APPENDIX E.

RECONNAISSANCE ALLUVIAL VALLEY FLOOR INVESTIGATION IN THE ALTON COAL TRACT LBA AND ADJACENT AREAS, KANE COUNTY, UTAH

Reconnaissance Alluvial Valley Floor Investigation in the Alton Coal Tract LBA and Adjacent Areas, Kane County, Utah

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PETERSEN HYDROLOGIC, LLC
CONSULTANTS IN HYDROGEOLOGY

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Prepared by:

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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Reconnaissance Alluvial Valley Floor Investigation in the Alton Coal Tract LBA and Adjacent area, Kane County, Utah

1.0 Introduction

The United States Department of the Interior, Bureau of Land Management (BLM) is currently preparing a draft environmental impact statement in conjunction with proposed federal coal leasing actions in the Alton Coal Field at the Alton Coal Tract LBA (LBA). The LBA includes federal coal reserves located near the town of Alton, Utah (Figure 1).

Under the provisions of the Surface Mining Control and Reclamation Act of 1977 (SMCRA), special consideration is given to coal mining in certain types of stream valleys in the western United States west of the 100th meridian. These valleys are called alluvial valley floors (AVF). While the regulatory definition of an alluvial valley floor is rather complex, in the general sense, alluvial valley floors are stream valleys which 1) are located in those topographic valleys having an associated stream channel, 2) are underlain by unconsolidated deposits whose surface usually has the landform appearance of flood plains or terraces, and 3) have agricultural importance derived from the availability of surface-water or groundwater (OSM, 1983). Under SMCRA, certain alluvial valley floors are prohibited from disturbance by coal mining activities, while other alluvial valley floors may be mined, but are subject to higher standards of reclamation than are other coal mined areas.

Because of the complexities of alluvial valley floor identification, a multi-step investigative identification process is often implemented in coal leasing and permitting actions. Initial

identification studies are typically performed at a reconnaissance level using currently available or easily obtainable information. The performance of detailed, site-specific AVF studies typically involves the collection and analysis of large amounts of data and requires considerable effort and expense. Consequently, where necessary, detailed site-specific AVF studies are typically performed at a later time (often during the mine permitting stage). The primary purpose of a reconnaissance-level initial identification study is to identify those areas in and adjacent to proposed coal mining areas that clearly are not alluvial valley floors as defined by SMCRA. Additionally, those areas that are determined to be probable alluvial valley floors, based on the reconnaissance-level information and identification criteria, are delineated in these studies. The results of these reconnaissance-level AVF identification studies are useful to regulatory agencies in making initial decisions regarding leasing actions and permitting of coal mining areas. Where considered necessary, additional more detailed investigations may subsequently be performed in those areas where the presence or absence of a regulatory alluvial valley floor is less clear.

It should be emphasized here that the delineation of an area as a probable alluvial valley floor at the reconnaissance-level identification stage should not result in any scientific or other bias with regards to any future post-identification-stage AVF determinations in that area. This is because 1) the AVF delineation criteria utilized at the reconnaissance-level investigatory stage are different and more generalized than those utilized at the detailed-study identification phase, and 2) the identification-stage determinations are typically based on regional-scale information that is commonly less refined and more general than the types of data obtained from detailed study investigations.

Specifically, the primary purpose of this investigation is to delineate those areas within the Alton Coal Tract LBA and the adjacent area that are clearly not alluvial valley floors. The secondary purpose of this investigation is to provide an initial identification of those areas that are probable alluvial valley floors based on a reconnaissance-level investigation.

Including this introduction, this report contains the following sections:

1. Introduction
2. Methods of Study
3. Alluvial Valley Floor Initial Identification Criteria
4. Regional Agricultural Practices
5. Mine Site Study Area
6. Water Availability
7. Presently Irrigated Lands
8. Subirrigated Areas
9. Lands Which Have the Capability of Being Flood Irrigated
10. Surficial Geology and Geomorphology
11. Reconnaissance-Level Alluvial Valley Floor Determinations
12. References Cited

2.0 Methods of Study

This reconnaissance-level alluvial valley floor identification study was performed using the following methods of study.

- Existing geologic and hydrogeologic maps and reports pertinent to this investigation were obtained and reviewed.

- A field reconnaissance survey was performed that included traversing each of the primary stream drainages in the study area as well as the upland portions of the area that could conceivably contain alluvial valley floors.

- The surficial geologic and geomorphologic characteristics of the surveyed areas were examined in the field and noted. Additional geologic information was obtained from the geologic map of the 7.5-minute Alton, Utah quadrangle (Tilton, 2001).

- Stream valleys and their associated stream channels were photographed for analysis.

- Aerial photographs were obtained and analyzed that included high-resolution color aerial photography, high-resolution color infrared imagery, and oblique color aerial photography.

- An analysis of high-resolution stereoscopic aerial photography was performed to delineate geomorphologic features.

- Information relating to the AVF identification criteria was plotted on a 1:24,000 United States Geological Survey topographic base for analysis.

3.0 Alluvial Valley Floor Identification Criteria

The identification criteria used to delineate probable alluvial valley floors in this reconnaissance investigation are based on the information provided in the document *Alluvial Valley Floor Identification and Study Guidelines,* which is published by the Office of Surface Mining Reclamation and Enforcement (OSM, 1983). It is important to note that, although the concept of an alluvial valley floor may have a technical meaning to a geologist, in the context of SMCRA, an alluvial valley floor is a *regulatory term* that has been defined in statute and clarified in legislative history, court decisions, regulations, and ongoing administrative decisions (OSM, 1983). Consequently, in this investigation, the AVF identification criteria established by SMCRA and as outlined by OSM have been strictly followed . These delineation criteria are summarized below.

The SMCRA definition of an alluvial valley floor is based on agricultural water use and surficial geologic characteristics of a stream valley. An alluvial valley floor is defined by SMCRA as:

> *the unconsolidated stream-laid deposits holding streams with water availability sufficient for subirrigation or flood irrigation agricultural activities but does not include upland areas which are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits formed by unconcentrated runoff or slope wash, together with talus, or other mass-movement accumulations and windblown deposits.*

Regulations, judicial review, and administrative decisions have expanded and clarified the statutory definition as follows (OSM, 1983):

The geologic criteria of an alluvial valley floor are understood to be:

(a) A topographic valley with a continuous perennial, intermittent, or ephemeral stream channel running through it; and
(b) Within that valley, those surface landforms that are either flood plains or terraces if these landforms are underlain by unconsolidated deposits; and
(c) Within that valley, those side-slope areas that can reasonably be shown to be underlain by alluvium and which are adjacent to flood plain or terrace landform areas.

The water availability criteria are met if:

(a) Water is available by surface-water irrigation or subirrigation and is being or has successfully been used to enhance production of agriculturally useful vegetation; or
(b) Surface water is available in sufficient quantities to support agricultural activities.

It is apparent that alluvial valley floors, in the regulatory sense, are not merely those valleys filled with alluvium. Additionally, stream valleys which do not have any agricultural importance or whose importance is not related to the greater water availability of the valleys are not alluvial valley floors (OSM, 1983).

The acquisition of the types and quantity of data required to make a definitive determination of a stream valley's alluvial valley floor status is typically a labor-intensive and expensive task. Commonly, the types of data utilized to make a final AVF determination at the detailed study level may include detailed subsurface characterization of alluvial sediments (typically performed by drilling and/or the excavation of soil pits), soil moisture characterizations, alluvial groundwater characterizations, baseline hydrologic information on groundwater and surface-water quantity and quality, detailed geomorphologic studies, detailed vegetative studies, and detailed evaluation of the agricultural potential of the land. At the preliminary land management and coal leasing stage, these types of data are typically not available to decision makers. Consequently, the determination of the AVF status of a stream valley is commonly performed in a multi-step process.

Commonly, prior to the performance of any detailed AVF investigation, a reconnaissance-level identification stage is performed in a coal lease study area. The reconnaissance-level identification study relies primarily on previously existing or easily obtained data from the project area. The primary goal of an identification stage study is to establish whether or not alluvial valley floors exist in the study area (OSM, 1983). Clearly, because the quantity and level of detail in the data utilized in a reconnaissance-level identification study are not of a detailed nature, the results of the reconnaissance-level identification study are utilized for general purposes only, and possibly to provide direction for future studies in the area.

Based on guidelines outlined by OSM, for the purpose of the reconnaissance-level identification study, the study procedure and criteria utilized to identify potential alluvial valley floors generally include the following:

Water Availability study procedure and Criteria (identification stage study)

- Presently irrigated lands are identified and mapped.

- All lands which appear to have the capability of being flood irrigated, based on a previous evaluation of commonly employed regional irrigation practices, are identified and mapped. If the type of undeveloped stream valley is not typically developed for irrigation elsewhere in the region, those valley floors are not AVF.

- Potential subirrigated lands which are of agricultural importance are identified and mapped.

Geologic study procedure and Criteria (identification stage study)

- Surficial geologic data are collected and flood plain or terrace areas are identified and mapped.

The water availability and geologic data in a reconnaissance-level study are typically plotted at a scale of 1:24,000 (1 inch = 2,000 feet).

Any areas meeting the geologic criteria and one of the water availability criteria can be considered alluvial valley floors for the purposes of initial identification (OSM, 1983).

4.0 Regional Agricultural Practices

This discussion of common agricultural practices in the study area is based on inspection of agricultural operations in the area and on discussions with local farmers and ranchers.

In the Alton, Utah and surrounding areas, the limiting factor for agricultural activity is typically the availability of a reliable supply of adequate water. In the Alton Coal Field area, near-surface groundwater resources are generally not sufficient to allow the pumping of groundwater for substantial crop irrigation. Groundwater in the near-surface formations in agricultural areas is generally limited to groundwater in shallow alluvial groundwater systems. Geologic conditions in the near-surface bedrock formations are not conducive to the production of appreciable quantities of groundwater (Petersen Hydrologic, 2007). It should be noted that appreciable groundwater resources are likely available in deep aquifers beneath the Alton Coal Field (i.e. the Navajo Sandstone regional aquifer). However, the difficulties and expense of producing groundwater from these deep formations are likely prohibitive. Consequently, appreciable production of groundwater from the deep aquifers for irrigation use is not known to have occurred in the area. Groundwater discharging from springs is commonly utilized for stock watering in the region.

Because of the unavailability of appreciable groundwater resources, the irrigation of croplands in the region is most commonly carried out using surface waters in streams originating in the upland areas of the adjacent Paunsaugunt Plateau located to the east of the study area (Figure 1). Because of the highly seasonal character of the discharge in these mountain streams (i.e. much of the annual yield from these streams occurs during the springtime snowmelt event prior to the growing season, while discharge usually declines dramatically thereafter in the summer months) surface waters are commonly diverted into earthen holding ponds and stored for use later in the growing season. Because of the appreciable stream gradients and topographic relief present in the area, surface water can be routed from up-stream diversions to irrigated fields at lower topographic elevations via earthen ditches or other conveyance mechanism under gravity flow. Crop yields in the region commonly show considerable variability from year to year depending on the surface-water availability as determined by the prevailing climatic conditions.

It is most commonly observed that irrigation of croplands is limited to parcels of land that are reasonably flat and of large enough acreage to warrant the effort required to design, construct, and maintain the irrigation system and to perform the irrigation. Commonly,

irrigated crop lands are irrigated using flood irrigation techniques. In other areas, sprinkler systems utilizing wheel lines and pivot systems (sourced with stored surface water) are increasingly being utilized.

5.0 Mine Site Study Area

The area of study for this reconnaissance-level identification study is shown on Plate 1. The study area boundaries encompass all of the Alton Coal LBA and the adjacent area. The boundaries of the study area have been delineated to facilitate the identification of alluvial valley floors within all areas possibly affected by coal mining activities in the Alton Coal Tract LBA.

It should be noted that a detailed alluvial valley floor study has previously been performed in the Coal Hollow Project and adjacent area in conjunction with the mine permitting activities with the Utah Division of Oil, Gas and Mining (Petersen Hydrologic, 2008). The study area for that investigation, which also includes portions of the Alton Coal LBA, is shown on Plate 1. The reader is referred to the report of that investigation (Petersen Hydrologic, 2008) for specific information regarding alluvial valley floors within that region. It should be noted that, prior to the issuance of the mining permit for the Coal Hollow Mine, the Utah Division of Oil, Gas and Mining made a finding that there are no alluvial valley floors present within the Coal Hollow Project area.

6.0 Water Availability

For general informational purposes, discharge hydrographs depicting seasonal flows rates measured historically in streams in the study area are provided in Figure 2. The discharge data used to create these hydrographs were obtained from data submitted to the Utah Division of Oil, Gas and Mining on-line hydrology database (UDOGM, 2008) by operators

in conjunction with mine permitting actions. It should be noted that these hydrographs depict instantaneous discharge measurements performed monthly or quarterly during times when the monitoring sites are accessible. These hydrographs do not depict a continuous, uninterrupted flow record, but rather are presented here to assist in evaluating the general magnitude of seasonal discharge rates in these streams.

It is apparent in Figure 2 that the most significant source of surface water in the study areas is from Kanab Creek. Kanab Creek provides irrigation water that is largely used in the Alton, Utah and nearby areas. Further downstream, flows diminish in the drainage, both as a result of upstream irrigation diversions and from losses to evapotranspiration. It is not uncommon for Kanab Creek to have little or no discharge south of the study area during much of the year.

Surface water flows in Sink Valley Wash below Sink Valley are usually present only in direct response to snowmelt and during torrential precipitation events. Consequently, Sink Valley Wash is not considered a significant source of irrigation water in the study area.

Water availability criteria in this alluvial valley floor identification study include 1) the identification and mapping of all presently irrigated lands, 2) the mapping of all lands which appear to have the capability of being flood irrigated, and 3) the mapping of potentially subirrigated areas. The results of these activities as performed for this investigation are summarized in the following three sections of this report.

7.0 Presently irrigated lands

A map showing presently irrigated lands in the study area is presented in Plate 2. The mapping of presently irrigated lands is based on 1) field observations of irrigated areas, and 2) analysis of high-resolution color IR aerial imagery.

Presently irrigated areas in the study area have been identified in two main regions. These include irrigated lands in the northern portion of the study area near the town of Alton, Utah, and irrigated lands located in the narrow valley bottoms adjacent to Kanab Creek in the central and southern portion of the study area about 2.5 miles south of Alton, Utah. The characteristics of these two irrigated areas are described below.

Alton area

Currently irrigated areas near the town of Alton, Utah are comprised mostly of irrigated hay fields. These fields are irrigated predominantly with sprinklers using wheel lines and pivots. The source of irrigation water is predominantly surface-water diverted from Kanab Creek into earthen storage ponds in upstream areas. Some apparently flood irrigated areas are also present, but these are generally smaller sized areas than are the sprinkler irrigated areas. It should be noted that all of the town has been mapped as presently irrigated lands. Irrigation within the town consists predominantly of irrigation of domestic and municipal landscaping and the irrigation of domestic gardens and pastures.

It is apparent that irrigation return water running off the irrigated fields immediately south of the town of Alton enhances the growth of vegetation and increases soil moisture in adjacent rangelands immediately south of the irrigated fields (see Plate 2). This conclusion is based in part on analysis of infrared imagery, which clearly shows the zones of increased wetness and vegetation occurring immediately below lowest elevation areas of the irrigated fields. Similar wet zones are not apparent in adjacent areas at similar elevations which are not adjacent to irrigated fields. Infiltration of springtime snowmelt runoff water from the fields and other up-gradient areas may also contribute to the increased wetness of these areas during the springtime. It is unlikely that there is an appreciable component of natural groundwater discharge in this area as the geologic conditions are not favorable for this to occur. The bedrock formation underlying the area consists of relatively impermeable Tropic Shale, which is overlain by an apparently thin veneer of alluvium and soil. The identification of a likely recharge location that could support appreciable natural groundwater discharge to these areas is also problematic.

Southern Kanab Creek valley area

Irrigated lands have been identified in the narrow valley bottoms adjacent to Kanab Creek about 2.5 miles south of Alton, Utah (Plate 2). Irrigation in these areas is by flood irrigation techniques. Water for irrigation of these areas is diverted from Kanab Creek into transmission ditches at upstream locations. This surface water is stored in earthen storage ponds for use in flood irrigation of the irrigable lands during the growing season.

It is apparent that at times in the past, hay production has likely occurred in these fields. However, during at least the past four years, it appears that these fields have been utilized primarily as pasture lands for seasonal cattle grazing.

8.0 Subirrigated Areas

Areas that appear to be potentially subirrigated and are of agricultural importance have not been identified within the study area. Narrow strips of riparian vegetation are present in some areas immediately adjacent to stream channels. While these narrow riparian areas are likely subirrigated, they are not considered significant to local agricultural activities and, consequently, are not mapped here. Subirrigation of the broader valley bottoms adjacent to the major stream drainages is generally not observed in the study area (other than in the narrow strip of riparian vegetation sometimes present near the stream channel). This condition is likely the result of several factors including 1) the lack of appreciable discharge in many of the stream reaches during much of the year, 2) the abundant presence of low permeability clayey sediments in the alluvial materials adjacent to the streams that limits the potential for appreciable lateral migration of water, and 3) the fact that many of the stream drainages in the study areas are deeply incised in their channels, often by several tens of feet, which results in an increased vertical distance between the active stream level and the vegetation present on the abandoned adjacent terrace.

9.0 Lands which appear to have the capability of being flood irrigated

Lands which appear to have the capability of being flood irrigated are mapped on Plate 3. The delineation of these areas is based on typical regional irrigation practices as described in Section 4 above. Regionally, those topographic valley areas which are reasonably flat and of a sufficient acreage to justify the effort and expense required to construct and maintain an irrigation system are often developed for irrigation. Narrow canyon bottoms and steep side slopes are generally not irrigated regionally. Because of the appreciable topographic relief present in the study area which provides the hydraulic head required to transport water through ditches or pipes under gravity flow, it has been assumed that surface waters could be conveyed via conveyance ditches to most valley bottom locations.

It should be noted that the mapping of potentially flood irrigable lands in Plate 3 is considered conservative. With sufficient effort, almost any lands in the project area (with the probable exception of some hill tops) could conceivably be flood irrigated. However, upland areas similar to those in the areas intervening between the major drainages in the study area are rarely irrigated in the region. For this investigation, essentially all of the valley bottoms and adjacent moderate side slope areas along the major drainages have been mapped as flood irrigable. It is acknowledged that many of these areas are probably too narrow to justify the efforts required to develop these lands for flood irrigation.

10.0 Surficial Geology and Geomorphology

A geologic map of the Alton, Utah 7.5 minute quadrangle was prepared by the Utah Geological Survey in cooperation with the United States Geological Survey in 2001 (Tilton, 2001).

As discussed above, detailed geologic information (particularly subsurface characteristics of alluvial sediments) is typically not available for reconnaissance-level AVF investigations. Consequently, for the purposes of the reconnaissance-level initial identification study, delineations of alluvial geomorphological features (flood plains and alluvial terraces) are usually relied upon as the basis for the geologic criteria for the identification-stage AVF delineation (OSM, 1983). The locations of flood plains and alluvial terraces identified in the study area are mapped in Plate 4. It should be noted that the shaded area on Plate 4 delineates regions where either flood plain or terrace geomorphic features have been identified. Regions including either of these geomorphic features (flood plains or terraces) were mapped together as the shaded region on Plate 4. However, these geomorphic features are not individually delineated on Plate 4. This methodology is considered appropriate as a determination of the presence of either flood plains or terrace landforms is inherent in a probable alluvial valley floor identification at the reconnaissance level.

The identification of geomorphologic features in this investigation were determined using high-resolution aerial photographs, high-resolution stereoscopic imagery, published geologic maps, and reconnaissance-level field investigations in the study area. It is apparent on Plate 4 that the mapable flood plains and terraces in the study area are located adjacent to Kanab Creek and lower Sink Valley Wash.

It is noteworthy that flood plains and alluvial terraces were not identified in the region near the town of Alton. Much of the region surrounding the town of Alton is underlain by bedrock of the Tropic Shale, which is a low-permeability marine shale (Tilton, 2001). Within the town itself, an apparently thin veneer of alluvium directly overlies the Tropic Shale. Alluvial sediments that would be consistent with those that would typically comprise an alluvial valley with associated flood plains and terrace complex are not present in this area.

11.0 Reconnaissance-Level Alluvial Valley Floor Determinations

As described in the OSM Alluvial Valley Floor Identification Guidelines (1983), those areas meeting the geologic criteria of the presence of alluvial flood plains and terraces, and also meeting one of the water availability criteria (lands presently irrigated, lands with the capability of being flood irrigated, or potentially subirrigated lands) are classified as probable alluvial floors for the purposes of the reconnaissance-level identification study.

Based on the reconnaissance-level identification study criteria outlined in Section 3 above, six Identification Areas have been identified in the study area. These areas encompass those lands within the study area that appear to have the greatest likelihood for being potential alluvial valley floors. Accordingly, these regions are considered areas for potential future detailed-level AVF delineation studies should additional characterization of the AVF status of these lands be warranted. The six Identification Areas are shown on Plate 5. Details summarizing the delineations of the AVF status of each of these areas are presented below.

Identification Area 1

Identification Area 1 is located in the Kanab Creek drainage in the northern portion of the study area east of the town of Alton, Utah (Plate 5). Photographs of the land surface in Area 1 are included in the Photographs Section of this report. Agricultural activities in Area 1 include the production of hay in irrigated fields in the flat lands adjacent to Kanab Creek. Pasture lands used for cattle grazing are also present in Area 1. The flat lands adjacent to Kanab Creek appear at the reconnaissance level to have the geomorphologic characteristics of flood plains. Consequently, at the reconnaissance-stage identification study level, the land in Area 1 is considered a probable alluvial valley floor.

It is noteworthy that bedrock outcrops are present along both the east and west margins of Area 1 with the land surface sloping toward the stream channel on both sides of the drainage. Additional information regarding the subsurface characteristics of the alluvial sediments and

the lateral alluvium/bedrock interface locations in Area 1 would facilitate the further refinement of the boundaries of the flood plain and to confirm the presence of an alluvial valley floor.

It should be noted that on satellite images, agricultural activities have been observed in upland areas (that are either alluvial fan or terrace geomorphic landforms) northeast of Identification Area 1 (beyond the study area extents of this investigation). The geomorphic character of these features, being outside the study area for this investigation, has not been definitively determined. However, within the study area for this investigation, upland alluvial terraces (beyond the flood plain and terrace complexes delineated in Plate 4) have not been identified. Accordingly, there is no identified potential for irrigation of any such upland alluvial terraces within the study area.

Identification Area 2

Identification Area 2 is located in the Kanab Creek drainage in the central portion of the study area (Plate 5). Photographs of the land surface in Area 2 are included in the photograph section of this report. The width of the valley bottom in Area 2 is much narrower than that of Area 1. A narrow flood plain is also present in Area 2. However, there has apparently not been any substantial agricultural development in Area 2, likely because of the narrowness of the valley. A narrow strip of riparian vegetation exists adjacent to the stream in the active channel area, but this does not seem to be large enough to be of appreciable agricultural importance for grazing. The surrounding land (outside the riparian area) consists mostly of undeveloped rangeland. While the land surface in Area 2 could conceivably be irrigated, the irrigation of valleys of similar geometry in the region has generally not been observed. Consequently, at the reconnaissance-stage identification study level, the land in Area 2 is considered a possible (though unlikely) alluvial valley floor. Refinement of the locations of the lateral margins of the stream-laid deposits overlying the flood plains could be accomplished with additional study of the subsurface characteristics of the sediments in the valley bottom.

It should be noted that grazing lands are present in regions located east of the northeast portion of Area 2 (which include privately owned lands in the southwestern quarter of Section 18, Township 39 South, Range 5 West). While some of these areas are mapped as alluvium in the Tilton (2001) geologic map of the area, the geomorphic landforms present in this region, which generally slope from the adjacent mountainous regions toward lower-lying regions adjacent to Kanab Creek, have been identified in this investigation as alluvial fan landforms. These areas do not show characteristics of flood plain or terrace geomorphic landforms. Accordingly, because of the absence of flood plain or terrace landforms, these areas are not considered as probable alluvial valley floors.

Within the study area for this investigation, upland alluvial terraces (beyond the flood plain and terrace complexes delineated in Plate 4) have not been identified. It should be noted that broad, sloping alluvial fan geomorphic features (which generally slope away from adjacent upland areas) have been identified in some areas, but these are not associated with either flood plain or terrace geomorphic features. Accordingly, there is no identified potential for irrigation of any such upland alluvial terraces within the study area (including the regions adjacent to Investigation Area 2).

Identification Area 3

Identification Area 3 is located in the Kanab Creek drainage in the central portion of the study area (Plate 5). The stream valley associated with Area 3 is a small tributary to Kanab Creek. A narrow, well-defined flood plain is present in the lower reaches of this tributary (See Photographs Section). A narrow corridor with increased vegetation is present in the bottom of this stream valley. As with Area 2 described previously, this stream drainage generally satisfies most of the reconnaissance-level identification criteria for AVF. However, its small size and narrow width probably preclude its development for irrigation and limit its agricultural importance. While the land surface in Area 3 could conceivably be irrigated, the irrigation of valleys of similar geometry in the region has generally not been observed. Consequently, at the reconnaissance-stage identification study level, the land in Area 2 is considered a possible (though unlikely) alluvial valley floor.

Identification Area 4

Identification Area 4 is located in the southwestern portion of the study area in the Kanab Creek drainage (Plate 5). Photographs showing the land surface in Area 4 are included in the Photographs Section of this report. It is apparent that the agricultural fields in Area 4 are currently utilized primarily for cattle grazing. The fields are currently flood irrigated using Kanab Creek surface water diverted from the creek at upstream diversions and conveyed through ditches to a series of earthen storage ponds (Plate 2). It appears likely that hay was produced in the past in some of the fields in Area 4 (dilapidated hay production equipment is still present at the site). In the southernmost portion of Identification Area 4, the Kanab Creek stream channel is incised below the adjacent abandoned terrace areas by more than 50 feet in some locations. The lands on the upland terrace adjacent to the active stream channel consist primarily of undeveloped rangelands. The flat lands adjacent to Kanab Creek that comprise Area 4 appear at the reconnaissance level to have the geomorphologic characteristics of flood plains. Consequently, at the reconnaissance-stage identification study level, the land in Area 4 is considered a probable alluvial valley floor.

Identification Area 5

Identification Area 5 is located in the southern portion of the study area in the Kanab Creek drainage immediately below Area 4 (Plate 5). Photographs showing the land surface in Area 5 are included in the Photographs Section of this report. The Kanab Creek stream drainage in Area 5 is deeply incised relative to the surrounding abandoned terrace areas. It is apparent that the lands in Area 5 outside the narrow, incised active stream channel area consist primarily of undeveloped rangelands with sagebrush and juniper vegetation. The riparian vegetation adjacent to the active stream channel in Area 5 is appreciably less extensive than in upstream locations. It is likely that the quantity of surface water available in this area for irrigation is meager during most of the year, given the numerous upstream irrigation diversions and potential losses to evapotranspiration in the considerable distance between Area 5 and the Paunsaugunt Plateau source areas for the stream. Consequently, the importance of this land for agricultural use seems low. However, the flat lands adjacent to Kanab Creek in Area 5 appear at the reconnaissance level to have the geomorphologic

characteristics of flood plains, and the relatively flat lands on the upper terrace appear to have the physical capability of being flood irrigated (although the availability of water for irrigation purposes is meager). Consequently, at the reconnaissance-stage identification study level, the land in Area 5 is considered a possible (although unlikely) alluvial valley floor.

Identification Area 6

Identification Area 6 is located in Sink Valley Wash in the southern portion of the study area (Plate 5). Photographs showing the land surface in Area 6 are included in the Photographs Section of this report. Surface water flows in Sink Valley Wash in this area are usually absent, with water usually being present in the drainage only in direct response to snowmelt or during torrential precipitation events. Consequently, the availability of water for irrigation of the land in Area 6 is very low and irrigation of these lands is probably a practical impossibility.

The land surface in lower Sink Valley Wash below the county road-136 crossing is relatively broad and consists predominantly of undeveloped rangeland. The relatively flat lands adjacent to Sink Valley Wash that comprise Area 6 appear at the reconnaissance level to have the geomorphologic characteristics of flood plains. In the adjacent region above the county road-136 crossing, a well-defined flood plain is not apparent. Based on these factors, at the reconnaissance-stage identification study level, the land in Area 6 is considered a possible (although unlikely) alluvial valley floor.

Alton Town Area

It should be noted that AVF status of the lands within and immediately south of the town of Alton and west of the Tropic Shale bedrock ridge that divides that area from the Kanab Creek stream valley were considered in this investigation. Although significant agricultural activity takes place on these lands, it is readily apparent that these lands do not meet the regulatory criteria described in Section 3 above to qualify as alluvial valley floors. The lands immediately south of the agricultural fields at the southern end of the town of Alton, and also the lands immediately to the west and east of the town consist of Tropic Shale bedrock

(Tilton, 2001). The apparently thin veneer of alluvial sediments overlying the Tropic Shale in the town of Alton does not show geologic characteristics consistent with stream-laid deposits associated with flood plains and terraces. Additionally, the presence of a continuous stream channel that runs though the area and which resulted in the deposition of stream-laid sediments with flood plains or terraces is not apparent. It seems most probable that the thin alluvial sediments near the town of Alton are associated with residuum or slope wash deposits derived from the adjacent soft Tropic Shale bedrock and mud slide deposits located topographically above the town (Tilton, 2001). For these reasons, this area is not considered to be an alluvial valley floor in this investigation.

Lower Robinson Creek Area

Most of the Lower Robinson Creek area is contained within the previously evaluated Coal hollow Project study area (Plate 1). Previously, the Utah Division of Oil, Gas and Mining found that there are no alluvial valley floors in the Lower Robinson Creek area within the Coal Hollow Project area study boundary. As part of this investigation, Identification Area 4, which includes lands adjacent to Kanab Creek and the lowest reaches of Lower Robinson Creek have been identified as a probable alluvial valley floor at the reconnaissance-stage identification study level. It should be noted here that the approximately 0.25 mile reach of the Lower Robinson Creek drainage between the previous Coal Hollow Project study area boundary and the eastern edge of Identification Area 4 has also been evaluated for AVF potential as part of this investigation. While alluvial sediments have been identified in this region and minor stream flows are commonly present in this reach of the creek, flood plain and terrace landforms have not been identified in this area. The narrow valley adjacent to Lower Robinson Creek in this portion of the drainage generally slopes from the adjacent upland areas towards Lower Robinson Creek. The land in this area consists of undeveloped rangeland. Accordingly, this area is not considered to be an alluvial valley floor in this investigation.

12.0 References Cited

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Petersen Hydrologic, 2008, Supplemental information for Utah Division of Oil, Gas and Mining alluvial valley floor finding for the proposed Coal Hollow Mine, unpublished consulting report.

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Tilton, T.L., 2001, Geologic map of the Alton Quadrangle, Kane County, Utah, Utah Geological Survey, Miscellaneous Publication 01-4, 7.5 minute geologic map, cross-sections, and text.

UDOGM, 2008, Utah Division of Oil, Gas and Mining, Utah coal mine water quality database, on-line at http://ogm.utah.gov/coal/edi/wqdb.htm.

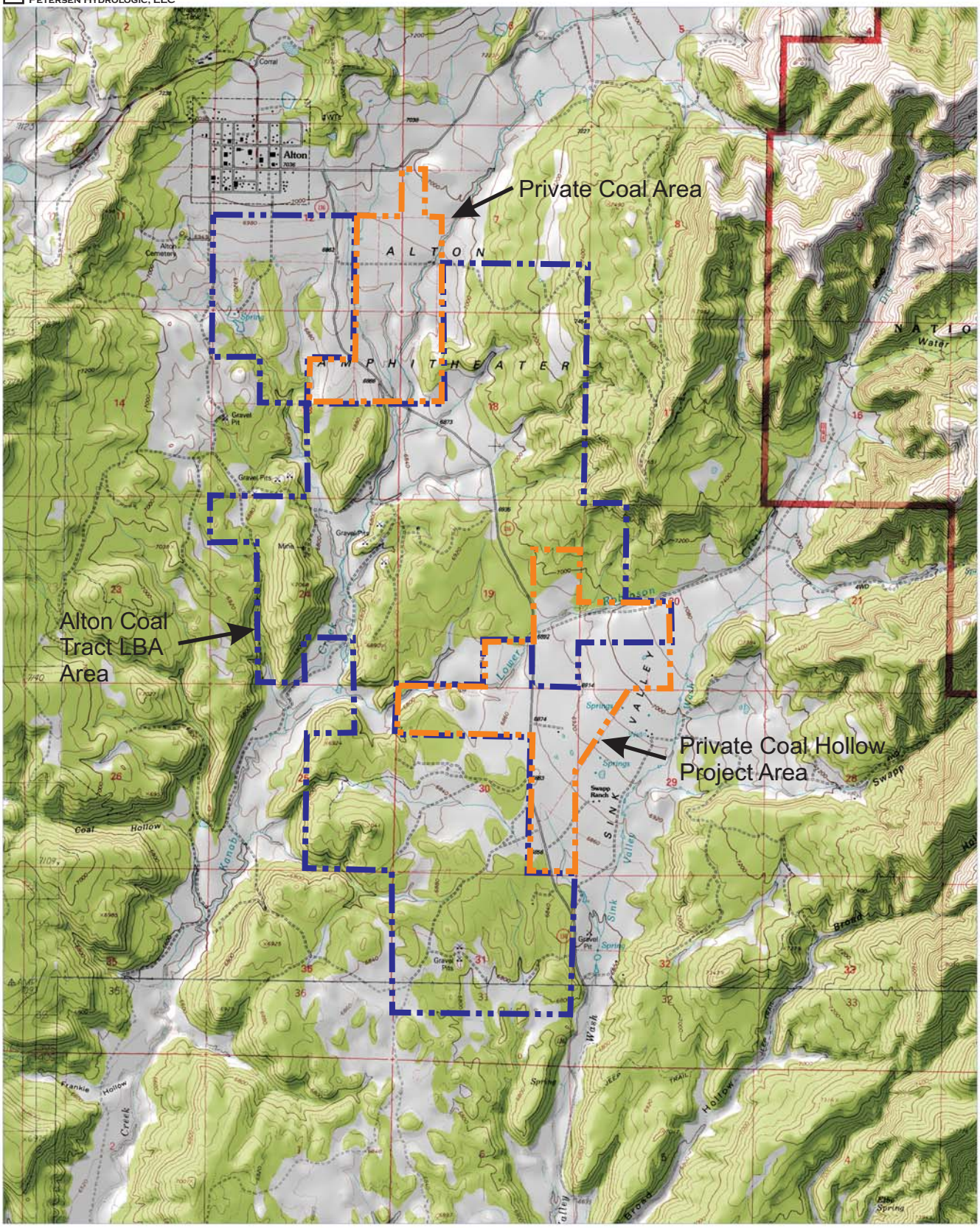


Figure 1 Location map showing the Alton Coat Tract LBA and adjacent areas and the town of Alton, Utah.

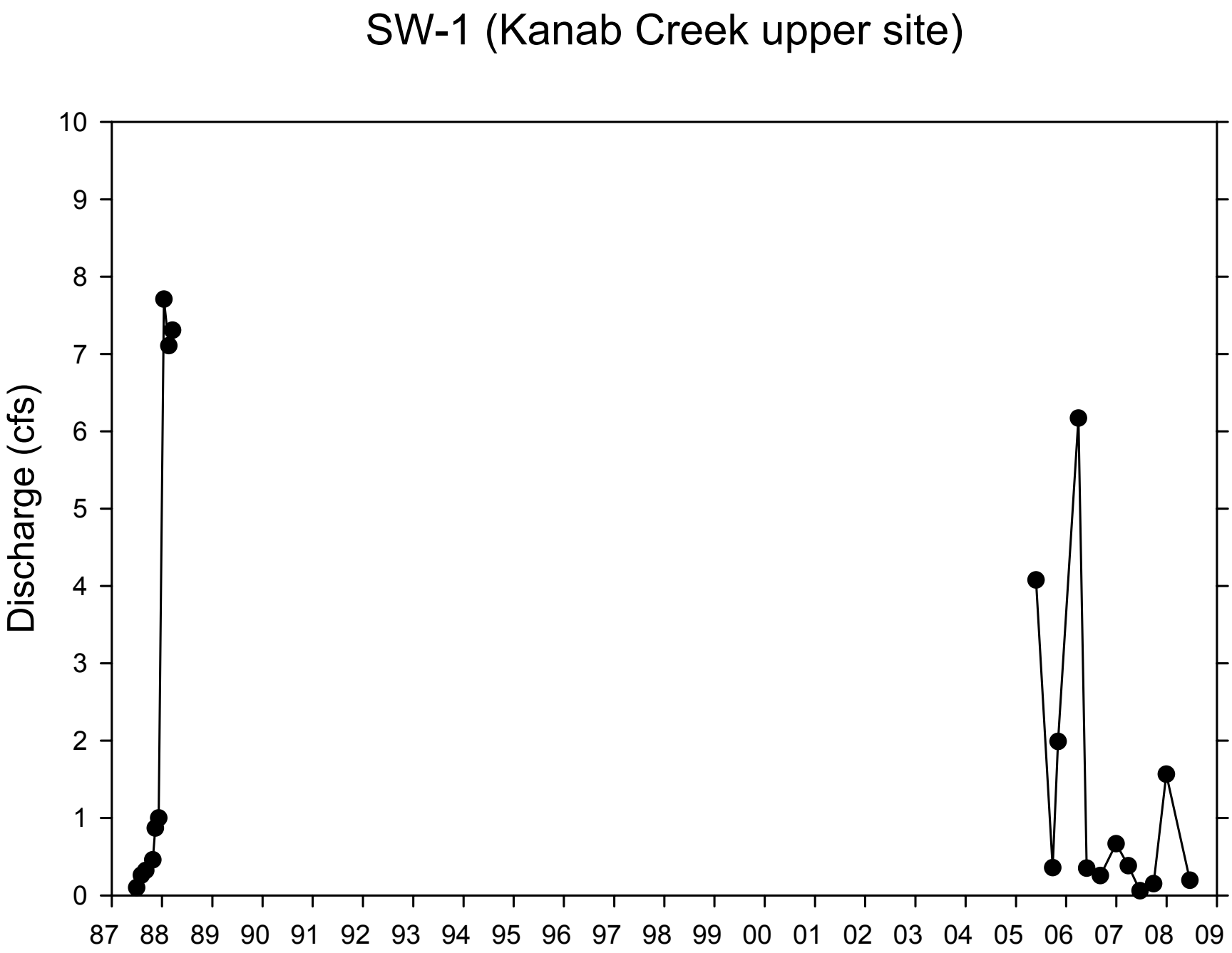


Figure 2a Discharge measured in Kanab Creek at site SW-1
(See Plate 2 for monitoring site location).

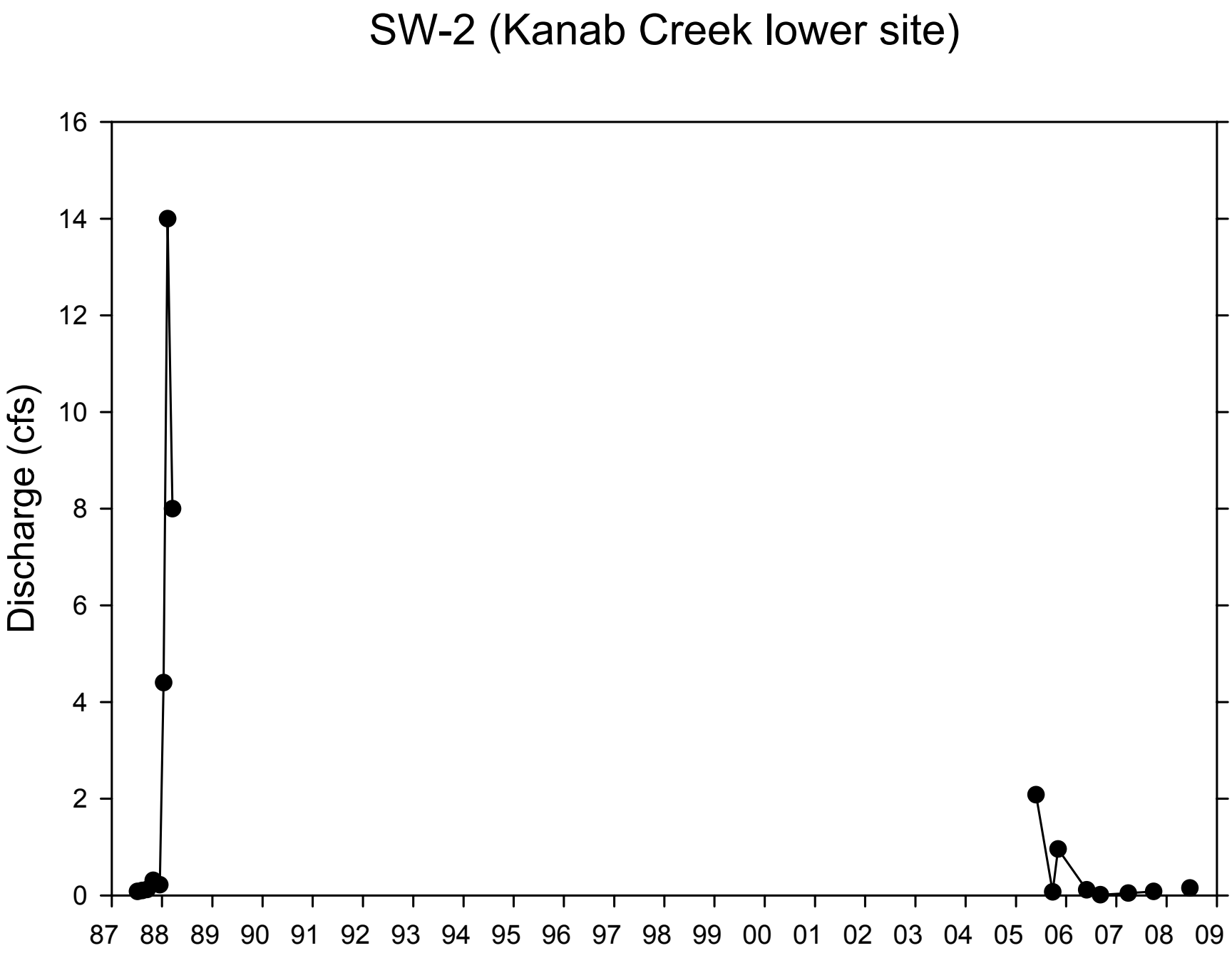


Figure 2b Discharge measured in Kanab Creek at site SW-2
(See plate 2 for monitoring site location).

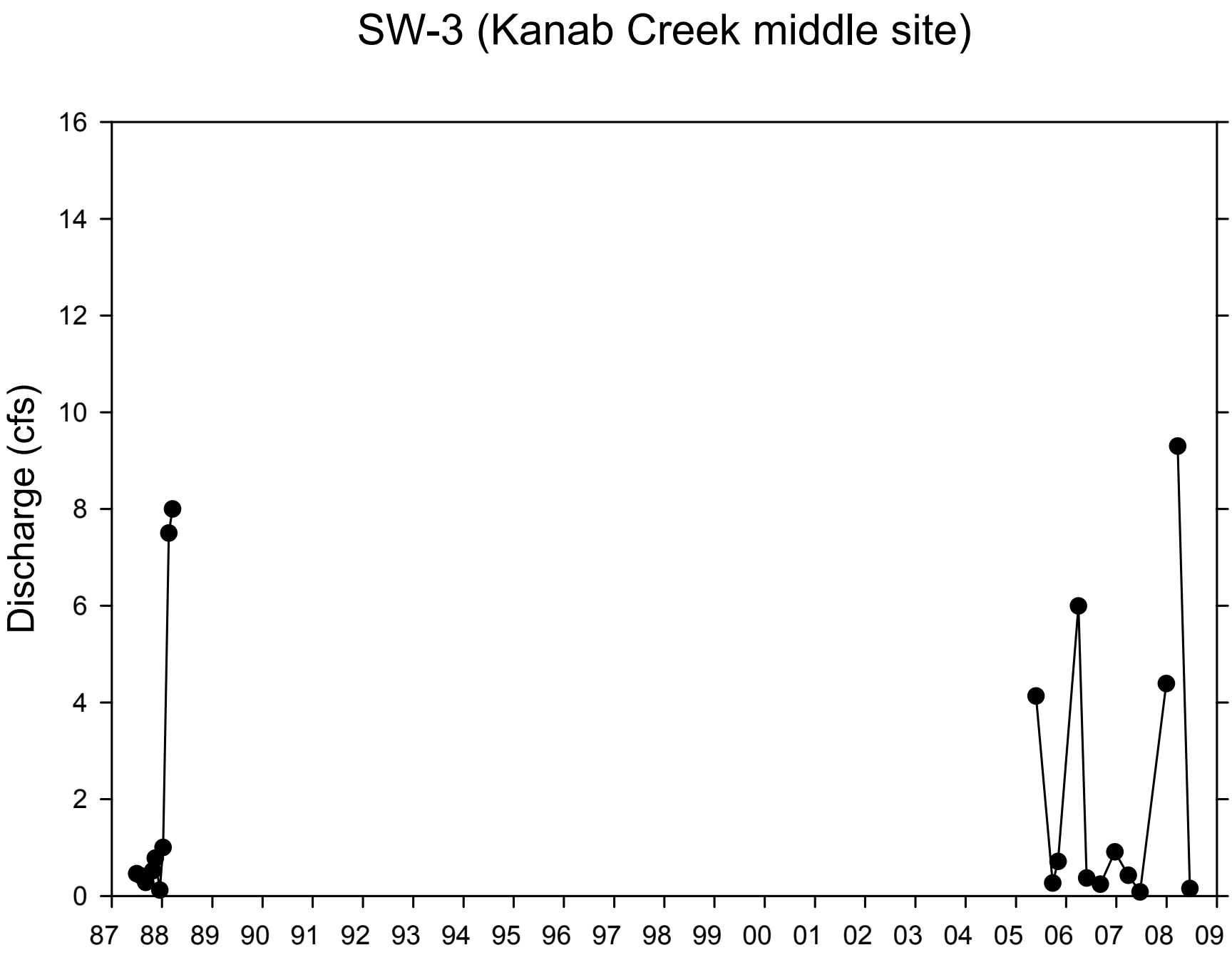


Figure 2c Discharge measured in Kanab Creek at site SW-3
(See Plate 2 for monitoring site location).

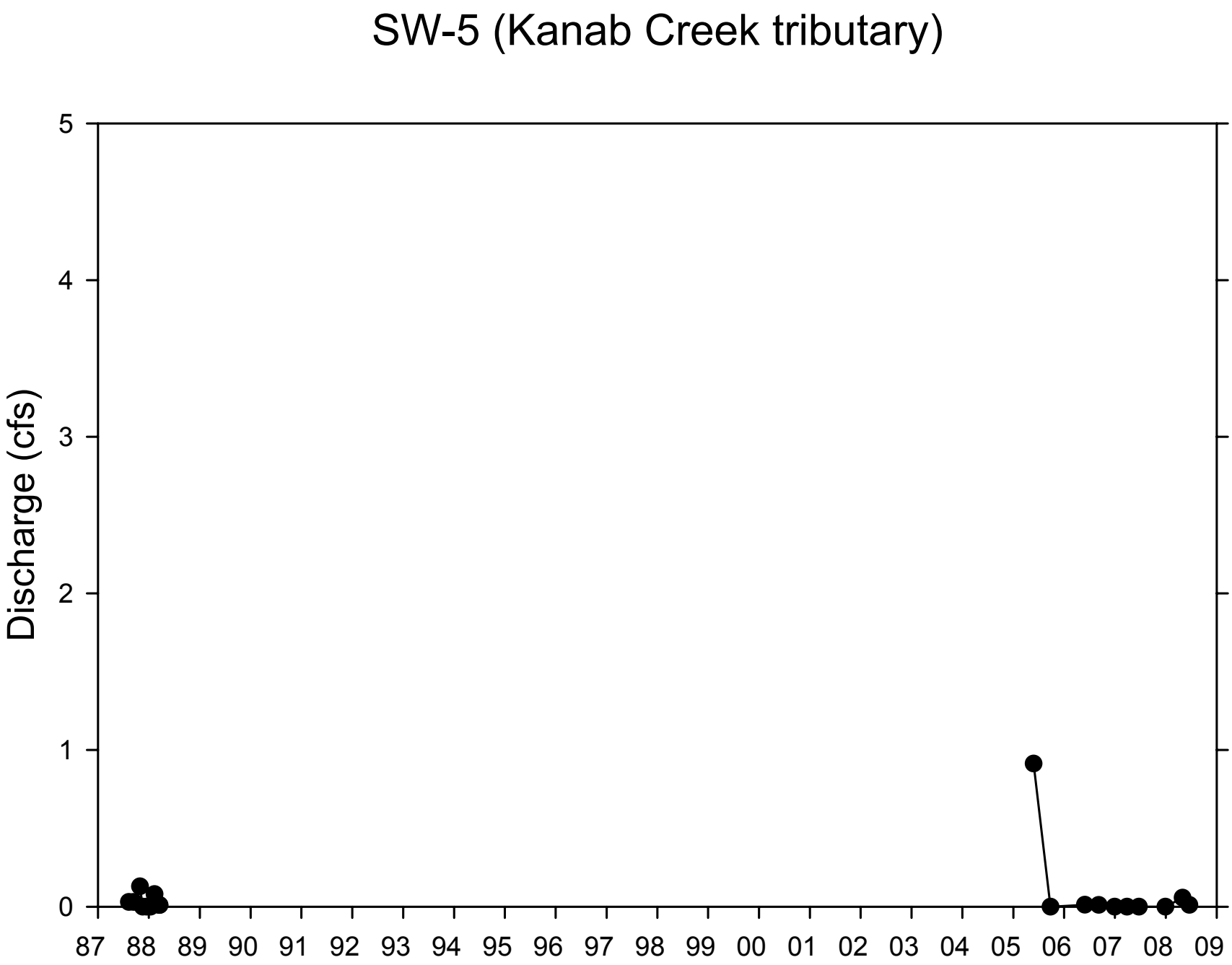


Figure 2d Discharge measured in Lower Robinson Creek, a tributary of Kanab Creek at site SW-5 (See Plate 2 for monitoring site location).

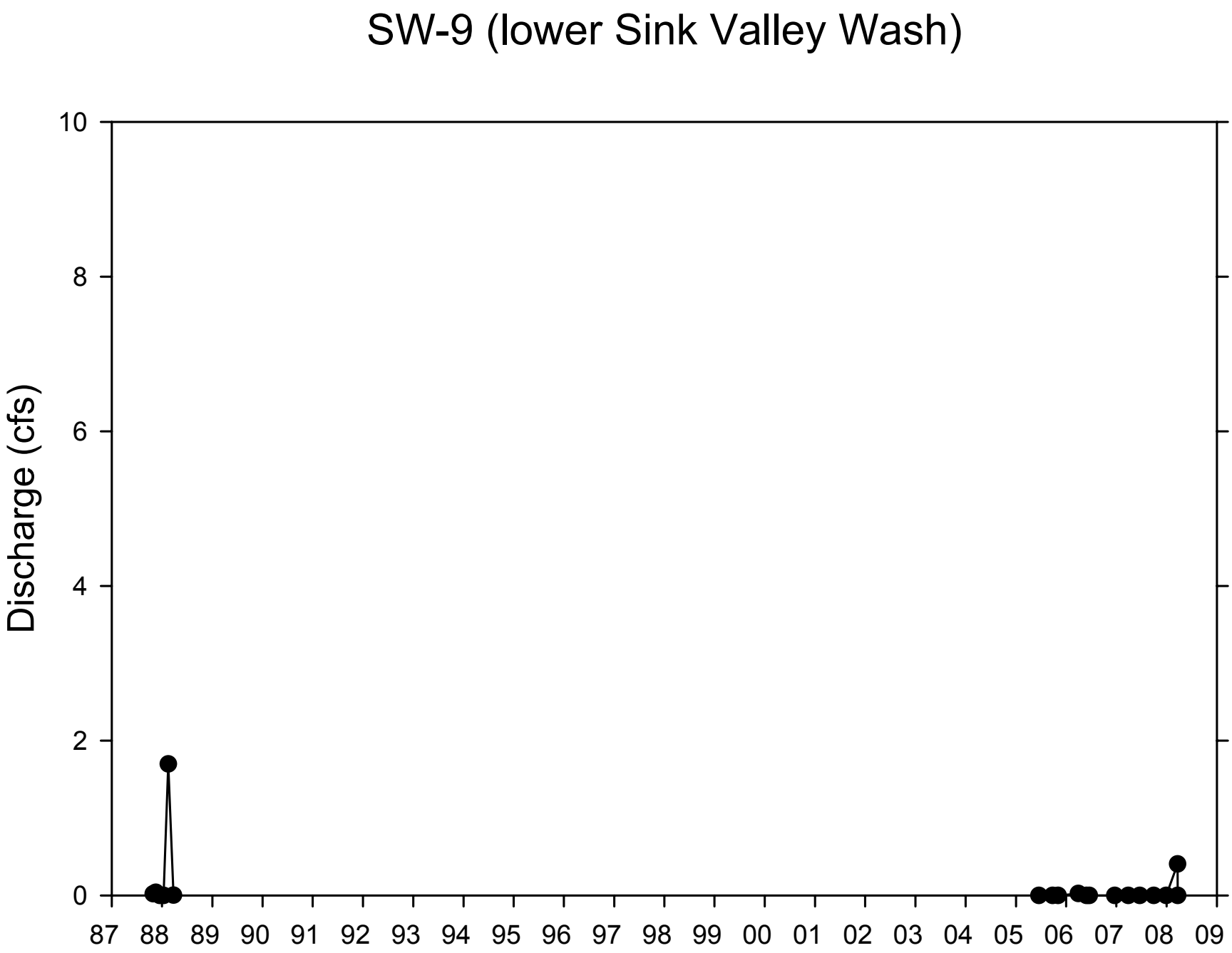


Figure 2e Discharge measured in Sink Valley Wash
(See Plate 2 for monitoring site location).

Table 1 Instananeous stream discharge measurements in streams in the study area.

Notes: Data from Utah Division of Oil, Gas and Mining on-line coal hydrology database.
See Plate 1 for monitoring site locations.

Site	Date	Discharge (cfs)
Kanab Creek upper monitoring site		
SW-1	7/1/1987	0.10
SW-1	8/3/1987	0.26
SW-1	9/4/1987	0.32
SW-1	10/26/1987	0.46
SW-1	11/13/1987	0.87
SW-1	12/8/1987	1.00
SW-1	1/15/1988	7.71
SW-1	2/20/1988	7.11
SW-1	3/17/1988	7.31
SW-1	5/27/2005	4.08
SW-1	9/25/2005	0.36
SW-1	11/3/2005	1.99
SW-1	3/31/2006	6.17
SW-1	5/30/2006	0.35
SW-1	9/7/2006	0.26
SW-1	12/30/2006	0.67
SW-1	3/29/2007	0.38
SW-1	6/22/2007	0.06
SW-1	9/29/2007	0.15
SW-1	12/30/2007	1.57
SW-1	6/18/2008	0.20
Kanab Creek upper lower monitoring site		
SW-2	7/7/1987	0.08
SW-2	8/10/1987	0.10
SW-2	9/14/1987	0.12
SW-2	10/29/1987	0.31
SW-2	12/16/1987	0.22
SW-2	1/13/1988	4.40
SW-2	2/11/1988	14.00
SW-2	3/17/1988	8.00
SW-2	5/27/2005	2.08
SW-2	9/25/2005	0.07
SW-2	11/3/2005	0.96
SW-2	5/30/2006	0.11
SW-2	9/7/2006	0.01
SW-2	3/29/2007	0.05
SW-2	9/29/2007	0.08
SW-2	6/18/2008	0.15

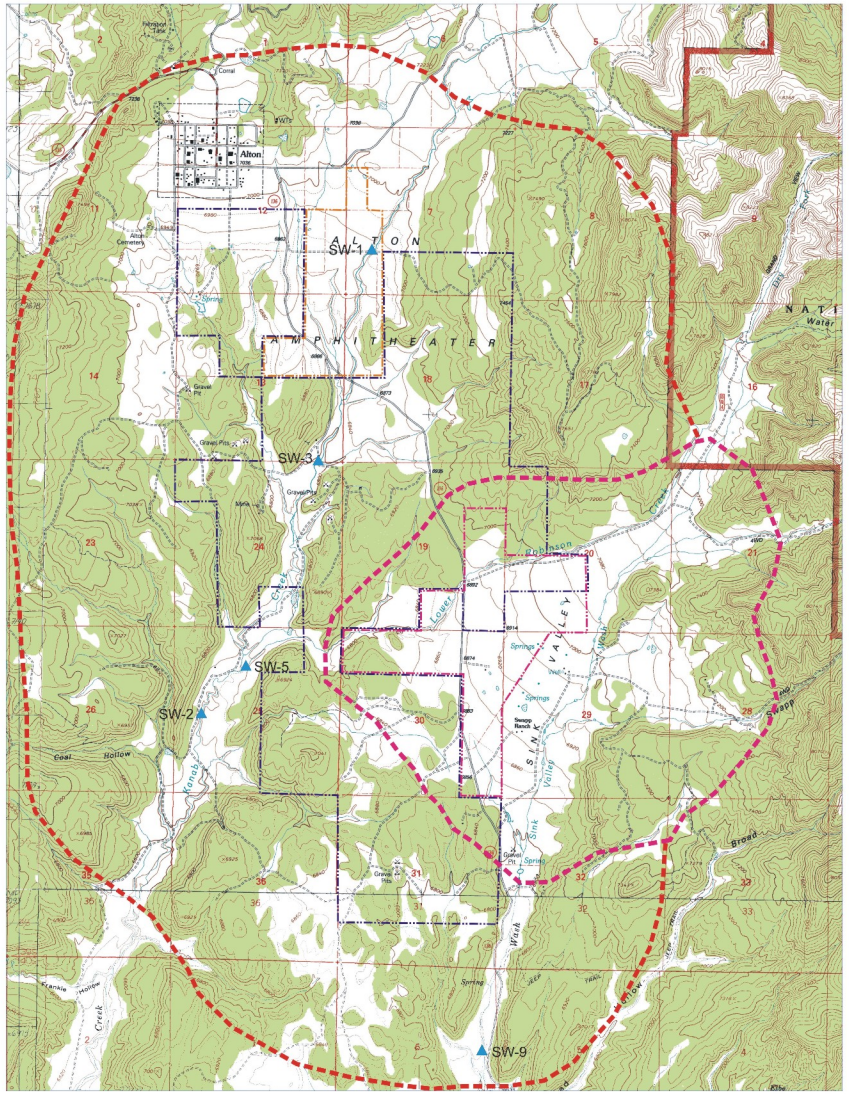
Site	Date	Discharge (cfs)
Kanab Creek upper middle monitoring site		
SW-3	7/1/1987	0.46
SW-3	8/3/1987	0.41
SW-3	9/4/1987	0.28
SW-3	10/26/1987	0.52
SW-3	11/13/1987	0.78
SW-3	12/16/1987	0.12
SW-3	1/9/1988	1.00
SW-3	2/20/1988	7.50
SW-3	3/17/1988	8.00
SW-3	5/27/2005	4.13
SW-3	9/25/2005	0.27
SW-3	11/3/2005	0.71
SW-3	3/31/2006	5.99
SW-3	5/30/2006	0.37
SW-3	9/7/2006	0.24
SW-3	12/21/2006	0.91
SW-3	3/29/2007	0.43
SW-3	6/22/2007	0.08
SW-3	12/30/2007	4.39
SW-3	3/22/2008	9.30
SW-3	6/18/2008	0.15
Lower Robinson Creek tributary at confluence with Kanab Creek		
SW-5	8/10/1987	0.03
SW-5	9/14/1987	0.03
SW-5	10/29/1987	0.13
SW-5	11/18/1987	0.00
SW-5	12/16/1987	0.00
SW-5	1/13/1988	0.00
SW-5	2/11/1988	0.08
SW-5	3/17/1988	0.01
SW-5	3/17/1988	0.01
SW-5	5/27/2005	0.91
SW-5	9/25/2005	0.00
SW-5	5/30/2006	0.01
SW-5	9/7/2006	0.01
SW-5	12/30/2006	0.00
SW-5	3/29/2007	0.00
SW-5	6/22/2007	0.00
SW-5	12/29/2007	0.00
SW-5	5/1/2008	0.06
SW-5	6/18/2008	0.01
Sink Valley Wash monitoring site		
SW-9	10/29/1987	0.02
SW-9	11/17/1987	0.04
SW-9	12/16/1987	0.00

Site	Date	Discharge (cfs)
SW-9	1/13/1988	0.00
SW-9	2/16/1988	1.70
SW-9	3/24/1988	0.00
SW-9	6/17/2005	0.00
SW-9	9/24/2005	0.00
SW-9	11/3/2005	0.00
SW-9	3/30/2006	0.02
SW-9	5/29/2006	0.00
SW-9	6/18/2006	0.00
SW-9	12/20/2006	0.00
SW-9	3/29/2007	0.00
SW-9	6/20/2007	0.00
SW-9	9/30/2007	0.00
SW-9	12/29/2007	0.00
SW-9	3/21/2008	0.41
SW-9	3/22/2008	0.00

Table 2 Summary of Alton Coal LBA reconnaissance-level Identification study designations

	Water Availability Criteria					Geologic Criteria	
Identifica ion Area	Presently irrigated?	Potentially Irrigable?	Sufficient water for irriga ion?	Subirrigated lands?	Agriculturally important?	Flood plains/terraces present?	Identification-stage AVF designation
Area 1	Yes	Yes	Yes	No	Yes	Yes	Probable AVF
Area 2	No	Yes	Probably	No	Probably not	Yes	Possible AVF (unlikely)
Area 3	No	Yes	Probably not	No	Probably not	Yes	Possible AVF (unlikely)
Area 4	Yes	Yes	Yes	No	Yes	Yes	Probable AVF
Area 5	No	Yes	Probably not	No	Probably not	Yes	Possible AVF (unlikely)
Area 6	No	Yes	Probably not	No	Probably not	Yes	Possible AVF (unlikely)
Alton Town and adjacent	Yes	Yes	Yes	No	Yes	No	Not an AVF
Lower Robinson Creek	No	Yes	Probably not	No	Probably not	No	Not an AVF

Note: Other areas within the study area were determined to have not met the identification-stage AVF identification criteria.



1927 North American Datum; UTM grid zone 12
Generated by BigTopo7 (www.igage.com)
Map compiled from USGS Quads: Long Valley Junction; UT Alton; UT Glendale; UT Bald Knoll; UT

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NORTH

BigTopo Map

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LBA AVF Recon.cdr
21 October 2009

Study area boundary

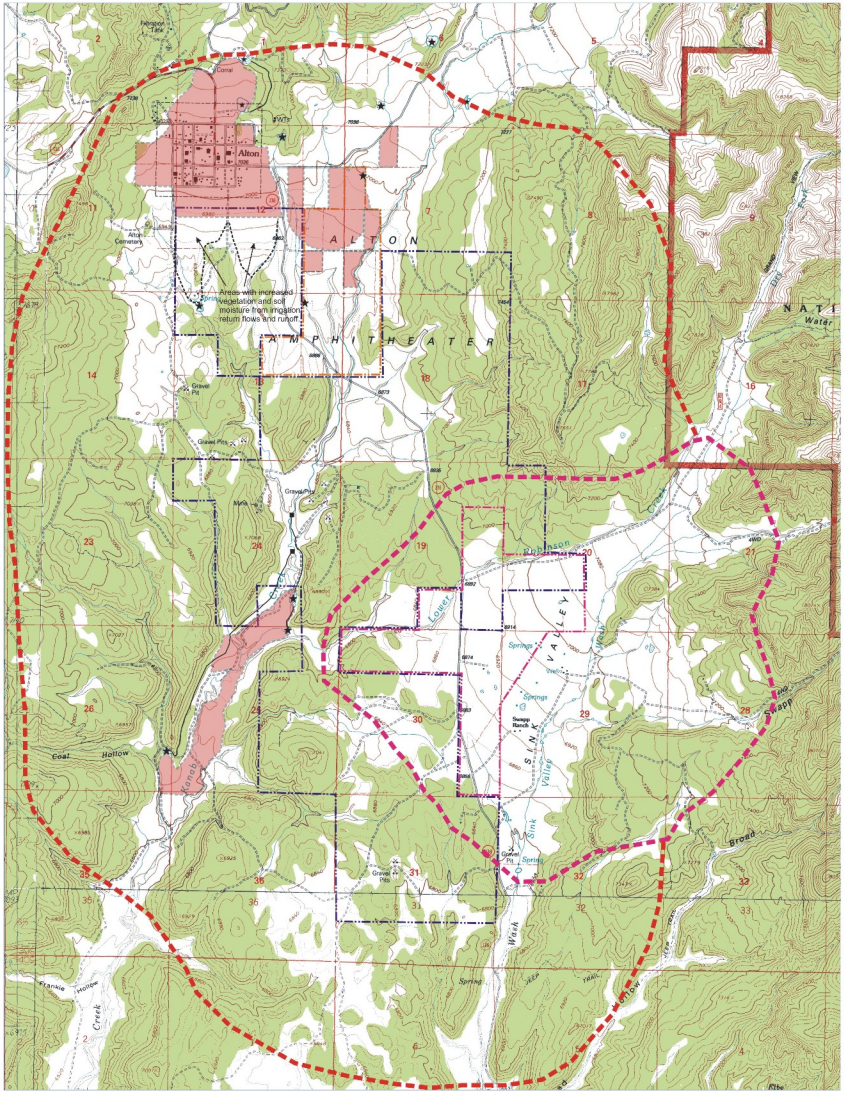
Coal Hollow Project study area boundary (separate investigation)

SW-2 Surface-water monitoring site.

Alton Coal LBA boundaries

Private coal boundaries

Plate 1 Study area location and surface-water data sites.



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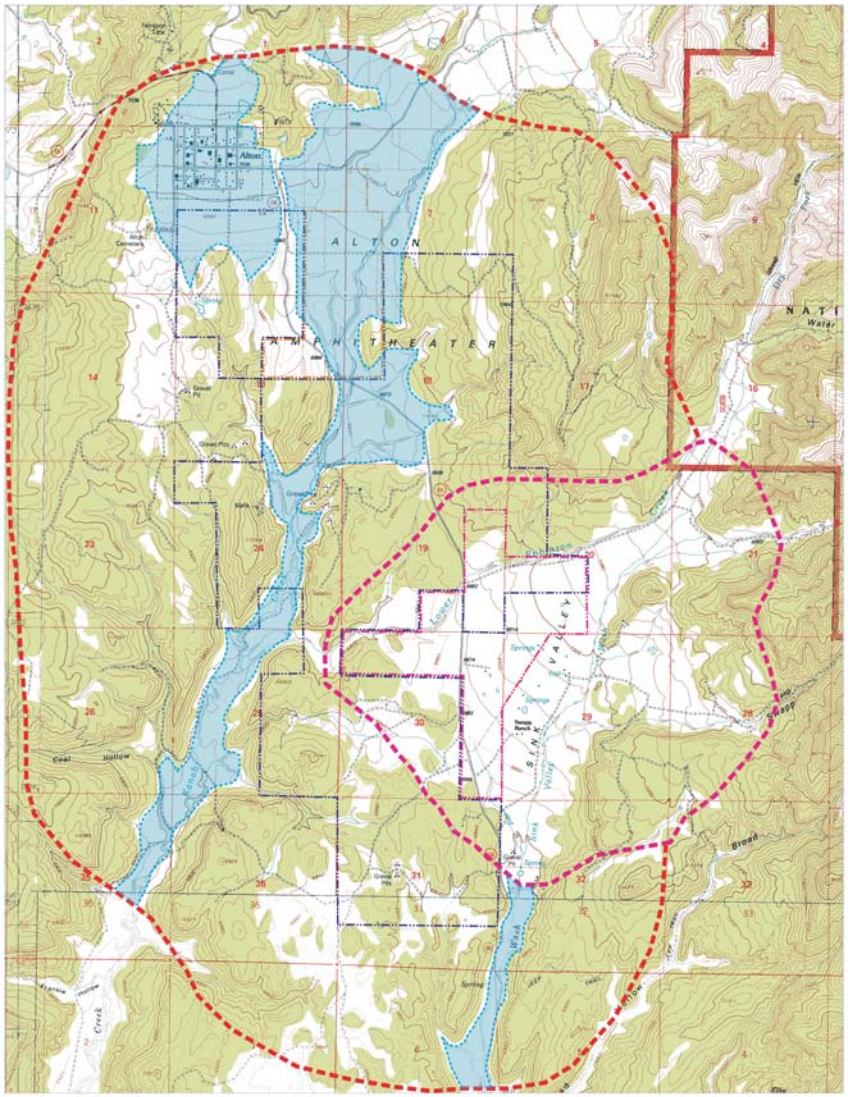
Presently irrigated lands

Irrigation diversion

Pond

Irrigation canal/ditch

Plate 2 Locations of presently irrigated lands, irrigation ditches, diversions, and ponds.



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Lands which appear to have the capability of being flood irrigated

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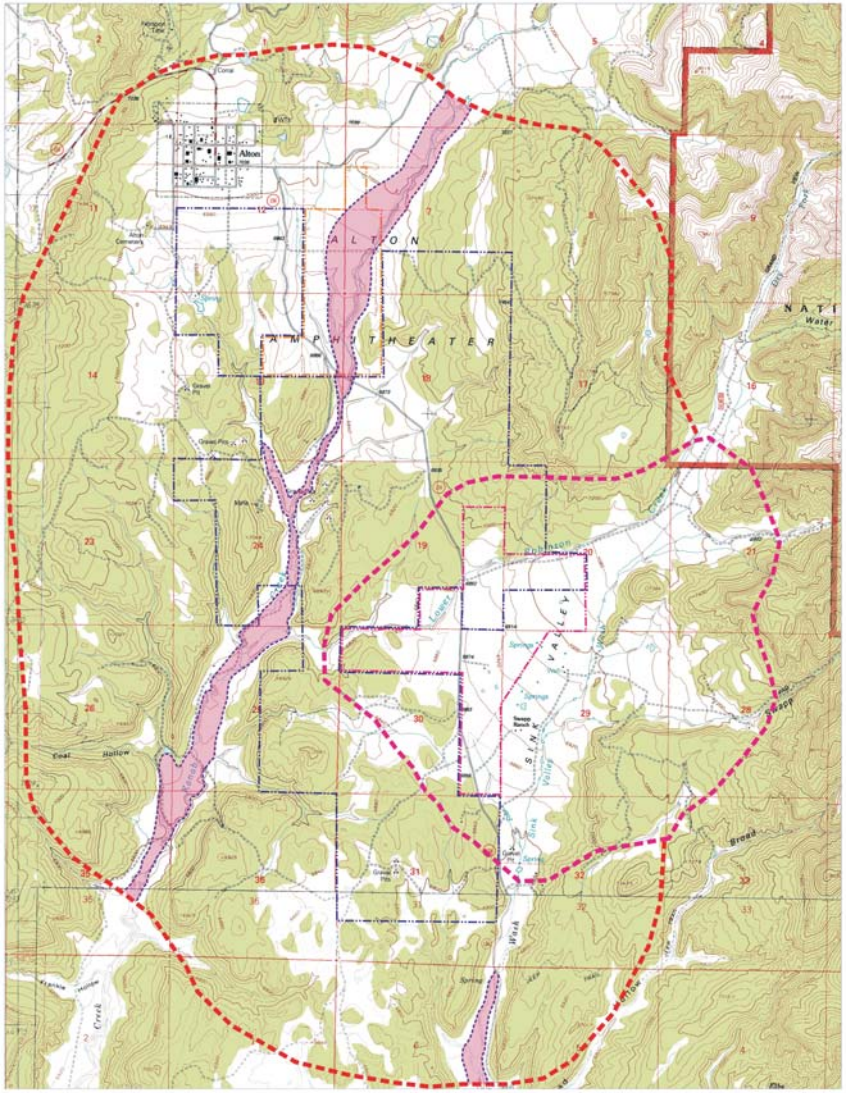
Plate 3 Lands which appear to have the capability of being flood irrigated.



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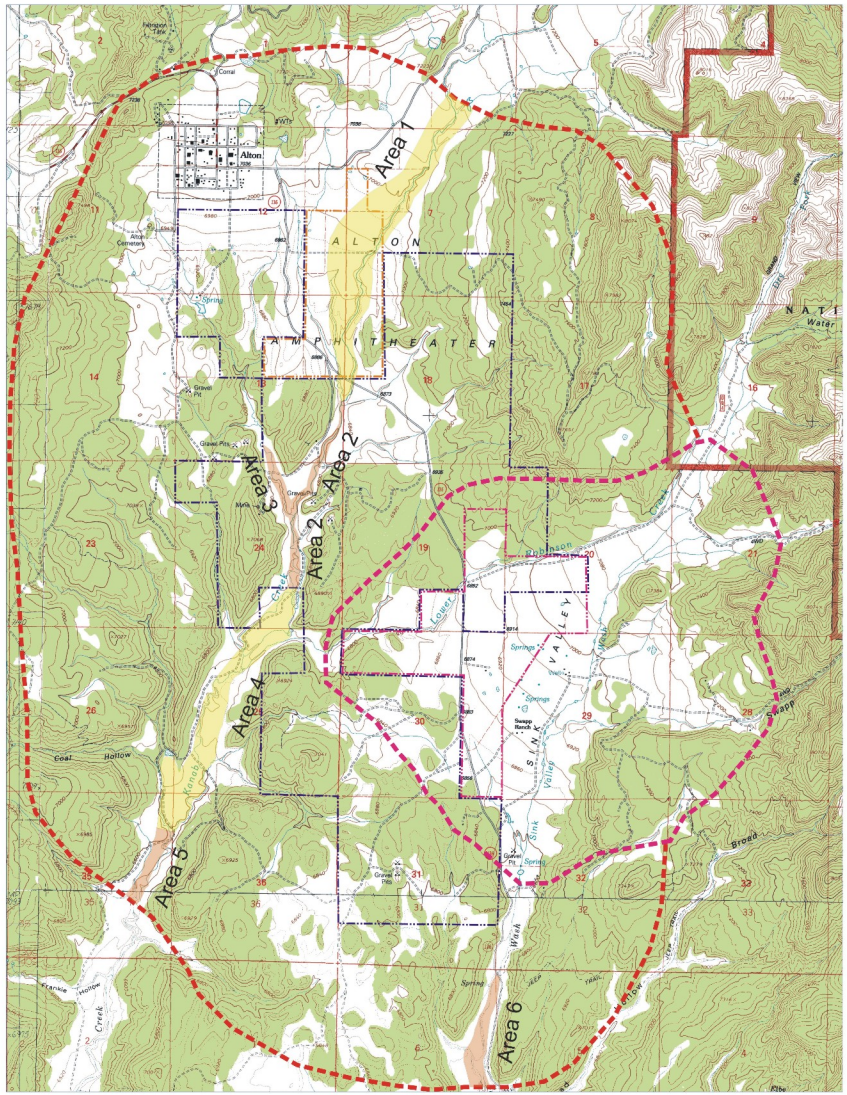
flood plains and terraces (approximate locations)

Plate 4 Map of flood plain and terrace locations (approximate).



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Probable AVF area

Potential AVF area

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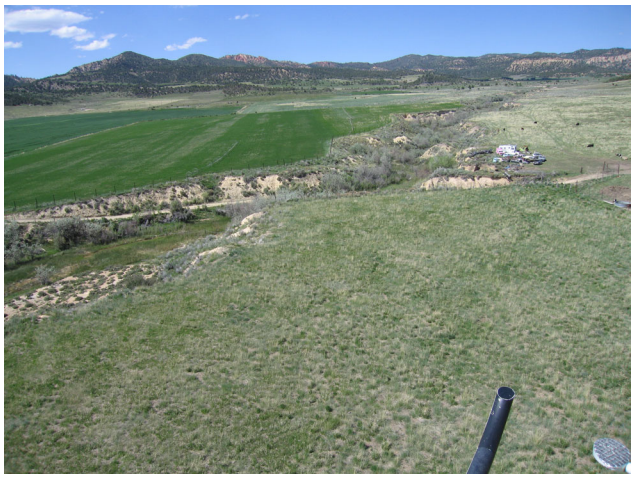
Note: The delineations presented here are for reconnaissance level evaluations and are not presented for final coal mine permitting actions.

Plate 5 Delineation of probable and potential AVF areas as determined by reconnaissance level investigation.

Photograph #1
View of central portion of Area 1.
Note incised Kanab Creek drainage.

Photograph #2
View of central portion of Area 1.
Note incised Kanab Creek drainage
and sprinkler irrigation.



Photograph #3
View looking north from cenral Area 1
near stream monitoring site SW-1.
Note incised Kanab Creek drainage.

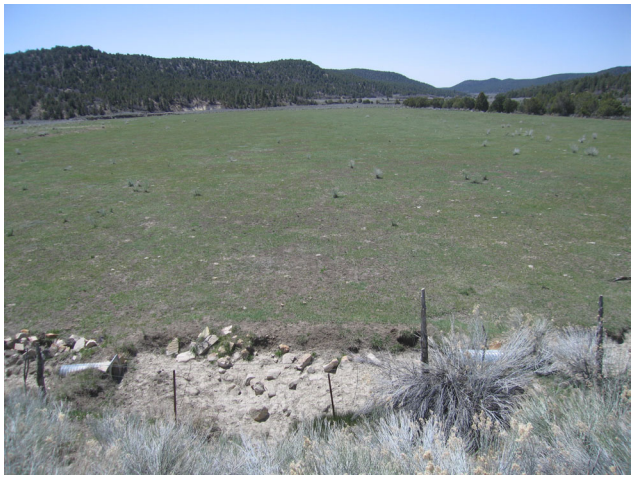
Photograph #4
View looking south in Area 2.
Note narrow valley bottom and
active flood plain area.

Photograph #5
View looking north in Area 2.
Note narrow valley bottom.

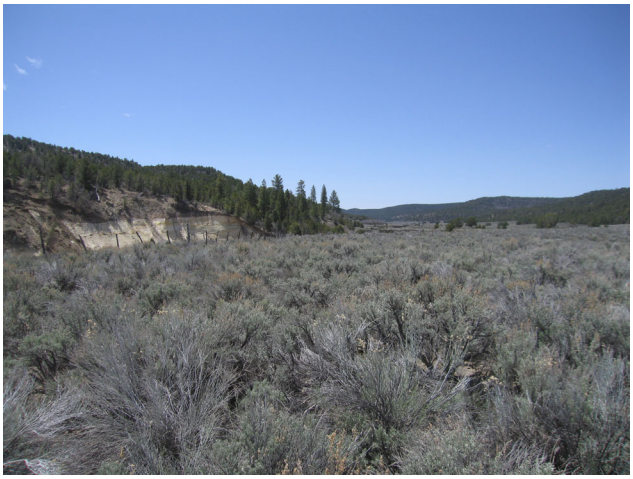
Photograph #6
View looking north in Area 3.
Note narrow valley bottom.

Photograph #7
View looking south in Area 3.

Photograph #8
View looking south in Area 4.
Note flood irrigated pasture/hay
field in foreground.



Photograph #9
View looking south from high bench below pond in southern part of Area 4.
Note irrigation infrastructure in foreground.



Photograph #10
View looking south in southern portion of Area 4.
Note lack of agriculture and bedrock outcrop in incised Kanab Creek steam channel on left.

Photograph #11
View looking south in Area 5.
Note deeply incised Kanab Creek stream channel.

Photograph #12
View looking south from Area 6.
Note deeply incised Sink Valley Wash stream channel.

Photograph #13
Aerial view of Area 6 below the county road crossing of Sink Valley Wash.
Note deeply incised stream channel.

Photograph #14
View looking east in the central upland portion of the Alton Coal LBA area.
Note rolling hills and chipped pinyon And juniper trees.