	7.96	690	386	68.6	53.1	7.62	1.26	376	< 5.	56	9	< .05	< .03	< .002	< .002
SP-36	22-Sep-2006	0.9	10.7	7.79	629	358	65.04	48.46	7.23	1.25	368	< 5.	51	8	< .05	< .03	< .002	< .002
SP-36	13-Nov-2006	1.00	9.2	7.49	619	371	66.82	49.26	7.84	1.25	378	< 5.	55	8	< .05	< .03	< .002	< .002
SP-36	15-Mar-2007	0.96	7.1	7.92	652	370	62.12	47.28	7.5	1.62	372	< 10.	51.2	9.47	0.044	< .005	< .005	< .005
SP-36	18-Jun-2007	0.94	9.1	7.83	637	379	68.18	51.11	8.24	1.35	380	< 10.	48.8	6.33	0.012	< .01	< .001	< .001
SP-36	12-Sep-2007	0.77	11.8	7.89	624	386	68.74	52.02	8.52	1.39	378	< 10.	51.7	6.95	0.028	< .01	< .001	< .001
SP-36	5-Dec-2007	0.84	9.8	7.77	595	365	59.95	48.67	7.62	1.26	367	< 10.	53.5	6.75	< .01	< .01	< .001	< .001
SP-36	26-Mar-2008	1.4	6.4	7.95	640	399	65.42	49.51	8.4	1.29	366	< 10.	58.9	8.12	0.018	< .01	< .001	< .001
SP-36	19-Jun-2008	1.02	9	7.85	590	386	66.46	49.03	7.69	1.26	378	< 10.	55.2	8.34	0.025	< .01	0.002	< .001
SP-36	9-Sep-2008	0.8	11.2	7.89	618	384	64.58	48.1	7.7	1.37	372	< 10.	52.3	6.7	0.016	< .01	0.001	< .001
SP-36	21-Dec-2008	0.91	8.4	7.83	624	368	63.2	45.39	7.49	1.29	358	< 10.	55.1	6.67	0.05	< .01	0.001	< .001
SP-36	24-Mar-2009	0.97	7.1	7.94	613	381	64.9	47.34	7.64	1.23	355	< 10.	54	6.59	0.071	< .01	< .001	< .001
SP-36	18-Jun-2009	0.96	8.9	7.83	626	388	66.14	45.57	7.07	1.17	362	< 10.	53.7	7.21	0.022	< .01	< .001	< .001
SP-36	10-Sep-2009	0.65	11.8	7.94	629	391	62.97	47.61	7.68	1.42	372	< 10.	52.6	6.44	0.069	< .01	0.005	< .001

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-36	3-Nov-2009	0.8	10.7	7.96	648	403	70.92	45.81	6.76	1.31	380	<10	56.5	6.91	0.041	< .01	0.001	< .001
SP-36	25-Mar-2010	0.97	6.5	8.01	611	376	64.48	48.39	7.66	1.19	361	< 10.	56.8	6.79	0.052	< .01	0.004	< .001
SP-36	27-Jun-2010	0.87	9.4	7.48	668	374	62.84	46.43	7.29	1.21	377	< 10.	60.2	6.06	0.037	< .01	0.004	< .001
SP-36	10-Sep-2010	0.658	11.1	7.64	649	389	67.41	49.51	7.38	1.79	379	< 5.	54	7	< .05	< .03	< .002	< .002
SP-36	2-Dec-2010	0.84	4.5	7.53	852	378	65.08	47.66	7.66	1.27	372	< 5.	54	7	< .05	< .03	< .002	< .002
SP-36	26-Jun-2011	1.32	8.3	7.88	646	405	66.5	49.79	7.85	1	308	< 5.	62	9	< .05	< .03	< .002	< .002
SP-36	20-Sep-2011	1.08	11.1	7.83	691	409	67.86	50.41	8.47	1.47	322	< 5.	58	8	< .05	< .03	< .002	< .002
SP-36	16-Nov-2011	1.21	9.7	7.84	671	399	67.14	50.14	8.54	1.26	313	< 5.	58	7	< .05	< .03	< .002	< .002
SP-58	31-Jul-1988	3.0	5.2	7.9	490	272	68.0	26.8	4.5	1.0	293	0	22.4	4.8		<0.05	<0.01	
SP-58	25-Aug-1988	7.0	8.9	6.8	545	264	70.0	28.0	5.0	1.1	293	0	23.5	3.8	<0.05		<0.01	
SP-58	28-Sep-1988	6.0	8.8	7.1	590	248	68.0	29.2	4.9	1.1	296	0	20.8	3.9	<0.05		<0.01	
SP-58	31-Oct-1988	6.0	5.2	8.0	597	292	68.0	26.8	3.8	1.2	294	0	28.6	3.1	<0.05		<0.01	
SP-58	22-Jun-1989					390	53.7	24.9	3.6	0.5	265	<1	28.0	15.0		0.08	<0.01	
SP-58	31-Aug-1989					300	69.9	26.0	31.0	0.8	344	<1	68.0	5.0		0.03	<0.01	
SP-58	28-Sep-1989					313	59.8	26.2	3.4	0.2	290	<1	20.0	10.0	<0.02		<0.01	
SP-58	31-Oct-1989					266	58.1	24.8	3.4	0.9	284	<1	200.0	10.0		<0.02	<0.01	
SP-58	26-Jun-1990	2.0	16.7		500													
SP-58	26-Jun-1990					254	89.5	25.9	2.1	0.1	330	<1	50.0	15.0		<0.02	<0.01	
SP-58	23-Jul-1990	2.5	18.9		500													
SP-58	24-Jul-1990					258	64.0	17.0	2.6	0.1	256	<1	15.0	20.0		<0.02	0.02	
SP-58	19-Aug-1990	6.0	8.3		400	275	75.2	20.0	9.6	0.1	303	<1	15.0	30.0	<0.02		<0.01	
SP-58	27-Sep-1990					356	79.1	22.4	7.4	0.5	321	<1	27.0	20.0		<0.02	<0.02	
SP-58	26-Sep-1990	5.5	8.7		400													
SP-58	18-Jun-1991	60.0	4.5	7.5	500													
SP-58	19-Jun-1991					270	58.2	25.7	3.0	1.0	290	<1	25.0	25.0		0.57	0.01	
SP-58	19-Jul-1991					289	67.9	24.8	3.7	3.2	312	<1	24.0	10.0		<0.02	0.31	
SP-58	21-Jul-1991	15.0	6.0	7.6	570													
SP-58	24-Aug-1991	12.0	6.0	7.2	600													
SP-58	27-Aug-1991					292	80.4	24.2	0.5	0.0	295	<1	26.0	15.0	<0.02		0.03	
SP-58	21-Sep-1991	10.0	7.0	7.2	600													
SP-58	24-Sep-1991					281	81.3	23.4	3.4	0.0	277	<1	28.0	20.0		0.02	<0.01	
SP-58	18-Jun-1992	10.0	10.0	7.2	694	259	81.0	19.7	1.1	0.0	317	0	5.0	5.0		0.00	0.07	
SP-58	31-Aug-1992	9.7	13.3	8.0	740	275	66.8	19.1	3.7	0.0	275	0	27.0	15.0		0.00	0.00	
SP-58	3-Jun-1993	1100.0	3.0	8.5	300	240	65.4	18.6	3.6	0.1	272	0	16.0	2.7	0.31	<0.05	<0.03	
SP-58	1-Jul-1993	62.0	9.0	8.0	340	237	56.5	15.2	3.3	1.0	242	0	21.0	3.0	0.05	0.05	0.03	
SP-58	25-Oct-1993	87.0	6.0	7.9	410	260	55.0	32.0	3.0	<2	265	<1	26.0	5.0	<0.2	<0.2	0.20	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-58	9-Jun-1994	15.0	41.0	7.9	450	232	60.5	22.8	3.2	1.0	306	1	28.0	<2	0.02	<0.01	<0.01	
SP-58	12-Sep-1994	5.0	41.0		571	266	64.0	24.0	3.9	1.2	263	6	34.0	3.8	<.05	<0.05	<0.02	
SP-58	16-May-1995	3.8	7.0	7.8	340	280	61.0	29.0	5.0	1.0	240	20	40.0	5.0	0.30	<0.1	<0.1	
SP-58	10-Aug-1995	125.9	9.0	8.4	368	250	58.0	22.0	5.0	<1	244	14	29.0	4.0	<0.1	<0.1	<0.1	
SP-58	28-Nov-1995	35.8	10.0		572	300	70.0	26.0	5.0	1.0	255	15	35.0	6.0	1.00	<0.1	<0.1	
SP-58	25-May-1997	0.5	7.0	9.0	815	434	73.0	51.9	7.1	1.8	387	<1	71.6	5.1		<0.02		<0.005
SP-58	27-Jun-1997	52.0	7.4	6.7	560	380	81.0	35.0	4.0	1.0	348	<5	90.0	4.0	<0.1	<0.1	<0.1	
SP-58	15-Aug-1997	30.0	5.0	8.0	567	350		35.0	4.0	1.0	353	<5	60.0	3.0		<0.1		<0.01
SP-58	7-Oct-1997	30.0	6.0	8.0	569	350	77.0	34.0	4.0	1.0	350	<5	57.0	6.8	<0.1	<0.1	<0.1	
SP-58	25-Sep-1998					328	71.0	28.0	4.0	1.0	307	<5	42.0	3.0	<0.1	<0.1	<0.1	
SP-58	10-Jun-1999	3.0				253	68.0	19.0	4.0	<1	270	7	17.0	<1	<0.1	<0.1	<0.1	
SP-58	15-Sep-1999	56.0	6.6	8.0	500	360	68.4	27.8	6.6	1.3	285	<1	46.0	7.0	0.04	<0.02	<0.01	
SP-58	4-Nov-1999	4.0	11.0	8.0	499	380	81.4	39.3	3.4	1.6	380	<1	61.0	7.0	0.18	<0.02	<0.01	
SP-58	20-Jun-2000	47.8	4.5	7.76	592	388	74		2	2	340	<5	62	2	<0.1	<0.1	<0.1	<0.1
SP-58	14-Sep-2000	15.4	4.8	7.94	605	349	74	33	4	2	334	<5	69	3	<0.1	<0.1	<0.1	<0.1
SP-58	8-Dec-2000	19.4	4.7	7.6	599	391	76	34	4	1	348	<5	69	3	<0.1	<0.1	<0.1	<0.1
SP-58	3-May-2001	23.75	4.4	7.7	610	377	79	38	3	1	350	<5	73	2	<0.1	<0.1	<0.1	<0.1
SP-58	7-Sep-2001	20.1	5.5	7.56	592	409	77	34	4	1	353	<5	77	3.2	<0.1	<0.1	<0.05	<0.05
SP-58	28-Oct-2001	16.5	5.6	7.77	608	376	82	36	4	2	389	<5	75.2	2.9	<0.1	<0.1	<0.05	<0.05
SP-58	8-Jun-2002	31.6	5.2	7.42	631	414	80	39	5	1	348	<5.	92	3	<0.1	<0.1	<0.05	<0.05
SP-58	27-Sep-2002	18.5	5.6	7.35	590	362	79	35	5	1	332	<5.	80	2	<0.1	<0.1	<0.05	<0.05
SP-58	6-Nov-2002	19.7	5.2	7.86	590	378	79	38	4	1	332	<5	85	2	<0.1	<0.1	<0.05	<0.05
SP-58	30-Jan-2003	17.9	4.9	7.31	626	400	87.7	39.2	4.08	1.72	346	<5.	92	2	<0.02	<0.005	<0.005	<0.005
SP-58	13-Jun-2003	38.9	4.8	7.68	642	436	89.9	40.8	3.86	1.63	332	<5.	119	2	<0.02	<0.005	<0.005	<0.005
SP-58	26-Sep-2003	16.1	5.2	7.20	535	406	88.1	39.6	3.96	1.56	348	<5.	102	2	<0.02	<0.005	<0.005	<0.005
SP-58	4-Dec-2003	18.1	5.2	7.67	647	418	88.1	38	4.95	1.68	344	<5	102	3	<0.02	0.007	<0.005	<0.005
SP-58	18-Jun-2004	41	5.1	7.48	672	443	85.9	39.3	4.37	1.6	282	< 5.	123	3	< .05	< .03	< .002	< .002
SP-58	20-Sep-2004	21.9	5.2	8.09	539	425	94.3	41.1	4.35	1.64	284	< 5.	107	2	< .05	< .03	< .002	< .002
SP-58	6-Nov-2004	20.2	5.4	7.62	589	434	87.7	37.3	4.32	1.54			107	2	< .05	< .03	< .002	< .002
SP-58	31-May-2005	44.9	4.8	7.43	639	499	103	49.3	4.87	1.64	337	< 5.	147	4	< .05	< .03	< .002	< .002
SP-58	25-Aug-2005	23.6	5.1	7.57	617	446	92.6	41.5	4.71	1.66	354	< 5.	129	3	< .05	< .03	< .002	< .002
SP-58	2-Nov-2005	18.9	5.2	7.57	651	436	84.9	38.8	5.07	1.58	339	< 5.	122	3	< .05	< .03	< .002	< .002
SP-58	25-Jun-2006	40.8	5	7.46	726	514	104	48.7	4.71	1.84	347	< 5.	144	4	< .05	< .03	< .002	< .002
SP-58	23-Sep-2006	30	5.3	7.68	708	478	96.41	44.6	4.25	1.77	344	< 5.	134	3	< .05	< .03	< .002	< .002
SP-58	5-Nov-2006	27.1	5.3	7.46	714	476	98.35	45.81	4.76	1.68	350	< 5.	135	3	< .05	< .03	< .002	< .002
SP-58	18-Jun-2007	40.4	5.1	7.4	763	512	103.6	48.77	5.33	2.04	347	< 10.	138	2.82	< .01	< .01	< .001	< .001
SP-58	12-Sep-2007	30.4	5.4	7.73	751	515	113.6	47.76	< .4	1.84	350	< 10.	154	2.93	< .01	< .01	< .001	< .001

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-58	26-Oct-2007	27.1	5.4	7.38	651	516	98.92	42.42	4.92	1.68	347	< 10.	168	2.63	< .01	< .01	< .001	< .001
SP-58	3-Jun-2008	46.4	5.5	7.13	667	538	107.6	46.33	9.08	1.99	341	< 10.	163	2.35	< .01	< .01	< .001	< .001
SP-58	9-Sep-2008	31.9	5.2	7.3	764	529	102.5	47.48	6.07	1.97	344	< 10.	159	2.89	< .01	< .01	< .001	< .001
SP-58	22-Oct-2008	27.5	5.2	7.33	767	536	98.34	45.02	8.38	1.82	344	< 10.	188	2.56	< .01	< .01	< .001	< .001
SP-58	8-Jun-2009	40.7	5.1	7.27	773	544	108.8	47.98	5.85	1.92	333	< 10.	151	2.9	< .01	< .01	< .001	< .001
SP-58	10-Sep-2009	28.3	5.6	7.17	788	536	102.9	47.6	5.99	1.96	338	< 10.	167.8	2.76	< .01	< .01	< .001	< .001
SP-58	21-Oct-2009	26.5	5.6	7.44	770	540	117	45.62	5.18	1.77	352	<10	170.6	1.6	< .01	< .01	< .001	< .001
SP-58	27-Jun-2010	38.2	5.5	7.46	863	559	105.6	47.37	6.2	1.86	346	< 10.	207.5	2.8	< .01	< .01	< .001	< .001
SP-58	10-Sep-2010	27.2	5.2	7.68	837	552	107.65	48.6	6.01	1.93	341	< 5.	179	3	< .05	< .03	< .002	< .002
SP-58	18-Nov-2010	25.4	5.9	7.58	872	566	105.63	47.21	5.9	1.83	341	< 5.	181	3	< .05	< .03	< .002	< .002
SP-58	26-Jun-2011	53.4	5.3	7.56	827	613	117.06	54.5	6.18	1.78	282	< 5.	227	3	< .05	< .03	< .002	< .002
SP-58	20-Sep-2011	36.3	5.6	7.51	873	615	111.57	52.35	6.66	2.15	293	< 5.	206	3	< .05	< .03	< .002	< .002
SP-58	26-Oct-2011	31.5	5.7	7.58	863	530	114.62	54.02	6.21	2.09	291	< 5.	199	3	< .05	< .03	< .002	< .002
LB-12	7-Nov-2004	0																
LB-12	27-Jul-2005	0.14	10.5	7.97	1037													
LB-12	2-Sep-2005	0.10	11	7.92	908													
LB-12	17-Oct-2005	0.12	8.9	7.88	931													
LB-12	24-Jun-2006	0.18	9.1	7.84	1118													
LB-12	21-Sep-2006	0.144	9.5	7.98	975													
LB-12	22-Oct-2006	0.183	7.8	8.05	1052													
LB-12	19-Jun-2007	0.083	9.4	7.99	1019													
LB-12	15-Sep-2007	0.053	11.6	7.91	922													
LB-12	24-Oct-2007	0.037	8	7.83	844													
LB-12	25-Jul-2008	0.054	11.1	7.93	1006													
LB-12	3-Sep-2008	0.054	10.9	7.79	953													
LB-12	20-Oct-2008	0.062	8.7	7.67	936													
LB-12	24-Jun-2009	0.088	8.7	7.82	1010													
LB-12	3-Sep-2009	0.055	11.8	7.93	942													
LB-12	10-Oct-2009	0.095	8.9	7.99	909													
LB-12	23-Jun-2010	0.11	8.5	7.71	992													
LB-12	26-Aug-2010	0.0695	12.8	7.95	943													
LB-12	13-Oct-2010	0.091	9.9	7.62	923													
LB-12	30-Aug-2011	0.137	10.7	7.97	1190													
LB-12	25-Oct-2011	0.185	8.4	7.79	1191													
LB-5A	27-Jul-2005	1.55	8.6	7.57	746	449	64.0	45.0	6.28	1.23	277	<5	106	5	<0.05	<0.03	<0.002	<0.002

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
LB-5A	2-Sep-2005	1.55	8.7	7.44	740	464	73.8	50.3	7.08	1.47	337	< 5.	119	5	< .05	< .03	< .002	< .002
LB-5A	17-Oct-2005	1.3	8.5	7.68	752	436	89.6	57.3	7.07	1.62	368	< 5.	128	6	0.38	< .03	0.021	< .002
LB-5A	24-Jun-2006	1.51	8.3	7.56	752	489	90.3	55.3	7.55	1.64	386	< 5.	110	7	< .05	< .03	< .002	< .002
LB-5A	21-Sep-2006	2.22	8.4	7.68	738	497	90.25	52.1	7.56	1.58	378	< 5.	119	6	0.05	< .03	< .002	< .002
LB-5A	22-Oct-2006	1.9	8.3	7.79	732	463	89.48	53.22	7.47	1.6	377	< 5.	120	6	< .05	< .03	< .002	< .002
LB-5A	19-Jun-2007	1.31	8.6	7.68	753	475	95.28	55.01	8.07	1.69	384	< 10.	118	4.83	< .01	< .01	< .001	< .001
LB-5A	15-Sep-2007	1.15	9.3	7.84	753	477	75.8	55.19	8.4	1.6	351	< 10.	122	5.31	< .01	< .01	< .001	< .001
LB-5A	24-Oct-2007	1.15	8.7	7.43	690	485	83.68	50.91	7.42	1.58	361	< 10.	131	5.18	< .01	< .01	< .001	< .001
LB-5A	25-Jul-2008	1.07	8.9	7.94	734	466	84.1	47.71	7.43	1.46	373	< 10.	112	5.48	< .01	< .01	< .001	< .001
LB-5A	3-Sep-2008	0.95	9.1	7.33	734	481	81.85	49.91	7.06	1.57	367	< 10.	119	5.98	< .01	< .01	< .001	< .001
LB-5A	20-Oct-2008	0.96	8.7	7.42	743	498	83.16	50.63	7.34	1.59	366	< 10.	128	4.87	0.22	< .01	0.014	< .001
LB-5A	24-Jun-2009	1.02	8.5	7.31	740	485	87.68	49.44	7.28	1.56	377	< 10.	113	5.99	0.012	< .01	< .001	< .001
LB-5A	3-Sep-2009	0.9	9.6	7.45	738	495	84.6	52.41	7.69	1.69	366	< 10.	125.4	4.24	0.012	< .01	< .001	< .001
LB-5A	10-Oct-2009	0.98	9.2	7.46	746	471	85.91	52.57	7.68	1.67	383	<10	122.4	5.72	<.01	< .01	<.001	< .001
LB-5A	23-Jun-2010	0.7	8.2	7.54	740	476	85.52	50.21	7.21	1.53	379	< 10.	60.4	2.47	0.07	< .01	0.005	< .001
LB-5A	26-Aug-2010	0.63	9.4	7.65	750	467	87.13	51.85	7.19	1.62	367	< 5.	118	6	< .05	< .03	< .002	< .002
LB-5A	13-Oct-2010	0.602	9.8	7.42	740	490	84.91	50.28	7.12	1.59	373	< 5.	119	6	< .05	< .03	0.002	< .002
LB-5A	30-Aug-2011	0.94	9.4	7.72	802	509	88.79	53.35	8.1	1.65	315	< 5.	125	6	< .05	< .03	< .002	< .002
LB-5A	25-Oct-2011	0.89	9	7.58	771	485	88.43	54.21	7.99	1.62	305	< 5.	124	6	< .05	< .03	< .002	< .002
LB-7	27-Jul-2005	1.03	11.4	8.31	876													
LB-7	2-Sep-2005	1.3	8.8	7.92	512													
LB-7	21-Oct-2005	1.6	8.7	7.92	611													
LB-7	24-Jun-2006	1.7	7.2	7.69	549													
LB-7	21-Sep-2006	2.4	8.6	7.77	535													
LB-7	22-Oct-2006	2.3	8.5	7.98	539													
LB-7	19-Jun-2007	1.31	8.3	7.81	558													
LB-7	15-Sep-2007	1.26	9.2	7.86	544													
LB-7	24-Oct-2007	1.4	8.9	7.87	501													
LB-7	25-Jul-2008	1.12	8.6	7.61	545													
LB-7	3-Sep-2008	1.13	8.9	7.68	535													
LB-7	20-Oct-2008	1.2	8.7	7.75	536													
LB-7	24-Jun-2009	1.19	8.4	7.64	558													
LB-7	3-Sep-2009	1.1	9.5	7.75	534													
LB-7	10-Oct-2009	1.17	9.4	7.87	549													
LB-7	23-Jun-2010	0.93	8.1	7.56	529													
LB-7	26-Aug-2010	0.906	9.8	7.98	560													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
LB-7	13-Oct-2010	0.987	9.5	7.46	551													
LB-7	30-Aug-2011	2.43	8.7	7.88	565													
LB-7	25-Oct-2011	2.46	8.7	7.75	565													
LB-7A	27-Jul-2005	0.12	9.8	8.39	423													
LB-7A	2-Sep-2005	0.11	9.6	8.43	459													
LB-7A	21-Oct-2005	0.11	11.3	8.25	529													
LB-7A	24-Jun-2006	0.24	9.7	8.54	495													
LB-7A	21-Sep-2006	0.53	9.7	8.43	456													
LB-7A	22-Oct-2006	0.37	10.7	8.31	470													
LB-7A	19-Jun-2007	0.3	12.9	8.72	469													
LB-7A	15-Sep-2007	0.31	10.3	8.83	459													
LB-7A	24-Oct-2007	0.286	9.8	8.47	483													
LB-7A	25-Jul-2008	0.37	12.7	8.66	456													
LB-7A	3-Sep-2008	0.22	8	8.69	466													
LB-7A	20-Oct-2008	0.26	9	8.58	469													
LB-7A	24-Jun-2009	0.165	9.6	8.56	478													
LB-7A	3-Sep-2009	0.217	11.6	8.74	458													
LB-7A	10-Oct-2009	0.166	8.6	8.72	479													
LB-7A	23-Jun-2010	0.148	8	8.45	482													
LB-7A	26-Aug-2010	0.12	11.8	8.59	463													
LB-7A	13-Oct-2010	0.109	9.6	8.5	473													
LB-7A	30-Aug-2011	0.457	11.9	8.73	484													
LB-7A	25-Oct-2011	0.495	7.7	8.46	472													
LB-7B	27-Jul-2005	0																
LB-7B	2-Sep-2005	0																
LB-7B	21-Oct-2005	0																
LB-7B	24-Jun-2006	0.05	9.6	8.5	536													
LB-7B	21-Sep-2006	0.05	10.7	7.96	336													
LB-7B	22-Oct-2006	0																
LB-7B	19-Jun-2007	< .05	9.8	8.27	422													
LB-7B	15-Sep-2007	0.004	12.2	8.49	617													
LB-7B	24-Oct-2007	< .1	13.9	7.85	317													
LB-7B	25-Jul-2008	0																
LB-7B	3-Sep-2008	0																
LB-7B	20-Oct-2008	0.015	10.3	8.55	450													

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
LB-7B	24-Jun-2009	0.053	10.3	8.04	446													
LB-7B	3-Sep-2009	0.007	11.9	8.26	466													
LB-7B	10-Oct-2009	0.016	14.4	8.27	451													
LB-7B	23-Jun-2010	0.028	9	8.13	442													
LB-7B	26-Aug-2010	0.0294	12.6	8.33	413													
LB-7B	13-Oct-2010	0.092	13.5	8.15	486													
LB-7B	30-Aug-2011	0.129	10.6	8.36	458													
LB-7B	25-Oct-2011	0.163	10.7	8.27	446													
LB-7C	27-Jul-2005	0.17	19.8	8.4	391													
LB-7C	2-Sep-2005	0.21	19.8	8.44	421													
LB-7C	21-Oct-2005	0.32	16.8	8.44	462													
LB-7C	24-Jun-2006	0.35	13.6	8.48	455													
LB-7C	21-Sep-2006	0.49	11.3	8.42	422													
LB-7C	22-Oct-2006	0.492	15.5	8.45	427													
LB-7C	19-Jun-2007	0.38	14.9	8.73	426													
LB-7C	15-Sep-2007	0.37	14.6	8.83	425													
LB-7C	24-Oct-2007	0.355	13	8.42	422													
LB-7C	25-Jul-2008	0.38	15.3	8.56	425													
LB-7C	3-Sep-2008	0.31	15.8	8.68	424													
LB-7C	20-Oct-2008	0.41	11	8.61	434													
LB-7C	24-Jun-2009	0.296	16.7	8.53	447													
LB-7C	3-Sep-2009	0.30	16.1	8.69	428													
LB-7C	10-Oct-2009	0.33	16.1	8.71	441													
LB-7C	23-Jun-2010	0.271	12.1	8.44	441													
LB-7C	26-Aug-2010	0.205	20.8	8.65	447													
LB-7C	13-Oct-2010	0.253	18.3	8.39	434													
LB-7C	30-Aug-2011	0.357	19.1	8.68	466													
LB-7C	25-Oct-2011	0.413	12.5	8.66	440													
Little Bear Spring	21-Jun-2005	---	8.6	7.61	496	333	68.8	37.6	7.37	1.53	333	< 5.	38	4	< .05	< .03	< .002	< .002
Little Bear Spring	23-Sep-2005	---	8.5	7.68	516	333	65.8	36.1	6.5	1.34	334	< 5.	35	4	< .05	< .03	< .002	< .002
Little Bear Spring	27-Dec-2005	---	8.2	7.58	576	312	65.4	34.9	7.34	1.74	340	< 5.	34	4	< .05	< .03	< .002	< .002
Little Bear Spring	6-Mar-2006	---	8.1	7.53	569	319	68.5	36.6	7.09	1.53	333	< 5.	33	4	< .05	< .03	< .002	< .002
Little Bear Spring	27-Jun-2006	---	8.6	7.56	565	302	68.5	37.5	6.41	1.41	327	< 5.	35	4	< .05	< .03	< .002	< .002
Little Bear Spring	22-Sep-2006	---	8.5	7.37	533	311	65.44	34.26	6.86	1.42	328	< 5.	33	4	< .05	< .03	< .002	< .002
Little Bear Spring	13-Nov-2006	---	8.4	7.67	529	309	67.41	35.77	6.87	1.35	335	< 5.	35	4	0.06	< .03	< .002	< .002

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Little Bear Spring	15-Mar-2007	---	8.1	7.89	593	330	63.7	36.35	7.53	1.83	345	< 10.	32.6	4.41	0.014	< .005	< .005	< .005
Little Bear Spring	18-Jun-2007	---	8.8	7.48	566	330	63.68	34.84	7.25	1.52	345	< 10.	35.6	3.88	0.014	< .01	< .001	< .001
Little Bear Spring	17-Sep-2007	---	8.8	7.69	568	335	69.41	38.48	7.28	1.46	341	< 10.	36	3.68	< .01	< .01	< .001	< .001
Little Bear Spring	26-Dec-2007	---	8.4	7.56	499	324	67.15	36.32	6.74	1.52	341	< 10.	41.5	3.04	0.079	< .01	0.003	< .001
Little Bear Spring	26-Mar-2008		8.4	7.48	536	328	67.71	35.37	7.2	1.58	343	< 10.	37.6	3.28	< .01	< .01	< .001	< .001
Little Bear Spring	19-Jun-2008		9	7.32	512	344	68.84	36.4	7.09	1.55	340	< 10.	40.7	4.53	0.032	< .01	0.002	< .001
Little Bear Spring	9-Sep-2008		8.7	7.41	557	337	65.04	34.97	7.01	1.51	332	< 10.	37.1	3.71	< .01	< .01	< .001	< .001
Little Bear Spring	23-Dec-2008		8.5	7.43	581	328	68.45	35.96	7.68	1.57	330	< 10.	39.9	3.68	< .01	< .01	< .001	< .001
Little Bear Spring	24-Mar-2009		8.9	7.46	561	337	70.19	36.19	7.23	1.51	335	< 10.	40.9	3.62	0.043	< .01	0.001	< .001
Little Bear Spring	18-Jun-2009		8.9	7.19	569	337	68.75	34.29	6.93	1.41	332	< 10.	41.1	4.14	0.078	< .01	0.005	< .001
Little Bear Spring	10-Sep-2009		9	7.24	563	321	64.71	35.65	7.23	1.53	328	< 10.	38.1	2.73	0.025	< .01	< .001	< .001
Little Bear Spring	29-Dec-2009		8.2	7.55	573	328	68.32	36.84	7.47	1.55	345	<10	36.7	3.59	0.022	< .01	< .001	< .001
Little Bear Spring	25-Mar-2010		8.2	7.59	568	327	70.05	36.06	6.89	1.43	346	< 10.	38.8	3.61	< .01	< .01	< .001	< .001
Little Bear Spring	24-Jun-2010		8.9	7.39	586	361	68.17	36.16	7.4	1.53	346	< 10.	41.7	3.22	0.021	< .01	0.001	0.001
Little Bear Spring	10-Sep-2010		8.4	7.63	567	326	67.37	35.88	6.8	1.5	343	< 5.	38	4	< .05	< .03	< .002	< .002
Little Bear Spring	16-Dec-2010		8.3	7.58	571	328	65.46	34.47	7.18	1.38	347	< 5.	39	4	< .05	< .03	< .002	< .002
Little Bear Spring	29-Mar-2011	---	8.3	7.7	569	351	68.08	36.85	6.21	1.45	284	< 5.	40	4	< .05	< .03	< .002	< .002
Little Bear Spring	20-Jun-2011	---	8.8	7.62	568	323	65.88	35.86	7.35	1.5	271	< 5.	41	4	< .05	< .03	0.002	< .002
Little Bear Spring	20-Sep-2011	---	8.8	7.57	583	344	64.45	34.71	7.33	1.51	276	< 5.	39	3	< .05	< .03	< .002	< .002
Little Bear Spring	27-Dec-2011	---	8.3	7.67	569	302	65.55	36.19	7.32	1.51	276	<5	38	3	<.05	<.03	<.002	<.002
SP-18	20-Jun-2005	0.17	6.4	8.08	610													
SP-18	23-Sep-2005	0.16	6.4	8.04	840													
SP-18	25-Oct-2005	0.16	3.8	8.18	766													
SP-18	25-Jun-2006	0.051	10.4	8.18	784													
SP-18	23-Sep-2006	0																
SP-18	5-Nov-2006	0																
SP-18	23-Jun-2007	0																
SP-18	17-Sep-2007	0																
SP-18	26-Oct-2007	0																
SP-18	29-May-2008	0																
SP-18	28-Aug-2008	0																
SP-18	16-Oct-2008	0																
SP-18	3-Jun-2009	0																
SP-18	2-Sep-2009	0																
SP-18	8-Oct-2009	0																
SP-18	19-Jun-2010	0																

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-18	8-Sep-2010	0																
SP-18	18-Oct-2010	0																
SP-18	24-Jun-2011	0.084	6.6	8.17	797													
SP-18	14-Sep-2011	0.017	8.3	8.19	946													
SP-18	14-Oct-2011	0.015	5.3	8.15	956													
SP-22	20-Jun-2005	1.09	7.6	7.84	506													
SP-22	23-Sep-2005	0.05	9.8	8.35	473													
SP-22	25-Oct-2005	0.1	4.9	7.87	503													
SP-22	25-Jun-2006	0.15	11.2	8.04	601													
SP-22	23-Sep-2006	0.24	5.7	8.05	531													
SP-22	5-Nov-2006	0.127	2.8	7.89	534													
SP-22	23-Jun-2007	< .05	14.9	7.84	571													
SP-22	17-Sep-2007	0																
SP-22	26-Oct-2007	0.0598	4.3	7.73	524													
SP-22	29-May-2008	0.56	4.8	7.98	448													
SP-22	28-Aug-2008	0																
SP-22	16-Oct-2008	0.085	4.6	7.92	572													
SP-22	3-Jun-2009	0.16	8.1	7.72	569													
SP-22	2-Sep-2009	0																
SP-22	8-Oct-2009	0.017	5.6	7.88	652													
SP-22	19-Jun-2010	0.009	10.9	8.09	721													
SP-22	8-Sep-2010	0																
SP-22	18-Oct-2010	0.006	6.1	7.6	706													
SP-22	24-Jun-2011	0.661	8.2	7.97	670													
SP-22	14-Sep-2011	0.049	9.2	7.92	713													
SP-22	14-Oct-2011	0.101	6.7	7.85	660													
SP-79	27-Jul-2005	0.54	9.8	8.05	901	632	75.3	76.0	16.2	5.63	458	<5	20	11	0.24	<0.03	0.033	<0.002
SP-79	2-Sep-2005	0.38	8.6	8.26	873	661	80.5	76.1	15	5.12	426	< 5.	221	15	0.78	< .03	0.07	< .002
SP-79	28-Dec-2005	1.05	2	8.19	928	594	78.6	77.1	15.2	4.99	411	5	201	14	2.14	< .03	0.152	< .002
SP-79	27-Jun-2006	0.78	9.7	8.19	946	641	84.5	85.8	15.6	5.51	422	< 5.	209	15	0.63	< .03	0.055	0.013
SP-79	22-Sep-2006	1.19	6	8.16	920	642	84.64	81.04	16.17	5.29	423	< 5.	208	14	0.9	< .03	0.077	0.013
SP-79	13-Nov-2006	1	2.8	7.99	914	653	85.07	82.47	16.31	4.8	408	< 5.	218	15	1.16	< .03	0.074	0.008
SP-79	15-Mar-2007	1.55	1.7	8.18	919	647	74.45	73.76	15	4.52	373	50	160	18.2	1.823	0.009	0.152	0.006
SP-79	19-Jun-2007	0.55	9.4	8.3	867	636	81.46	74.49	14.69	5.22	411	< 10.	149	12.1	0.766	0.012	0.074	0.002
SP-79	18-Sep-2007	0.66	8.5	8.33	893	637	91	84.65	17.28	4.89	406	< 10.	207	12.6	0.862	< .01	0.063	0.005

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
SP-79	5-Dec-2007	0.962	2.6	8.3	751	621	73.49	79.84	16.6	4.54	400	< 10.	190	12.6	1.317	< .01	0.091	0.003
SP-79	25-Jul-2008	0.71	9.9	8.18	913	621	81.36	72.02	15.16	4.8	405	< 10.	189	13.2	0.218	0.011	0.016	0.004
SP-79	4-Sep-2008	0.71	7.9	8.13	914	634	82.77	78.13	15.32	4.93	405	< 10.	173	12.2	0.272	< .01	0.023	0.005
SP-79	23-Dec-2008	0.89	1.5	8.18	929	635	78.64	75.44	16.3	4.67	390	< 10.	214	12	0.621	< .01	0.046	< .001
SP-79	24-Mar-2009	1.39	2	8.13	924	654	82.72	79.69	17.5	4.86	391	< 10.	213	12.1	1.874	< .01	0.103	0.001
SP-79	24-Jun-2009	0.743	9.5	8.06	885	625	82.92	73.85	15.59	4.99	366	< 10.	192	12.2	3.074	< .01	0.227	< .001
SP-79	9-Sep-2009	0.57	9.6	8.14	892	621	80.74	75.94	15.6	5.03	396	< 10.	200	11.6	0.376	< .01	0.026	0.002
SP-79	3-Nov-2009	1.08	3.9	8.19	912	649	90.83	76.41	14.52	4.37	416	<10	212.5	13.3	0.212	< .01	0.014	0.002
SP-79	24-Jun-2010	0.58	9.3	7.72	933	618	80.78	75.3	15.38	4.99	410	< 10.	204	10.15	0.804	< .01	0.062	0.002
SP-79	10-Sep-2010	0.746	7	8.08	928	601	85.5	79.05	15.15	4.94	411	< 5.	186	13	0.17	< .03	0.016	0.006
SP-79	2-Dec-2010	0.98	2.3	8.01	972	645	81.79	80.52	16.74	4.46	421	< 5.	198	14	0.19	< .03	0.017	0.002
SP-79	30-Aug-2011	0.7	10	8.16	940	602	78.82	76.35	16.32	5.26	333	< 5.	189	13	0.12	< .03	0.013	0.007
SP-79	16-Nov-2011	1.2	3.4	8.07	939	633	80.06	81.46	18.12	4.86	346	< 5.	200	13	< .05	< .03	0.004	< .002
DH-1	11-Mar-1988	1.0	5.4	8.3	1125		60.0	85.1	14.1	8.0	521	0	88.5	10.0		0.05	<0.01	
DH-1	31-May-1988	0.2	7.0	7.9	1100		92.0	86.3	14.2	11.0	605	0	63.0	11.8	<0.05		0.03	
DH-1	28-Sep-1988	1.0	8.2	8.2	460		84.0	82.7	14.8	7.5	312	0	82.5	10.4			<0.01	
DH-1	3-Nov-1988	0.3	7.6	8.1	1039		58.0	81.5	14.1	7.8	560	0	91.2	8.1	<0.05		0.06	
DH-1	31-Mar-1989					673	91.1	86.8	15.3	8.1	556	28	150.0	5.0		<0.02	<0.01	
DH-1	12-Jun-1989					680	104.0	87.2	11.4	6.3	614	<1	150.0	10.0		<0.02	<0.01	
DH-1	18-Jan-1990	1.0	7.5	7.8	840													
DH-1	29-Jan-1990					620	92.8	85.1	11.9	6.2	617	<1	100.0	7.5		<0.02	<0.01	
DH-1	13-Apr-1990					633	120.0	79.5	12.0	8.1	559	<1	170.0	35.0		<0.02	<0.01	
DH-1	14-Apr-1990	0.0	7.8	7.9	835													
DH-1	23-Jul-1990	0.0	7.0	7.9	840													
DH-1	24-Jul-1990					573	83.1	84.5	3.6	6.3	531	<1	100.0	30.0		<0.02	<0.01	
DH-1	9-Oct-1990	0.0	4.9	8.9	600													
DH-1	10-Oct-1990					499	87.5	89.9	14.0	5.6	574	<1	130.0	20.0	<0.02	<0.02	<0.01	
DH-1	12-Jan-1991	0.0	9.5		300													
DH-1	14-Jan-1991					556	97.2	89.4	15.6	7,41	564	<1	130.0	100.0		0.08	0.30	
DH-1	4-Apr-1991	0.0	4.4	8.6	500													
DH-1	30-Apr-1991					560	96.2	84.5	11.4	6.5	602	<1	90.0	30.0	<0.02		<0.01	
DH-1	1-Jul-2191	0.0	7.2	9.1	710	557	84.6	58.0	23.1	8.0	543	<1	76.0	10.0		<0.02	0.22	
DH-1	11-Oct-1991	0.0	8.0	8.0	900	595	79.0	82.3	13.9	2.3	584	<1	100.0	10.0		0.07		
DH-1	8-Mar-1992	dry																
DH-1	2-Jun-1992	dry																
DH-1	22-Sep-1992	dry																

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
DH-1	16-Dec-1992	dry																
DH-1	2-Mar-1994	dry																
DH-1	6-Jun-1994	dry																
DH-1	28-Sep-1994	dry																
DH-1	20-Dec-1994	dry																
DH-1	29-Mar-1995	dry																
DH-1	27-Jun-1995	dry																
DH-1	27-Sep-1995	dry																
DH-1	18-Mar-1999	dry																
DH-1	24-Jun-1999	dry																
DH-1	15-Sep-1999	dry																
DH-1	7-Dec-1999	dry																
DH-1	30-Mar-2000	dry																
DH-1	27-Jun-2000	dry																
DH-1	27-Sep-2000	dry																
DH-1	14-Dec-2000	dry																
DH-1	13-Mar-2001	dry																
DH-1	1-May-2001	dry																
DH-1	27-Sep-2001	dry																
DH-1	3-Dec-2001	dry																
DH-1	27-Mar-2002	dry																
DH-1	20-Jun-2002	dry																
DH-1	25-Sep-2002	dry																
DH-1	26-Dec-2002	dry																
DH-1	28-Mar-2005	dry																
DH-1	28-Jun-2005	dry																
DH-1	22-Aug-2005	dry																
DH-1	22-Nov-2005	dry																
DH-1	27-Mar-2006	dry																
DH-1	17-May-2006	dry																
DH-1	15-Aug-2006	dry																
DH-1	21-Nov-2006	dry																
DH-1	15-Mar-2007	0																
DH-1	18-Jun-2007	0																
DH-1	12-Sep-2007	Inaccessible; mine closed																

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MW-1	11-Mar-1988	185.0	9.5	7.7	530	308	34.0	25.5	32.5	6.4	284	0	6.6	5.3		0.05	<0.01	
MW-1	31-May-1988	185.5	8.2	8.6	350	240	34.2	24.2	33.4	0.0	284	0	5.7	4.5	0.14		0.01	
MW-1	28-Sep-1988	186.7	19.0	7.1	460	240	34.0	24.3	44.0	4.7	295	0	5.1	5.3	<0.05		0.02	
MW-1	3-Nov-1988		10.9	10.9	460	196	32.0	17.0	39.1	4.3	282	0	5.7	3.5	<0.05		<0.01	
MW-1	31-Mar-1989					312	23.8	16.5	69.7	4.5	301	<1	24.0	10.0		<0.02	<0.01	
MW-1	12-Jun-1989					392	25.1	18.0	77.2	3.8	285	<1	50.0	20.0		0.06	<0.01	
MW-1	3-Oct-1989					341	15.7	13.2	78.6	3.2	311	<1	10.0	15.0		<0.02	<0.01	
MW-1	18-Dec-1989					292	20.6	14.5	74.0	2.1	311	<1	23.0	15.0		0.31	0.05	
MW-1	18-Jan-1990		10.2	8.1	450													
MW-1	29-Jan-1990					300	31.0	17.0	65.2	0.2	314	<1	24.0	10.0		<0.02	<0.01	
MW-1	13-Apr-1990					279	31.2	13.7	64.1	6.4	303	<1	18.0	10.0		<0.02	<0.01	
MW-1	14-Apr-1990	2.0	10.3	7.8														
MW-1	1-Jul-2390	0.0	10.3	8.1														
MW-1	24-Jul-1990					307	22.4	12.2	74.4	3.5	315	<1	5.0	25.0		<0.02	0.02	
MW-1	9-Oct-1990		6.2	8.4	400													
MW-1	10-Oct-1990					261	21.0	13.1	86.1	2.8	339	<1	15.0	10.0	<0.02		<0.01	
MW-1	20-Dec-1990					247	29.3	11.1	73.6	2.9	297	<1	27.0	15.0	0.13		<0.01	
MW-1	11-Jan-1991					247	29.3	11.1	73.6	2.9	297	<1	27.0	15.0	0.13		<0.01	
MW-1	12-Jan-1991		7.7	8.2	300													
MW-1	14-Jan-1991					288	30.5	20.0	76.9	12.2	346	<1	21.0	14.5		0.03	0.28	
MW-1	4-Apr-1991	4.8	7.2	8.0	400	306	25.1	7.2	69.4	2.3	280	<1	18.0	25.0	<0.02	<0.02	<0.01	
MW-1	21-Jul-1991					298	22.4	14.6	71.4	4.2	298	<1	14.0	15.0		0.02	<0.01	
MW-1	11-Oct-1991		12.0	7.8	700	289	24.2	4.6	8.6	0.0	289	<1	23.0	15.0		0.07		
MW-1	10-Dec-1991					265	21.8	15.1	68.8	6.8	316	0	21.0	10.0		0.00	0.00	
MW-1	8-Mar-1992		12.2	7.9		326	27.2	12.4	96.5	3.8	334	0	27.0	10.0	0.00		0.00	
MW-1	24-Jun-1992		12.2	8.0		288	26.9	9.2	84.8	5.0	287	0	28.0	15.0	0.00		0.00	
MW-1	22-Sep-1992		12.2	7.6		372	27.9	17.1	51.7	61.8	281	0	60.0	45.0	0.00		0.02	
MW-1	8-Dec-1992		13.1	7.3		252	10.9	1.4	88.0	2.1	291	0	27.0	15.0	0.08		0.00	
MW-1	4-Mar-1993	1.1	12.8	7.5	532		18.9	14.5	71.4	3.4	285	0	21.0	0.1		6.80	0.47	
MW-1	15-Jun-1993	6.0	14.6	7.3	561	333	20.2	14.9	68.3	2.4	284	0	20.0	26.3		0.05	<0.03	
MW-1	16-Sep-1993	1.8	11.3	7.9	568	333	19.6	18.0	90.0	4.0	283	0	17.0	28.9	0.16	<0.05	<0.03	
MW-1	7-Dec-1993	3.0	12.4	6.7	528	353	19.0	16.0	70.0	9.0	233	<1	20.0	31.0	0.02	<0.02	<0.1	
MW-1	2-Mar-1994	0.4	56.0	6.7	554	292	27.0	10.0	78.0	4.0	284	0	19.0	15.0		0.08	<.02	
MW-1	6-Jun-1994	2.3	56.3	6.7	785	290	25.0	17.0	69.0	0.4	299	0	21.0	10.0		<0.05	<.02	
MW-1	28-Sep-1994	0.6	58.7	6.3	920	315	18.0	14.0	80.0	16.0	291	0	19.0	26.0		0.09	<.02	
MW-1	20-Dec-1994	0.5	56.2	7.0	860	300	18.0	13.0	75.0	4.0	262	0	18.0	14.0		<0.1	<0.1	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MW-1	29-Mar-1995					230	24.0	20.0	69.0	4.0	275	<5	17.0	12.0		<0.1		<0.1
MW-1	7-Jun-1995	0.5	12.0			290	20.0	16.0	73.0	4.0	260	15	18.0	14.0		<0.1		<0.1
MW-1	27-Sep-1995	0.5	15.0	7.9	540	410	110.0	43.0	14.0	5.0	475	<5	26.0	7.0		<0.1		<0.1
MW-1	18-Dec-1995	0.5	15.0	7.7	705	300	21.0	16.0	69.0	4.0	295	<5	17.0	13.0		<0.1		<0.1
MW-1	26-Mar-1996					268	19.0	15.0	72.0	3.8	302	<2	37.0	13.0		<0.03		<.04
MW-1	19-Jun-1996	0.5	15.4	7.7	508	296	20.0	15.0	73.0	4.0	296	<5	18.0			<0.1		<0.1
MW-1	30-Sep-1996					442	85.0	47.0	15.0	6.0	460	<5	39.0	13.0		0.10		<0.1
MW-1	30-Oct-1996	0.4	14.5	8.1	498	298	20.0	14.0	72.0	4.0	308	<5	18.0	13.0		<0.1		<0.1
MW-1	3-Feb-1997		12.7	8.0	500	244	19.0	16.0	73.0	4.0	293	<5	18.0	12.0	0.80	<0.1	<0.1	
MW-1	22-May-1997	0.4	10.4	7.8	504	280	19.0	13.0	66.0	3.0	299	<5	18.0	12.0	0.40	<0.4	<0.1	
MW-1	30-Dec-1997	0.4	13.2	7.5	496	290	21.0	16.0	67.0	3.0	307	<5	18.0	7.0	<0.1	<0.1	<0.1	
MW-1	31-Mar-1998	0.1	12.6	7.7	530	279	20.0	16.0	67.0	4.0	305	<5	15.0	12.0	<0.1	<0.1	<0.1	
MW-1	28-May-1998	0.2	12.6	7.6	518	279	21.0	15.0	76.0	4.0	300	<5	15.0	11.0	2.10	<0.1	<0.1	
MW-1	24-Jun-1999	0.0	12.5	7.9	490	258	22.0	15.0	73.0	5.0	303	<5	17.0	12.0	<0.1	<0.1	<0.1	
MW-1	15-Sep-1999	0.0																
MW-1	7-Dec-1999	0.0																
MW-1	30-Mar-2000	0.30	13.4	8.3	491	298	22	17	74	4	297	<5	18	12	<0.1	<0.1		<0.1
MW-1	27-Jun-2000	0.67	14.2	7.3	494	260	19	15	71	4	300	<5	18	11	<0.1	<0.1	<0.1	<0.1
MW-1	27-Sep-2000	0.7	14.7	7.3	494	266	19	15	73	4	295	<5	19	13	0.4	<0.1	<0.1	<0.1
MW-1	14-Dec-2000	0.5	13.4	8	545	285	18	14	68	4	303	<5	16	10	<0.1	<0.1	<0.1	<0.1
MW-1	13-Mar-2001	0																
MW-1	1-May-2001	0																
MW-1	27-Sep-2001	0																
MW-1	3-Dec-2001	0.3	10.9	8	476	274	22	16	64	4	296	<5	15	9.4	0.7	<0.1	<0.05	<0.05
MW-1	27-Mar-2002	0																
MW-1	20-Jun-2002	0																
MW-1	25-Sep-2002	0																
MW-1	26-Dec-2002	0																
MW-1	27-Feb-2004	0																
MW-1	17-Jun-2004	0																
MW-1	30-Sep-2004	0																
MW-1	25-Oct-2004	0																
MW-1	28-Mar-2005	0																
MW-1	28-Jun-2005	0																
MW-1	22-Aug-2005	0																
MW-1	22-Nov-2005	0																
MW-1	27-Mar-2006	0																

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		μS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MW-1	17-May-2006	0																
MW-1	15-Aug-2006	0																
MW-1	21-Nov-2006	0																
MW-1	15-Mar-2007	0																
MW-1	18-Jun-2007	0																
MW-1	12-Sep-2007	Inaccessible; mine closed																
MW-2	21-Jun-1989					614	121.2	67.6	22.4	0.7	368	<1	290.0	10.0		1.9	0.1	
MW-2	2-Oct-1989					464	75.8	47.6	16.9	7.2	410	<1	80.0	10.0		1.1	0.1	
MW-2	30-Jan-1990						852.0	146.3	22.6	27.7			16.50.0		44	30.7	0.6	
MW-2	30-Apr-1990					990	463.2	77.9	13.9	41.6	510	<1	800.0	15.0		0.0	0.8	
MW-2	23-Jul-1990	57.8 feet	10.0	7.8														
MW-2	24-Jul-1990					254	118.3	47.4	18.8	7.4	448	<1	150.0	20.0		<0.02	0.1	
MW-2	9-Oct-1990	54.0 feet	9.6	7.9	700													
MW-2	10-Oct-1990					492	135.5	48.9	19.9	5.4	422	<1	200.0	20.0	2	1.4	0.1	
MW-2	12-Jan-1991	72.2 feet	11.4	7.5	500													
MW-2	14-Jan-1991					592	149.9	57.8	61.0	10.5	507	<1	180.0	125.0		2.1	0.2	
MW-2	4-Apr-1991	52.6 feet	11.3	7.8	600	540	108.4	52.9	18.3	13.1	398	<1	170.0	45.0	1	0.0	0.1	
MW-2	21-Jul-1991					388	73.5	31.7	11.9	7.2	402	<1	18.0	10.0		0.0	0.0	
MW-2	11-Oct-1991	55.2 feet	11.0	7.2	800	389	89.3	40.0	13.7	0.0	425	<1	25.0	10.0		0.2		
MW-2	10-Dec-1991					369	74.8	37.5	1.1	6.7	398	<1	23.0	15.0		1.9	0.0	
MW-2	8-Mar-1992	56.0 feet	10.0	7.2	500	361	95.9	39.3	12.5	5.3	447	<1	17.0	15.0		0.0	0.0	
MW-2	2-Jun-1992	56.6 feet	8.3	7.7		420	94.4	41.4	15.1	6.6	457	<1	60.0	20.0		0.3	0.0	
MW-2	15-Sep-1992	53.5 feet	13.3	7.6		364	90.2	49.1	10.9	7.7	461	<1	27.0	15.0	5	4.9	0.0	
MW-2	16-Dec-1992	53.3 feet	9.7	7.3	813	313	158.0	63.2	14.6	5.1	424	<1	310.0	10.0	4	4.2	0.1	
MW-2	4-Mar-1993	53.5 feet	11.7	7.4	768	200	84.6	44.6	12.9	4.2	434	<1	70.0	0.1	41	37	0	
MW-2	15-Jun-1993	53.9 feet	12.2	7.4	748		67.2	37.6	12.3	4.6	423	<1	32.0	4.8		0	<0.03	
MW-2	16-Sep-1993	52.8 feet	11.0	7.4	754		76.3	16.0	85.0	4.0	446	<1	11.0	4.8	3	<0.05	<0.03	
MW-2	7-Dec-1993	52.4 feet	11.4	7.2	672		77.0	45.0	14.0	6.0	355	<1	30.0	5.0	3	<0.02	<0.10	
MW-2	2-Mar-1994	52.3 feet	53.0	7.4	694	416	81.0	45.0	15.0	5.0	476	<5	31.0	5.2		1	<0.02	
MW-2	6-Jun-1994	52.0 feet	53.7	6.4	910	390	33.0	74.0	15.0	5.6	468	<5	30.0	3.1		3	0	
MW-2	28-Sep-1994	51.6 feet	54.0	7.0	724	413	79.0	45.0	14.0	5.9	442	<5	47.0	3.7		2	0	
MW-2	20-Dec-1994	51.7 feet	55.0	7.0	810	420	80.0	44.0	15.0	6.0	418	<5	30.0	5.0		<.1	<0.1	
MW-2	29-Mar-1995					370	89.0	46.0	14.0	5.0	425	<5	26.0	6.0		0	<0.1	
MW-2	27-Jun-1995		12.0			430	73.0	45.0	15.0	5.0	460	<5	21.0	7.0		<0.1	<0.1	
MW-2	27-Sep-1995		12.9	7.6	782	410	110.0	43.0	14.0	5.0	475	<5	26.0	7.0		<0.1	<0.1	
MW-2	18-Dec-1995	51.2 feet	12.5	7.3	1178	470	78.0	43.0	19.0	5.0	450	<5	41.0	6.0		<0.1	<0.1	

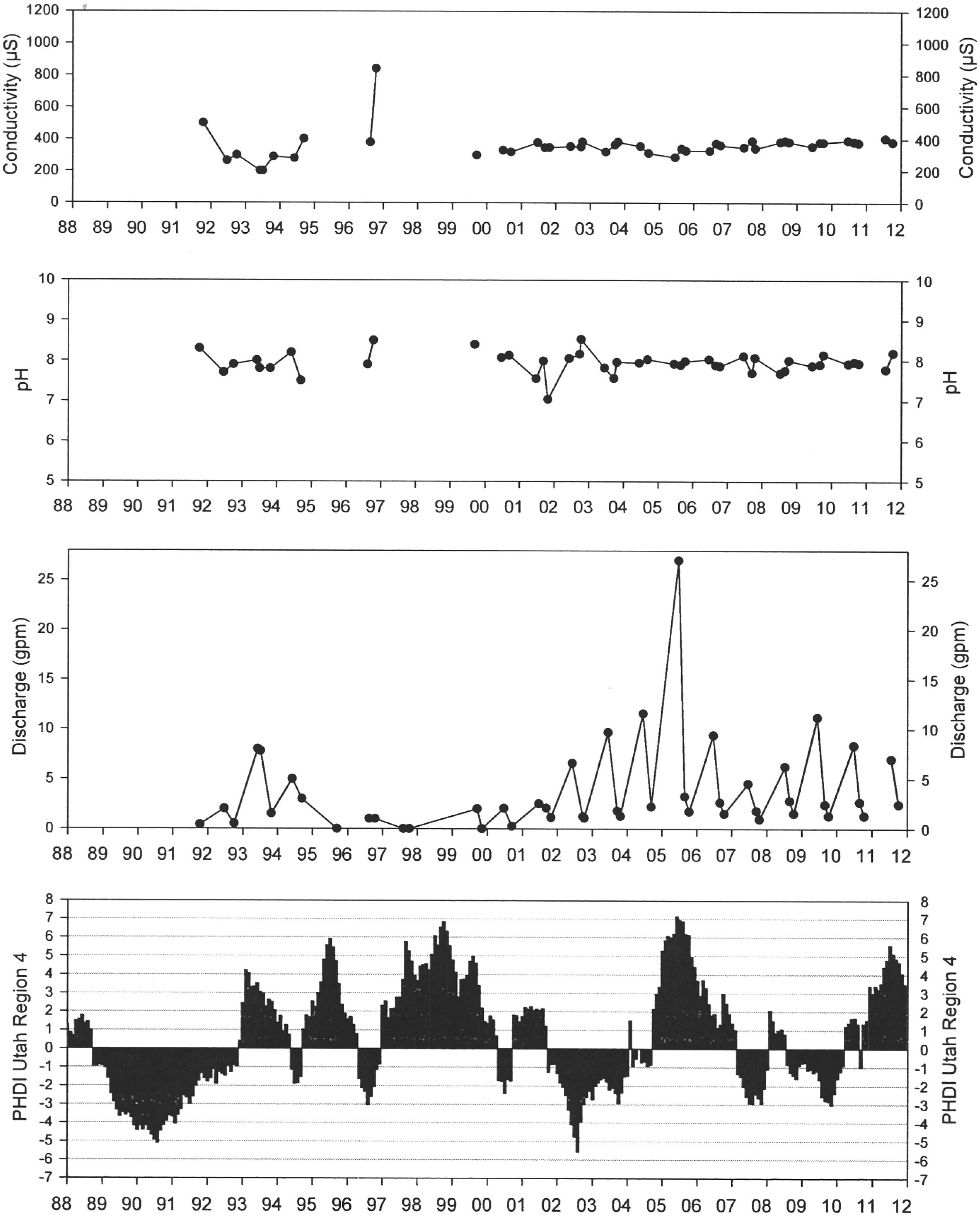
	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MW-2	3-Feb-1997		10.9	7.3	731	413	74.0	41.0	14.0	5.0	450	<5	39.0	5.0	5	<0.1	<0.1	
MW-2	22-May-1997	49.4 feet	11.6	7.1	706	430	77.0	42.0	12.0	4.0	455	<5	51.0	7.0	2	<0.1	<0.1	
MW-2	21-Aug-1997	51.6 feet	11.9	6.5	713	390	88.0	47.0	19.0	6.0	427	<5	59.0	6.0	2	<0.1	<0.1	
MW-2	30-Dec-1997	flooded																
MW-2	31-Mar-1998	flooded																
MW-2	28-May-1998	flooded																
MW-2	18-Mar-1999	flooded																
MW-2	24-Jun-1999	flooded																
MW-2	15-Sep-1999	flooded																
MW-2	7-Dec-1999	flooded																
MW-2	30-Mar-2000	flooded																
MW-2	27-Jun-2000	flooded																
MW-2	27-Sep-2000	flooded																
MW-2	14-Dec-2000	flooded																
MW-2	13-Mar-2001	flooded																
MW-2	1-May-2001	flooded																
MW-2	27-Sep-2001	flooded																
MW-2	3-Dec-2001	flooded																
MW-2	27-Mar-2002	flooded																
MW-2	20-Jun-2002	flooded																
MW-2	25-Sep-2002	flooded																
MW-2	26-Dec-2002	flooded																
MW-2	27-Feb-2004	flooded																
MW-2	17-Jun-2004	flooded																
MW-2	30-Sep-2004	flooded																
MW-2	25-Oct-2004	flooded																
MW-2	28-Mar-2005	flooded																
MW-2	28-Jun-2005	flooded																
MW-2	22-Aug-2005	flooded																
MW-2	22-Nov-2005	flooded																
MW-3	21-Jun-1989					572	74.0	48.4	24.3	6.8	349	<1	110.0	15.0		3.13	0.23	
MW-3	2-Oct-1989					797	150.0	73.6	30.7	13.5	394	<1	410.0	20.0		<0.02	0.13	
MW-3	18-Mar-1999	Inaccessible																
MW-4	4-Mar-1993	dry																
MW-4	15-Jun-1993	dry																

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{-}	SO_4^{2-}	Cl^{-}	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MW-4	16-Sep-1993	dry																
MW-4	17-Feb-1993	dry																
MW-4	2-Mar-1994	dry																
MW-4	6-Jun-1994	dry																
MW-4	28-Sep-1994	dry																
MW-4	20-Dec-1994	dry																
MW-4	29-Mar-1995	dry																
MW-4	27-Jun-1995	dry																
MW-4	27-Sep-1995	dry																
MW-4	18-Mar-1999	Inaccessible																
MW-5	22-Sep-1992	dry																
MW-5	8-Dec-1992	dry																
MW-5	4-Mar-1993	dry																
MW-5	15-Jun-1993					1352	850.0	356.0	18.2	9.7				3.3	26.6		0.91	
MW-5	16-Sep-1993	109 ft	12.5	7.5	104	759	157.0	90.0	8.7	8.0	411	<5	250.0	12.1	1.0		0.14	
MW-5	7-Dec-1993	108.8 ft	12.1	7.2	953	650	51.0	120.0	8.0	11.0	320	<1	250.0	8.0	8.0		0.30	
MW-5	2-Mar-1994	111.0 ft	12.3	7.1	920	653	120.0	69.0	9.2	8.0	400	<5	245.0	5.2				
MW-5	6-Jun-1994	111.0 ft	11.9	6.2	1063	655	34.0	114.0	9.9	20.0	394	<5	267.0	16.0		5.5	0.24	
MW-5	28-Sep-1994	dry																
MW-5	20-Dec-1994	51.5 ft	13.3	7.5	890	740	505.0	224.0	9.0	9.0	577	<5	130.0	12.0		<0.1	0.60	
MW-5	18-Dec-1995	108.2 ft	13.2	7.4	1132	650	108.0	58.0	7.0	5.0	520	<5	214.0	7.0		<0.1	0.10	
MW-5	18-Mar-1999	destroyed																
MW-6a	6-May-1997		14.2	8.2	544	320	46.0	32.0	22.0	12.0	243	<5	61.0	17.0	0.8	<0.1	0.40	
MW-6a	28-May-1998		12.5	7.1	524	330	63.0	36.0	13.0	5.0	310	<5	33.0	9.0	1.8	<0.1	0.20	
MW-6a	18-Mar-1999	1.8 feet	13.1	7.7	519	317	41.0	35.0	11.0	5.0	311	<5	5.0	6.0	0.5	<0.1	<0.1	
MW-6a	24-Jun-1999	inaccessible																
MW-6a	15-Sep-1999	2.3 feet																
MW-6a	7-Dec-1999	4.5 feet	12.5	8.1	526	294	62.0	39.0	15.0	4.0	343	<5	32.0	3.0	0.4	<0.1	<0.1	
MW-6a	30-Mar-2000	2 feet	12.5	7.9	526	303	53	38	13	4	340	<5	34	3	0.2	<0.1		<0.1
MW-6a	27-Jun-2000	0.8 feet	13.3	8.00	480	263	48	31	8	3	305	<5	28	4	3.6	<0.1	<0.1	0.1
MW-6a	27-Sep-2000	0.8 feet	13.3	8.00	480	265	46	32	9	4	294	<5	34	5	0.6	<0.1	<0.1	<0.1
MW-6a	14-Dec-2000	1.5 feet	12.9	8.2	489	270	45	30	9	3	300	<5	14	2	0.6	<0.1	<0.1	<0.1
MW-6a	13-Mar-2001	Impacted by mining, inaccessible																
MW-8	5-Jun-1997	dry	14.1	7.8	547	340	64.0	37.0	17.0	6.0	317	<5	40.0	8.0	3.7	<0.1	<0.1	

	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^+	K^+	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MW-8	21-Aug-1997	51.6 feet	14.3	7.2	507	280	60.0	35.0	13.0	4.0	308	<5	36.0	4.0	3.2	<0.1	0.10	
MW-8	30-Dec-1997	2.1 feet	12.7	6.5	504	260	53.0	35.0	13.0	4.0	306	<5	39.0	2.0	5.2	<0.1	<0.1	
MW-8	31-Mar-1998	2.2 feet	13.4	7.7	52	284	57.0	34.0	12.0	5.0	327	<5	33.0	5.0	2.1	<0.1	<0.1	
MW-8	28-May-1998		12.9	7.8	506	274	53.0	35.0	13.0	4.0	311	<5	29.0	4.0	2.8	<0.1	<0.1	
MW-8	18-Mar-1999	2.3 feet	13.3	7.7	512	348	52.0	35.0	13.0	4.0	309	<5	35.0	33.0	2.2	<0.1	<0.1	
MW-8	24-Jun-1999	2.2 feet	11.7	7.4	511	267	64.0	38.0	13.0		328	<5	40.0	3.0	3.8	<0.1	<0.1	
MW-8	15-Sep-1999	2.5 feet																
MW-8	7-Dec-1999	4.5 feet	13.0	7.6	524	305	53.0	37.0	13.0	4.0	332	<5	38.0	4.0	0.7	<0.1	<0.1	
MW-8	30-Mar-2000	2.2 feet	13	7.5	519	310	67	42	13	4	304	<5	41	3	1.3	<0.1		<0.1
MW-8	27-Jun-2000	2.2 feet	13.6	7.1	515	275	48	33	12	4	320	<5	38	3	0.7	<0.1	<0.1	<0.1
MW-8	27-Sep-2000	2.2 feet	13.6	7.1	515	257	47	33	13	4	309	<5	40	3	0.6	<0.1	<0.1	<0.1
MW-8	14-Dec-2000	2.1 feet	13.3	8	518	275	46	32	12	4	312	<5	34	2	0.8	<0.1	<0.1	<0.1
MW-8	13-Mar-2001	Impacted by mining, inaccessible																
MW-6	5-Jun-1997		13.3	12.6	6170	1390	742.0	5.0	62.0	24.0	<5	128	48.0	40.7	1.60	<0.1	0.20	
MW-6	22-Aug-1997	3.3 feet	13.8	10.8	960	280	60.0	4.0	49.0	6.0	<5	35	27.0	8.0	0.70	<0.1	<0.1	
MW-6	30-Dec-1997	0.8 feet	11.9	10.1	635	1030	69.0	6.0	48.0	7.0	<5	24	15.0	4.0	2.80	<0.1	<0.1	
MW-6	31-Mar-1998	0.1 feet	13.5	11.8	488	1009	450.0	2.0	31.0	9.0	<5	56	20.0	13.0	0.60	<0.1	1.00	
MW-6	28-May-1998		12.4	11.5	461	985	304.0	1.0	29.0	9.0	<5	233	23.0	16.7	0.60	<0.1	<0.1	
MW-6	16-Sep-1998		12.9	11.8	6075	1344	397.0	<1	29.0	9.0	<5	35	12.0	2.0	0.20	<0.1	<0.1	
MW-6	18-Mar-1999	0.0 feet	13.3	12.3	6780	1404	626.0	2.0	31.0	9.0	<5	39	10.0	5.0	0.2	<0.1	<0.1	
MW-6	15-Sep-1999	—	13.5	12.2	6290	1241	600.0	10.0	26.0	9.0	<5	57	11.0	8.0	0.3	<0.1	<0.1	
MW-6	7-Dec-1999	0.0 feet	12.5	12.1	6640	1345	604.0	4.0	28.0	8.0	<5	86	14.0	7.0	0.3	<0.1	<0.1	
MW-6	27-Jun-2000	0.0 feet	13.8	12.2	6190	1223	546	<1	25	7	<5	40	18	8	0.1	<0.1	<0.1	<0.1
MW-6	27-Sep-2000	0.0 feet	13.8	12.27	6190	866	343	<1	22	6	31	<5	36	6	0.1	<0.1	<0.1	<0.1
MW-6	14-Dec-2000	0.0 feet	13	12.5	4090	808	270	<1	21	6	<5	38	16	7	<0.1	<0.1	<0.1	<0.1
MW-6	13-Mar-2001	Impacted by mining, inaccessible																
MW-7	5-Jun-1997		12.1	7.7	511	310	62.0	<0.1	4.0	2.0	319	<5	33.0	6.2	0	<0.1	32.00	<0.1
MW-7	21-Aug-1997	0.2	11.0	6.7	496	270	63.0	33.0	5.0	2.0	314	<5	30.0	5.0	0	<0.1	<0.1	
MW-7	11-Feb-1998		20.1	7.4	520	3	58.0	31.0	3.0	2.0	323	<5	31.0	5.0	0	<0.1	<0.1	<0.1
MW-7	28-May-1998	0.1	10.7	6.9	514	301	60.0	34.0	5.0	2.0	312	<5	83.0	10.0	0	<0.1	<0.1	
MW-7	16-Sep-1998	0.1	11.2	7.3	577	35	61.0	32.0	4.0	2.0	324	<5	33.0	4.0	0	<0.1	<0.1	
MW-7	25-May-1999		10.9	8.0	578	323							61.0	6.0				
MW-7	7-Dec-1999	0.1	10.5	7.0	517	281	61.0	32.0	4.0	3.0	327	<5	29.0	4.0		<0.1	<0.1	
MW-7	30-Mar-2000	0.11	10.5	7.5	503	200	63	35	4	2	313	<5	34	4	1.3	<0.1		<0.1
MW-7	27-Jun-2000	0.12	11	7.6	500	263	58	32	4	2	321	<5	32	3	0.2	<0.1	<0.1	<0.1

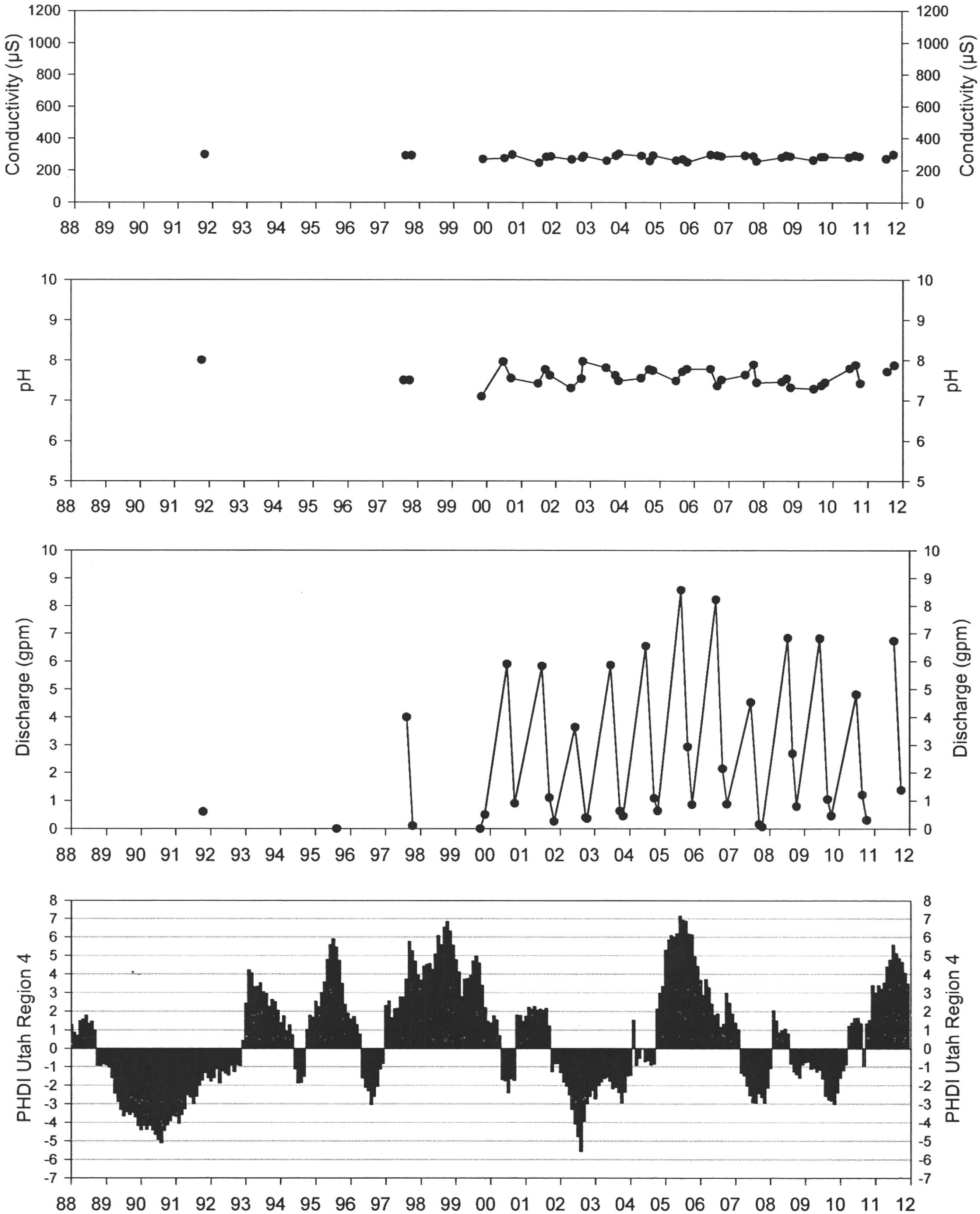
	Date	flow	T	pH	Cond.	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	CO_3^-	SO_4^{2-}	Cl^-	Fe(T)	Fe(d)	Mn(T)	Mn(d)
		gpm	°C		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MW-7	27-Sep-2000	0.1	11	7.6	500	283	57	32	5	2	313	<5	34	4	3.1	<0.1	<0.1	<0.1
MW-7	14-Dec-2000	0.1	11.1	7.8	512	288	56	30	4	2	316	<5	29	3	0.2	<0.1	<0.1	<0.1
MW-7	13-Mar-2001					323	56	32	4	2	314	<5	32	3	0.2	<0.1	<0.1	<0.1
MW-7	1-May-2001	0.1	11.6	7.6	499	275	58	32	3	2	313	<5	32	3	0.3	<0.1	<0.1	<0.1
MW-7	27-Sep-2001		12.2	7.8	487	314	56	32	5	2	316	<5	26.1	5	0.1	<0.1	<0.05	<0.05
MW-7	3-Dec-2001	0.1	10.5	7.5	494	282	57	32	5	2	306	<5	28	3	0.2	<0.1	<0.05	<0.05
MW-7	27-Mar-2002	0.1	11.9	7.5	487	323	55	31	4	2	313	<5.	31	3	0.2	<0.1	<0.05	<0.05
MW-7	20-Jun-2002	0.2	12.8	7.3	480	283	36	24	32	6	226	<5.	69	9	<0.1	<0.1	<0.05	<0.05
MW-7	25-Sep-2002	0.05	11.5	6.8	488	310	51	31	6	2	300	<5.	30	3	0.2	<0.1	<0.05	<0.05
MW-7	26-Dec-2002	0.9		7.83	502	286	42	25	25	6	215	<5	68	7	<0.1	<0.1	<0.05	<0.05
MW-7	31-Jan-2003	Well area inaccessible																

SP2-24



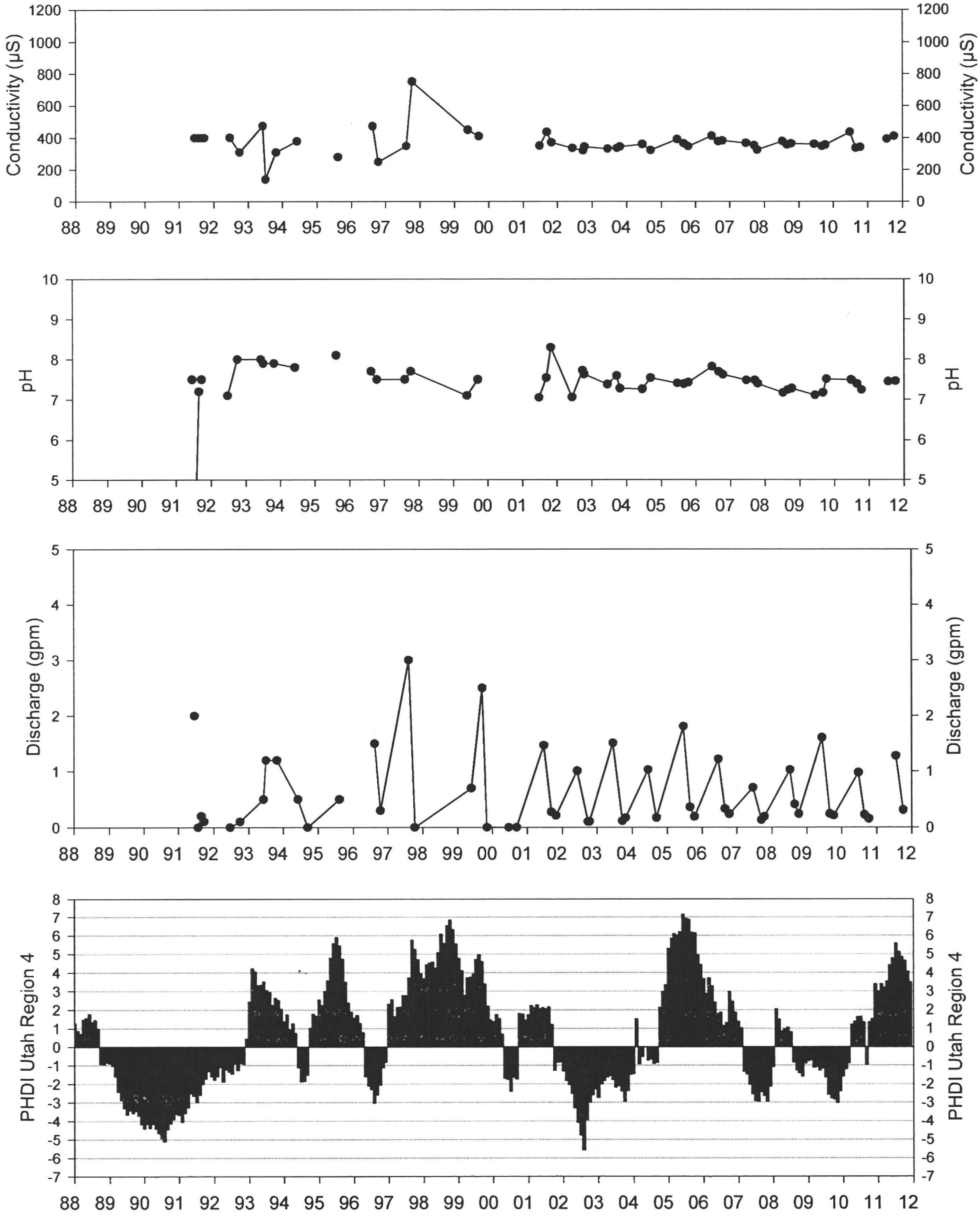
Conductivity (µS)
1200
1000
800
600
400
200
0
pH
10
9
8
7
6
5
Discharge (gpm)
25
20
15
10
5
0
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP2-9



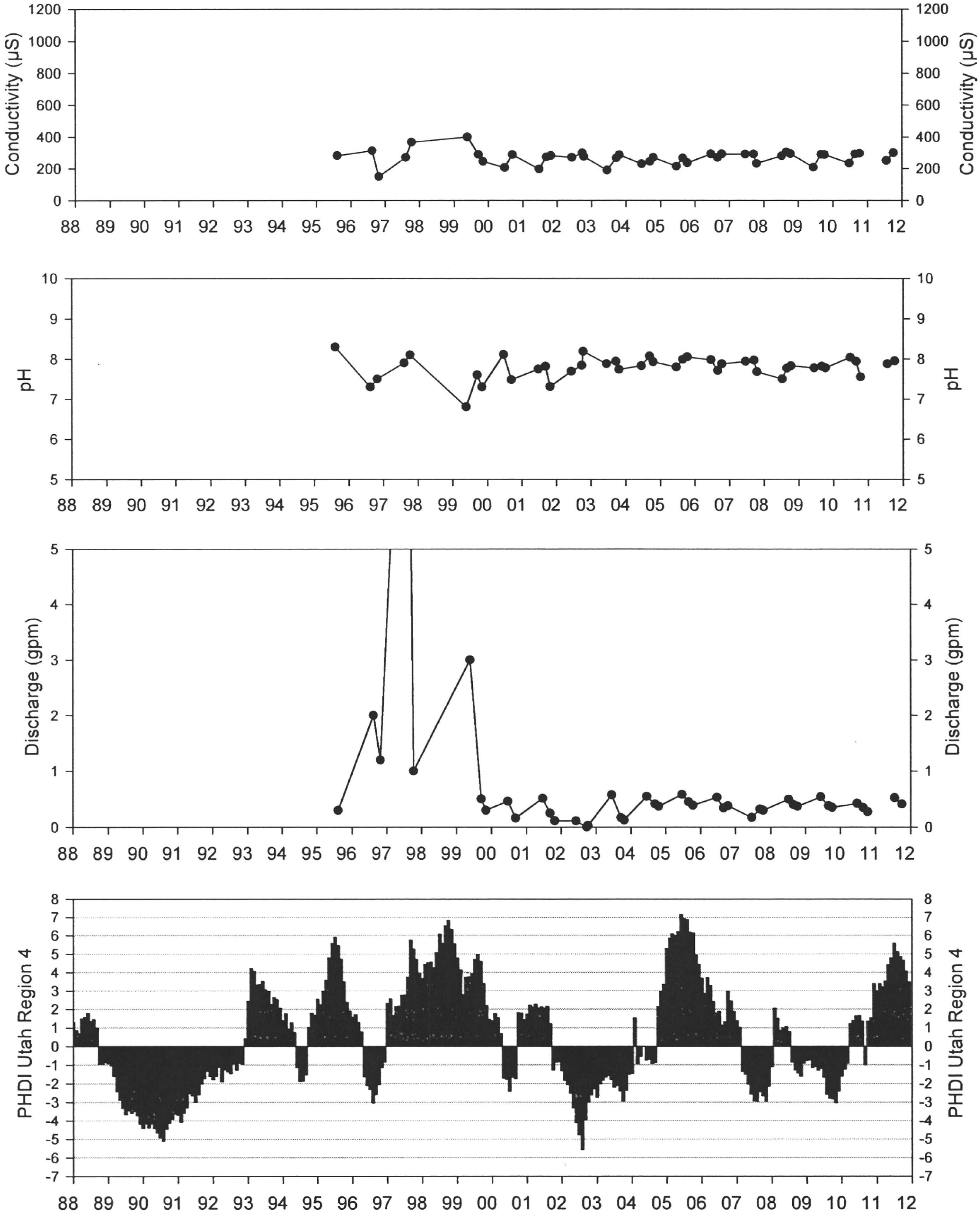
Conductivity (µS)
pH
Discharge (gpm)
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP-47A



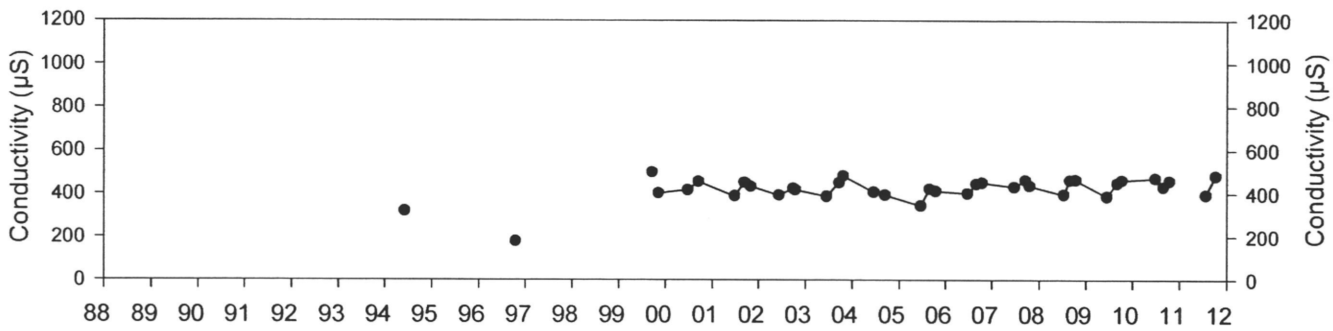
Conductivity (µS)
Conductivity (µS)
pH
pH
Discharge (gpm)
Discharge (gpm)
PHDI Utah Region 4
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP1-3

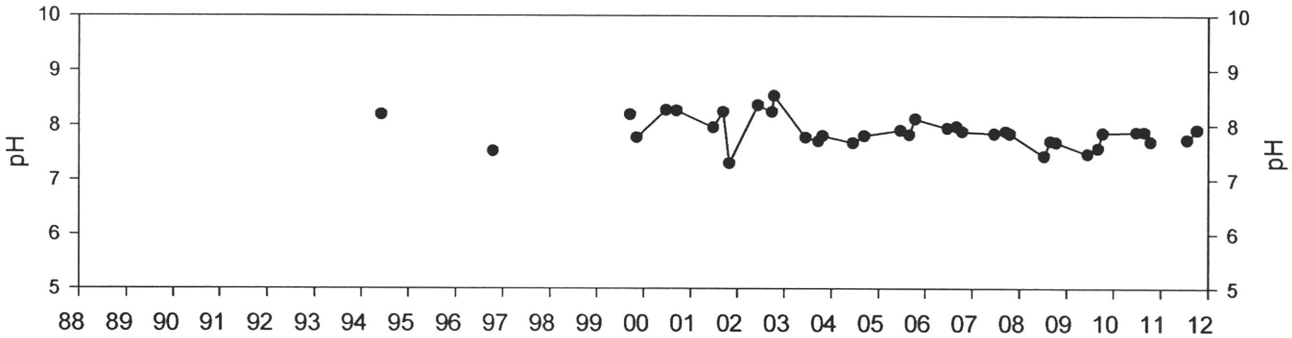


Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
pH
10
9
8
7
6
5
Discharge (gpm)
5
4
3
2
1
0
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7

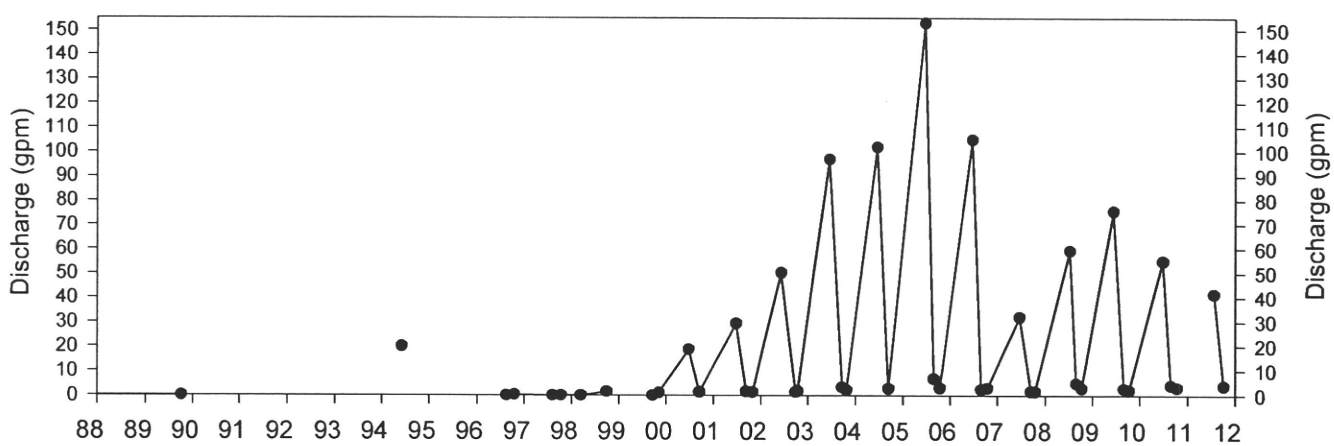
SP1-19



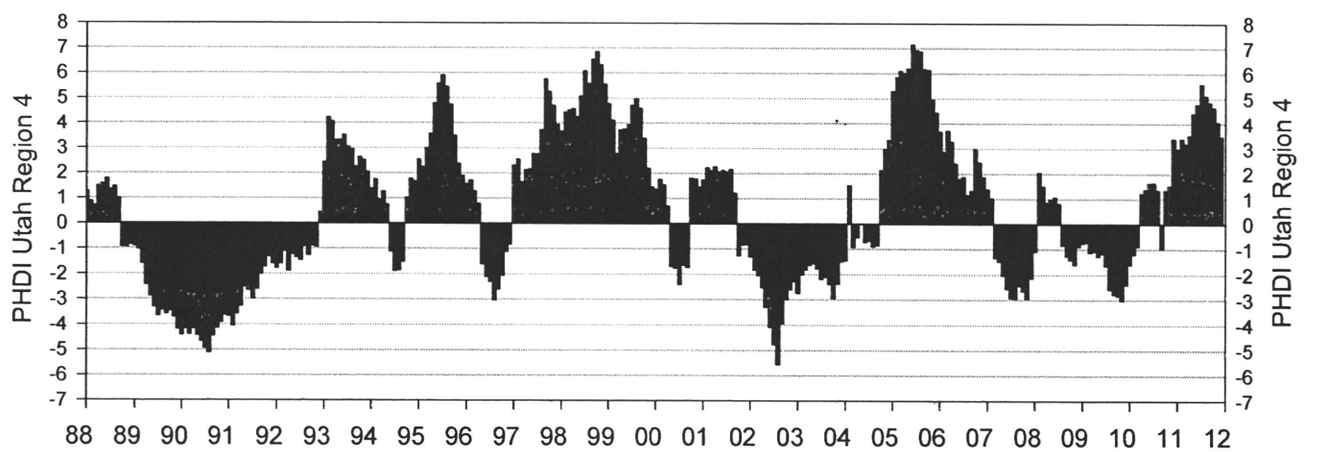
Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

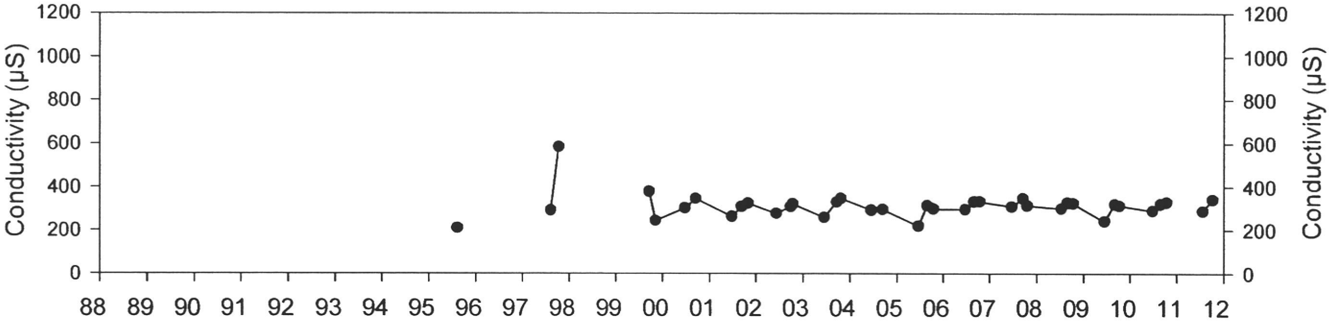


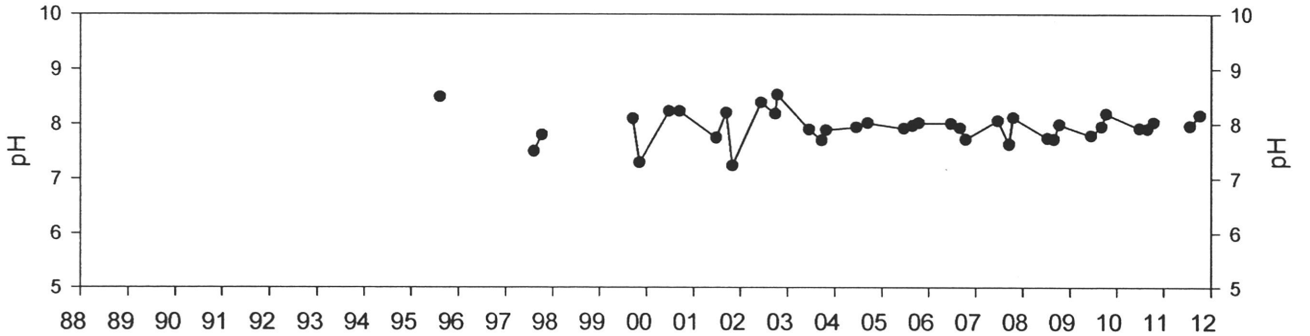
Discharge (gpm)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

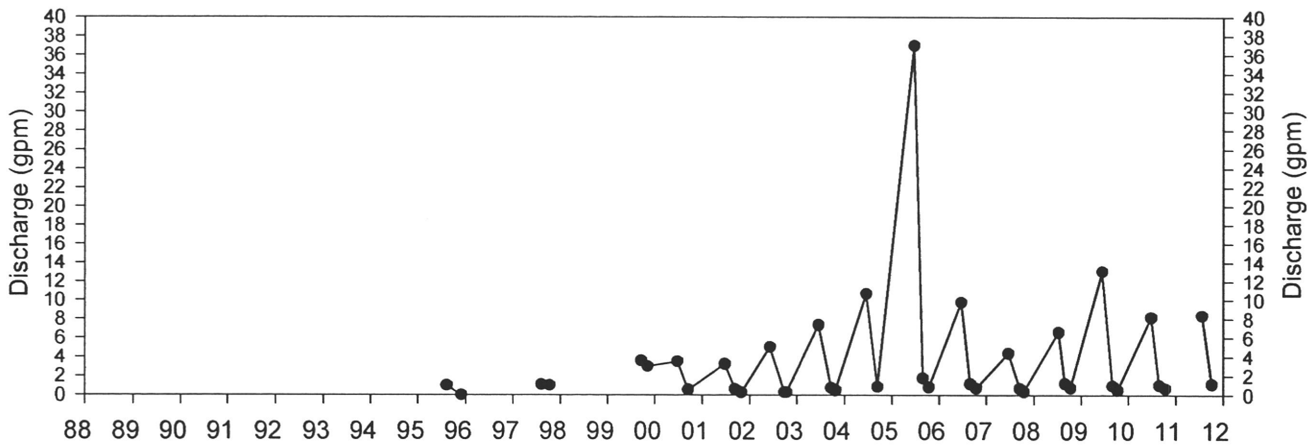


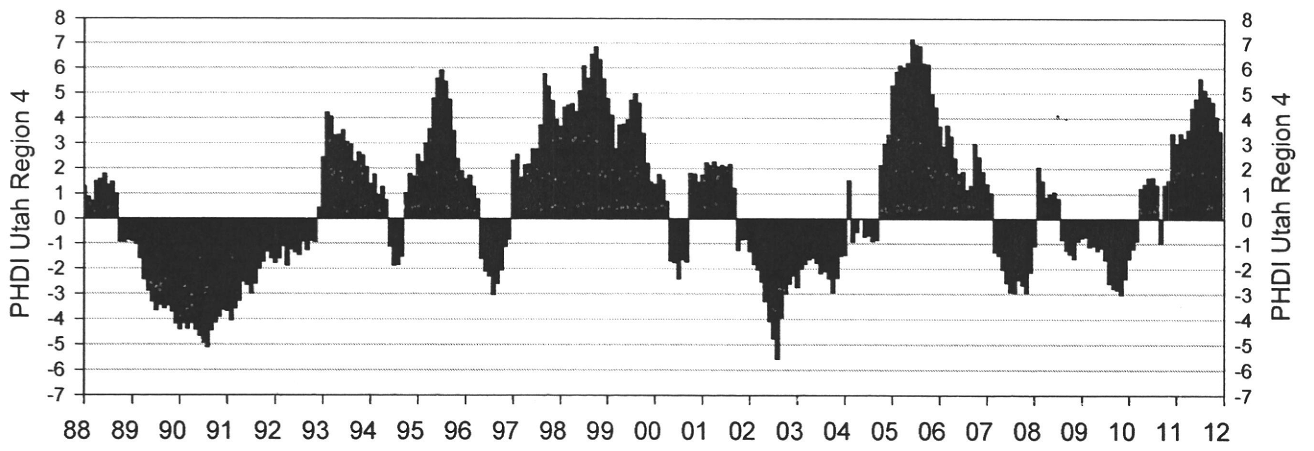
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP1-22

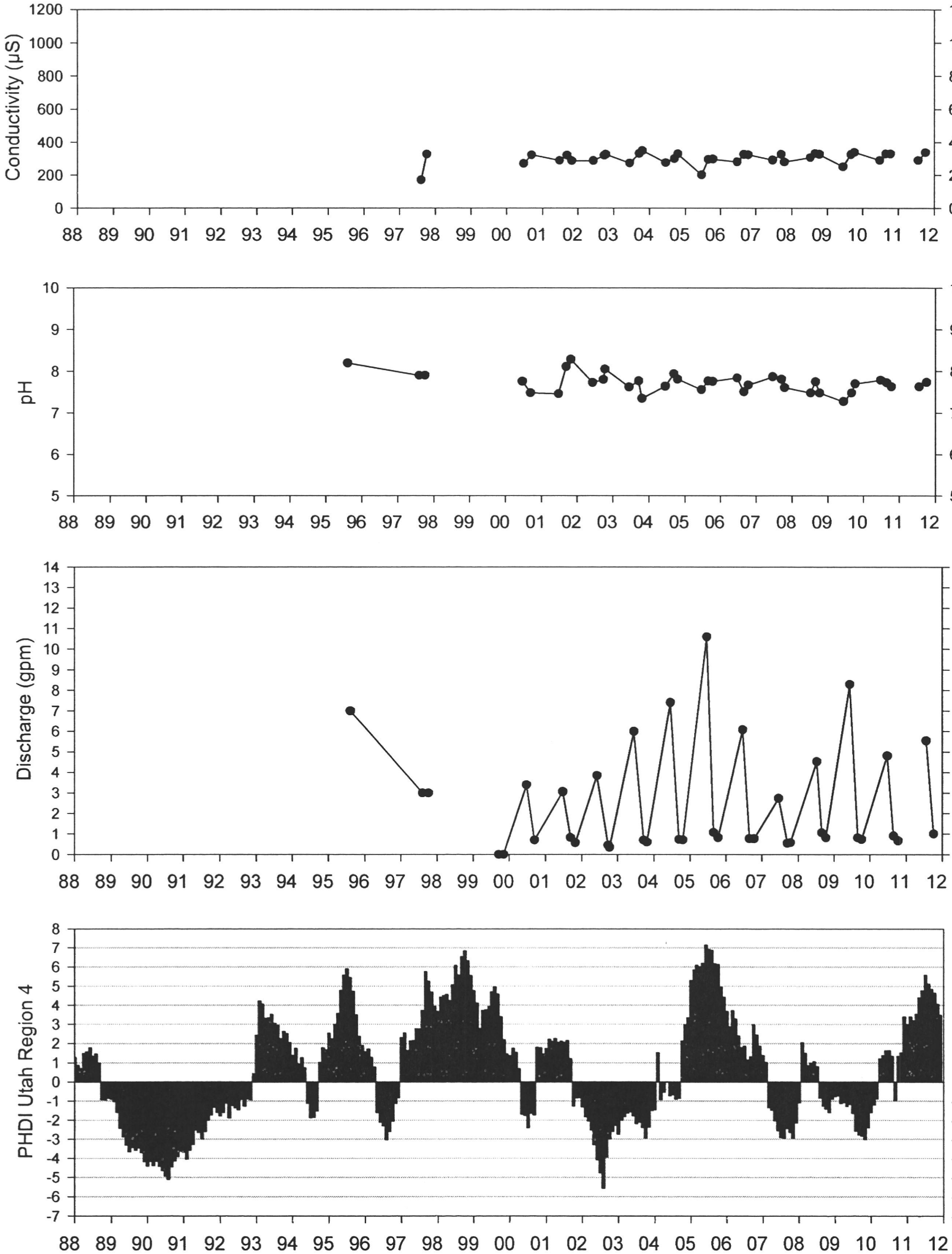

Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12


pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

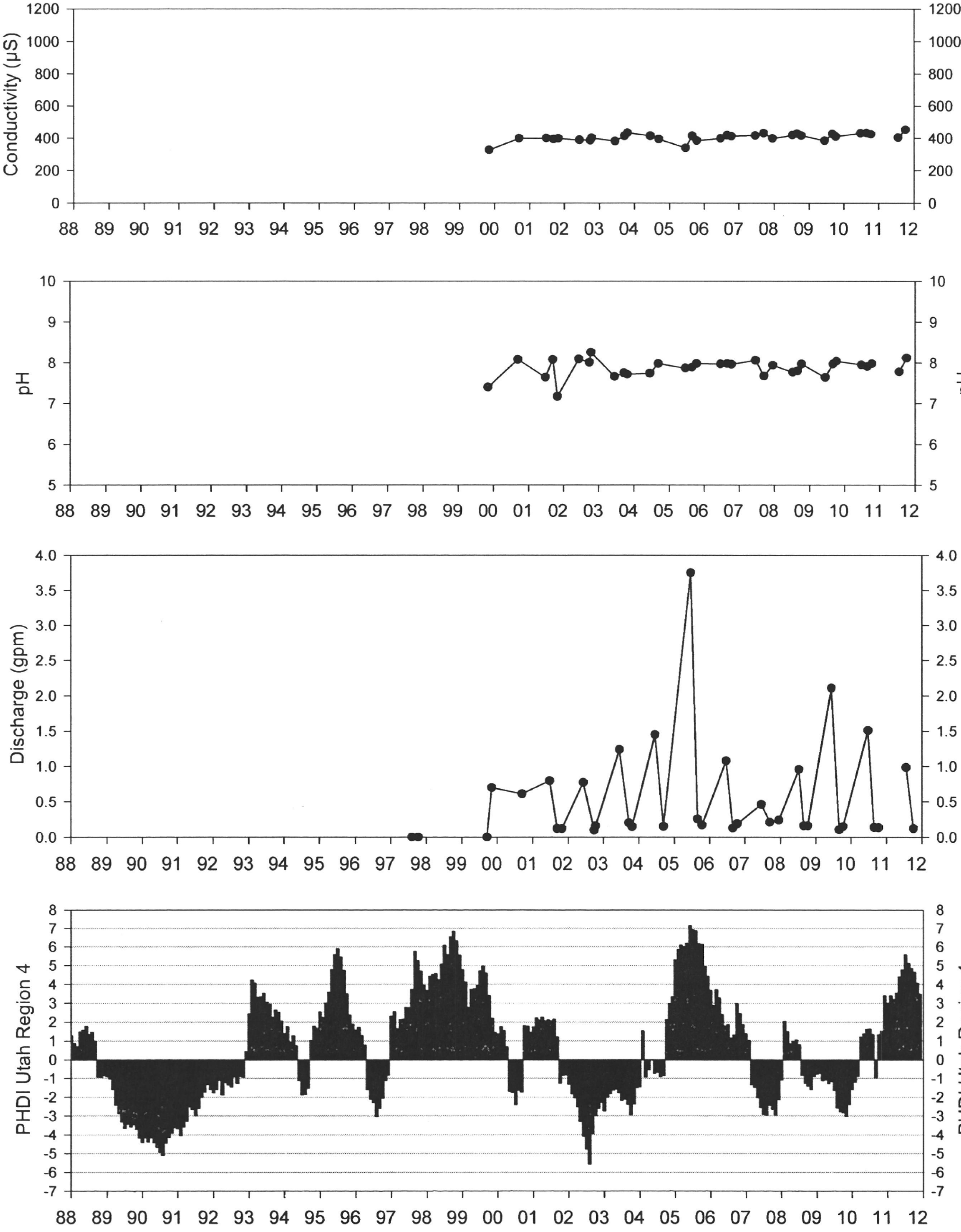

Discharge (gpm)
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12


PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP1-9

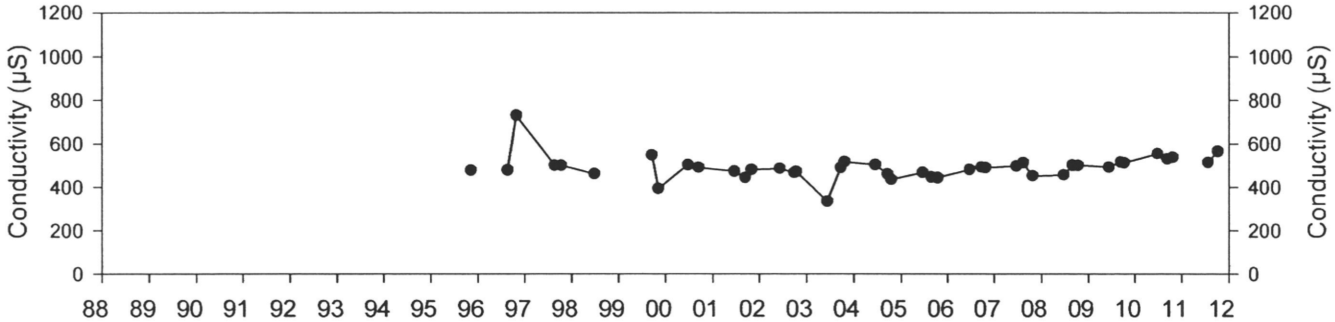

Conductivity (µS)
0
200
400
600
800
1000
1200
pH
5
6
7
8
9
10
Discharge (gpm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
PHDI Utah Region 4
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP1-24

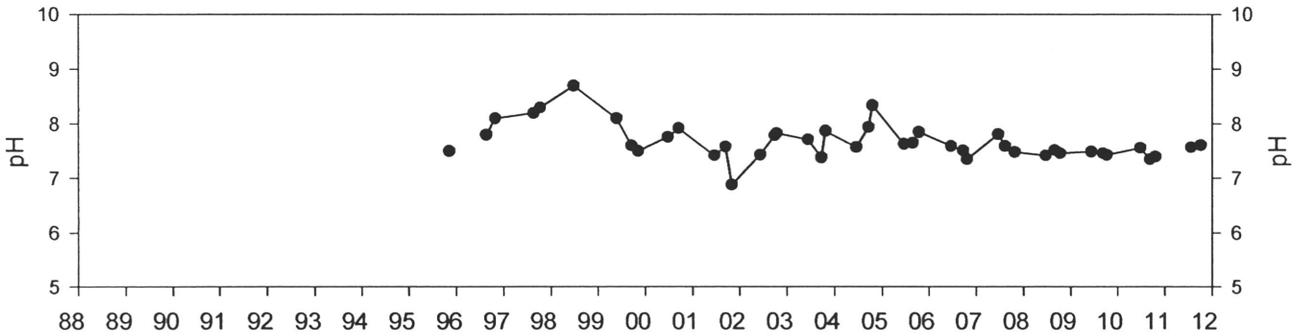


Conductivity (µS)
0
200
400
600
800
1000
1200
pH
5
6
7
8
9
10
Discharge (gpm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
PHDI Utah Region 4
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

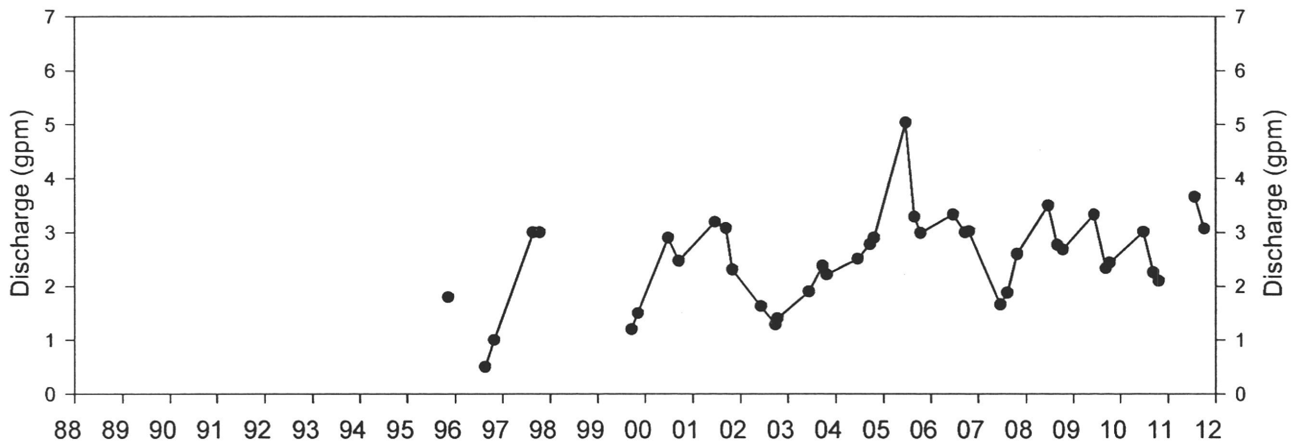
SP1-33



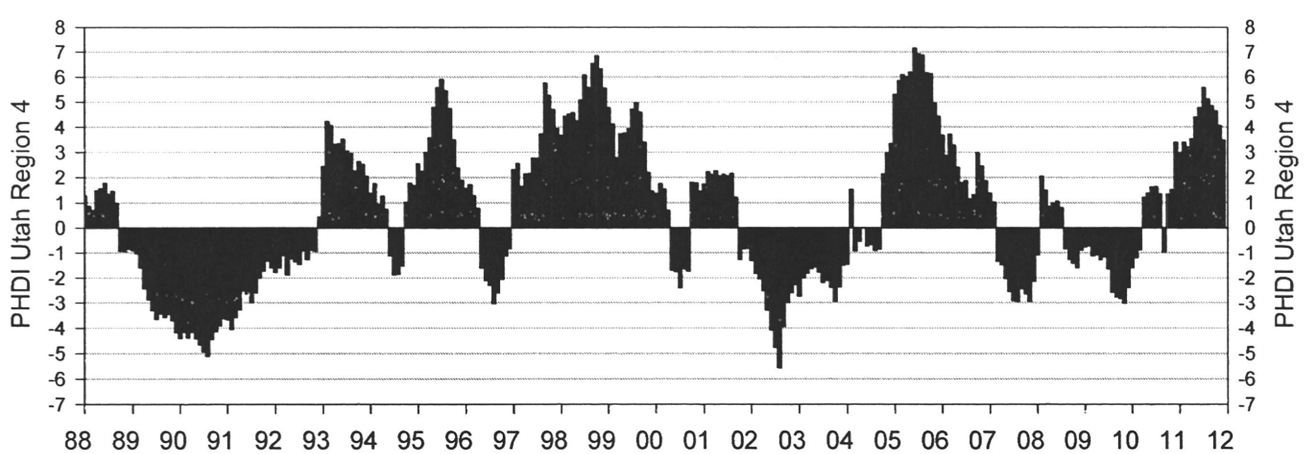
Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

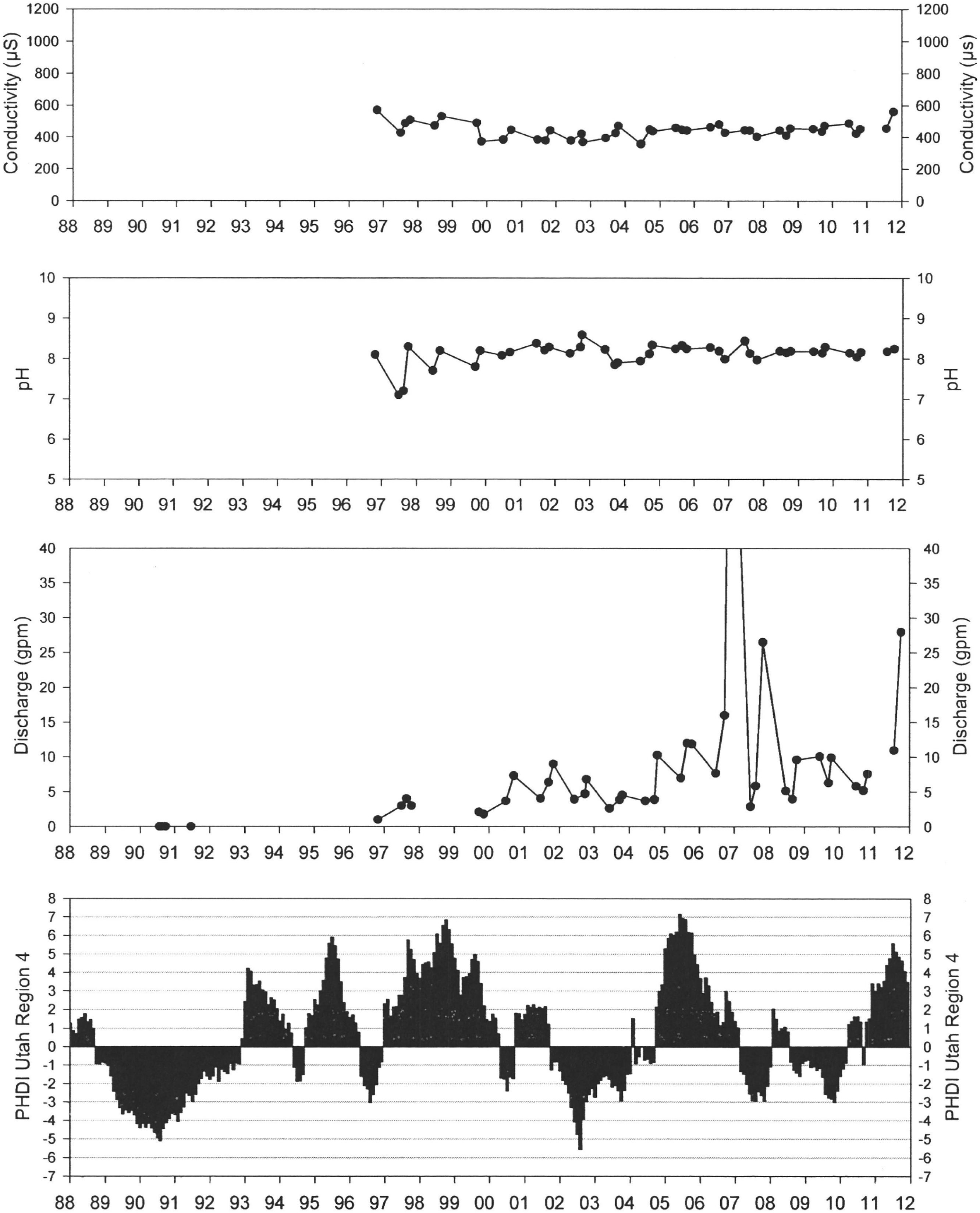


Discharge (gpm)
7
6
5
4
3
2
1
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



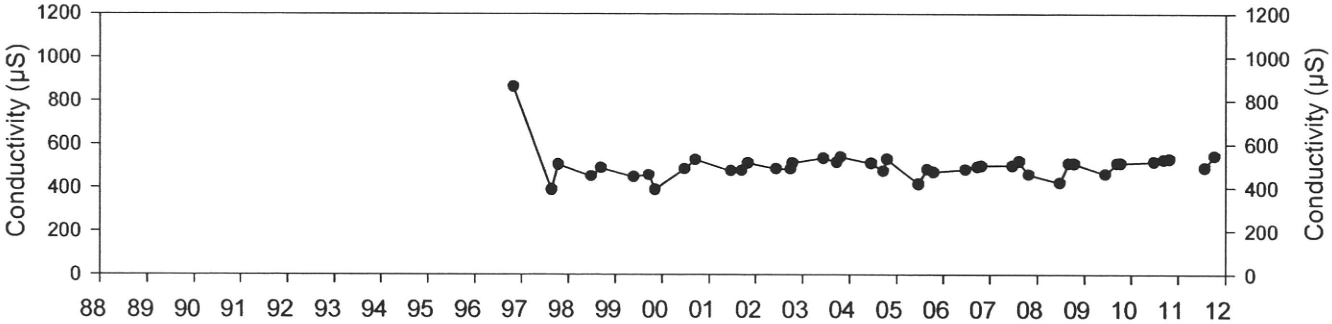
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP1-47

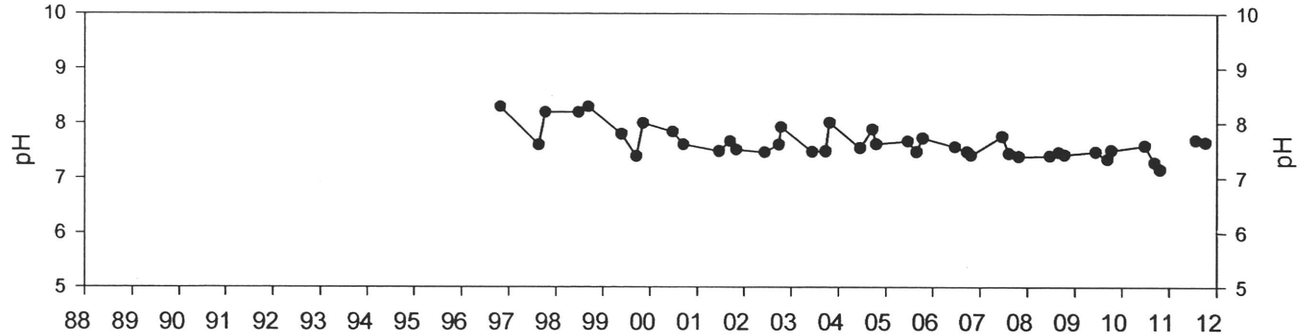


Conductivity (µS)
Conductivity (µs)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
pH
10
9
8
7
6
5
Discharge (gpm)
40
35
30
25
20
15
10
5
0
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7

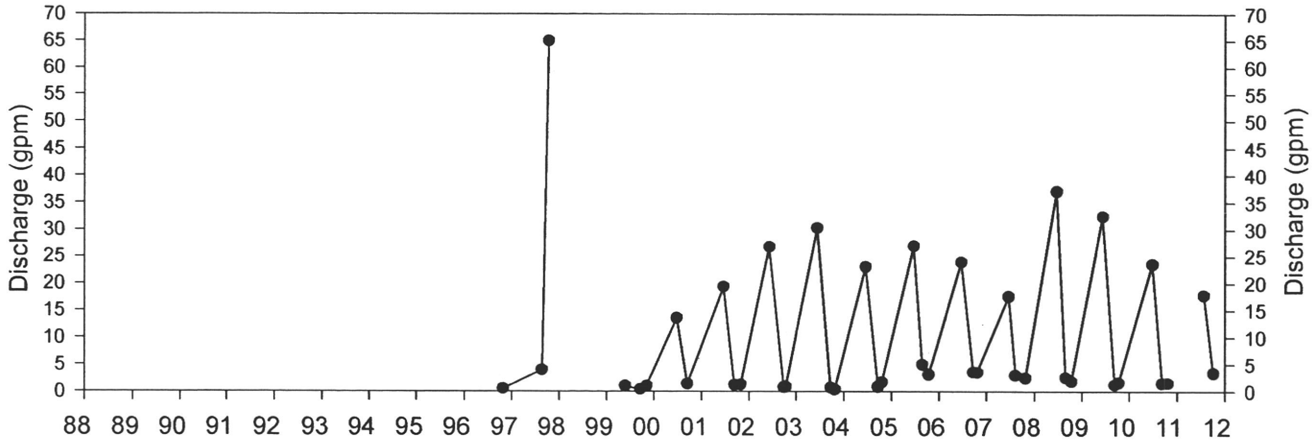
SP2-1



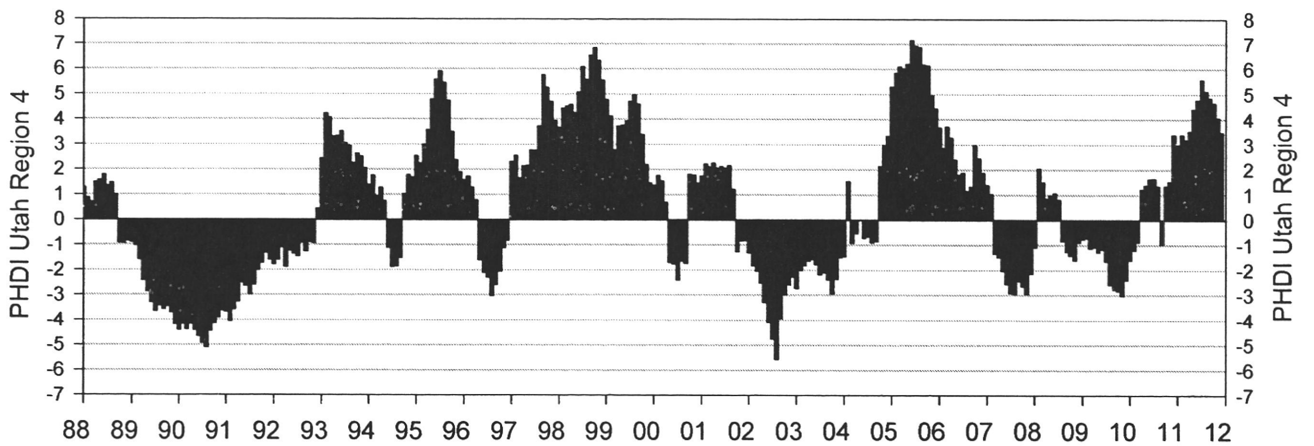
Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

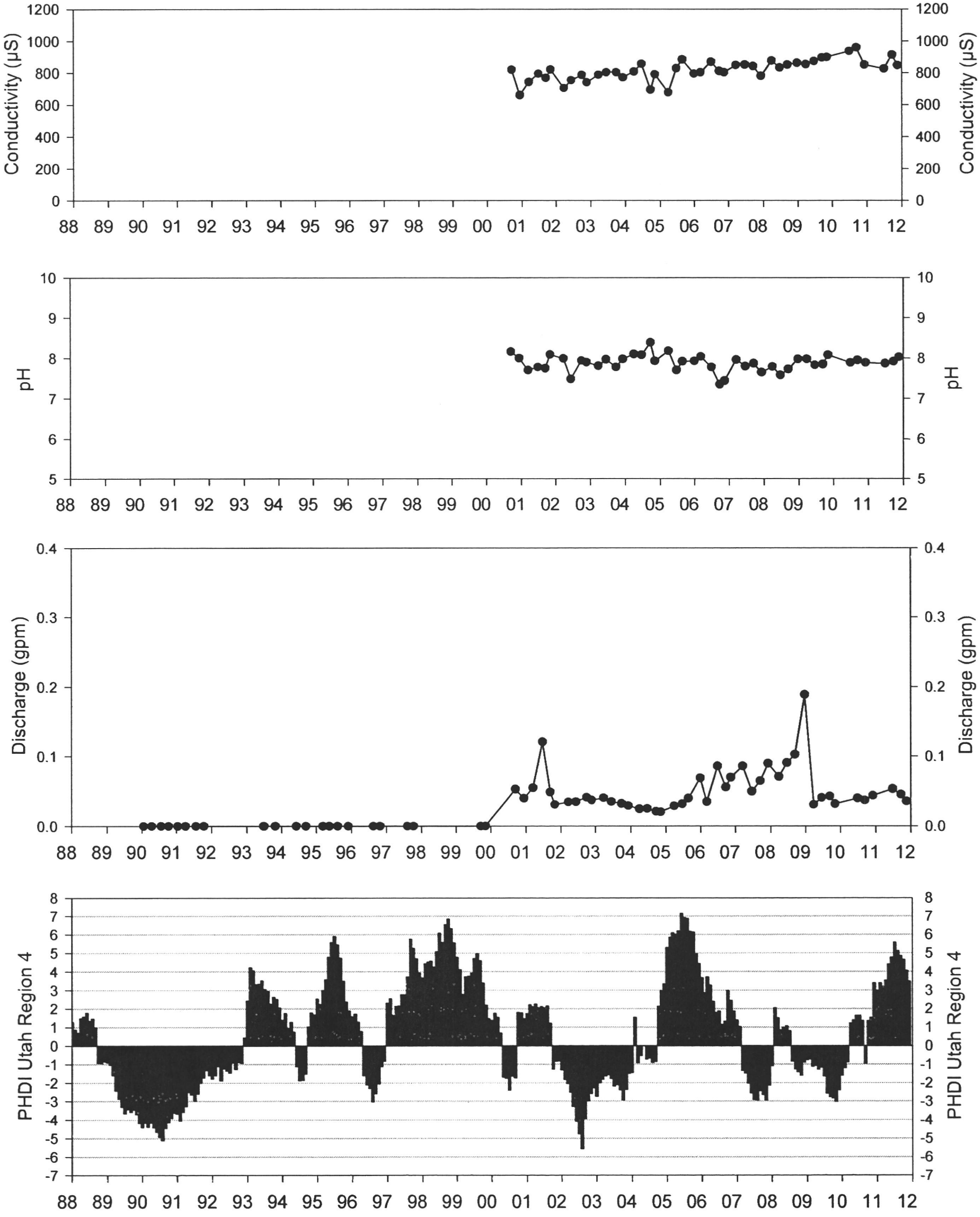


Discharge (gpm)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



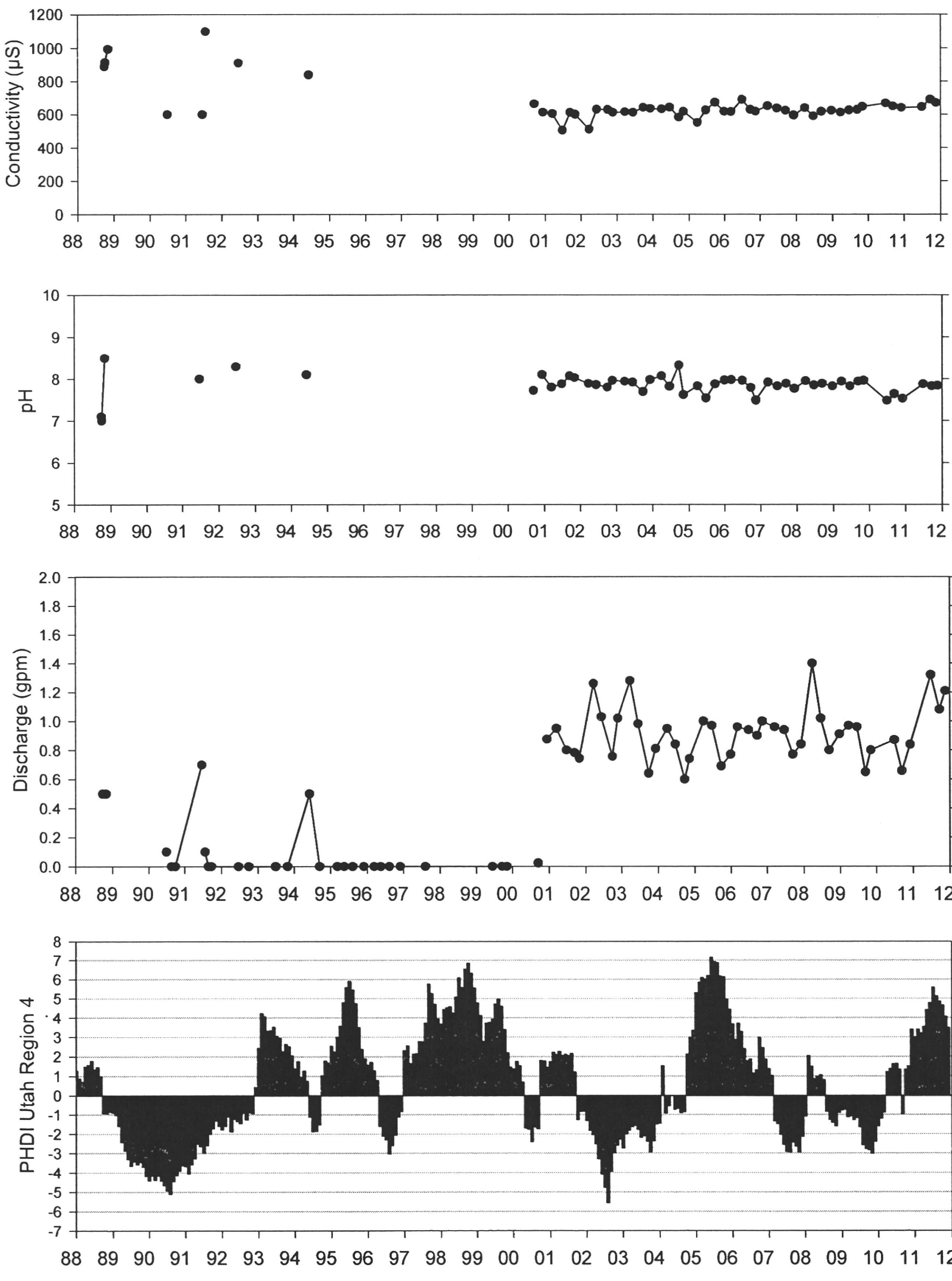
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP-30

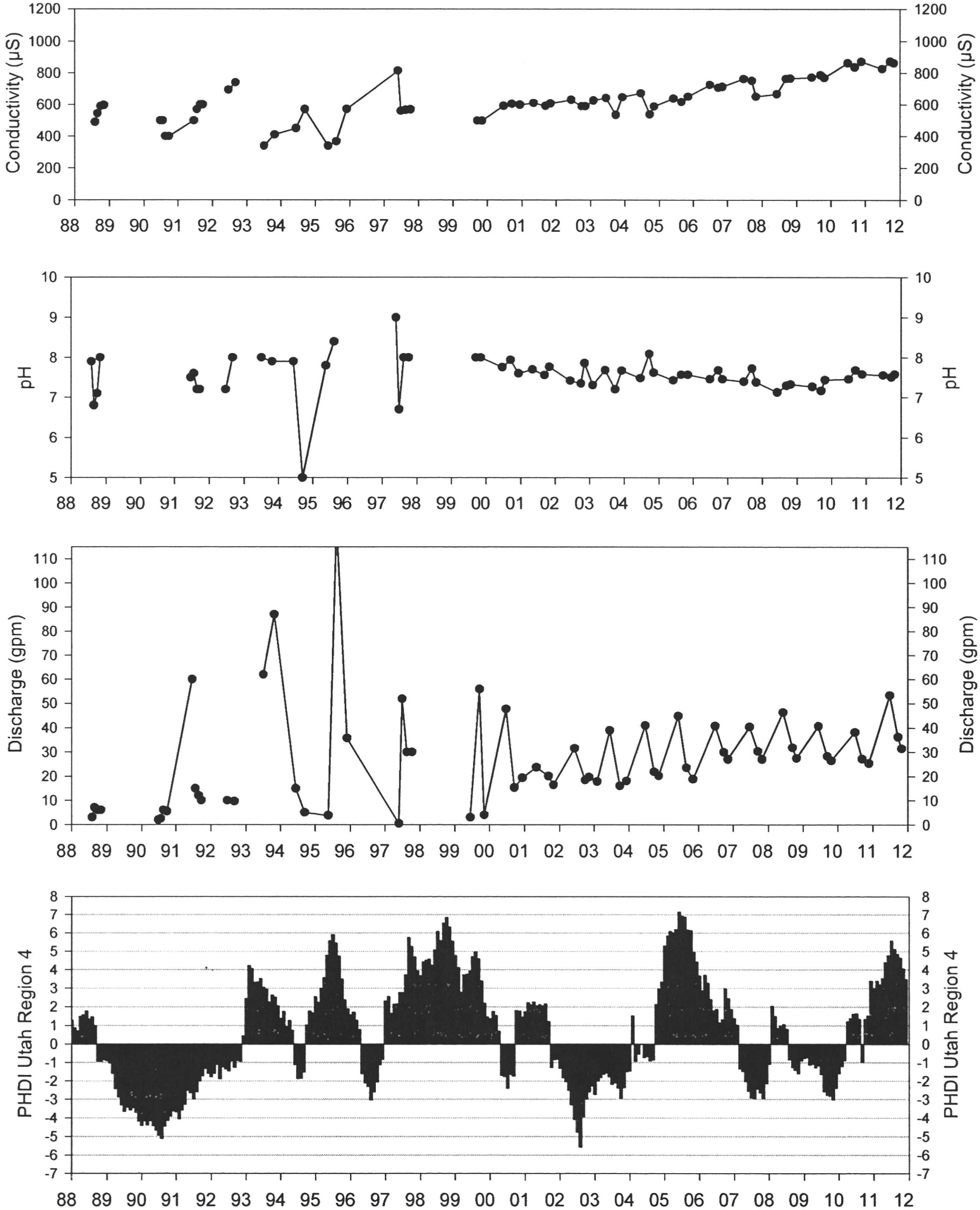


Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
pH
10
9
8
7
6
5
Discharge (gpm)
0.4
0.3
0.2
0.1
0.0
PHDI Utah Region 4
8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7

SP-36

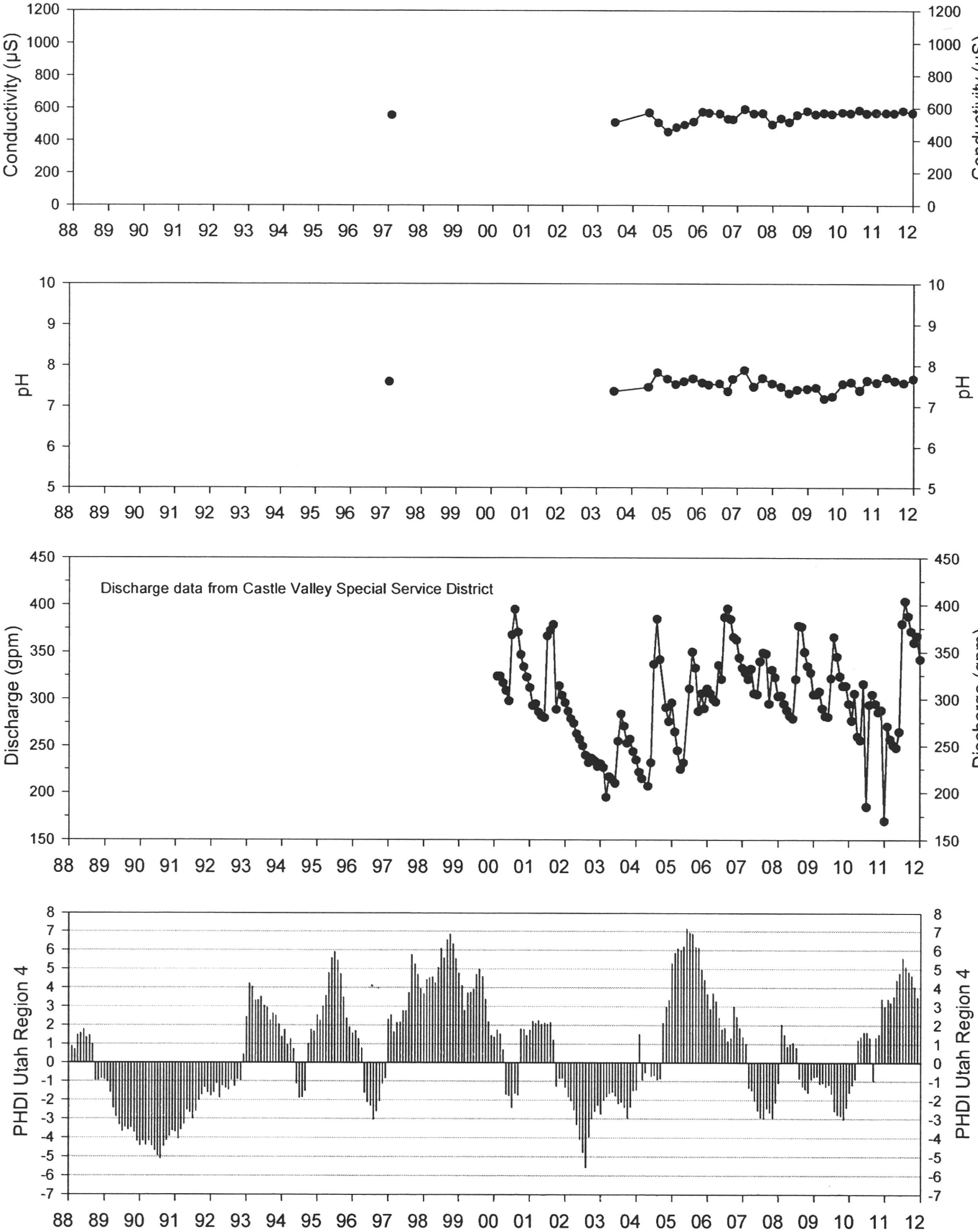


SP-58

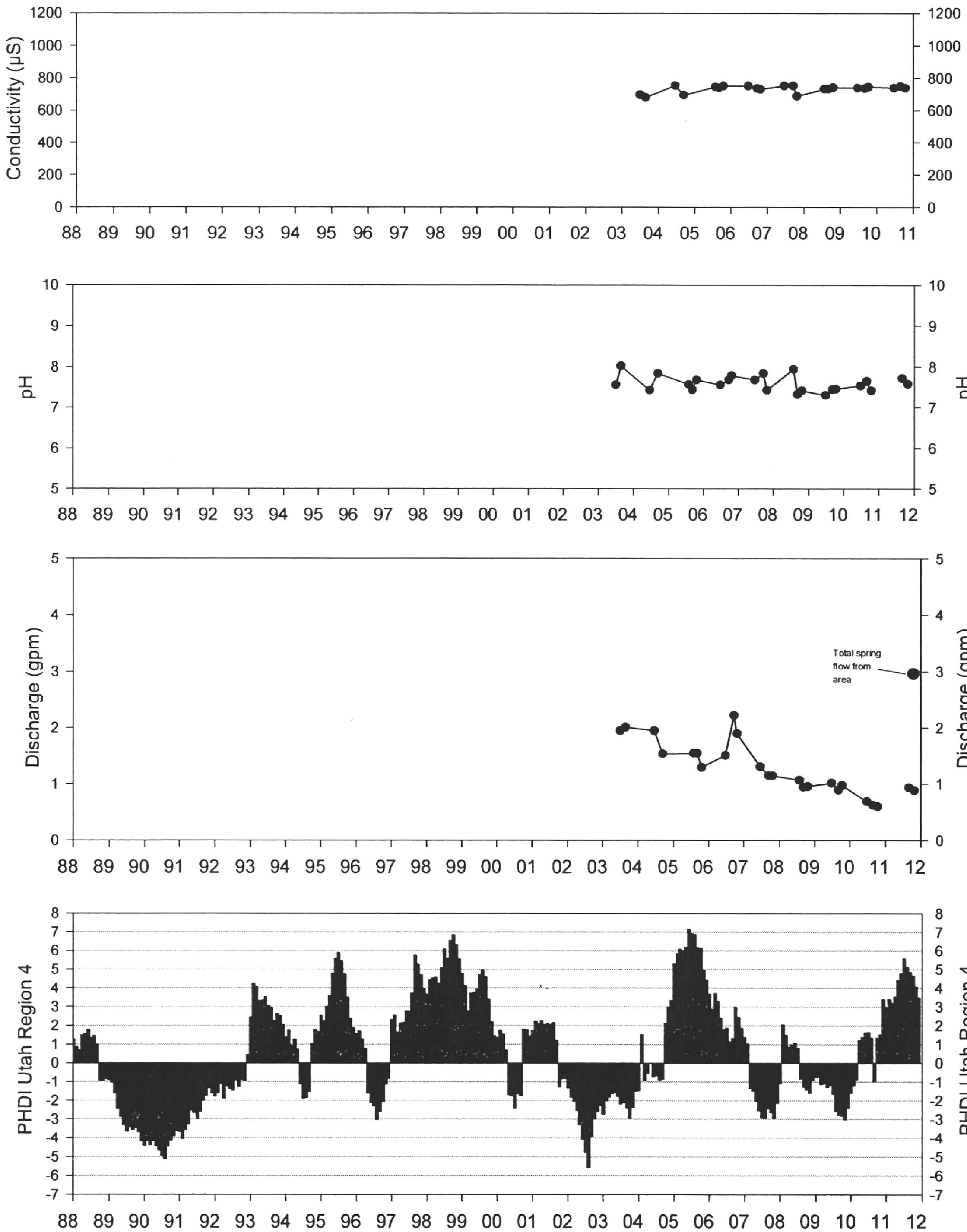


Conductivity (µS)
pH
Discharge (gpm)
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

Little Bear Spring

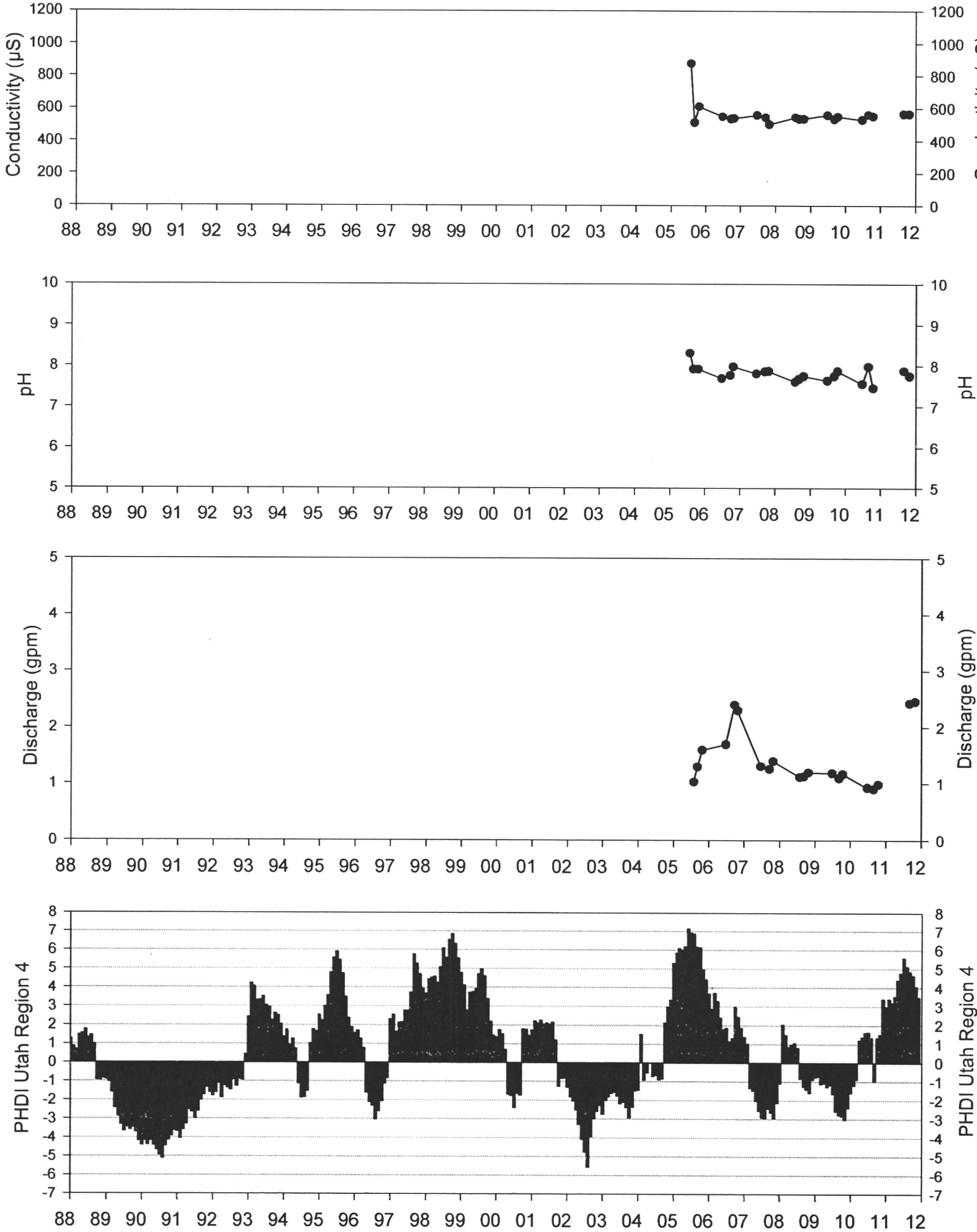


LB-5A

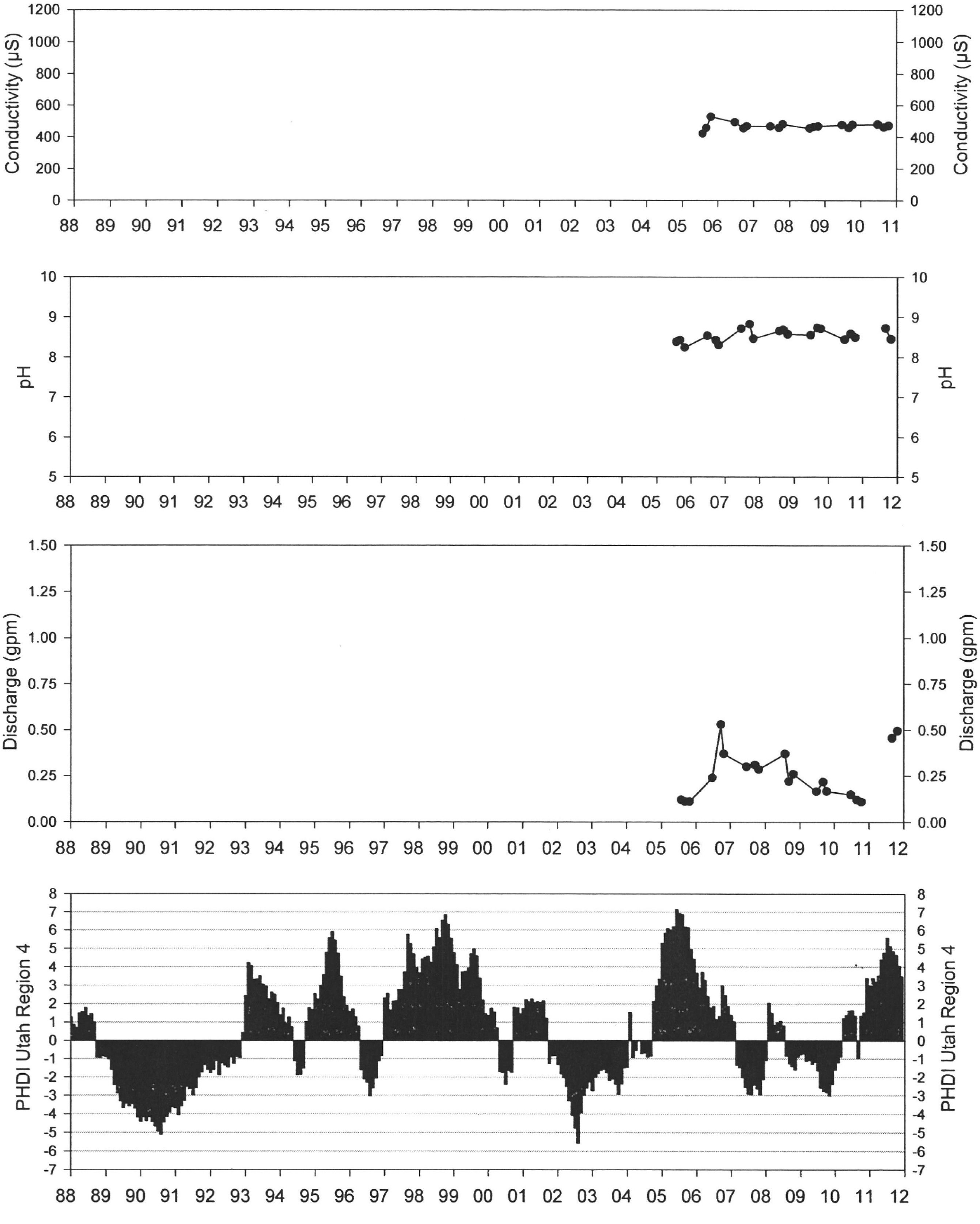


Conductivity (µS)
pH
Discharge (gpm)
Total spring flow from area
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

LB-7

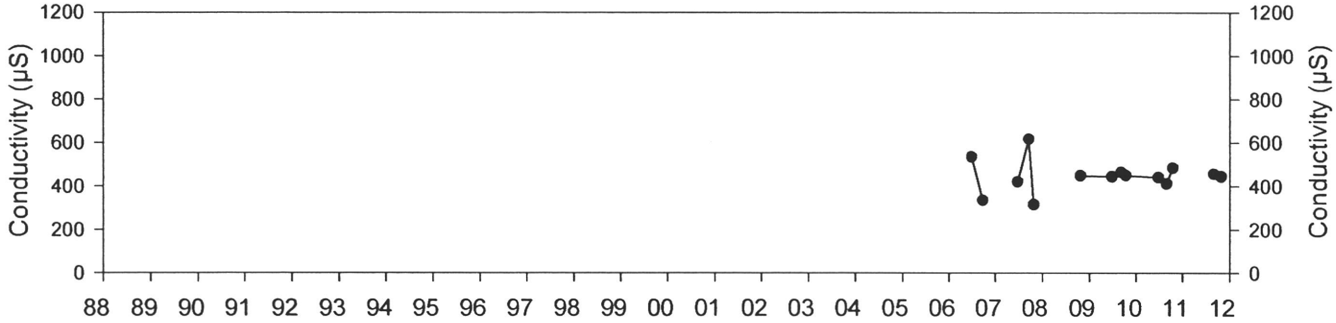

Conductivity (µS)
pH
Discharge (gpm)
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

LB-7A

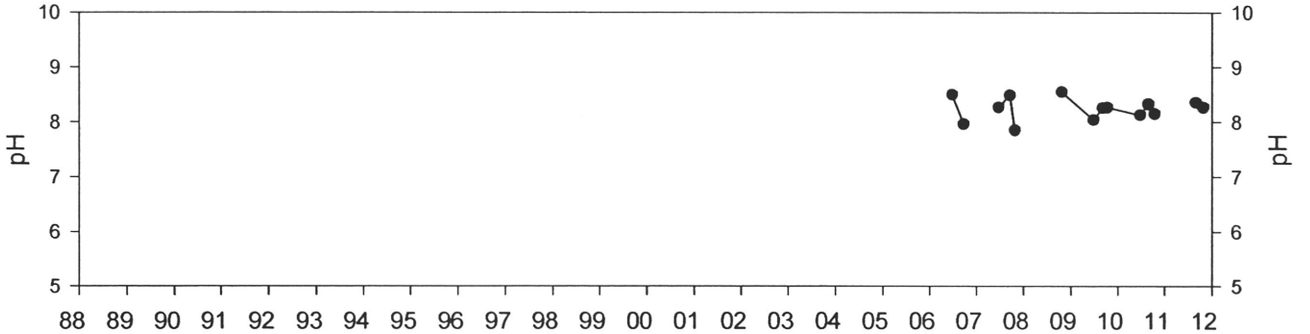


Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11
pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
Discharge (gpm)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

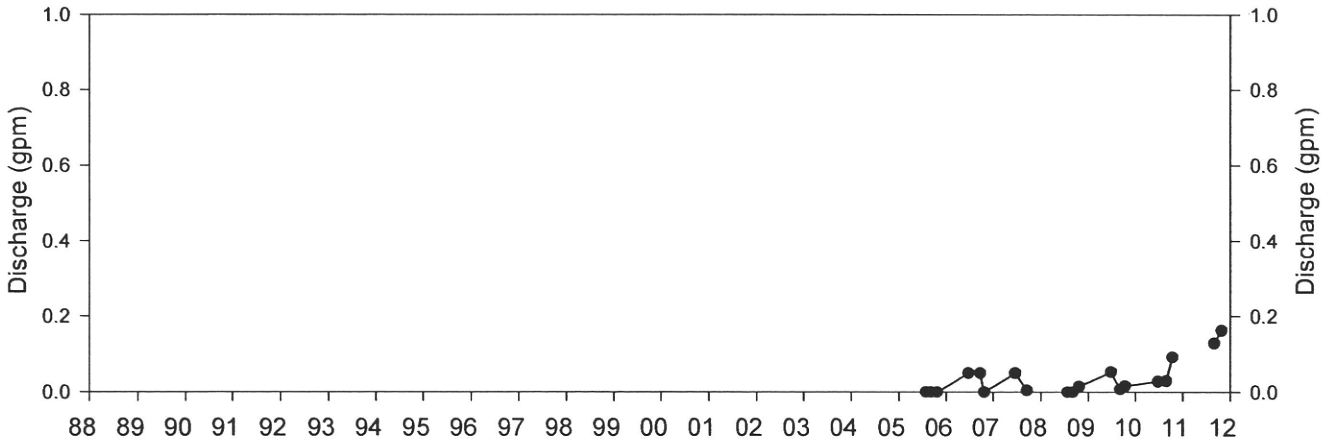
LB-7B



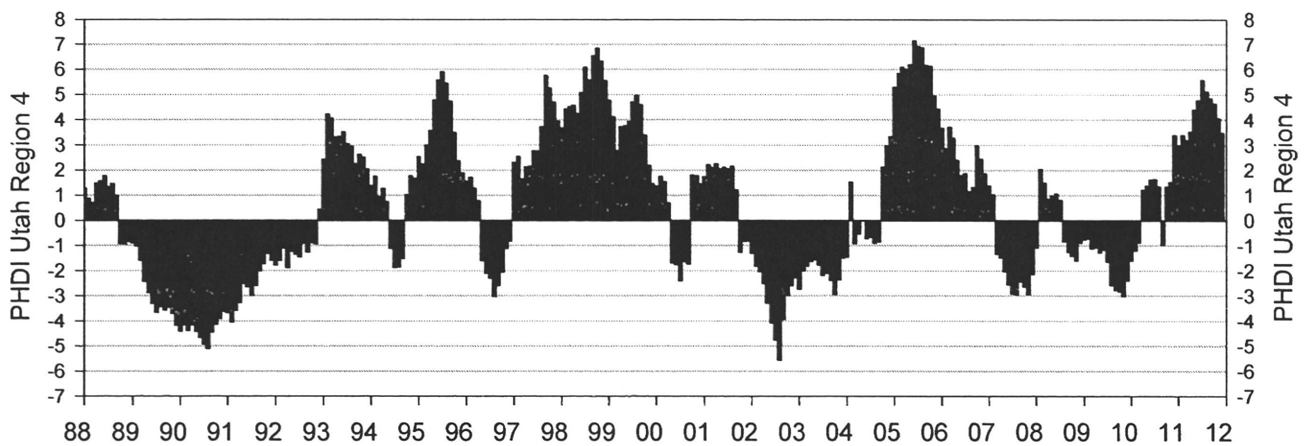
Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

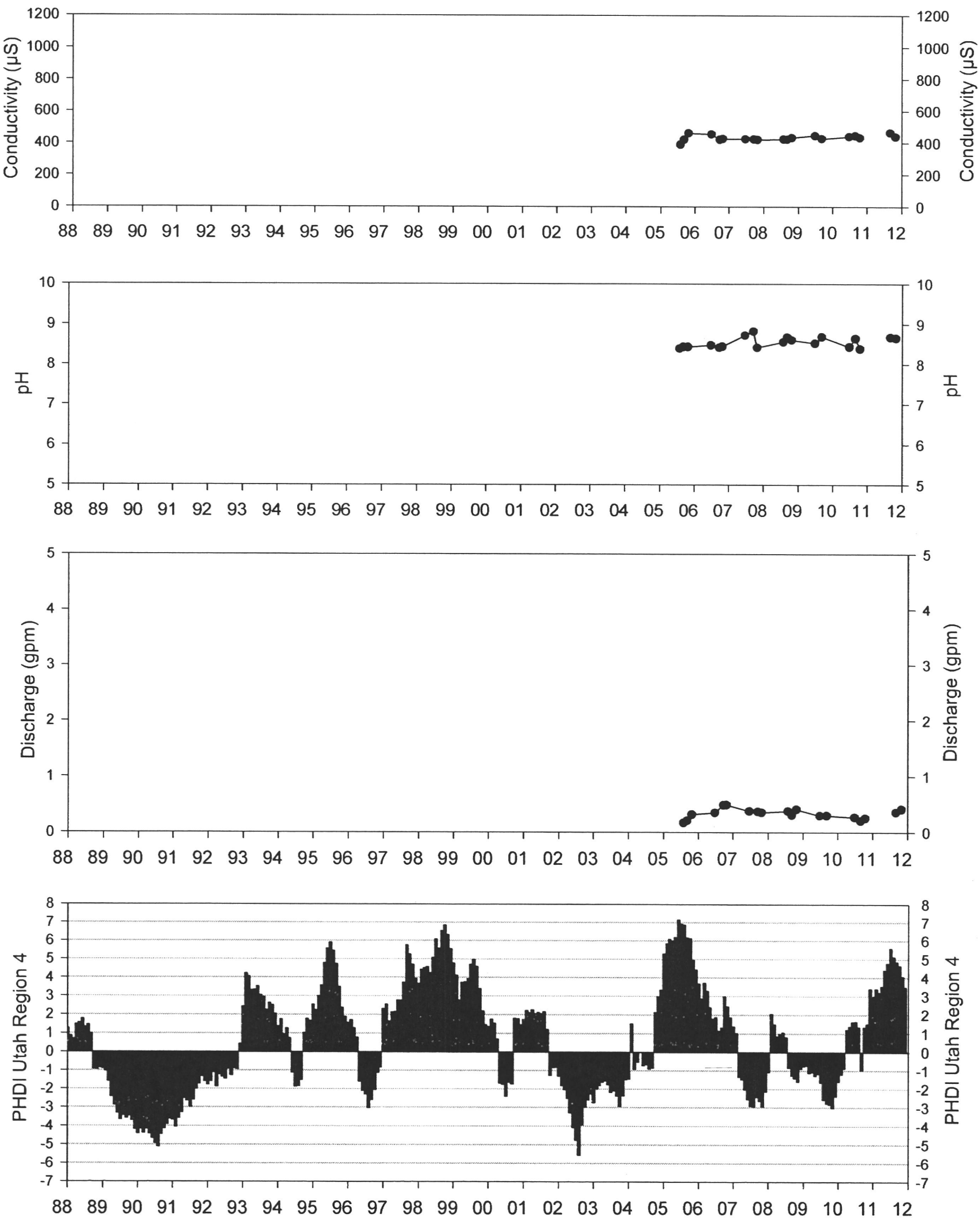


Discharge (gpm)
1.0
0.8
0.6
0.4
0.2
0.0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



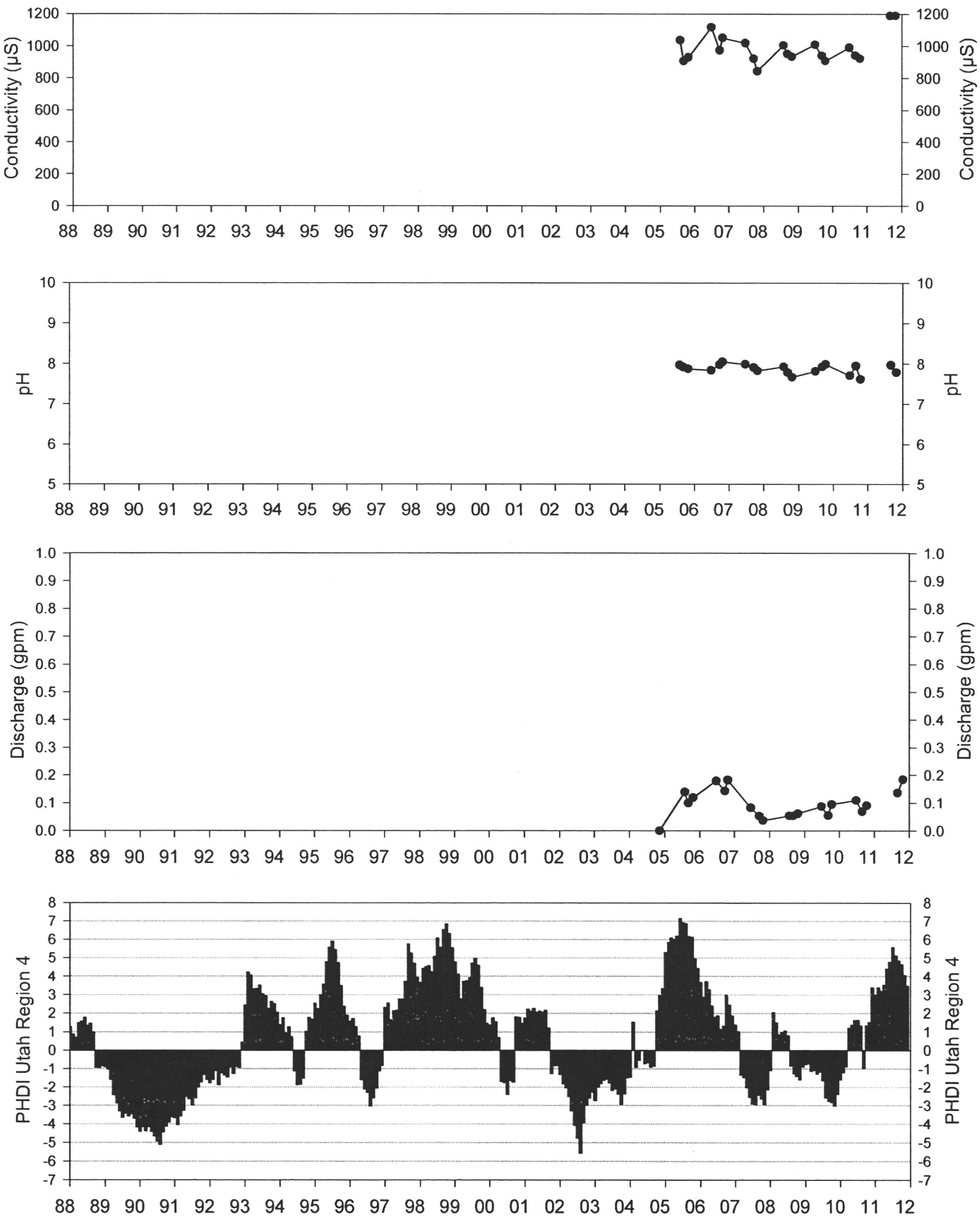
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

LB-7C

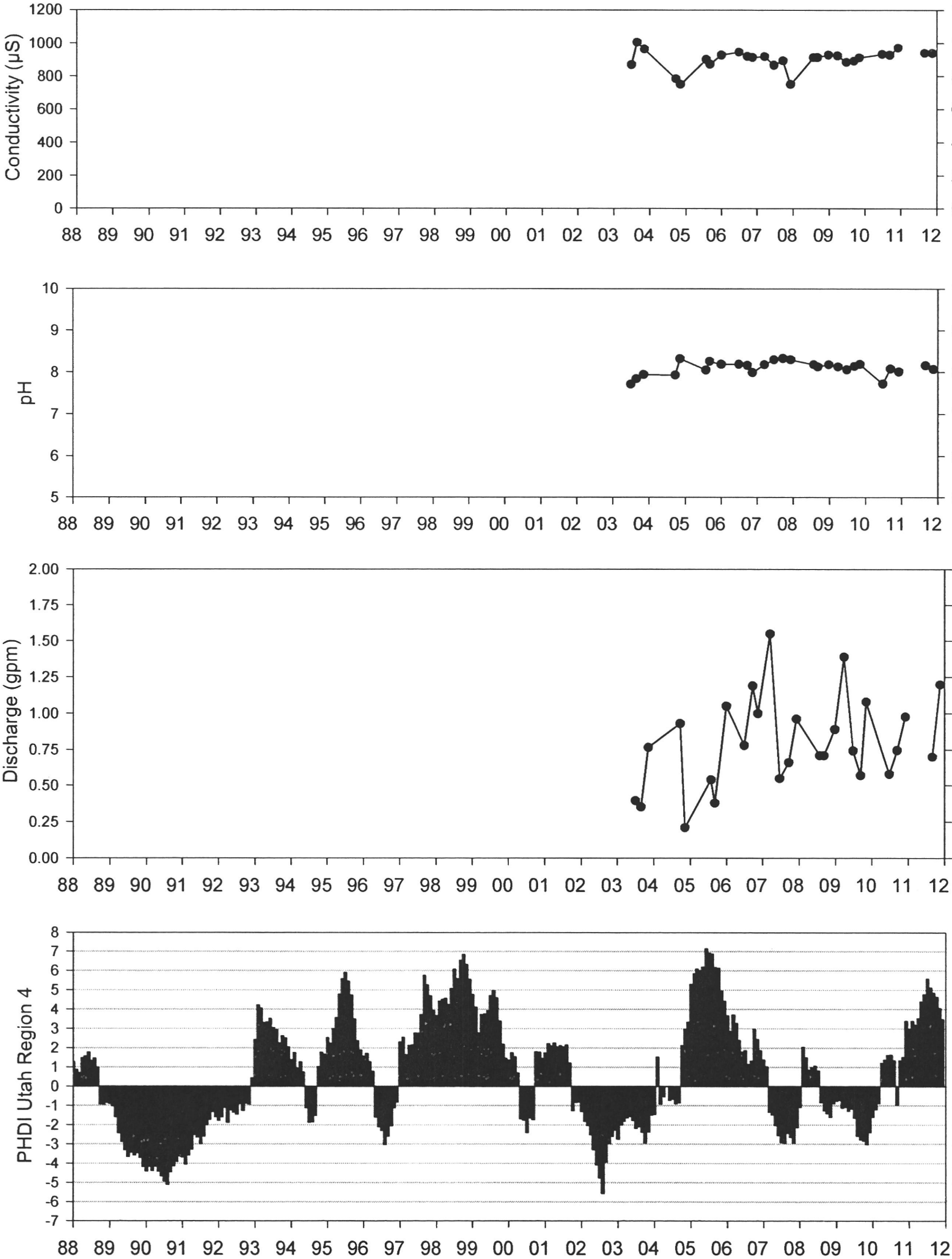


Conductivity (µS)
pH
Discharge (gpm)
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

LB-12

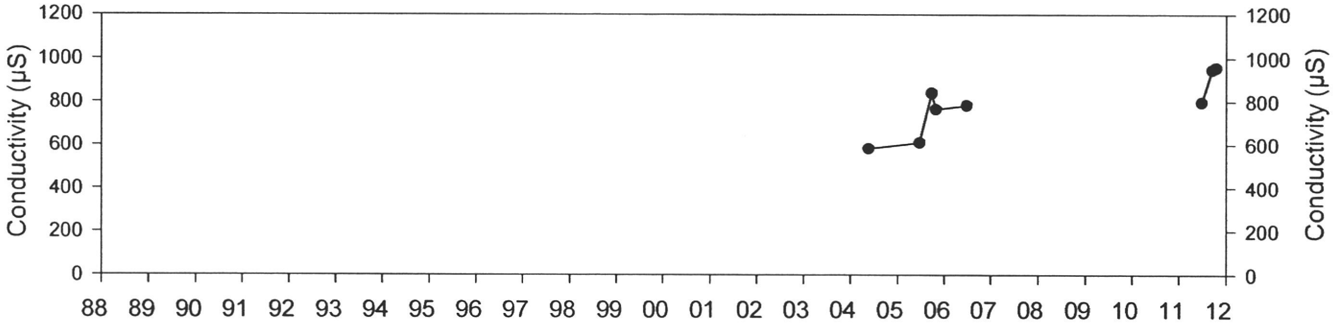

Conductivity (µS)
pH
Discharge (gpm)
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP-79

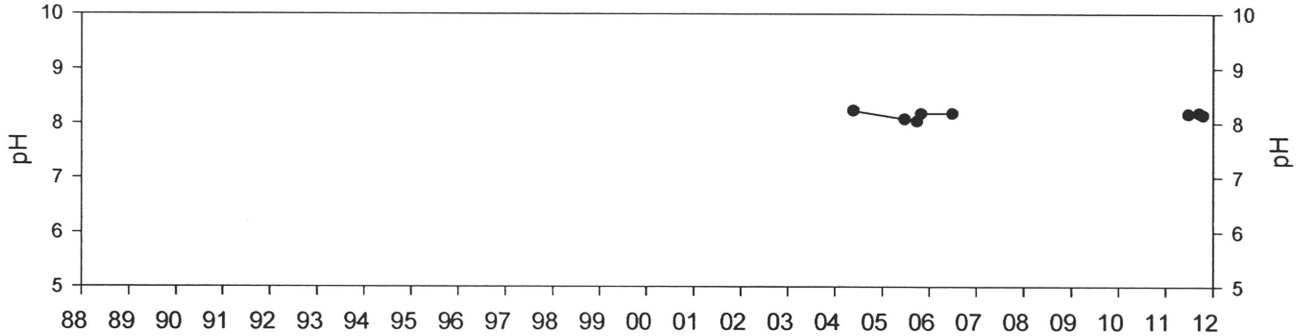


Conductivity (µS)
pH
Discharge (gpm)
PHDI Utah Region 4
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

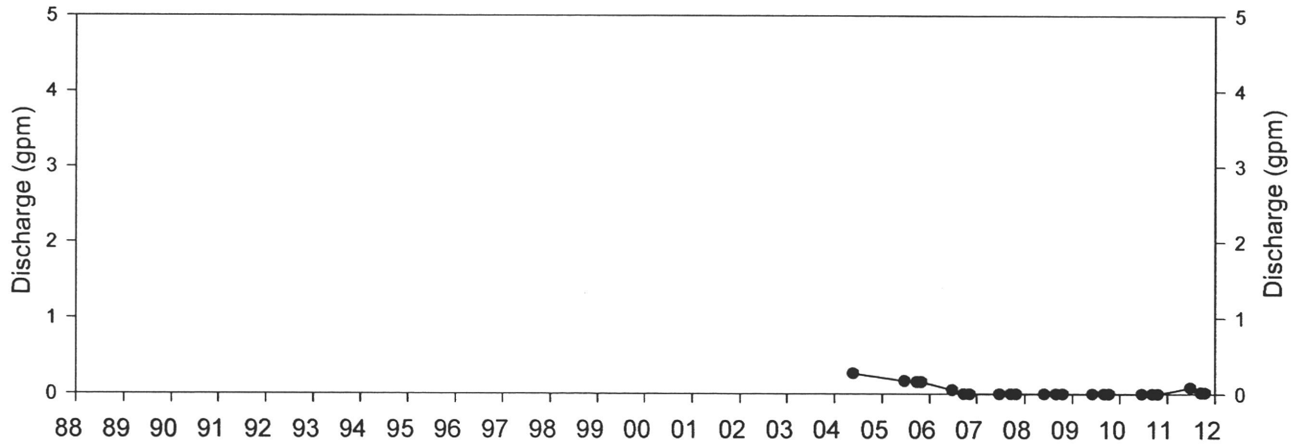
SP-18



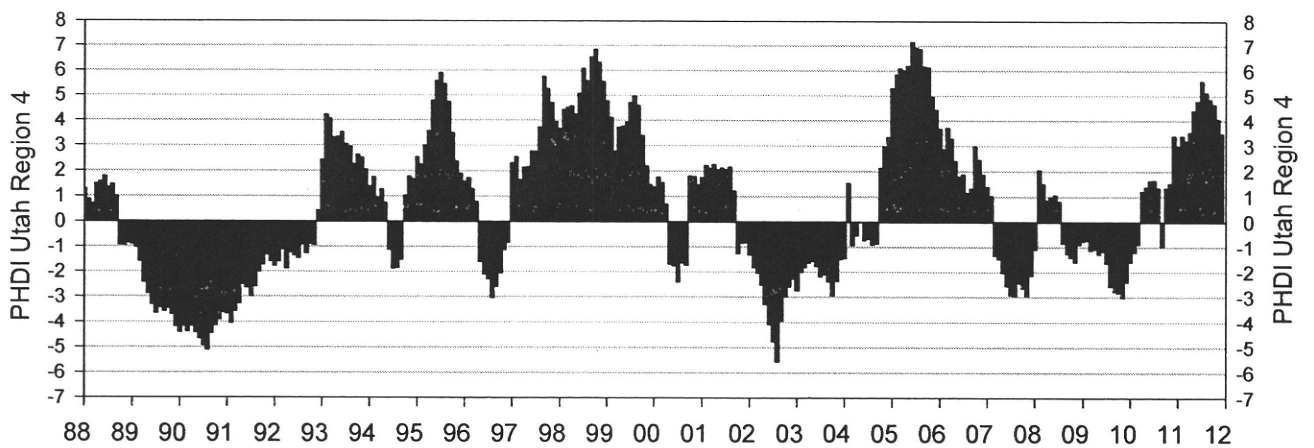
Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

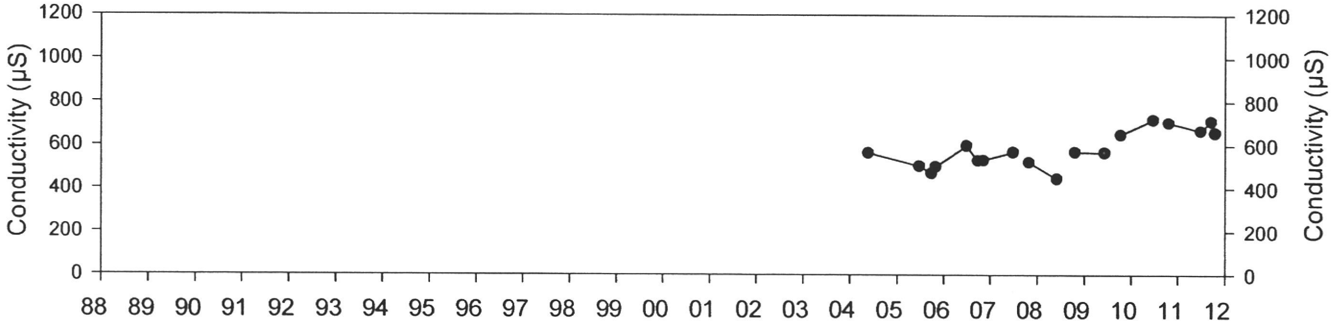


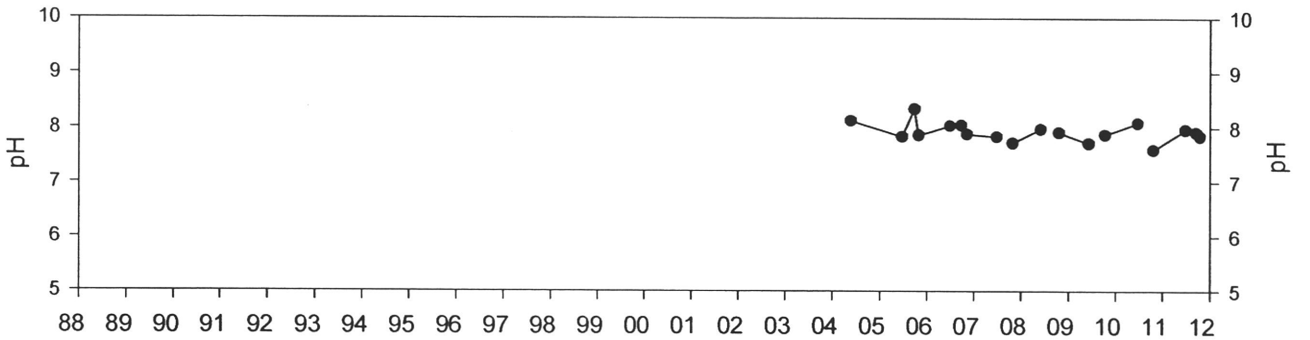
Discharge (gpm)
5
4
3
2
1
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

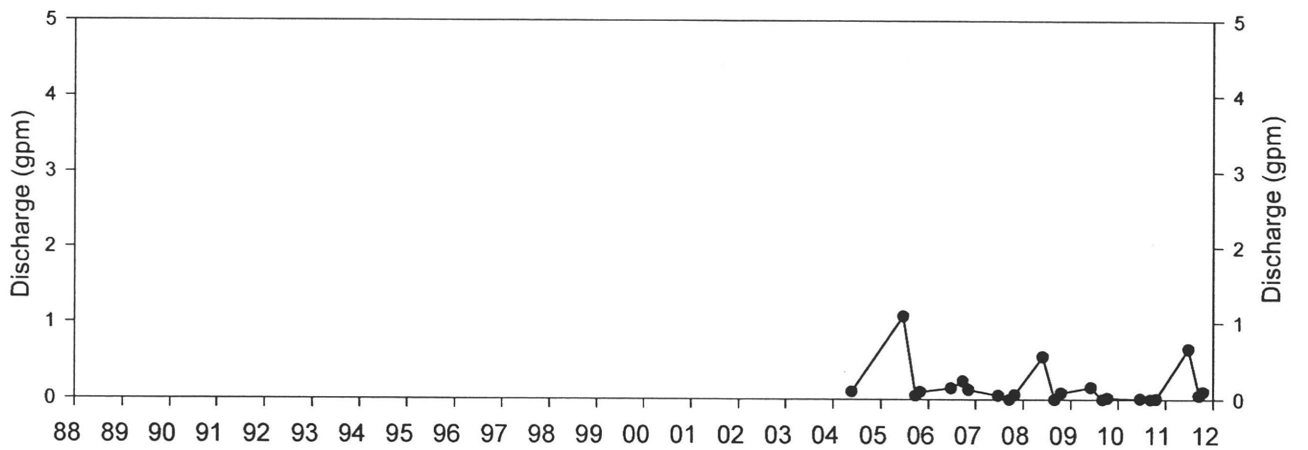


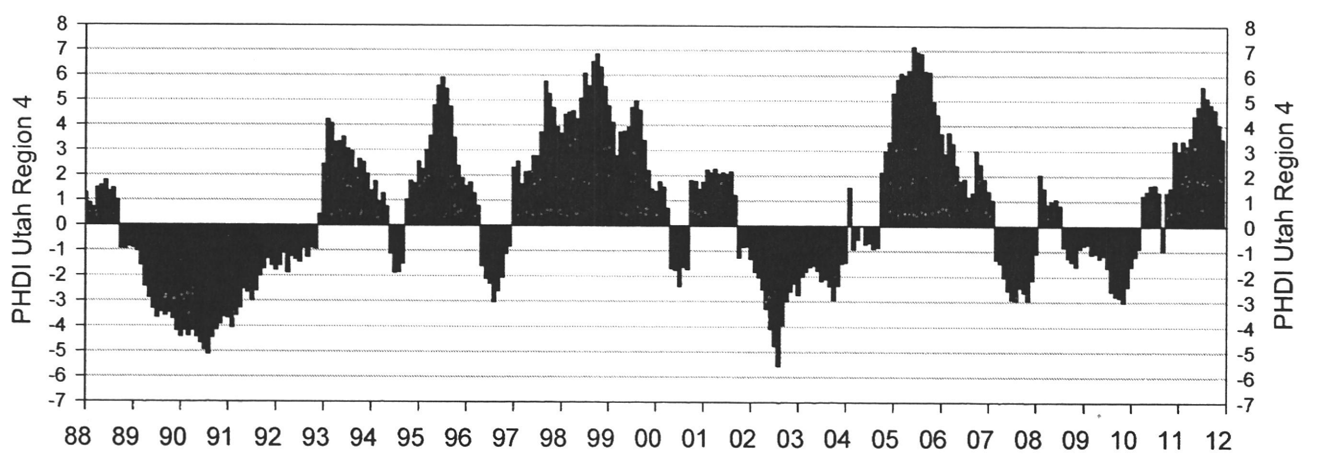
PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

SP-22

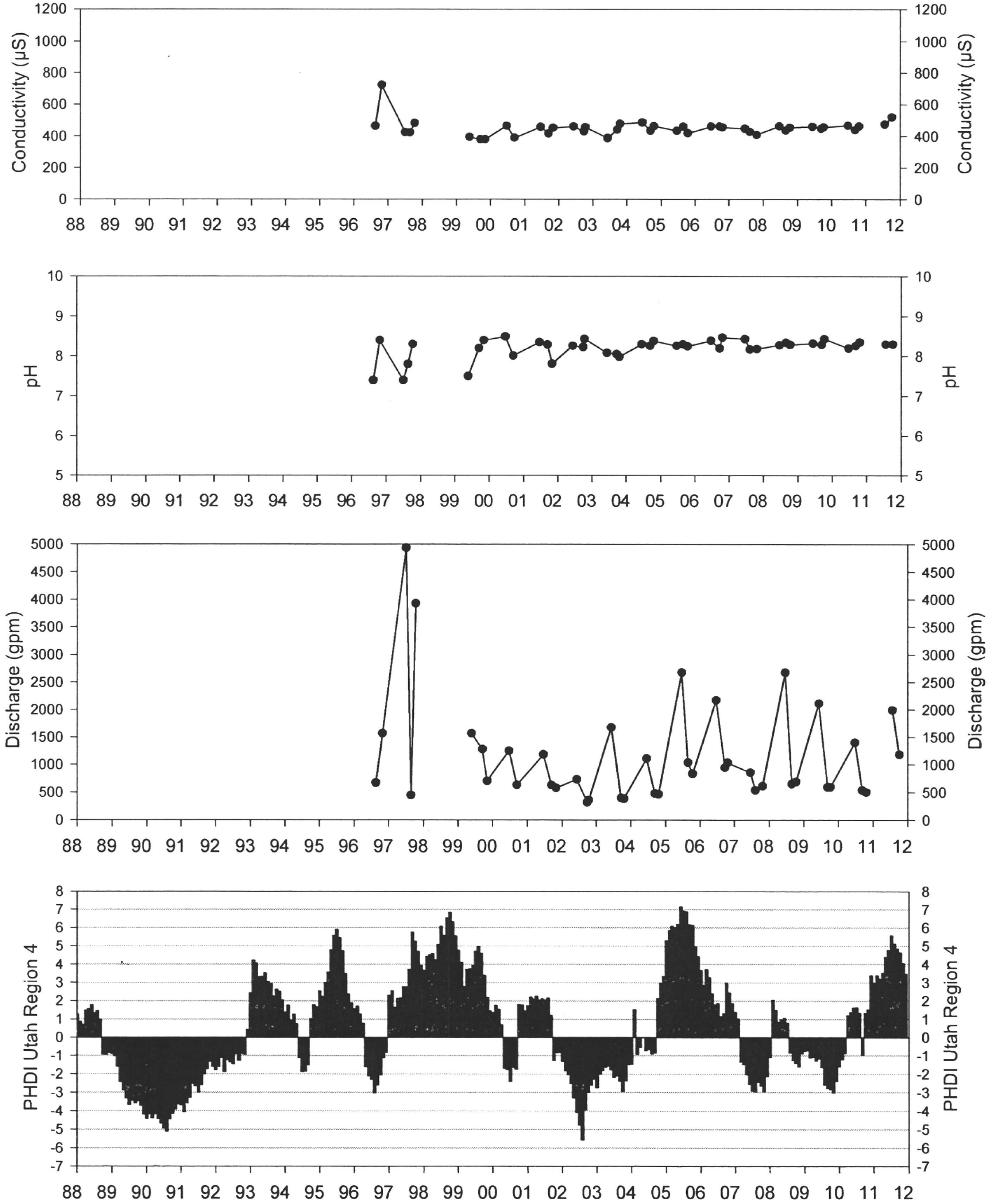

Conductivity (µS)
Conductivity (µS)
0
200
400
600
800
1000
1200
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12


pH
pH
5
6
7
8
9
10
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

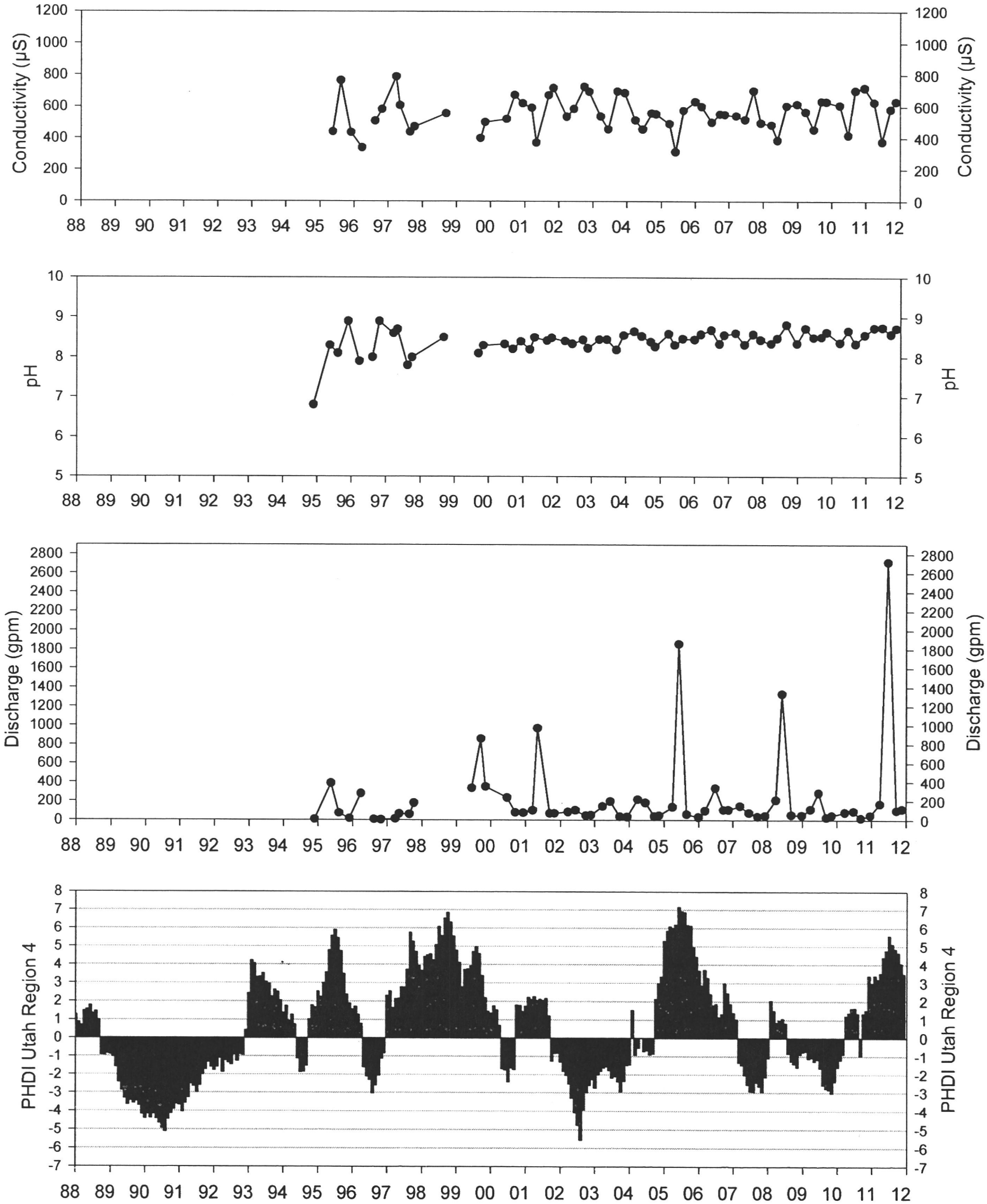

Discharge (gpm)
Discharge (gpm)
0
1
2
3
4
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12


PHDI Utah Region 4
PHDI Utah Region 4
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

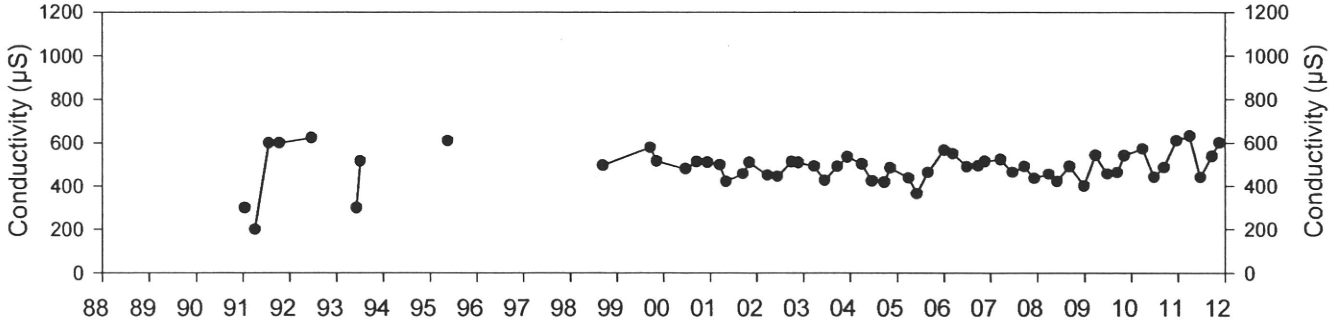
Indian Creek

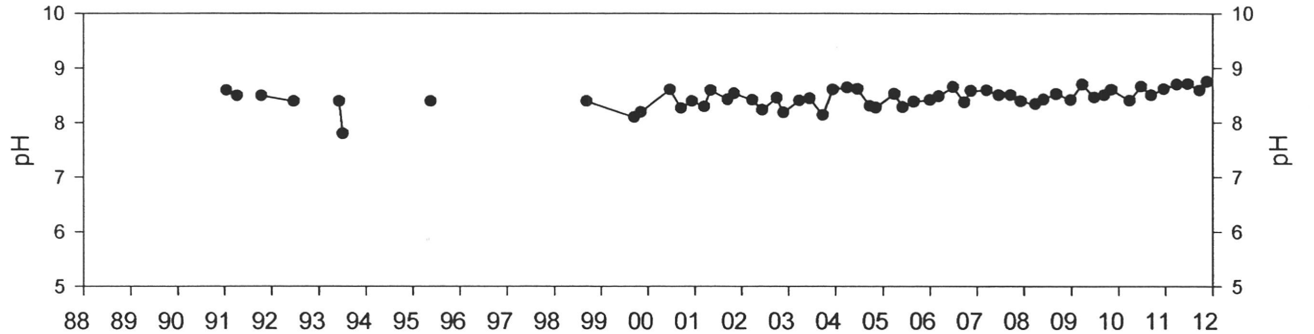


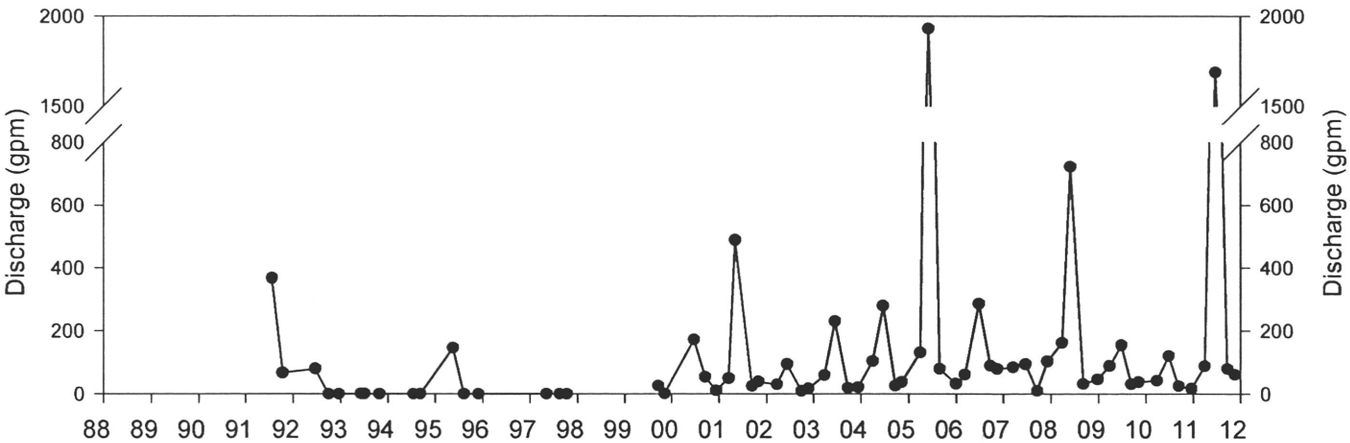
Horse Canyon Creek

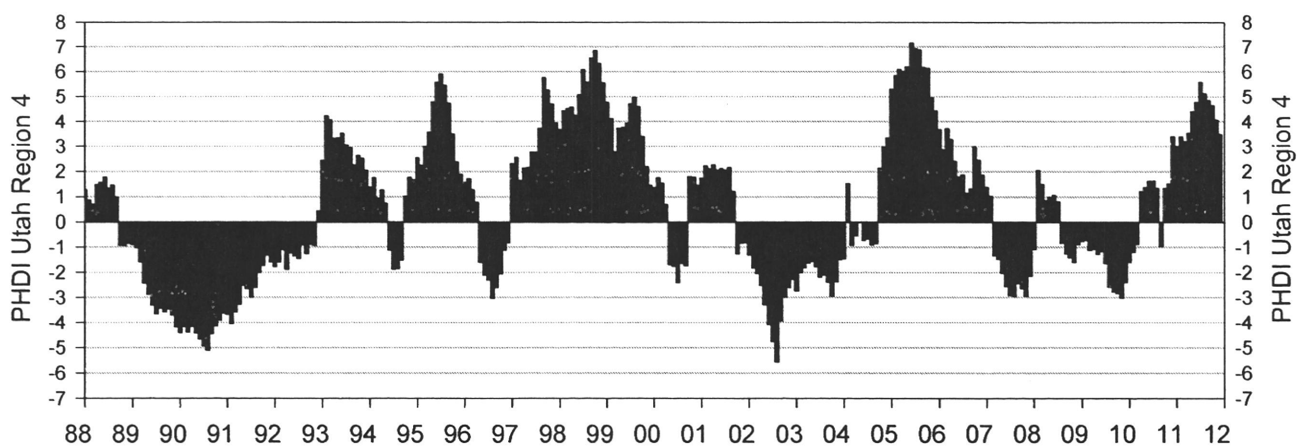


Blind Canyon Creek

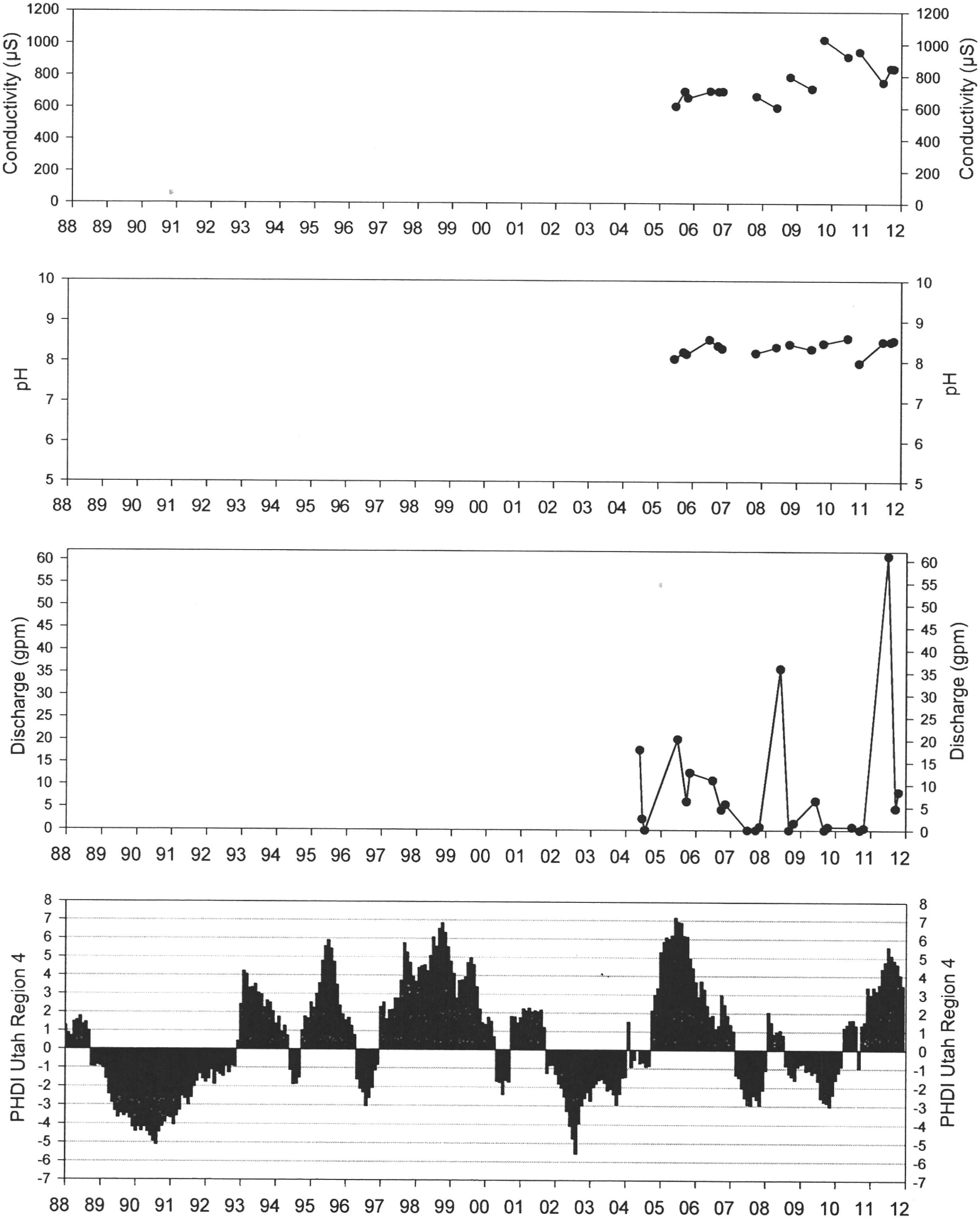




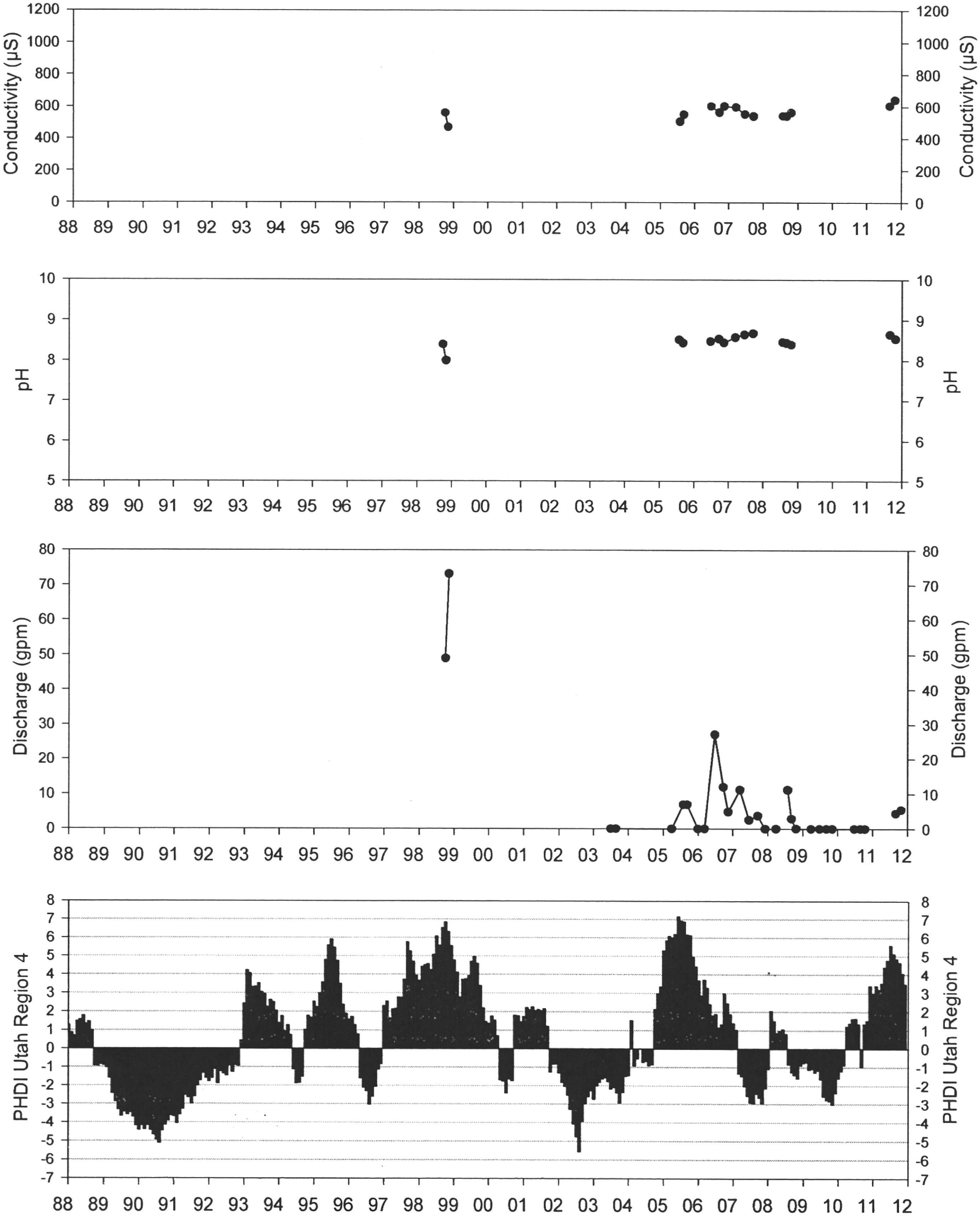




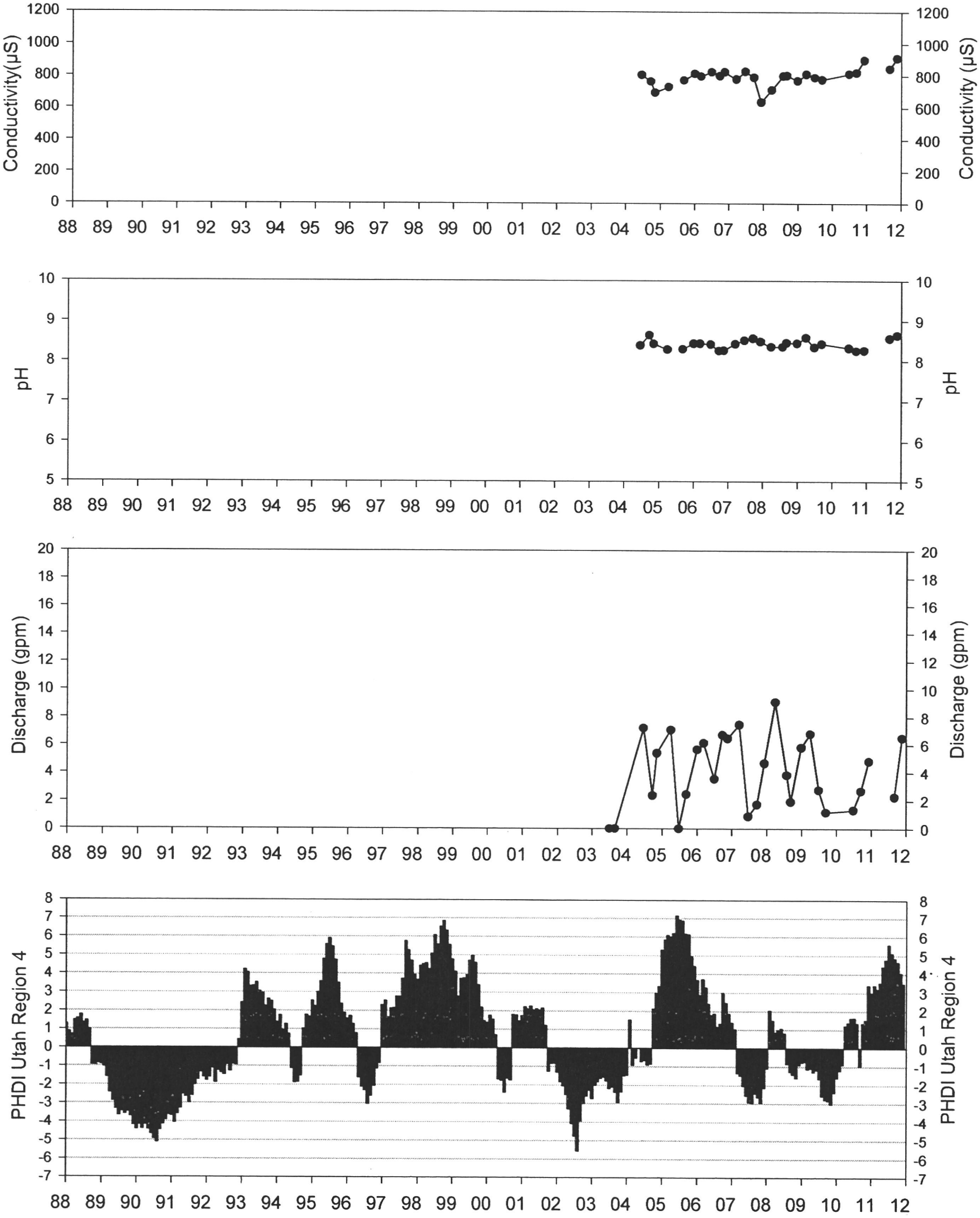
Shingle Creek



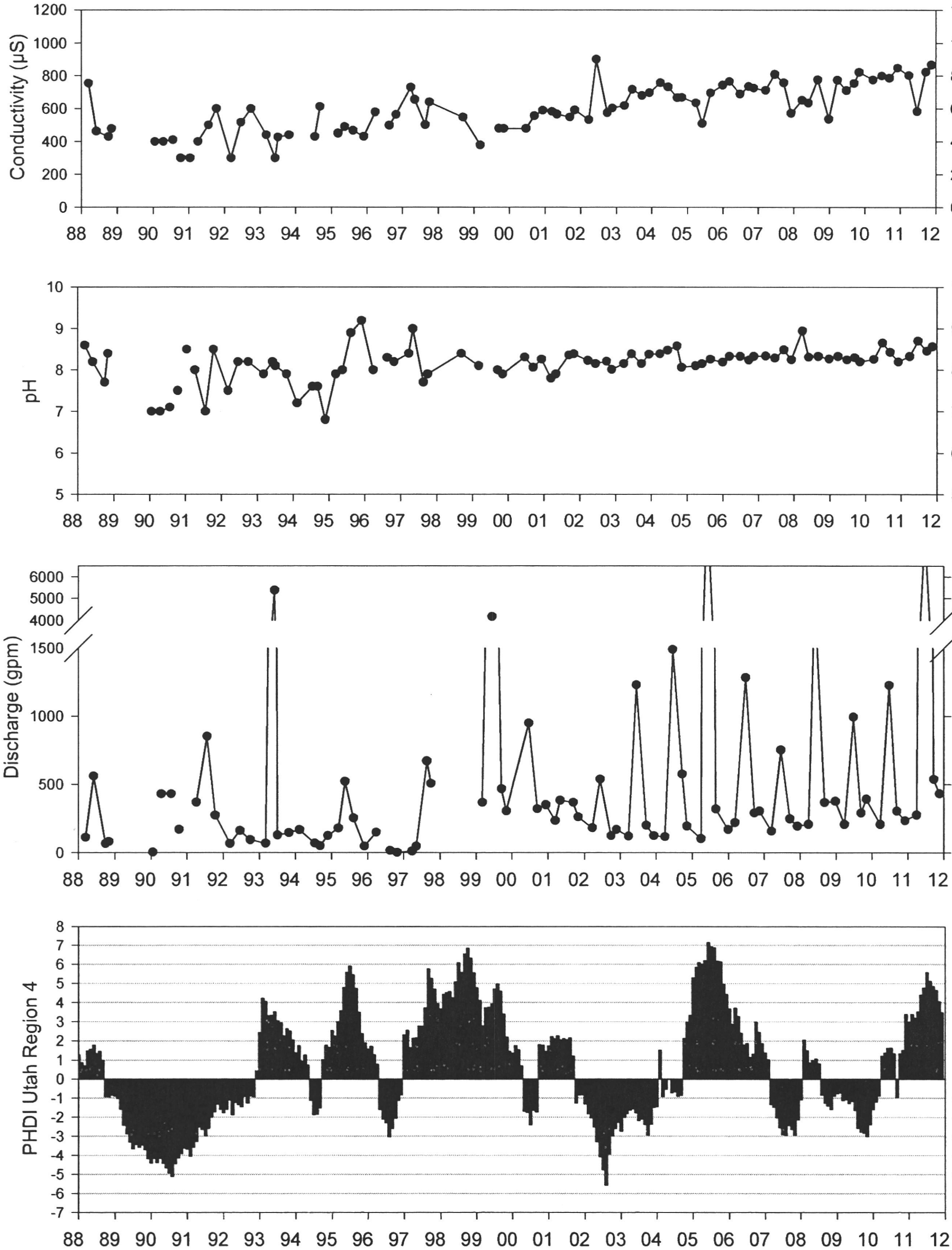
Little Bear Creek



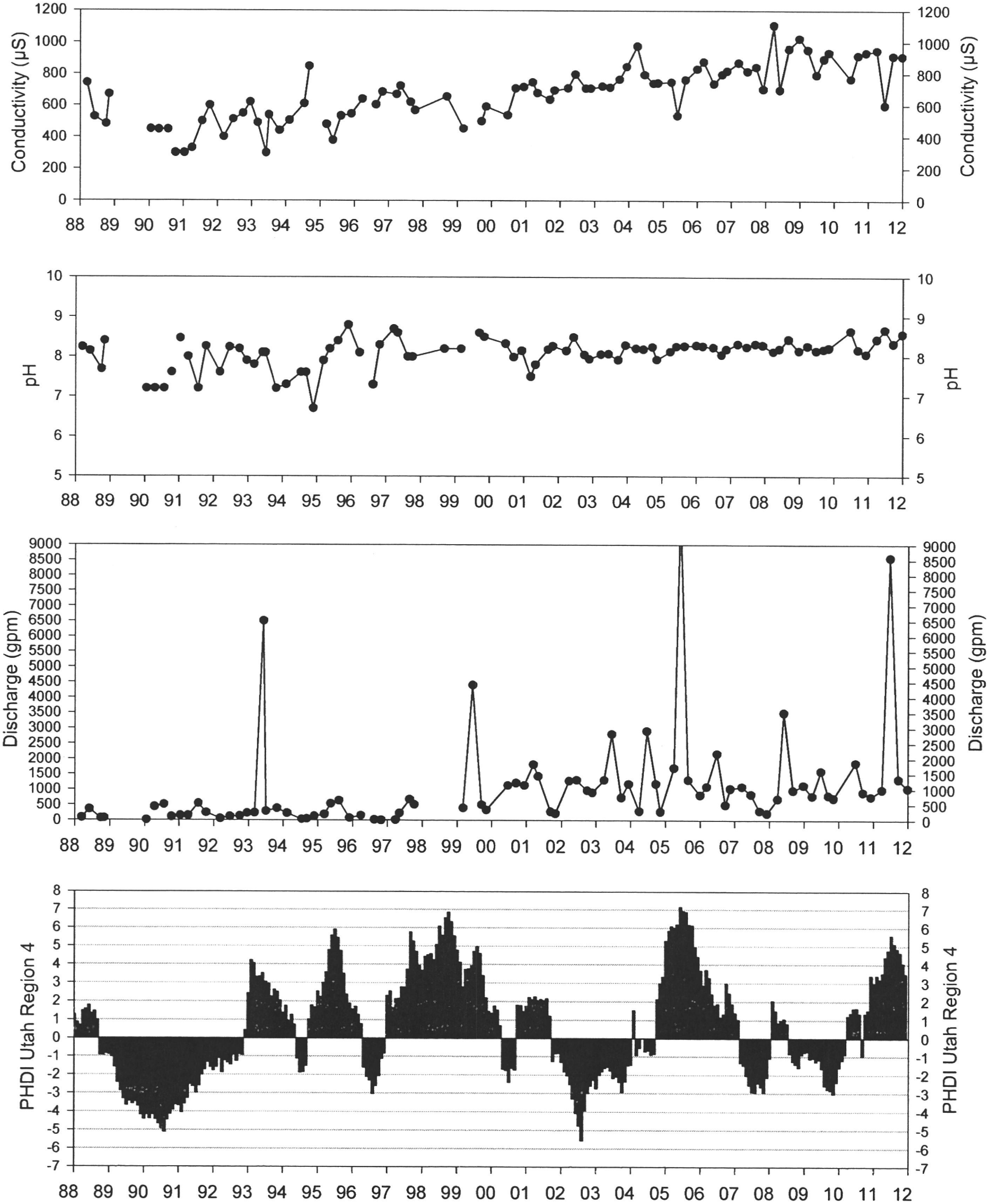
Section 4 Creek



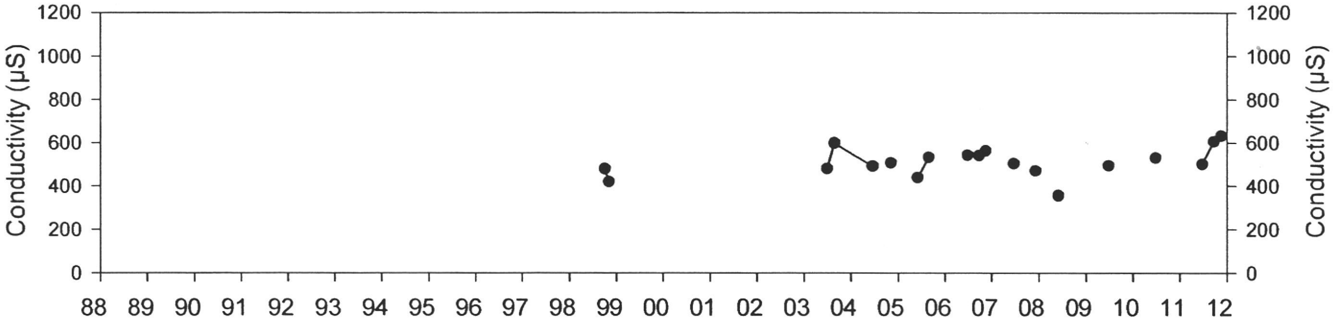
Crandall Canyon Upper Flume (UPF-1)



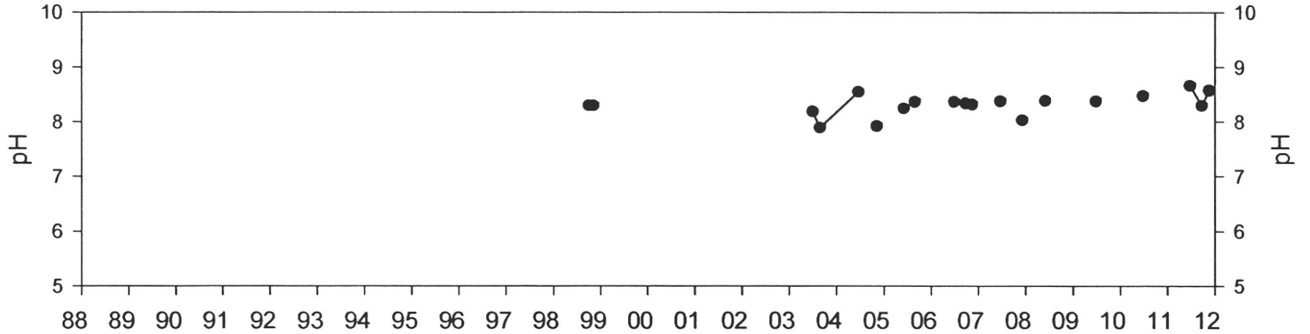
Crandall Canyon Lower Flume (LOF-1)



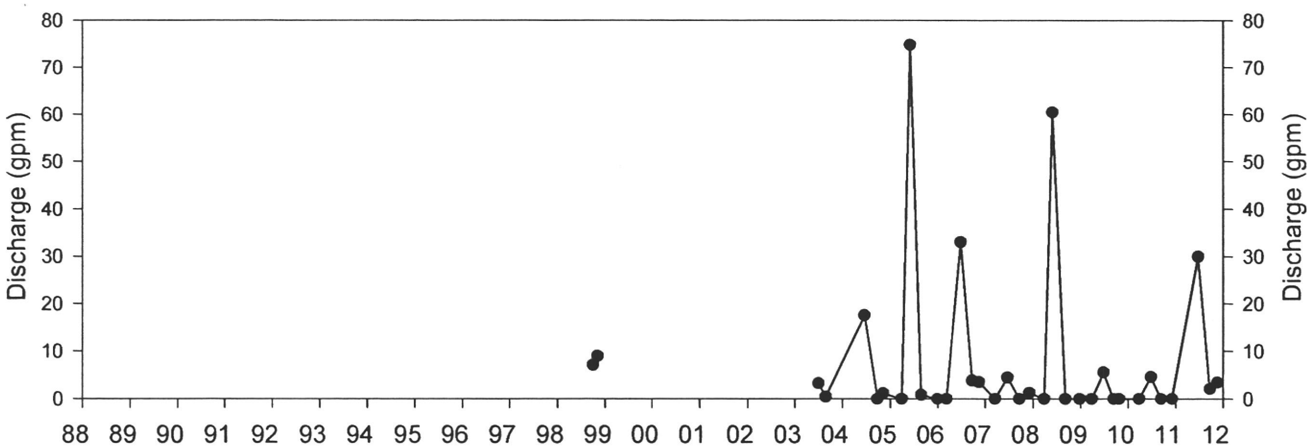
IBC-1



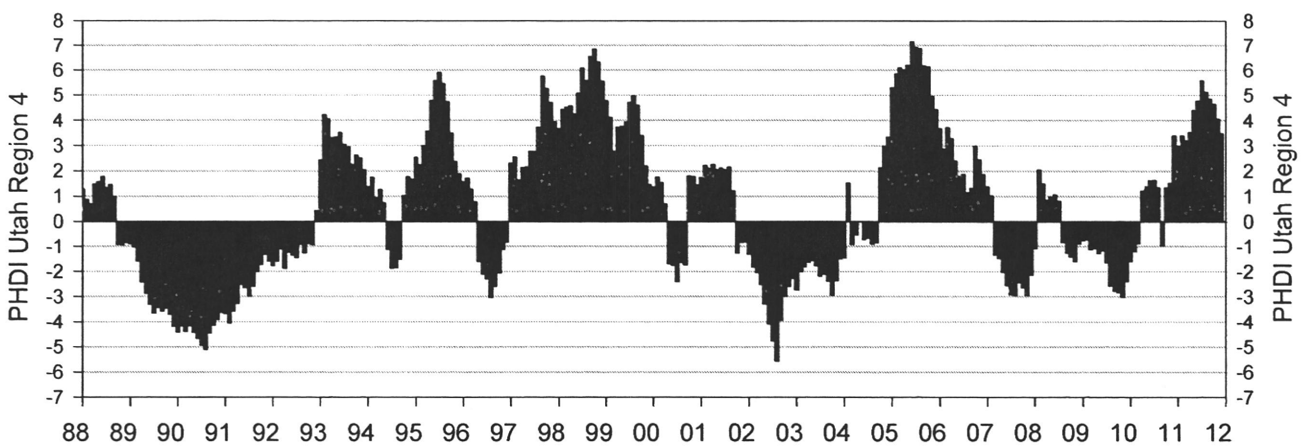
Conductivity (µS)
1200
1000
800
600
400
200
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12



pH
10
9
8
7
6
5
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

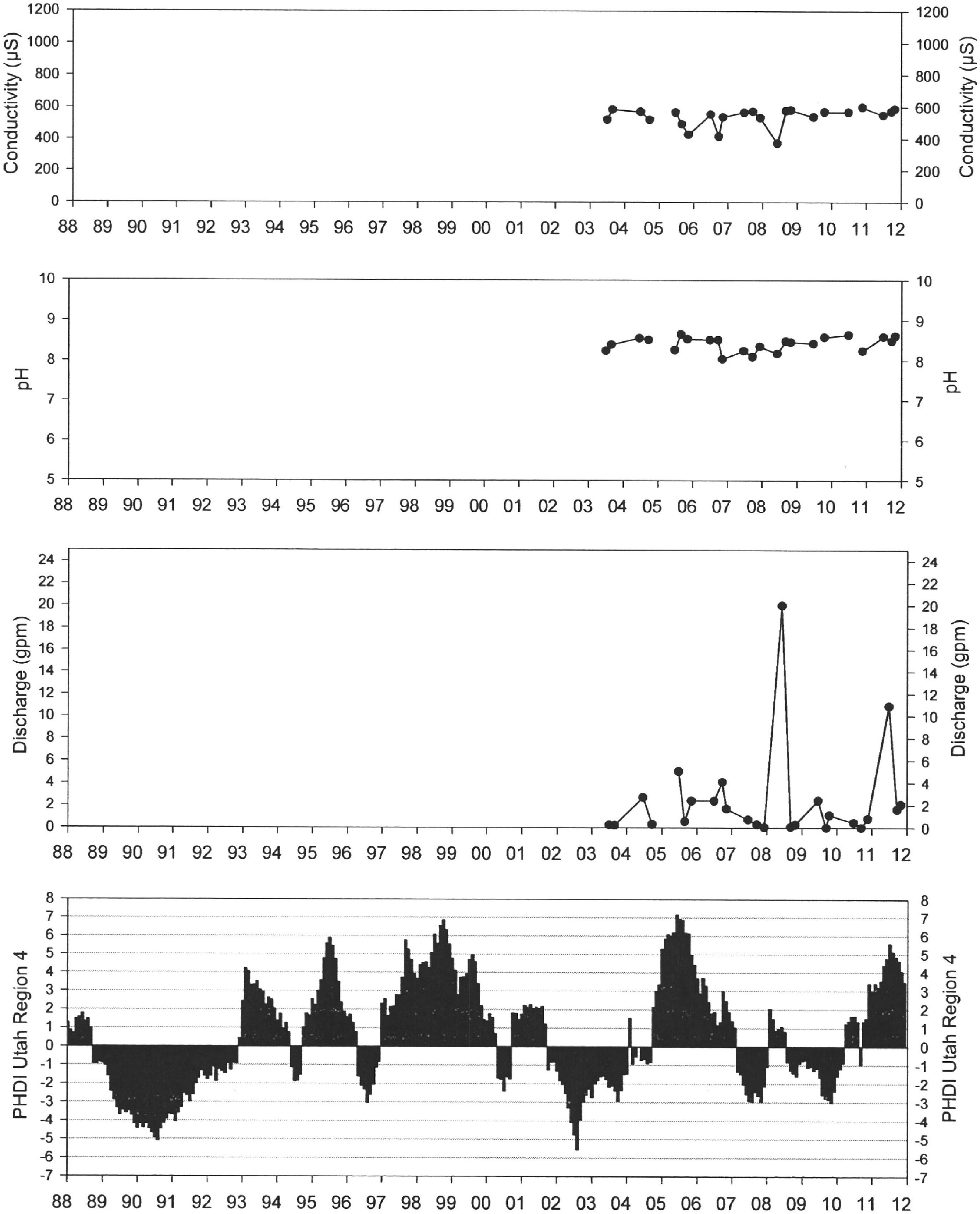


Discharge (gpm)
80
70
60
50
40
30
20
10
0
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

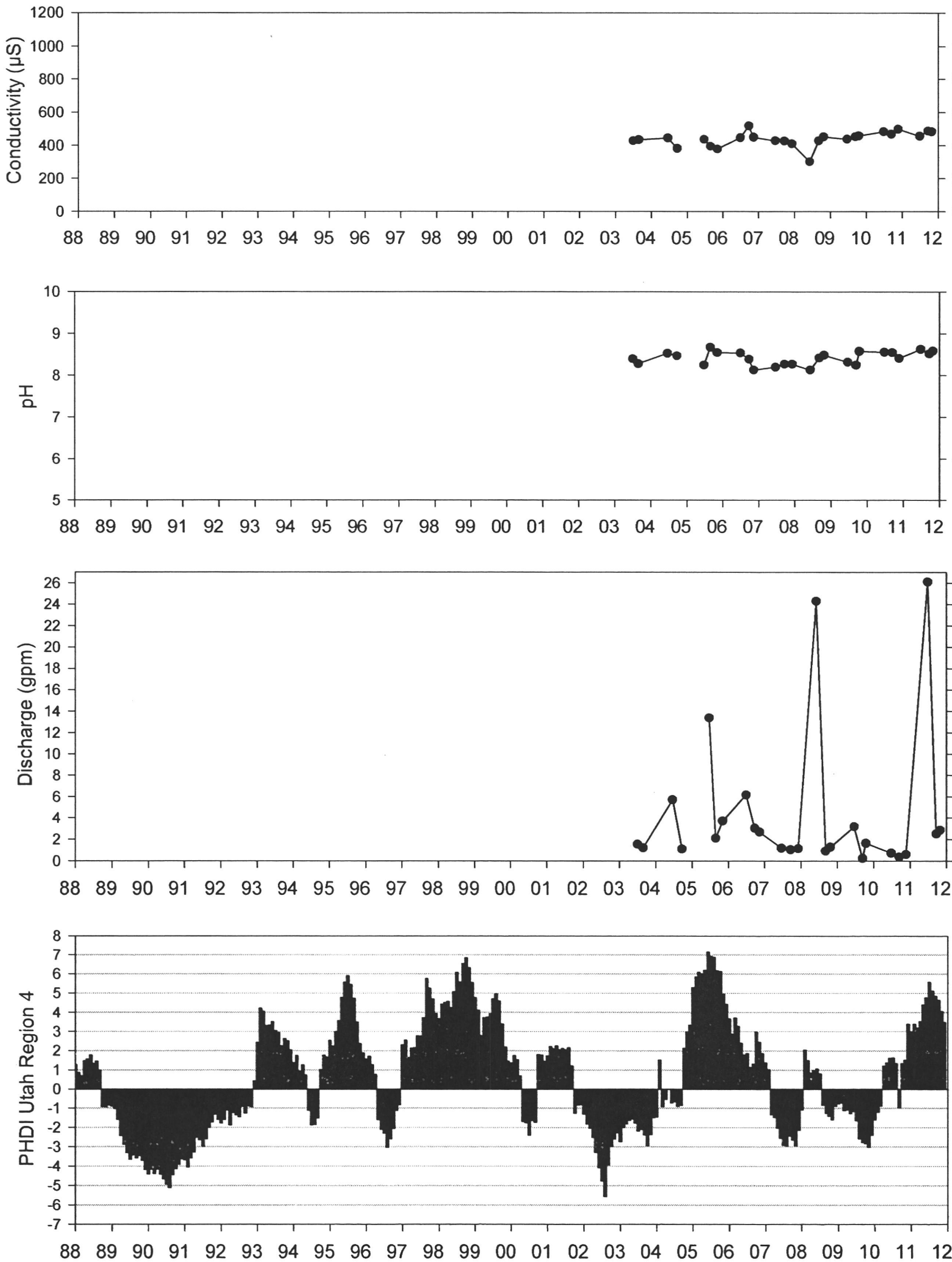


PHDI Utah Region 4
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12

Section 5 U.R. Creek



Section 5 U.L. Creek



Section 5 Creek