Survey of Seeps and Springs within the Bureau of Land Management's Grand Junction Field Office Management Area (Mesa County, CO)

Colorado Natural Heritage Program
Colorado State University
8002 Campus Delivery
Fort Collins, Colorado 80523-8002

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We appreciate all of the landowners who allowed us access through their property. The Colorado Natural Heritage Program staff in Fort Collins, including Jodie Bell, Jill Handwerk, Jeremy Siemers, Amy Lavender, and Alison Loar all worked with us patiently.

Cover photo: Pepper Spring (SS-Q) on Salt Creek.

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EXECUTIVE SUMMARY

Springs and seeps are unique habitats, which have often been found to harbor concentrations and refuges of endemic plants and animals. Because seeps and springs provide relatively constant water temperature and chemistry, due to their dependence on subterranean flow through aquifers, many spring source species do not occupy downstream habitats where temporal fluctuations in water temperature and flow are greater (BLM 2000; Martinson 1980). Surveys conducted in the Great Basin have shown that seeps and springs are often hot spots of biological diversity, providing habitat for many uncommon species of plants and animals, including some that proved to be new to science. In Colorado, several rare plant and animal species are known to be limited to these wet areas within otherwise dry landscapes. Seeps and springs are important to regional landscape diversity, especially in western Mesa County where most areas receive less than 20 inches of annual precipitation, as they provide small but widely distributed habitat that offers a source of water, food, cover, nesting habitat, and habitat for rare and/or unique species.

The objective of this project was to survey the most intact or relatively pristine seeps and springs on BLM land within the Grand Junction Field Office Management Area (GJFOMA) in Mesa County. This biological survey was conducted to complement a similar spring and seep survey conducted in Garfield County on BLM lands in the Grand Junction Field Office Management Area (Rocchio et al. 2001). This project was completed in conjunction with the Survey of Critical Wetlands and Riparian Areas in Mesa County for the Colorado Department of Natural Resources through a grant from the Environmental Protection Agency, Region VIII (Rocchio et al. 2002). Additionally, information collected during 1996 for the Survey of Critical Biological Resources for Mesa County, a CNHP project funded by Great Outdoors Colorado, was incorporated into this report (Lyon et al. 1996).

Information regarding the location of seeps and springs within the BLM, GJFOMA portion of Mesa County, was gathered to assist in prioritizing which seeps and springs would be visited. Under the assumption that most disturbed or "developed" springs would likely have lower biodiversity, due to sparse vegetation cover (trampling and overgrazing), disruption of hydrology, and presence of non-native species (BLM 2000; Sada and Nachlinger 1996), CNHP decided to focus inventory efforts on those springs where ecological processes have not been altered.

Site assessments included a general description, rating of Proper Functioning Condition (Bureau of Land Management 1998; Bureau of Land Management 1994; Bureau of Land Management 1993), plant species list, assessment of any natural heritage elements, discussion of ecological functions, collection of water chemistry data and selected macroinvertebrates, and restoration and management needs.

There are currently 143 seeps and springs identified on BLM lands in Mesa County. Locations for these seeps and springs are included in a GIS layer prepared by BLM and

amended by CNHP. Of the 143 seeps and springs, 69% were indicated to be potentially undeveloped and 31% were identified as developed (modified from their natural state). The undeveloped seeps and springs were targeted for surveys. Twenty-eight seep and spring survey summaries are included in this report. The seeps and springs summarized include those visitied that harbor the highest biodiversity values. Others are included that were considered to either harbor biodiversity values despite anthropogenic disturbances or had most ecological processes intact. Due to time constraints and difficulty of access, not all BLM seeps and springs in the county could be surveyed. Future surveys will likely reveal additional seeps and springs with high biodiversity value.

At the 28 seeps and springs documented in this report, CNHP has record of 25 elements of biodiversity significance. Some of the more significant elements documented include the critically imperiled (G3T1/S1) Nokomis fritillary (*Speyeria nokomis nokomis*) at Unaweep Seep, hanging garden communities of Mancos columbine and Eastwood monkeyflower (*Aquilegia micrantha*-(*Mimulus eastwoodiae*)) (G2G3/S2S3) at Sewemup Mesa seeps, globally vulnerable (G2G3/S2S3) beaked spikerush emergent wetland (*Eleocharis rostellata*) communities at Unaweep Seep and Salt Creek, and critically imperiled (G1G2/S1S2) wild privet (*Forestiera pubescens*) shrubland communities at Salt Creek.

Additionally, 11 of the 28 seeps and springs documented in this report occur within a CNHP Potential Conservation Area. These 11 seeps and springs represent those with the highest conservation priority and specifically warrant BLM attention (see table).

Seeps and springs occurring within CNHP Potential Conservation Areas.

Potential Conservation Area	Seep or Spring
Big Dominguez Creek	SS-K, SS-L
Escalante Canyon	SS-A
Mee Canyon	SS-Y
Salt Creek	SS-0, SS-P, SS-Q, SS-V
Sewemup Mesa	SS-N
Sulphur Gulch	SS-W
Unaweep Seep	SS-C

No rare or endemic macroinvertebrates were found during this project. However, it is likely that their populations are different than those found in other riparian/wetland habitats (streams, lakes, ponds, etc.) and represent an important aspect of biodiversity in Mesa County.

INTRODUCTION

Springs and seeps are unique habitats, which have often been found to harbor concentrations and refuges of endemic plants and animals (USDI 2001a). Because seeps and springs provide relatively constant water temperature and chemistry, due to their dependence on subterranean flow through aquifers, many spring source species do not occupy downstream habitats where temporal fluctuations in water temperature and flow are greater (USDI 2001a; BLM 2000; Martinson 1980).

Surveys conducted in the Great Basin have shown that seeps and springs are often hot spots of biological diversity, providing habitat for many uncommon species of plants and animals, including some that proved to be new to science. Of particular interest are springsnails, which have been little studied to date, and may prove to be unique to particular seeps and springs (USDI 2001a).

In Colorado, several rare plant and animal species are known to be limited to these wet areas within otherwise dry landscapes. For example, Unaweep Seep in Mesa County is home to the Nokomis fritillary (*Speyeria nokomis nokomis*) butterfly, canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) and giant helleborine orchid (*Epipactis gigantea*); seeps on Sewemup Mesa in Mesa and Montrose counties are the sites of the Kachina daisy (*Erigeron kachinensis*) and Eastwood monkeyflower (*Mimulus eastwoodiae*); and seeps in Escalante Canyon in Delta and Montrose counties support giant helleborine orchids and canyon bog orchids. These sites have been ranked by CNHP as B1 (Outstanding Biodiversity Significance) and B2 (Very High Biodiversity Significance) Potential Conservation Areas based on their unique flora and fauna. In addition, wildlife species including canyon tree frogs (*Hyla arenicolor*) and northern leopard frogs (*Rana pipiens*) use these small wetlands.

Since human activity has been focused on these ecosystems, leading to alteration and loss of native species, it is imperative that the remaining pristine seeps and springs be identified, and that impacted areas be assessed for potential restoration.

The objective of this project was to survey the most intact or relatively pristine seeps and springs on BLM land within the Grand Junction Field Office Management Area (GJFOMA) in Mesa County. This project was completed in conjunction with the Survey of Critical Wetlands and Riparian Areas in Garfield County for the Colorado Department of Natural Resources funded via a grant from the Environmental Protection Agency, Region VIII (Rocchio et al. 2002). Information collected during 1996 for the Survey of Critical Biological Resources conducted in Mesa County, funded by Great Outdoors Colorado, was incorporated into this report (Lyon et al. 1996). A similar biological survey has been conducted for seeps and springs in Garfield County on BLM lands in the Grand Junction Field Office Management Area (Rocchio et al. 2001).

PROJECT BACKGROUND

Location and Physical Characteristics of Study Area

Mesa County comprises 3,334 square miles, or 2,133,760 acres, of west central Colorado (Figure 1). It is located in the following Nature Conservancy Ecoregions (based on Bailey et al. (1994)): the Utah High Plateaus in the north, the Rocky Mountains in the northeast, and the Colorado Plateau in most of the west and along the Gunnison River valley (Figure 2). Major physiographic features are the Colorado River and its tributaries, including the Gunnison and Dolores rivers; the Uncompahgre Plateau, dissected by Unaweep Canyon; Grand Mesa; the Bookcliffs; and the Grand Valley. Elevations range from about 4,400 ft. to 11,236 ft.

The area lies in a rain shadow caused by mountain ranges to the east, west and north. Precipitation in Grand Junction is about 20 cm per year, but significantly higher at the upper elevations on the mesa tops (Figure 3). Precipitation is highest in August. Grand Junction is frost-free for about 185 days (USDA 1989). Temperatures vary as much as 20 degrees with elevation, with mean lows in January ranging from 0 to 16 degrees F and highs in July from 70 to 95 degrees F. Summer temperatures over 100 degrees F are common. Humidity is generally 22 % in midsummer. Prevailing winds are from the southwest, but are influenced by local topography (USDA 1989).

Mesa County is underlain by geologic formations ranging in age from Precambrian metamorphic and granitic rocks, through Triassic, Jurassic and Cretaceous sedimentary rocks, to the Tertiary basalt of Grand Mesa, and Quaternary alluvial deposits of the valleys (Figure 4). These formations influence the distribution of wetland plant associations through their direct affect on soil development, groundwater movement, and fluvial processes. For example, many seeps and springs in the southern part of the county are associated with the Wingate sandstone and Chinle sandstone contact, where groundwater from the Glen Canyon aquifer often discharges (USGS 1995).

Soils of the area may be alluvial, wind deposited, or weathered in place. Some soils at the lowest elevations may have excess salt or sodium. A special situation in the semi-desert is the presence of cryptobiotic crusts on the soils. This living soil, containing mosses, lichens, algae and bacteria is important for stabilizing the sandy soils and adding to the long-term stability of desert grasslands (USDI 2001b). Mountain soils are normally rocky and shallow, except in areas where groundwater discharge or slope wetlands occur. On Grand Mesa, these areas often form organic soils (e.g., peat or muck) due to organic matter production, persistent soil saturation and thus anaerobic conditions, and cool year round temperatures. Along drainages, both in the mountains and at lower elevations, wetland plant associations occur on alluvial soils. There is minimal soil development around many of the seeps and springs in Mesa County, as many of these wet areas are located on steep hillsides or atop geologic bedrock. Soils along the Colorado River are highly variable ranging from very fine material to areas of sand and gravel. Some oxbows and backchannels have organic soil horizons but would not be classified as an organic soil. For more specific information, see "Soil Survey of Mesa County Area,

Colorado" and "Soil Survey of Uncompahgre National Forest Area, Colorado, Parts of Mesa, Montrose, Ouray, and San Miguel Counties" which are all published by the USDA Natural Resources Conservation Service (NRCS).

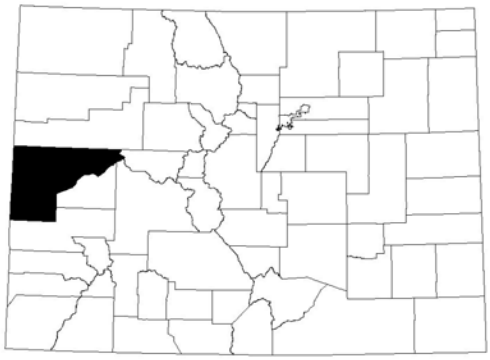


Figure 1. Location of Mesa County in Colorado.

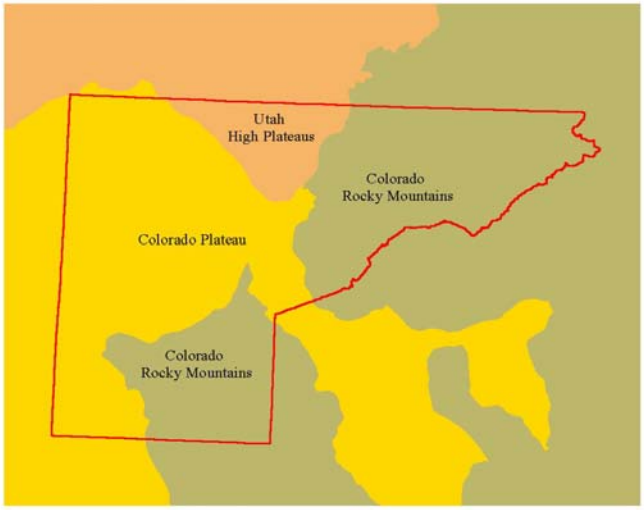


Figure 2. Ecoregions of Mesa County.

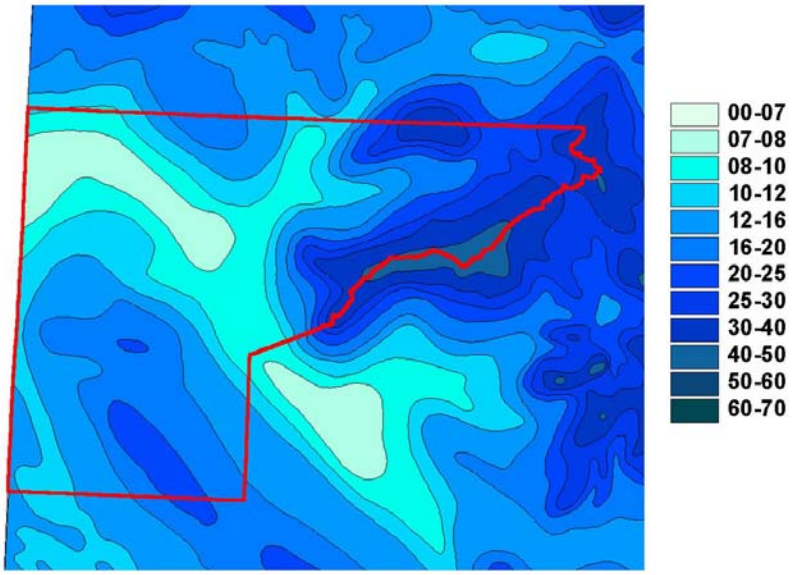


Figure 3. Precipitation (cm) in Mesa County.

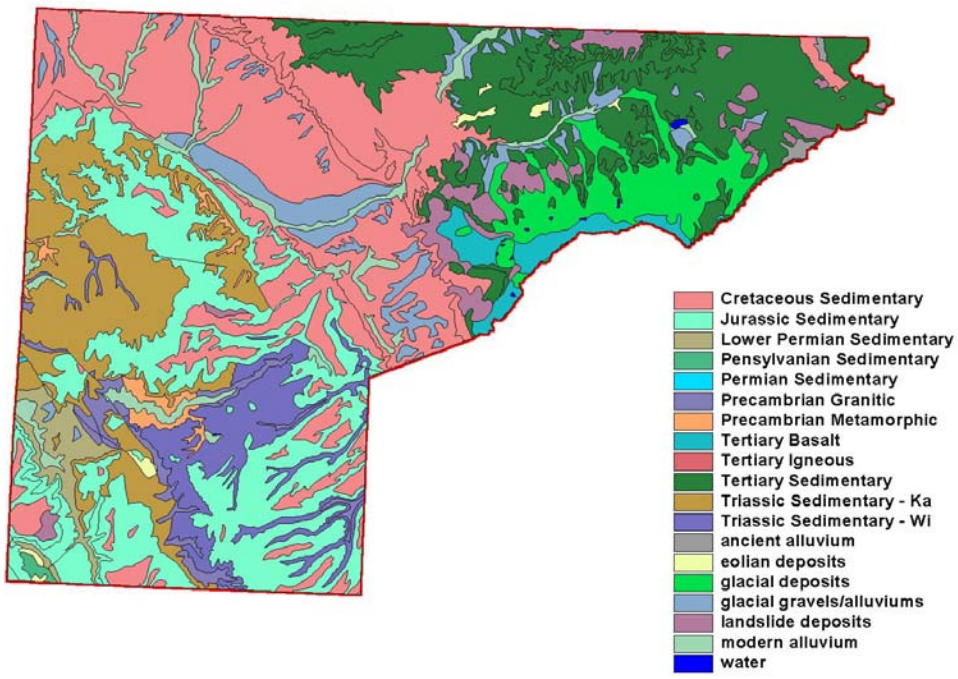


Figure 4. Geological Summary of Mesa County.

Ownership is divided between private, municipal, State of Colorado, National Park Service, BLM and US Forest Service lands (Figure 5). Private lands are located primarily along the river corridors, especially the Colorado River, and in Glade Park. Although private lands often comprise only a narrow strip along streams and roads, they effectively block access to vast amounts of public lands. BLM land is found throughout the county, but concentrated in the western half. The Grand Mesa and White River National Forests occupy the northeastern part of the county, while the Uncompahgre National Forest occurs on the Uncompahgre Plateau (except for a small parcel in Glade Park which is managed by the Grand Mesa National Forest). The state of Colorado holds land mainly along the Colorado River (Figure 5).

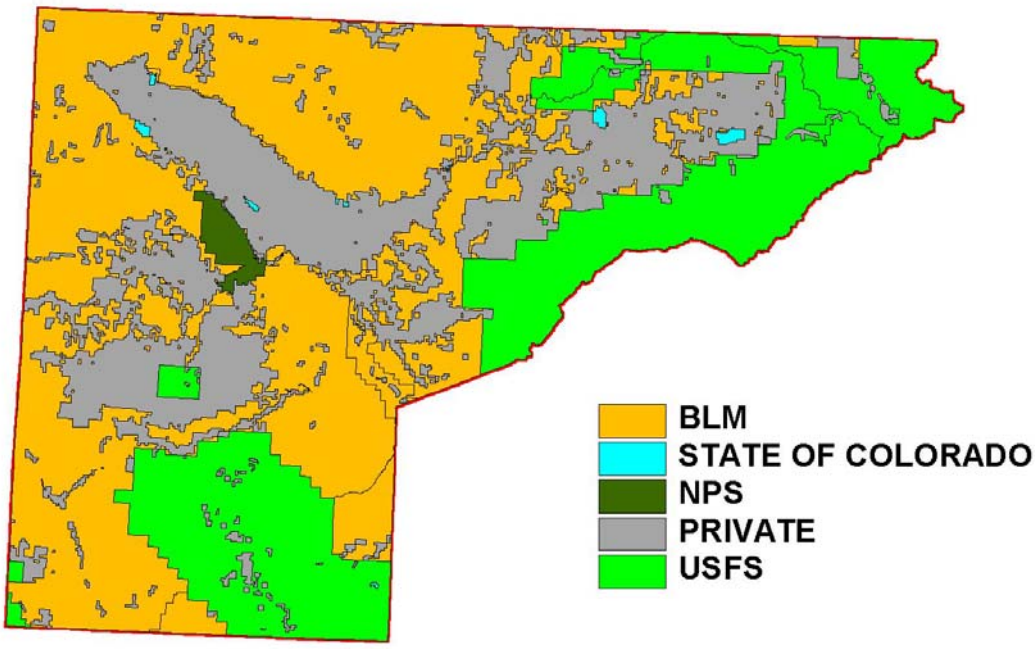


Figure 5. Land ownership in Mesa County.

Hydrology

Historically the flow regime of the Colorado and Gunnison rivers consisted of high, turbid spring flows and clearer low flow from late summer through winter (Burdick 1995). The flow of both rivers has been significantly altered due to water development projects (mainstem dams, diversions, and transmountain water diversions) for irrigation and municipal use. Using data from the Natural Resources Conservation Service, which are estimates of what flow would be without regulation (i.e. dams, diversions, etc.),

Osmundson (2001) found that mean monthly flows along the Colorado River at Cameo have generally increased during base-flow months (September/October and winter months) and decreased during runoff months (April-July) since the inception of river-flow regulation. For example, during the months of May-July, Osmundson (2001) found that flow declined by 17-41%, with the highest declines occurring during the month of June. Although total annual flows may be similar to pre-development records, the timing, duration, and magnitude of flow in the Colorado and Gunnison rivers have been drastically altered (Burdick 1995; Cooper and Severn 1994). Floodplains are not inundated as frequently during spring runoff due to altered flows and channelization structures (e.g. levees, dikes, and/or rip-rap) (Irving and Burdick 1995). Tamarisk has decreased the amount of sediment deposition in floodplains and has stabilized streambanks, which further reduce the connectivity between the river and floodplain areas (Graf 1978, as cited in Irving and Burdick 1995). Cooper and Severn (1994) note that the alteration in the magnitude of maximum annual flows along the Colorado River has decreased overbank flood frequency and duration resulting in reduced salt flushing, sediment deposition, connectivity of wetlands to the river, and cottonwood recruitment. In summary, floodplain dynamics along the major rivers (Colorado and Gunnison) in Mesa County, which are necessary for continued development of wetland habitat, have been greatly altered. As a result of this change, new wetlands are not being created within the floodplains, non-native species (e.g. tamarisk) have thrived, and aquatic habitat for endangered fish has been reduced.

Groundwater in Mesa County is associated with the four principal aquifers of the Colorado Plateau (this discussion on groundwater is almost entirely based on USGS 1995 "Groundwater Atlas of the United State – HA 730-C" see references). Discharge from these aquifers is mainly associated with small seep and spring wetlands, but occasionally supports large slope wetlands, such as the aspen/Rocky Mountain maple (*Populus tremuloides*/*Acer glabrum*) wetland forest near Vega Reservoir. Discharge also provides critical flow to many small streams in Mesa County, and thus is vital to the health of many riparian associations. The four aquifers are composed of permeable, moderately to well consolidated sedimentary rocks which range in age from Permian to Tertiary and are separated by impermeable confining units. The numerous water-yielding units have been grouped into four principal aquifers: (1) Uinta-Animas aquifer; (2) Mesa Verde aquifer; (3) Dakota-Glen Canyon aquifer; and (4) Coconino aquifer. All four aquifers underlie Mesa County but discharge in different geographical locations within the county:

(1) Uinta-Animas aquifer – this aquifer is found in the northeast part of the county and is associated with the Uinta Formation (silty sandstone, siltstone, and marlstone) and Green River Shale Formation (dolomitic marlstone). This aquifer is associated with the numerous seeps and springs that occur in western Garfield County. Seeps and springs associated with this aquifer in Mesa County are not as widespread as in Garfield, mainly due to the fact that outcrops of the Uinta and Green River Formation are not as common in Mesa County. However, discharge from this aquifer is believed to be the hydrological source for the large aspen/Rocky Mountain maple wetland forest near Vega Reservoir. Recharge occurs in the uplands near the margins of the

aquifer while discharge occurs along tributaries to the Colorado River and along the slopes of Grand Mesa, where the Green River Formation underlies thick basalt flows. The lower part of the Green River Formation, which is somewhat impermeable due to less fractures and a high concentration of kerogen (oil shale), and the Wasatch Formation serve as the confining unit between the Uinta-Animas and the underlying Mesa Verde aquifer.

(2) Mesa Verde aquifer – this aquifer is found in essentially the same geographic region as the Uinta-Animas in Mesa County, the northeast portion. The aquifer is found within rocks of the Mesa Verde Group (which locally consists of sandstone with interbedded shale and coal) which are older than those associated with the Uinta-Animas. Thus, the Mesa Verde aquifer is typically found at a lower elevation than the Uinta-Animas. Seeps found along the I-70 corridor in De Beque Canyon and in the Little Book Cliffs area are associated with this aquifer. Locally, recharge occurs on the northern flanks of the West Elk Mountains, areas near Grand Mesa, and along the Roan Plateau. Discharge not only occurs via seeps and springs but also directly into streams. The Mancos Shale Formation serves as the confining unit between the Mesa Verde and the underlying Dakota-Glen Canyon aquifer.

(3) Dakota-Glen Canyon aquifer – this aquifer contains four permeable zones that are referred to as the Dakota aquifer (associated with the Dakota Sandstone), Morrison aquifer (associated with sandstone portions of the Morrison Formation), Entrada aquifer (associated with the Entrada Sandstone), and Glen Canyon aquifer (associated with the Kayenta and Wingate Sandstone). The aquifer underlies both the Uinta-Animas and Mesa Verde aquifers but only surfaces in Mesa County on and around the Uncompahgre Plateau. For example, near the Mesa-Montrose County border along the Dolores River, numerous seeps discharge from the Glen Canyon aquifer at the contact between the Wingate Sandstone and the underlying Chinle Formation (sandstone and shale). The Dakota-Glen Canyon aquifer has been utilized in the Grand Valley as a source of irrigation water for agriculture. Many of these wells, once artesian, now have to be pumped due to overuse and subsequent release of pressure (Chronic 1980). Locally, recharge occurs near the southeastern end of the Uncompahgre Plateau and on the eastern side of the Piceance Basin. From these recharge areas, groundwater then flows toward discharge areas along the Colorado, Dolores, and Gunnison rivers. The Chinle Formation is the lower confining unit of the Dakota-Glen Canyon aquifer and rests atop Permian sandstone.

(4) Coconino-DeChelly aquifer – this aquifer is contained in rocks of Early Permian age and underlies most of the southern part of the Colorado Plateau. Rocks associated with this aquifer are only exposed in Mesa County along the Dolores River where a few springs discharge near the base of the canyon slopes. This aquifer may be contributing to base flows in the Dolores River along certain reaches since the river essentially cuts through these rock layers

between the Mesa-Montrose county border and the Utah state line. Locally, recharge occurs near the Uncompahgre Plateau while discharge is probably only occurring along the Dolores River.

Upland Vegetation

Upland vegetation in Mesa County can be classified into six broad types, each containing several plant associations. These types more or less correspond to elevation: from lowest to highest, 1) semi-desert shrublands; 2) sagebrush; 3) pinyon-juniper woodlands; 4) mountain shrublands; 5) aspen forests; 6) coniferous forests. Within each of these zones, the addition of water (streams, rivers, or springs) creates additional vegetation types. The only major types of vegetation in Colorado that are not represented in Mesa County are plains grasslands and alpine tundra.

Semi-desert shrubland is found at the lowest elevations in the county, often on saline or alkaline shale soils. The entire Grand Valley falls within this zone, including the majority of private land in the county. It also represents over 30% of BLM lands. Most of this type is north of the Colorado River or in the Gunnison Valley. Low shrubs of the goosefoot family such as shadscale (*Atriplex confertifolia)*, saltbush (*Atriplex* spp.), and greasewood (*Sarcobatus vermiculatus*), are the dominant life form. These plants are indicators of both climatically dry areas and physiologically dry soils. Within this zone are several characteristic, more or less distinct, plant associations, which can often be correlated with specific differences in soils, slope, aspect, and moisture (Singh and West 1971).

Imperiled plant species found in this zone include Grand buckwheat (*Eriogonum contortum*), tall cryptantha (*Cryptantha elata*), Ferron milkvetch (*Astragalus musiniensis*), and Uinta Basin hookless cactus (*Sclerocactus glaucus*). Rare animals of the zone include Ord's kangaroo rat (*Dipodomys ordii sanrafaeli*), white-tailed antelope squirrel (*Ammospermophilus leucurus pennipes*), Botta's pocket gopher (*Thomomys bottae howelli*), kit fox (*Vulpes macrotis*), and a variety of birds and lizards.

Semi-desert shrublands have been used primarily as livestock range for about a century. Before irrigation projects were developed, they were unsuited for homesteading, and so remained largely in public ownership. Most of this range was misused for about a half century by overgrazing domestic livestock, prior to the Taylor Grazing Act. Although the range has generally improved in recent years, much of it remains in poor condition. BLM has estimated that the condition of the majority of its land in this zone is fair to poor (USDI 1985). This is most noticeable in the absence of native perennial grasses. Bunch grasses, which are a natural part of this ecosystem, include galleta (*Hilaria jamesii*), Indian ricegrass (*Oryzopsis hymenoides*), needle and thread (*Hesperostipa comata*), and Salina wild rye (*Elymus salina*). Non-native aggressive species such as cheatgrass (*Bromus tectorum*), halogeton (*Halogeton glomeratus*), and Russian thistle (*Salsola australis*) have invaded much of this land. Under proper grazing management, it is possible for recovery to occur. Chances are best when native species are least depleted; the poorer the condition, the slower the recovery (Blaisdell and Holmgren 1984). Remnants of plant associations with a good stand of native bunch grasses have

been identified in Lyon et al. (1996). Whenever good native grass associations are encountered, they should be valued and protected. They can supply the seed source, and the nucleus for the improvement of adjacent areas.

Present uses, in addition to grazing, include oil and gas development, wildlife habitat, and recreation. This largely uninhabited landscape provides unique areas for camping and solitude. Most people do not perceive this ecosystem to be as aesthetically pleasing as other parts of the county, and it is therefore less heavily used for hiking and camping. It also seems to suffer from a lack of respect and appreciation, and many areas have been heavily altered. Off-road vehicle use is very popular. Unfortunately, the wheels of off road vehicles (ORVs) can destroy vegetation and damage the soil. This can cause accelerated wind and water erosion, or create favorable conditions for the invasion of non-native species. The shale badlands in the salt desert shrub areas yield about 85% of sediments, but only 1% of the water in the Colorado River. There are very few wetlands found in this vegetation type.

Sagebrush in Mesa County is often found on deep, well-drained sandy soils of valley bottoms and mesas, where adjacent steeper slopes are covered with pinyon-juniper woodlands or mountain shrubs. Four species of sagebrush are found here: big sage (*Artemisia tridentata* ssp. *tridentata*); mountain big sage (*A. tridentata* ssp. *vaseyana*); black sage (*A. nova*) and silver sage (*A. cana*). Each has its own ecological requirements, and they rarely mix. The most abundant species in Mesa County is mountain big sage, followed by black sage. The potential natural vegetation of these sites is a mixture of sagebrush (about 10% cover) and native grasses and forbs (USDA 1978). Common associated graminoid species are western wheatgrass (*Pascopyrum smithii*), Indian ricegrass, and muttongrass (*Poa fendleriana*). Forbs include lupine (*Lupinus* spp.), penstemon (*Penstemon* spp.), and Indian paintbrush (*Castilleja* spp.). There may be a scattering of other shrubs such as rabbitbrush (*Chrysothamnus* spp.), winterfat (*Krascheninnikovia lanata*), and four-wing saltbush (*Atriplex canescens*). At higher elevations, sagebrush is mixed with Gambel's oak (*Quercus gambelii*) and snowberry *(Symphoricarpos oreophilus*). Heavy grazing and other disturbances will increase sagebrush cover and decrease perennial bunch grasses. Shrubs such as rabbitbrush and snakeweed will increase, and cheatgrass and other annual non-native aggressive species may invade (USDA 1978). In some cases, removal of herbaceous species has left a "sagebrush desert," with only bare soil under the shrubs. When burned, big sagebrush, mountain big sagebrush, and black sagebrush do not resprout, and are often replaced by pure stands of cheatgrass. This, in turn, makes the area much more susceptible to fire.

Sagebrush areas account for 8% of the BLM lands of the Grand Junction Resource Area. The majority of these areas were judged by BLM to be in poor to fair condition (BLM 1987). Lyon et al. (1996) indicate that the majority of the sagebrush remaining on private lands in Mesa County is in the Glade Park-Pinyon Mesa area, and in the area west of De Beque. In both locations, grazing and planting of non-native grasses have largely altered the community. According to Tisdale (1969), "The balance between sagebrush and grass has been upset over vast areas. Affected areas now support either dense stands of sagebrush with a scant understory or, where unrestricted grazing has been accompanied

by repeated fires, vegetation composed primarily of annual species." Recovery of this vegetation type, once altered, is difficult to achieve. In some cases, restricting grazing for twenty-five years has failed to change the composition back to a more desirable mix of shrubs, grass and forbs (Tisdale 1969). Partial removal of dense shrub cover is usually ineffective, because remaining shrubs will compensate by increasing their canopy cover, and take up all available resources. Complete removal of shrubs usually results in the invasion of non-native aggressive species like cheatgrass. It may be necessary to seed with native grasses, and even then, success is not assured.

A species dependent on the sagebrush zone in Mesa County is the Gunnison Sage Grouse (*Centrocercus minimus gunnisonii*). Its population has declined in recent years, probably because of loss of suitable habitat. In some of its range, pinyon-juniper have invaded the sagebrush flats. The Sage Grouse needs abundant grasses and forbs, in addition to the shrubs. Nearly all manipulations of sagebrush for grazing improvements (e.g., chaining, burning and planting of crested wheat), have been detrimental to the birds (Woods and Braun 1995). Wetlands found in the sagebrush vegetation type are cricital habitat for the Sage Grouse as they use wet meadows and riparian areas for brood-rearing.

Pinyon-Juniper Woodlands are a major vegetation type dominating much of Mesa County. Also known as "pygmy forests," pinyon-juniper woodlands cover the slopes of the Uncompahgre Plateau, Grand Mesa, South Shale Ridge and other areas from 4,600 to 8,900 ft., with their highest development between 5,000 and 7,000 ft. At higher elevations they occur on south and west facing slopes. This type accounts for more than half of the BLM lands in the county. It occupies the zone between sagebrush and mountain shrub, often on rocky hillsides. Trees are typically short and widely spaced, with an understory ranging from almost barren to a diverse mixture of shrubs, forbs and grass. Soils are usually coarse, sandy, and shallow, with low fertility. With increased moisture the canopy can become denser, with a resulting decrease in understory vegetation. It is thought that the pinyon-juniper zone has expanded over the last century, perhaps as a result of grazing (Miller and Wigand 1994). Decreasing the grass cover both reduces competition for the tree seedlings and lowers the frequency of fire. The pinyon-juniper type is widespread throughout the western United States, with different species of pinyon pine and juniper in different areas. The species found in Mesa County are pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*), with Rocky Mountain juniper (*Juniperus scopulorum*) occurring mostly in riparian areas. In most of the region pinyon pine and juniper are co-dominant. However, of the two tree species, pinyon is more tolerant of cold, and juniper more tolerant of drought (Mutel and Emerick 1992). Juniper therefore occurs at lower elevations, where it is often mixed with sagebrush and desert shrubs, while pinyon is found at the higher elevations, where it may occur with ponderosa pine and oak. Sites are usually warm and dry, with a mean annual temperature between 45 and 55 degrees F, annual precipitation between 25 and 50 cm, and at least 80 frost-free days (Mutel and Emerick 1992). Erdman (1970) found that in Mesa Verde, pinyon trees in climax pinyon-juniper woodlands were often over 400 years old, and junipers much older.

The shrub understory depends on site characteristics such as slope, aspect, and disturbance history. Shrubs may include saltbush and other species discussed above under the semi-desert shrub vegetation type at the lower elevations; and mountain mahogany (*Cercocarpus montanus* and *C. ledifolius*), Gambel's oak, serviceberry (*Amelanchier utahensis*), snowberry, and other shrubs discussed below under mountain shrublands vegetation type, at the higher elevations.

The herbaceous understory is usually sparse, especially where grazed by cattle. Typical native grasses are Indian rice grass, galleta, mutton grass and bottlebrush squirreltail (*Elymus elymoides*). Cheatgrass is the most frequent non-native invader. Common forbs are golden aster (*Heterotheca villosa*), twin bladderpod (*Physaria acutifolia*), yellow cat's-eye (*Cryptantha flava*), and scarlet globemallow (*Sphaeralcea coccinea*). Many of Mesa County's rare plants are found in this zone: Canyonlands lomatium (*Lomatium latilobum*), Dolores skeleton-plant (*Lygodesmia doloresensis*), Fisher Towers milkvetch (*Astragalus piscator*), Grand Junction milkvetch (*A. linifolius*), San Rafael milkvetch (*A. rafaelensis*), Naturita milkvetch (*A. naturitensis*), and Wetherill milkvetch (*A. wetherillii*), and Jones blue-star (*Amsonia jonesii*).

Mountain shrublands occur between the pinyon-juniper zone and the lower limits of ponderosa pine (*Pinus ponderosa*). Often this zone is not well defined, and there is oak mixed with both pinyon-juniper and ponderosa pine. Mountain shrublands occur on hillsides, upland benches, and well-drained lowlands, with 38 to 68 cm of precipitation per year (Johnston 1987) and are widespread in central and western Colorado and Utah (Knight 1994).

Gambel's oak occurs between 5,100 and 9,200 ft. and is most common between 7,000 and 9,000 ft. It may occur as the dominant species, or associated with ponderosa pine, aspen (*Populus tremuloides*), and other mountain shrubs such as mountain mahogany, serviceberry, and snowberry. It often displays its greatest stature in riparian areas, on slopes and benches above streams, where it often forms a band of thick vegetation just above the riparian zone, where pinyon-juniper occupy the drier slopes above.

Gambel's oak is a clonal species, and may live to be very old. Stands in Utah exceed 4,000 years of age (Mutel and Emerick 1992). It is an important invader after fire. In disturbed ponderosa pine forest, it may prevent the re-establishment of pine. Many of the stands in Mesa County may represent seral stages where the climax community will be pinyon-juniper. Erdman (1970) found that in Mesa Verde, oak and the other mountain shrubs became established in only a few years after a fire, and remained dominant for one hundred years before being replaced by pinyon-juniper.

Another notable shrub community, less common in Colorado, occurs in the region. Along the northwest part of the Uncompahgre Plateau, at about 8,000 ft., are hundreds of acres dominated by greenleaf manzanita (*Arctostaphylos patula*). This shrub is also found as an understory in ponderosa pine forest on the Uncompahgre Plateau, but on the exposed slopes here, it occurs without the trees.

Aspen forests. Aspen, the only upland deciduous forest tree in the region, is the most widespread tree in North America, due to its great genetic variability. Although deciduous, aspen is effectively evergreen, because its bark is able to perform photosynthesis, even at freezing temperatures.

Aspen occurs in Mesa County between elevations of 7,200 and 10,200 ft. At lower elevations it is associated with Gambel's oak and ponderosa pine, where it occurs in mesic sites, often in draws with cool air drainage, on north-facing slopes, in riparian zones, or in areas with snowdrifts or seeps. At upper elevations it may be dominant, or mixed with Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*).

Aspen, like Gambel's oak, is clonal. Although individual stems live for about 100 years, their root systems can live for 1,000 or more years (Peet 1988). They are able to thrive in sunny places with poor soils and are thus adapted for colonizing disturbed or burned sites. The other tree which is a major colonizer after fire in the Rocky Mountains, lodgepole pine (*Pinus contorta*), is conspicuously absent from the county. Aspen is especially plentiful in sites once heavily disturbed by mining, logging, and grazing. After disturbance, colonization can be completed within five to ten years. Maximum density is reached in 25 to 50 years, after which shade tolerant species such as Douglas-fir (*Pseudotsuga menziesii*) and subalpine fir may increase. Whether or not aspen is sometimes the climax, rather than a seral species, is a matter of some debate. Presumed climax forests are characterized by large trees, a lush understory, and soil which is loamy, porous, and moist throughout the season (Mutel and Emerick 1992).

Once established, aspen forests are the most species rich of all the upland vegetation types. This may be due to the increased fertility and moisture holding capacity of the soil with the addition of the deciduous leaf litter (Peet 1988). Aspen leaves decompose readily, since they are low in the tannins and resins which retard decomposition in conifer needles (Mutel and Emerick 1992).

Aspen is most abundant in Mesa County on Uncompahgre Plateau and Grand Mesa National Forest lands. Outside Forest Service lands, the Glade Park-Pinyon Mesa area has the most aspen.

Coniferous Forests. Forested areas dominated by conifers, including ponderosa pine, Douglas-fir, Engelmann spruce and subalpine fir, occur above or intermixed with aspen forests. In Mesa County, they occur on the Uncompahgre Plateau, both north and south of Unaweep Canyon, and on Grand Mesa.

Ponderosa pine tends to occupy lower elevation and drier sites, between 7,000 and 8,500 ft, with coarse, shallow and rocky soils. Ponderosa pines are the largest conifers in the Southern Rocky Mountains. The trees are adapted to withstand drought, with taproots up to 35 ft. and lateral roots as long as 100 ft. (Mutel and Emerick 1992). Their thick, corky bark protects them from the frequent ground fires to which they are adapted. Some of the greenleaf manzanita stands may have once had ponderosa pine as an overstory. In their natural state, ponderosa pine landscapes are open and park-like, with widely spaced trees

and a rich understory of native grasses. Removal of grass by grazing reduces fire frequency. Grazing may also increase tree density by removing competition for seedlings. The result is a more closed canopy, with dense stands of weaker trees. Because these trees do not get adequate sun and nutrients, they are unable to produce enough resins, and are susceptible to beetle infestation (Mutel and Emerick 1992).

Douglas-fir is found in cooler and more mesic sites within the ponderosa pine zone, and extending to somewhat higher elevations. It typically occurs in patches on north-facing slopes, in draws, and in riparian areas. It does not form large stands here as it does farther east in the Central Rocky Mountains. Douglas-fir, like ponderosa pine, has thick bark that has adapted it to survive fire. Mature stands have an open structure, maintained by fire. When dense, it is susceptible to spruce budworm and Douglas-fir bark beetle. Douglas-fir is cold tolerant and can perform photosynthesis even under snow (Mutel and Emerick 1992).

Spruce and fir forests are found at the highest elevations in the National Forest land of Mesa County. They are most highly developed between 9,000 and 10,500 ft. The forest typically has a closed canopy, with a sparse understory of shade tolerant species. Interspersed with the forests, and becoming more common at higher elevations, are subalpine meadows or "parks." Soils are acidic, and often shallow and infertile, due to leaching and the acidic foliage. There is little bacterial activity at the low temperatures of this zone, and much of the carbon in the ecosystem is locked up in humus. Of the two species, spruce is longer lived and has a higher survival rate, whereas fir is shade tolerant, and is able to become established beneath spruce. Subalpine fir is considered by many to be the climax species. However, Aplet et al. (1988) have found that, in forests studied in Colorado, spruce and fir can co-exist indefinitely. Stand development is dependent on a broad range of disturbances, interacting with the life histories of the two species.

Wetlands are most numerous in Mesa County within this vegetation type.

Wetland and Riparian Vegetation

Wetland and riparian vegetation is the most threatened vegetation type in Mesa County. Riparian areas are found within all of the zones discussed above, at all elevations in the county. At the lowest elevations, along the major rivers, the dominant native vegetation is the Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), skunkbrush (*Rhus trilobata*), and coyote willow *(Salix exigua*). Horsetails (*Equisetum* sp.) and scouring rushes (*Hippochaete* spp.) are fairly common in the understory of these riparian areas. Floodplain wetlands along these low elevation rivers are typically dominated by common reed (*Phragmites australis*), cattail (*Typha latifolia*), bulrush (*Schoenoplectus lacustris* ssp. *acutus*), threesquare bulrush (*S. pungens*), alkali bulrush (*S. maritimus*), and saltgrass (*Distichlis spicata*). Above about 5,500 ft., the Rio Grande cottonwood is replaced by narrowleaf cottonwood (*Populus angustifolia*). The understory slowly makes a transition from that similar to Rio Grande cottonwood stands to one dominated by various willows (*Salix* spp.), red-osier dogwood (*Cornus sericea*), chokecherry (*Prunus virginiana*), and wild rose (*Rosa woodsii*). At higher elevations, narrowleaf cottonwood is replaced by

river birch (*Betula occidentalis*), alder (*Alnus incana*), aspen (*Populus tremuloides*), Douglas-fir (*Pseudotsuga menziesii*), and blue spruce (*Picea pungens*).

Seep and spring wetlands also occur within the county. The dominant vegetation in these areas varies depending on elevation, topographic position, and the permanence of groundwater discharge. Higher elevation springs often support similar plant species as those found in other wetlands at that elevation. At lower elevations, vegetation ranges from alkaline tolerant species such as common reed, saltgrass, threesquare bulrush, and Baltic rush (*Juncus balticus*) to unique hanging garden associations consisting of Eastwood monkeyflower *(Mimulus eastwoodiae*) and Mancos columbine (*Aquilegia micrantha*). These hanging gardens are one of the most unique wetland types found in Mesa County and are only found along the Dolores River valley in the county. They harbor three rare plant species: Eastwood monkeyflower, giant helleborine orchid (*Epipactis gigantea*), and southern maidenhair fern (*Adiantum capillus-veneris*). Other seep wetlands along the Dolores River support dense stands of ditch reedgrass (*Calamagrostis scopulorum*). Another very unique wetland in Mesa County in Unaweep Seep, which supports a high density of populations of rare plants, plant associations, butterflies, and birds.

Much of the riparian zone in the county has been invaded by non-native species, the most damaging of which is tamarisk (*Tamarix ramosissima*), a native of the Middle East, which was probably introduced in the U.S. around the turn of the century. It is salt-tolerant, and has displaced much of the native vegetation along the major rivers, and continues to extend its range upstream along the tributaries. Unfortunately, it has proved almost impossible to eradicate. Other common aggressive non-native species in the lower riparian zone are Russian olive (*Elaeagnus angustifolia*), tumble mustard (*Sisymbrium altissimum*), Canada thistle (*Cirsium canadensis*), Russian knapweed (*Acroptilon repens*), alfalfa (*Medicago sativa*), and sweet clover (*Melilotus alba*; *M. officinalis*). Low elevation wetlands have been invaded by many non-native species such as barnyard grass (*Echinochloa crus-galli*) and cocklebur (*Xanthium strumarium*). Upstream, red top (*Agrostis gigantea*) and Kentucky bluegrass (*Poa pratensis*) are frequent non-natives.

Disruption of the natural flood regime of the rivers by dams and alteration of the river channel has severely impacted regeneration of cottonwoods. Large cottonwood trees are important for nesting and roosting of Bald Eagles, Great Blue Herons, and other birds. Protection of young cottonwoods, and planting new trees along the Colorado River may be necessary to ensure replacement of older trees for the future.

Smaller streams in the canyons and mountains are essential for wildlife. It has been estimated that riparian areas, which account for only 1% of the landscape, are used by greater than 70% of wildlife species (Knopf 1988). In Colorado, 27% of the breeding bird species depend on riparian habitats for their viability (Pague and Carter 1996.) The denser riparian vegetation provides a protected corridor for migration of deer and elk, as well as cover for smaller animals. Riparian areas generally have a greater diversity of plant species than surrounding uplands. Rare or imperiled plants of Mesa County found

in riparian zones are the canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) and the giant helleborine orchid (*Epipactis gigantea*). Along the smaller streams, grazing has altered much natural riparian vegetation. Protection of some riparian areas by fencing out cattle has improved some formerly degraded areas.

Seeps/Springs Ecology

Seeps and springs are small wetland ecosystems that are hydrologically supported by groundwater discharge (USDI 2001a; Hynes 1970). They are distinctive from other wetland and riparian habitats by the relatively constant water temperature and chemistry of the discharging groundwater (BLM 2000). This results from the groundwater being in contact with minerals for an extended period of time, which equilibrates solute concentrations. Thus, spring water tends to have constant concentrations of dissolved minerals while surface-fed streams vary in response to rainfall and snowmelt (McCabe 1998). Seeps differ from springs in that they often periodically dry and consequently support a lower diversity of wetland vegetation. Springs often have a more persistent source of water and thus support a greater diversity of wetland vegetation and often provide aquatic habitat (BLM 2000). However, springs supported by local aquifers may periodically dry, since local aquifers are comparatively small and shallow, and the amount of groundwater discharge associated with them varies in response to local precipitation levels. Springs supported by regional aquifers, or aquifers covering thousands of square kilometers, rarely dry, even during droughts, since the quantity of water within the aquifer is high and the groundwater flow is typically slow (BLM 2000). Many springs in western North America, below an elevation of 7000 feet, are isolated from other wetlands, frequently flow a short distance before infiltrating back into the ground, and periodically dry out (Hendrickson and Minckley 1984). This lack of connectivity restricts dispersal of many macroinvertebrates and fishes and thus, along with unique environmental characteristics (water chemistry, geology, etc.), has resulted in many unique and endemic species occupying isolated spring wetlands.

Spring environments (water temperature, water chemistry, etc.) are typically less variable than other aquatic habitats such as lakes, ponds, and streams. This results in low variability in macroinvertebrate populations at spring sources while downstream habitats typically show more variability in population dynamics (BLM 2000). In addition, the factors that lead to the evolution of endemic species or to the value of these isolated wetlands as refugia for relict species, can also result in low species richness due to the small size, isolation, and adverse conditions of these wetlands (Myers and Resh 1999). Martinson (1980) found that macroninvertebrate populations in the Piceance Basin, Colorado had greater density and biomass but fewer species (less diversity) at spring sources than in downstream habitats. This may be attributed to various factors: (a) constant, or less variable, environmental conditions at spring sources may prevent the initiation or completion of the life cycles of some species; (b) those organisms able to survive these conditions may be able to expand their populations due to less competition; (c) the absence of suspended particles in discharging groundwater does not allow filter feeding organisms to survive; and (d) drift patterns may play a role, since there are no upstream sources of macroinvertebrates for the springs (many occur at the headwaters of

first-order streams) (Martinson 1980). In that same study, Martinson also found that, although many spring sources had similar water temperatures and water chemistry, they often exhibited a different suite of macroinvertebrate species. This may be due to the variation in topographic gradients in which the springs occur, which influence water depth, water velocity, seasonal fluctuations, and substrate type (e.g. gravel vs. silt). Given similar geology and geographic proximity to the Piceance Basin, similar patterns in the structure of macroinvertebrate populations would be expected for the seeps and springs surveyed for this project.

Seeps and springs often exhibit diverse flora composition and structural characteristics which provide potential cover for resting, nesting, and feeding for many different organisms, especially birds (BLM 2000). For example, submergent vegetation such as pondweed (*Potamogeton* sp.), duckweed (*Lemna* sp.), ditch-grass (*Ruppia* sp.), horned-pondweed (*Zannichellia* sp.), and watercress (*Rorippa* sp.) provide a food source for waterfowl, while watercress has been shown to be a critical resource for mollusks (Sada 1996). Watercress, duckweed, and hornwort (*Ceratophyllum demersum*) were the most common submergent plant species located in springs in western Mesa County. Sedges (*Carex utriculata*, *C. nebrascensis*, and *C. pellita*), rushes (*Juncus balticus* and *J. saximontanus*), grasses (*Agrostis gigantea*, and *Glyceria striata*), and other herbaceous species such as alkali crowfoot (*Halerpestes cymbalaria* subsp. *saximontana*), which are often found growing along the banks of springbrooks and in spring wetlands, help regulate water temperatures and provide areas for hiding and nesting, in addition to the habitat they provide for macroinvertebrates (Sada 1996). Some springs in the project area support an overstory of occasional trees (*Populus angustifolia* and *P. deltoides* ssp. *wislizeni*) and shrubs such as river birch (*Betula occidentalis*), thinleaf alder (*Alnus incana*), and various willows (*Salix* spp.), which provide excellent habitat for birds and browse for large mammals. Unique water chemistry and/or edaphic conditions often provide habitat for rare plant species.

Many seeps and springs in Mesa County have been altered and/or modified from their natural condition due to anthropogenic disturbances such as livestock grazing and diversions and impoundments to capture water for human or livestock use. These disturbances can result in an increase in non-native species, decrease in vegetation cover, inundation of springbrook habitat, replacement of species requiring flowing water with those more adapted to stagnate or slow moving water (lakes, ponds, etc.), and cause the extirpation of endemic spring species (Sada in press). Sada and Nachlinger (1996) found higher levels of biodiversity in undisturbed springs while disturbed springs had a high percentage of non-native species present.

Diversions, which decrease flow from spring sources, can result in greater variation of water temperature which causes a shift in the composition of macroinvetebrate species from those adapted to spring source habitats, where water temperature is fairly constant, to those adapted to downstream habitats, where water temperature exhibits more variation. In addition, typically an increase in water temperature, which often occurs when water flow is decreased, decreases the number of aquatic invertebrate species found in that location (Myers and Resh 1999). Seeps and springs which are isolated, are

especially susceptible to disturbances since they lack connectivity, and thus, have few mechanisms for recolonization via drift and upstream movements. Restoring disturbed wetlands can result in the reestablishment of wetland plant species and adequate vegetation structure, however it does not guarantee the restoration of endemic fauna, especially for species that have limited dispersal capabilities (Myers and Resh 1999).

THE NATURAL HERITAGE NETWORK AND BIOLOGICAL DIVERSITY

Just as ancient artifacts and historic buildings represent our cultural heritage, a diversity of plant and animal species and their habitats represent our "natural heritage." Colorado's natural heritage encompasses a wide variety of ecosystems from tallgrass prairie and shortgrass high plains to alpine cirques and rugged peaks, from canyon lands and sagebrush deserts to dense subalpine spruce-fir forests and wide-open tundra.

These widely diversified habitats are determined by water availability, temperature extremes, altitude, geologic history, and land use history. The species that inhabit each of these ecosystems have adapted to the specific set of conditions found there. Because human influence today touches every part of the Colorado environment, we are responsible for understanding our impacts and carefully planning our actions to ensure our natural heritage persists for future generations.

Some generalist species, like house finches, have flourished over the last century, having adapted to habitats altered by humans. However, many other species are specialized to survive in vulnerable Colorado habitats; among them are Bell's twinpod (a wildflower), the Arkansas darter (a fish), and the Pawnee montane skipper (a butterfly). These species have special requirements for survival that may be threatened by incompatible land management practices and competition from non-native species. Many of these species have become imperiled not only in Colorado, but also throughout their range of distribution. Some species exist in less than five populations in the entire world. The decline of these specialized species often indicates disruptions that could permanently alter entire ecosystems. Thus, recognition and protection of rare and imperiled species is crucial to preserving Colorado's diverse natural heritage.

Colorado is inhabited by some 800 vertebrate species and subspecies, and tens of thousands of invertebrate species. In addition, the state has approximately 4,300 species of plants and more than 450 recognized plant associations that represent upland and wetland ecosystems. It is this rich natural heritage that has provided the basis for Colorado's diverse economy. Some components of this heritage have always been rare, while others have become imperiled with human-induced changes in the landscape. This decline in biological diversity is a global trend resulting from human population growth, land development, and subsequent habitat loss. Globally, the loss in species diversity has become so rapid and severe that Wilson (1988) has compared the phenomenon to the great natural catastrophes at the end of the Paleozoic and Mesozoic eras.

The need to address this loss in biological diversity has been recognized for decades in the scientific community. However, many conservation efforts made in this country were not based upon preserving biological diversity; instead, they primarily focused on preserving game animals, striking scenery, and locally favorite open spaces. To address the absence of a methodical, scientifically based approach to preserving biological

diversity Dr. Robert Jenkins of The Nature Conservancy pioneered the Natural Heritage Methodology in the early 1970s.

Recognizing that rare and imperiled species are more likely to become extinct than common ones, the Natural Heritage Methodology ranks species according to their rarity or degree of imperilment. The ranking system is scientifically based upon the number of known locations of the species as well as their biology and known threats. By ranking the relative rarity or imperilment of a species, the quality of its populations, and the importance of associated conservation sites, the methodology can facilitate the prioritization of conservation efforts so the most rare and imperiled species may be preserved first. As the scientific community realized that plant associations are equally important as individual species, this methodology has been applied to ranking and preserving rare plant associations, as well as the best examples of common associations.

The Natural Heritage Methodology is used by Natural Heritage Programs throughout North, Central, and South America, forming an international database network. The 85 Natural Heritage Network data centers are located in each of the 50 U.S. states, five provinces of Canada, and 13 countries in South and Central America and the Caribbean. This network enables scientists to monitor the status of species from a state, national, and global perspective. Information collected by the Natural Heritage Programs can provide a means to protect species before the need for legal endangerment status arises. It can also enable conservationists and natural resource managers to make informed, objective decisions in prioritizing and focusing conservation efforts.

What is Biological Diversity

Protecting biological diversity has become an important management issue for many natural resource professionals. Biological diversity at its most basic level includes the full range of species on Earth, from single-celled organisms such as bacteria and protists through the multicellular kingdoms of plants and animals. At finer levels of organization, biological diversity includes the genetic variation within species, both among geographically separated populations and among individuals within a single population. On a wider scale, diversity includes variations in the biological associations in which species live, the ecosystems in which associations exist, and the interactions between these levels. All levels are necessary for the continued survival of species and plant associations, and many are important for the well being of humans.

The biological diversity of an area can be described at four levels:

Genetic Diversity — the genetic variation within a population and among populations of a plant or animal species. The genetic makeup of a species varies between populations within its geographic range. Loss of a population results in a loss of genetic diversity for that species and a reduction of total biological diversity for the region. Once lost, this unique genetic information cannot be reclaimed.

Species Diversity — the total number and abundance of plant and animal species and subspecies in an area.

Community Diversity — the variety of plant associations or associations within an area that represent the range of species relationships and inter-dependence. These associations may be diagnostic or even restricted to an area. Although the terms plant association and community have been described by numerous ecologists, no general consensus of their meaning has developed. The terms are similar, somewhat overlapping, and are often used more or less interchangeably. The U.S. National Vegetation Classification (USNVC) (Anderson et al. 1998), the accepted national standard for vegetation, defines a community as an "assemblage of species that co-occur in defined areas at certain times and that have the potential to interact with one another" (The Nature Conservancy 1999), and a plant association as a type of plant community with "definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910). The term plant "association" is hereafter used in lieu of "community" except when referring to a broader definition of community (e.g. natural community). Identifying and protecting representative examples of plant associations ensures conservation of multiple number of species, biotic interactions, and ecological process. Using associations as a "coarse-filter" enables conservation efforts to work toward protecting a more complete spectrum of biological diversity.

Landscape Diversity — the type, condition, pattern, and connectedness of natural communities. A landscape consisting of a mosaic of natural communities may contain one multifaceted ecosystem, such as a wetland ecosystem. A landscape also may contain several distinct ecosystems, such as a riparian corridor meandering through shortgrass prairie. Fragmentation of landscapes, loss of connections and migratory corridors, and loss of natural communities all result in a loss of biological diversity for a region. Humans and the results of their activities are integral parts of most landscapes.

The conservation of biological diversity should include all levels of diversity: genetic, species, community or association, and landscape. Each level is dependent on the other levels and inextricably linked. In addition, and all too often omitted, humans are also closely linked to all levels of this hierarchy. We at the Colorado Natural Heritage Program believe that a healthy natural environment and a healthy human environment go hand in hand, and that recognition of the most imperiled species is an important step in comprehensive conservation planning.

Colorado Natural Heritage Program

To place this document in context, it is useful to understand the history and functions of the Colorado Natural Heritage Program (CNHP).

CNHP is the state's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. After operating in the Colorado Division of Parks and Outdoor Recreation for 14 years, the Program was relocated to the University of Colorado Museum in 1992, and then to

the College of Natural Resources at Colorado State University in 1994, where it has operated since.

The multi-disciplinary team of scientists, planners, and information managers at CNHP gathers comprehensive information on the rare, threatened, and endangered species and significant plant associations of Colorado. Life history, status, and locational data are incorporated into a continually updated data system. Sources include published and unpublished literature, museum and herbaria labels, and field surveys conducted by knowledgeable naturalists, experts, agency personnel, and our own staff of botanists, ecologists, and zoologists.

The Biological and Conservation Data System (BCD) developed by The Nature Conservancy is used by all Natural Heritage Programs to house data about imperiled species. This database includes taxonomic group, global and state rarity rank, federal and state legal status, observation source, observation date, county, township, range, watershed, and other relevant facts and observations. The Colorado Natural Heritage Program also uses the Biodiversity Tracking and Conservation System (BioTiCS) for digitizing and mapping occurrences of rare plants, animals, and plant associations. These rare species and plant associations are referred to as "elements of natural diversity" or simply "elements."

Concentrating on site-specific data for each element enables CNHP to evaluate the significance of each location for the conservation of biological diversity in Colorado and in the nation. By using species imperilment ranks and quality ratings for each location, priorities can be established to guide conservation action. A continually updated locational database and priority-setting system such as that maintained by CNHP provides an effective, proactive land-planning tool.

To assist in biological diversity conservation efforts, CNHP scientists strive to answer questions like the following:

- What species and ecological associations exist in the area of interest?
- Which are at greatest risk of extinction or are otherwise significant from a conservation perspective?
- What are their biological and ecological characteristics, and where are these priority species or associations found?
- What is the species' condition at these locations, and what processes or activities are sustaining or threatening them?
- Where are the most important sites to protect?
- Who owns or manages those places deemed most important to protect, and what is threatening those places?

- What actions are needed for the protection of those sites and the significant elements of biological diversity they contain?

- How can we measure our progress toward conservation goals?

CNHP has effective working relationships with several state and federal agencies, including the Colorado Department of Natural Resources, the Colorado Division of Wildlife, the Bureau of Land Management, and the U.S. Forest Service. Numerous local governments and private entities, such as consulting firms, educators, landowners, county commissioners, and non-profit organizations, also work closely with CNHP. Use of the data by many different individuals and organizations encourages a cooperative and proactive approach to conservation, thereby reducing the potential for conflict.

The Natural Heritage Ranking System

Key to the functioning of Natural Heritage Programs is the concept of setting priorities for gathering information and conducting inventories. The number of possible facts and observations that can be gathered about the natural world is essentially limitless. The financial and human resources available to gather such information are not. Because biological inventories tend to be under-funded, there is a premium on devising systems that are both effective in providing information that meets users' needs and efficient in gathering that information. The cornerstone of Natural Heritage inventories is the use of a ranking system to achieve these twin objectives of effectiveness and efficiency.

Ranking species and ecological assocations according to their imperilment status provides guidance for where Natural Heritage Programs should focus their information-gathering activities. For species deemed secure, only general information needs to be maintained by Natural Heritage Programs. Fortunately, the more common and secure species constitute the majority of most groups of organisms. On the other hand, for those species that are by their nature rare, more detailed information is needed. Because of these species' rarity, gathering comprehensive and detailed population data can be less daunting than gathering similarly comprehensive information on more abundant species.

To determine the status of species within Colorado, CNHP gathers information on plants, animals, and plant associations. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). This factor is weighted more heavily than other factors because an element found in one place is more imperiled than something found in twenty-one places. Also of importance are the size of the geographic range, the number of individuals, the trends in both population and distribution, identifiable threats, and the number of protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. For example, the lynx, which is thought to be secure in northern North America but is known from less than five current locations in Colorado, is ranked G5/S1 (globally-secure, but critically imperiled in this state). The Rocky Mountain Columbine, which is known only in Colorado from about 30 locations, is ranked a G3/S3 (vulnerable both in the state and globally, since it only occurs in Colorado and then in small numbers). Further, a tiger beetle that is only known from one location in the world at the Great Sand Dunes National Monument is ranked G1/S1 (critically imperiled both in the state and globally, because it exists in a single location). CNHP actively collects, maps, and electronically processes specific occurrence information for animal and plant species considered extremely imperiled to vulnerable in the state (S1 - S3). Several factors, such as rarity, evolutionary distinctiveness, and endemism (specificity of habitat requirements), contribute to the conservation priority of each species. Certain species are "watchlisted," meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. A complete description of each of the Natural Heritage ranks is provided in Table 1.

This single rank system works readily for all species except those that are migratory. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding, and resident species. As noted in Table 1, ranks followed by a "B," for example S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N," for example S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Global imperilment ranks are based on the range-wide status of a species. State imperilment ranks are based on the status of a species in an individual state. State and Global ranks are denoted with an "S" or a "G" respectively, followed by a number or letter. These ranks should not be interpreted as legal designations.

Table 1. Definition of Natural Heritage Imperilment Ranks.

G/S1	Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.
G/S3	Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).
G/S4	Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the

	periphery.
G/SX	Presumed extinct globally, or extirpated within the state.
G#?	Indicates uncertainty about an assigned global rank.
G/SU	Unable to assign rank due to lack of available information.
GQ	Indicates uncertainty about taxonomic status.
G/SH	Historically known, but usually not verified for an extended period of time.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season imperilment of elements that are not residents.
S#N	Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used.
SZ	Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected.
SA	Accidental in the state.
SR	Reported to occur in the state but unverified.
S?	Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.

Note: Where two numbers appear in a state or global rank (for example, S2S3), the actual rank of the element is uncertain, but falls within the stated range.

Legal Designations for Rare Species

Natural Heritage imperilment ranks should not be interpreted as legal designations. Although most species protected under state or federal endangered species laws are extremely rare, not all rare species receive legal protection. Legal status is designated by either the U.S. Fish and Wildlife Service under the Endangered Species Act or by the Colorado Division of Wildlife under Colorado Statutes 33-2-105 Article 2. In addition, the U.S. Forest Service recognizes some species as “Sensitive,” as does the Bureau of Land Management. Table 2 defines the special status assigned by these agencies and provides a key to abbreviations used by CNHP.

Candidate species for listing as endangered or threatened under the Endangered Species Act are indicated with a “C." While obsolete legal status codes (Category 2 and 3) are no longer used, CNHP continues to maintain them in its Biological and Conservation Data system for reference.

Table 2. Federal and State Agency Special Designations for Rare Species.

Federal Status:	
1. U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996)	
LE	Listed Endangered: defined as a species, subspecies, or variety in danger of extinction throughout all or a significant portion of its range.
E (S/A)	Endangered: treated as endangered due to similarity of appearance with listed species.
LT	Listed Threatened: defined as a species, subspecies, or variety likely to become endangered in the foreseeable future throughout all or a significant portion of its range.
P	Proposed: taxa formally proposed for listing as Endangered or Threatened (a proposal has been published in the Federal Register, but not a final rule).
C	Candidate: taxa for which substantial biological information exists on file to support proposals to list them as endangered or threatened, but no proposal has been published yet in the Federal Register.
2. U.S. Forest Service (Forest Service Manual 2670.5) (noted by the Forest Service as "S")	
FS	Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by: Significant current or predicted downward trends in population numbers or density. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.
3. Bureau of Land Management (BLM Manual 6840.06D) (noted by BLM as "S")	
BLM	Sensitive: those species found on public lands designated by a State Director that could easily become endangered or extinct in a state. The protection provided for sensitive species is the same as that provided for C (candidate) species.
4. State Status:	
The Colorado Division of Wildlife has developed categories of imperilment for non-game species (refer to the Colorado Division of Wildlife's Chapter 10 – Nongame Wildlife of the Wildlife Commission's regulations). The categories being used and the associated CNHP codes are provided below.	
E	Endangered: those species or subspecies of native wildlife whose prospects for survival or recruitment within this state are in jeopardy, as determined by the Commission.
T	Threatened: those species or subspecies of native wildlife which, as determined by the Commission, are not in immediate jeopardy of extinction but are vulnerable because they exist in such small numbers, are so extremely restricted in their range, or are experiencing such low recruitment or survival that they may become extinct.
SC	Special Concern: those species or subspecies of native wildlife that have been removed from the state threatened or endangered list within the last five years; are proposed for federal listing (or are a federal listing "candidate species") and are not already state listed; have experienced, based on the best available data, a downward trend in numbers or distribution lasting at least five years that may lead to an endangered or threatened status; or are otherwise determined to be vulnerable in Colorado.

Element Occurrences and their Ranking

Actual locations of elements, whether they are single organisms, populations, or plant associations, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. To prioritize element occurrences for a given species, an element occurrence rank (EO Rank) is assigned according to the ecological quality of the occurrences whenever sufficient information is available. This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful. The EO Rank is based on three factors:

Size – a measure of the area or abundance of the element's occurrence, relative to other known, and/or presumed viable, examples. Takes into account factors such as area of occupancy, population abundance, population density, population fluctuation, and minimum dynamic area (which is the area needed to ensure survival or re-establishment of an element after natural disturbance).

Condition/Quality – an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence. This includes factors such as reproduction, age structure, biological composition (such as the presence of non-native versus native species), structure (for example, canopy, understory, and ground cover in a forest community), and biotic interactions (such as levels of competition, predation, and disease).

Landscape Context – an integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the element, and connectivity. Dominant environmental regimes and processes include herbivory, hydrologic and water chemistry regimes (surface and groundwater), geomorphic processes, climatic regimes (temperature and precipitation), fire regimes, and many kinds of natural disturbances. Connectivity includes such factors as a species having access to habitats and resources needed for life cycle completion, fragmentation of ecological associations and systems, and the ability of the species to respond to environmental change through dispersal, migration, or re-colonization.

Each of these factors is rated on a scale of A through D, with A representing an excellent grade and D representing a poor grade. These grades are then averaged to determine an appropriate EO Rank for the occurrence. If not enough information is available to rank an element occurrence, an EO Rank of E is assigned. EO Ranks and their definitions are summarized in Table 3.

Table 3. CNHP Element Occurrence Ranks and their Definitions.

A	Excellent viability.
B	Good viability
C	Fair viability.
D	Poor viability.
H	Historic: known from historical record, but not verified for an extended period of time.
X	Extirpated (extinct within the state).
E	Extant: the occurrence does exist but not enough information is available to rank.
F	Failed to find: the occurrence could not be relocated.

Potential Conservation Areas and Their Ranking

In order to successfully protect populations or occurrences, it is helpful to delineate Potential Conservation Areas (PCAs). These PCAs focus on capturing the ecological processes that are necessary to support the continued existence of a particular element occurrence of natural heritage significance. Potential Conservation Areas may include a single occurrence of a rare element, or a suite of rare element occurrences or significant features.

The goal of the PCA process is to identify a land area that can provide the habitat and ecological processes upon which a particular element occurrence, or suite of element occurrences, depends for its continued existence. The best available knowledge about each species' life history is used in conjunction with information about topographic, geomorphic, hydrologic features, vegetative cover; and current and potential land uses. In developing the boundaries of a Potential Conservation Area, CNHP scientists consider a number of factors that include, but are not limited to:

- ecological processes necessary to maintain or improve existing conditions;
- species movement and migration corridors;
- maintenance of surface water quality within the PCA and the surrounding watershed;
- maintenance of the hydrologic integrity of the groundwater;
- land intended to buffer the PCA against future changes in the use of surrounding lands;
- exclusion or control of invasive non-native species;
- land necessary for management or monitoring activities.

The boundaries presented are meant to be used for conservation planning purposes and have no legal status. The proposed boundary does not automatically recommend exclusion of all activity. Rather, the boundaries designate ecologically significant areas in which land managers may wish to consider how specific activities or land use changes within or near the PCA affect the natural heritage resources and sensitive species on which the PCA is based. Please note that these boundaries are based on our best estimate of the primary area supporting the long-term survival of targeted species and plant associations. A thorough analysis of the human context and potential stresses has not been conducted. However, CNHP's conservation planning staff is available to assist with these types of analyses where conservation priority and local interest warrant additional research.

Off-Site Considerations

Frequently, all necessary ecological processes cannot be contained within a PCA of reasonable size. For example, taken to the extreme, the threat of ozone depletion could expand every PCA to include the entire planet. The boundaries described in this report indicate the immediate, and therefore most important, area to be considered for protection. Continued landscape level conservation efforts are necessary as well, which will involve regional efforts in addition to coordination and cooperation with private landowners, neighboring land planners, and state and federal agencies.

Ranking of Potential Conservation Areas

CNHP uses element and element occurrence ranks to assess the overall biological diversity significance of a PCA, which may include one or many element occurrences. Based on these ranks, each PCA is assigned a biological diversity rank (or B-rank). See Table 4 for a summary of these B-ranks.

Table 4. Natural Heritage Program Biological Diversity Ranks and their Definitions.

B1	Outstanding Significance (indispensable): Only known occurrence of an element A-ranked occurrence of a G1 element (or at least C-ranked if best available occurrence) Concentration of A- or B-ranked occurrences of G1 or G2 elements (four or more)
B2	Very High Significance: B- or C-ranked occurrence of a G1 element A- or B-ranked occurrence of a G2 element One of the most outstanding (for example, among the five best) occurrences rangewide (at least A- or B-ranked) of a G3 element. Concentration of A- or B-ranked G3 elements (four or more) Concentration of C-ranked G2 elements (four or more)
B3	High Significance: C-ranked occurrence of a G2 element A- or B-ranked occurrence of a G3 element D-ranked occurrence of a G1 element (if best available occurrence) Up to five of the best occurrences of a G4 or G5 community (at least A- or B-ranked) in an ecoregion (requires consultation with other experts)
B4	Moderate Significance: Other A- or B-ranked occurrences of a G4 or G5 community C-ranked occurrence of a G3 element A- or B-ranked occurrence of a G4 or G5 S1 species (or at least C-ranked if it is the only state, provincial, national, or ecoregional occurrence) Concentration of A- or B-ranked occurrences of G4 or G5 N1-N2, S1-S2 elements (four or more) D-ranked occurrence of a G2 element At least C-ranked occurrence of a disjunct G4 or G5 element Concentration of excellent or good occurrences (A- or B-ranked) of G4 S1 or G5 S1 elements (four or more)
B5	General or State-wide Biological Diversity Significance: good or marginal occurrence of common community types and globally secure S1 or S2 species.

Protection Urgency Ranks

Protection urgency ranks (P-ranks) refer to the timeframe in which it is recommended that conservation protection occur. In most cases, this rank refers to the need for a major change of protective status (for example agency special area designations or ownership). The urgency for protection rating reflects the need to take legal, political, or other administrative measures to protect the area. Table 5 summarizes the P-ranks and their definitions.

Table 5. Natural Heritage Program Protection Urgency Ranks and their Definitions.

P1	Protection actions needed immediately. It is estimated that current stresses may reduce the viability of the elements in the PCA within 1 year.
P2	Protection actions may be needed within 5 years. It is estimated that current stresses may reduce the viability of the elements in the PCA within this approximate timeframe.
P3	Protection actions may be needed, but probably not within the next 5 years. It is estimated that current stresses may reduce the viability of the elements in the PCA if protection action is not taken.
P4	No protection actions are needed in the foreseeable future.
P5	Land protection is complete and no protection actions are needed.

A protection action involves increasing the current level of protection accorded one or more tracts within a potential conservation area. It may also include activities such as educational or public relations campaigns, or collaborative planning efforts with public or private entities, to minimize adverse impacts to element occurrences at a site. It does not include management actions. Situations that may require a protection action are as follows:

- Forces that threaten the existence of one or more element occurrences at a PCA. For example, development that would destroy, degrade or seriously compromise the long-term viability of an element occurrence; or timber, range, recreational, or hydrologic management that is incompatible with an element occurrence's existence;

- The inability to undertake a management action in the absence of a protection action; for example, obtaining a management agreement;

- In extraordinary circumstances, a prospective change in ownership or management that will make future protection actions more difficult.

Management Urgency Ranks

Management urgency ranks (M-ranks) indicate the timeframe in which it is recommended that a change occur in management of the element or PCA. This rank refers to the need for management in contrast to protection (for example, increased fire frequency, decreased grazing, weed control, etc.). The urgency for management rating focuses on land use management or land stewardship action required to maintain element occurrences at the potential conservation area.

A management action may include biological management (prescribed burning, removal of non-natives, mowing, etc.) or people and site management (building barriers, rerouting trails, patrolling for collectors, hunters, or trespassers, etc.). Management action does not include legal, political, or administrative measures taken to protect a potential conservation area. Table 6 summarizes M-ranks and their definitions.

Table 6. Natural Heritage Program Management Urgency Ranks and their Definitions.

M1	Management actions may be required within one year or the element occurrences could be lost or irretrievably degraded.
M2	New management actions may be needed within 5 years to prevent the loss of the element occurrences within the PCA.
M3	New management actions may be needed within 5 years to maintain the current quality of the element occurrences in the PCA.
M4	Current management seems to favor the persistence of the elements in the PCA, but management actions may be needed in the future to maintain the current quality of the element occurrences.
M5	No management needs are known or anticipated in the PCA.

METHODS

Survey Site Selection

Information regarding the location of seeps and springs within the BLM, GJFOMA portion of Mesa County was gathered to assist in prioritizing which seeps and springs would be visited. Under the assumption that most disturbed or "developed" springs would likely have lower biodiversity, due to sparse vegetation cover (trampling and overgrazing), disruption of hydrology, and presence of non-native species (USDI, 2001; BLM 2000; Sada and Nachlinger 1996), CNHP decided to focus inventory efforts on those springs where ecological processes have not been altered. The locations of intact or relatively undisturbed seeps and springs and/or those seeps and springs with known biodiversity values were identified by:

- Utilizing ArcView coverage, provided by the Bureau of Land Management, of seeps and springs within the BLM GJFOMA.
- Refering to the BLM Water Atlas maps at the BLM Grand Junction Field Office.
- Consulting with BLM personnel.
- Cross-referencing spring locations on UGSS 1:24,000 topographic maps and the ArcView coverage with National Wetland Inventory Maps, which often indicate whether a wetland has been modified by anthropogenic activity, and the BLM 1996 Grand Junction Resource Area Map, which also indicates whether a spring has been developed.
- Using aerial photography.
- Using information regarding the known locations of species and significant plant communities within the study area's seeps and springs were downloaded from CNHP's Biological Conservation Database (BCD)

Additionally, many seeps and springs were encountered in the field that were not identified via maps or aerial photography. There are likely additional seeps and springs within the study area that will be discovered as future field studies are conducted.

Site Assessment

Access to some BLM lands was limited by private inholdings and/or right-of-way restrictions. Landowners were contacted, prior to attempting to access these areas, to obtain permission to cross their properties. The inability to contact certain landowners and time constraints did not allow CNHP to visit every seep and spring targeted. Thus, it is important to note that although the seeps and springs presented in this report represent CNHP's estimate of the highest quality seeps and springs in the project area, there are undoubtedly additional seeps and springs, which harbor significant biodiversity value, in the project area.

Seeps and springs visited were assigned a simple label in alphabetic order, SS-A, SS-B, SS-C, etc. This was done to eliminate name confusions among springs and to make it easy to discern which were visited by CNHP. The spring names provided with the BLM

ArcView coverage are included in parentheses where available. Springs that were added to the BLM ArcView coverage by CNHP are noted.

Site assessments included a general description, rating of Proper Functioning Condition (Bureau of Land Management 1998; Bureau of Land Management 1994; Bureau of Land Management 1993) species list, assessment of any natural heritage elements, discussion of ecological functions, collection of water chemistry data and macroinvertebrates, and restoration and management needs.

The following information was collected and is described in this report:

General Description

- Hydrological characteristics of the site
- Ecological processes maintaining site characteristics
- Landscape context
- GPS location (GPS units were set to NAD 27 using UTM coordinates).
- Elevation (from 7.5 min. USGS topographic maps)
- Current and historic land use (e.g., grazing, logging, recreational use) when apparent
- Notes on geology and geomorphology
- Indicators of disturbance such as grazing, flooding, spring "development," etc.
- Reference photos of the site

Proper Functioning Condition

Each seep/spring visited was assessed using the Bureau of Land Management's wetland/riparian functional assessment, "Process for Assessing Proper Functioning Condition" (Bureau of Land Management 1993). Thus, each site was given a rating of:

(1) **Proper Functioning Condition** – riparian/wetland area has all natural ecological functions intact.

(2) **Functional-At Risk** – riparian/wetland area that is in functional condition but some attribute of the site makes it susceptible to degradation.

(3) **Nonfunctional** – riparian/wetland areas is clearly not providing natural ecological functions.

(See Bureau of Land Management 1998; Bureau of Land Management 1994; and Bureau of Land Management 1993 for more details).

Plant and Animal Species List and Dominant Plant Associations

- List of all plant and animal species observed
- List of all dominant plant species and/or plant associations in the seep/spring area. Plant associations were classified according to CNHP's Statewide Wetland Classification and Characterization Project (Carsey et al., 2001), which is based on the U.S. National Vegetation Classification System (Anderson et al. 1998).
- Vegetation data for each major plant association in the wetland were collected using visual ocular estimates of species cover in a representative portion of the plant association.

Natural Heritage Information

- List of elements present at the site
- Element occurrence (EO) ranks
- Potential Conservation Area (if a particular seep or spring is within a potential conservation area identified by CNHP)

Discussion of Ecological Functions

Wetlands perform many functions beyond simply providing habitat for plants and animals. It is commonly known that wetlands act as natural filters, helping to protect water quality, but it is less well known that wetlands perform other important functions. (Adamus et al. 1991) list the following functions performed by wetlands:

- Groundwater recharge--the replenishing of below ground aquifers.
- Groundwater discharge--the movement of ground water to the surface (e.g., springs).
- Floodflow alteration--the temporary storage of potential flood waters.
- Sediment stabilization--the protection of stream banks and lake shores from erosion.
- Sediment/toxicant retention--the removal of suspended soil particles from the water, along with toxic substances that may be adsorbed to these particles.
- Nutrient removal/transformation--the removal of excess nutrients from the water, in particular nitrogen and phosphorous. Phosphorous is often removed via sedimentation; transformation includes converting inorganic forms of nutrients to organic forms and/or the conversion of one inorganic form to another inorganic form (e.g., NO_3^- converted to N_2O or N_2 via denitrification).
- Production export--supply organic material (dead leaves, soluble organic carbon, etc.) to the base of the food chain.
- Aquatic diversity/abundance--wetlands support fisheries and aquatic invertebrates.
- Wildlife diversity/abundance--wetlands provide habitat for wildlife.

Water Chemistry and Macroinvertebrates

Using a Myron L EP11 pH/Conductivity Meter the following were measured:

- pH
- Conductivity

Also, the following was determined:

- Temperature (measured using standard thermometer)
- Estimate of flow volume using a drop weir or ocular estimate
- Species of targeted macroinvertebrates (mussels and snails) observed and/or collected (these were sent to Dr. Jay Cordiero, at NatureServe for identification).

Restoration Potential and Management Needs

- Cause of disturbances, if any (e.g., alteration of hydrology, peat/soil removal, fill material, improper grazing, presence of non-native species, etc.)
- Feasibility of rectifying the disturbance (re-establishing natural hydrological regime, remove fill material, plant native species, altering grazing regime, etc.)

RESULTS

There are currently 143[1] seeps and springs identified on BLM lands in Mesa County (Figure 6). Locations for these seeps and springs are included in a GIS layer prepared by BLM and amended by CNHP. Of the 143 seeps and springs, 69% were indicated to be potentially undeveloped and 31% were identified as developed (modified from their natural state) (Table 7). The undeveloped seeps and springs were targeted for surveys. Twenty-eight spring and seep survey summaries are included in this section. The seeps and springs summarized were considered to either harbor biodiversity values despite anthropogenic disturbances or had most ecological processes intact. Due to time constraints and difficulty of accesss, not all BLM seeps and springs in the county could be surveyed. Future surveys will likely reveal additional seeps and springs with high biodiversity value.

Table 7. Development and survey status of 143 seeps and springs.

	Not Developed	**Developed**
	99	44
Visited	72	4
Summarized	56 (as 26 writeups)*	3 (as 2 writeups)*
Failed to Find	10	0
Poor Quality	4	1

* Seeps and springs located in close proximity summarized as a group.

At the 28 seeps and springs documented in this report, CNHP has record of 25 elements of biodiversity significance as occurring in seeps and springs (Table 8). Some of the more significant elements documented include the critically imperiled (G3T1/S1) Nokomis fritillary (*Speyeria nokomis nokomis*) at Unaweep Seep, hanging garden communities of Mancos columbine and Eastwood monkeyflower (*Aquilegia micrantha-* (*Mimulus eastwoodiae*)) (G2G3/S2S3) at Sewemup Mesa seeps, globally vulnerable (G2G3/S2S3) beaked spikerush emergent wetland (*Eleocharis rostellata*) communities at Unaweep Seep and Salt Creek, and critically imperiled (G1G2/S1S2) wild privet (*Forestiera pubescens*) shrubland communities at Salt Creek. The globally imperiled (G2/S1) Kachina daisy (*Erigeron kachinensis*) (G2/S1) included in Table 8 was not documented within Mesa County but on Sewemup Mesa seeps just south of the Mesa/Montrose county line at seeps very similar to those found within Mesa County. Thus, seeps and springs on BLM land in this area should be closely monitored for this species.

No rare or endemic aquatic macroinvertebrates were found during this project. However, it is likely that their populations are different than those found in other riparian/wetland habitats (streams, lakes, ponds, etc.) and represent an important aspect of biodiversity in Mesa County.

[1] An additional 21 seeps and springs were identified on a GIS layer received from BLM in February 2002. These 21 seeps and springs (development status unknown) were not targeted for surveys.

It is important to note that not all seeps and springs were surveyed due to time constraints and access difficulties. There are likely many additional springs not noted on Figure 6. Additionally, the BLM base map was not ground truthed by CNHP to indicate whether springs noted are accurately located or occur. This effort was in no way comprehensive and it is *very important to realize that there are likely many intact seeps and springs in the project area not highlighted in this report.*

Figure 6. BLM Seeps and Springs visited.

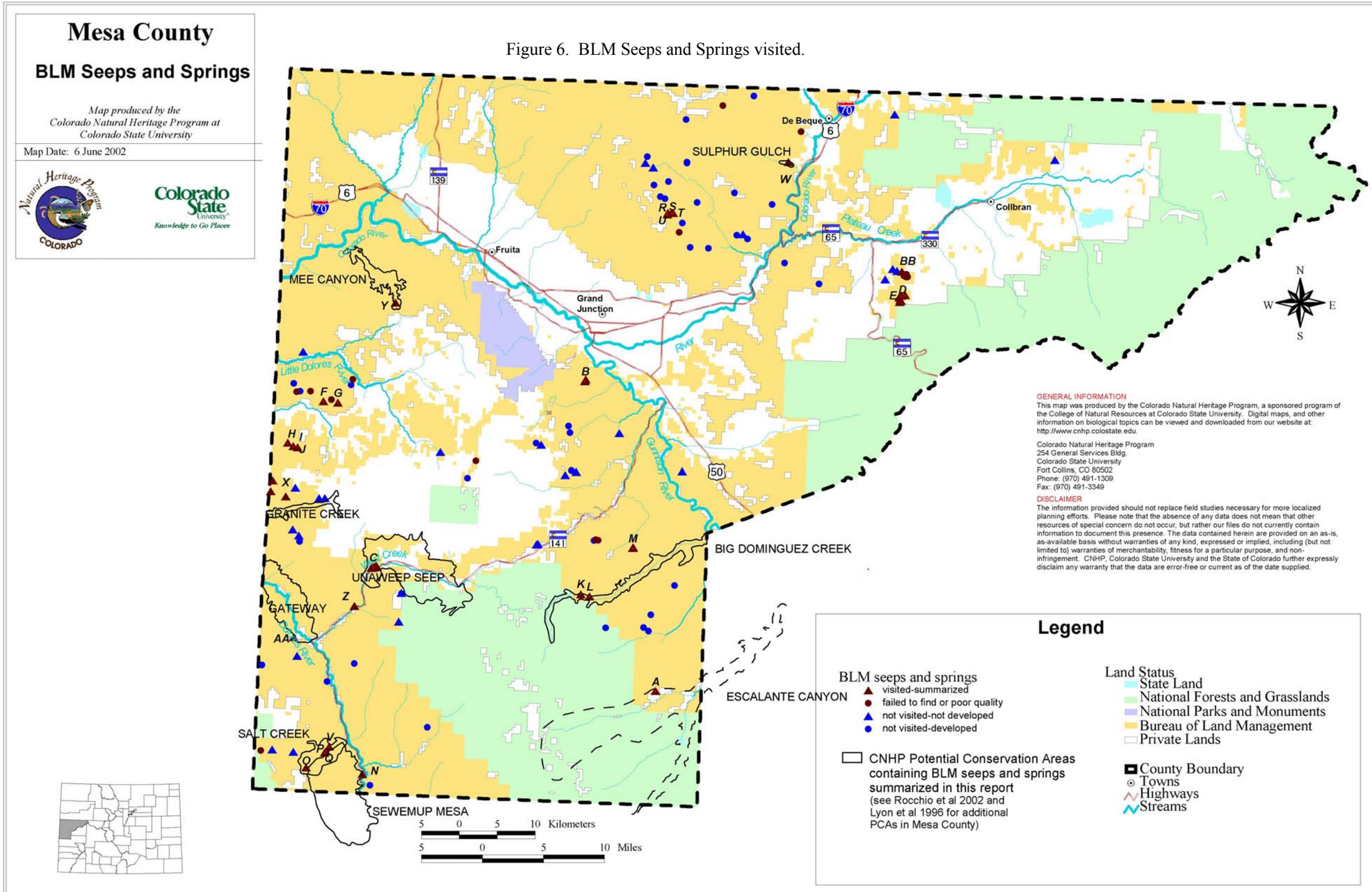


Table 8. Natural Heritage elements at BLM seeps and springs within Mesa County.

Element	Common Name	Global Rank	State Rank	Seep/Spring Location
Plant Communities				
Acer negundo-Hippochaete hyemalis	Boxelder riparian forest	GU	SU	SS-Y
Acer negundo-Populus angustifolia/Celtis reticulata	Narrowleaf cottonwood riparian forest	G1Q	S1Q	SS-C
Alnus incana-Cornus sericea	Alder-red-osier dogwood riparian shrubland	G3Q	S3	SS-K SS-L
*Alnus incana/*mesic forb	Thinleaf alder riparian shrubland	G3G4Q	S3	SS-C
Aquilegia micrantha-(*Mimulus eastwoodiae*)	Hanging gardens	G2G3	S2S3	SS-O, SS-Y
*Betula occidentalis/*mesic forb	Foothills riparian shrubland	G4?	S2	SS-K, SS-L
Cornus sericea	Foothills riparian shrubland	G4	S3	SS-F
Eleocharis rostellata	Emergent wetland	G2G3	S2S3	SS-C, SS-V
Forestiera pubescens	Wild privet shrubland	G1G2	S1	SS-P, SS-Q
Phragmites australis	Common reed wetland	G5	S3	SS-P, SS-Q
Picea pungens/Cornus sericea	Blue spruce/red-osier dogwood	G4	S2	SS-K, SS-L
Populus angustifolia/ Cornus sericea	Cottonwood riparian forest	G4	S3	SS-K, SS-L
Populus angustifolia-Pseudotsuga menziesii	Montane riparian forest	G3	S2	SS-A
Populus angustifolia/ Salix exigua	Narrowleaf cottonwood riparian forest	G4	S4	SS-H,SS- I, SS-J
Salix exigua/Hippochaete hyemalis	Coyote willow riparian shrubland	GU	S2S4	SS-Y
Salix exigua/mesic graminoid	Coyote willow riparian shrubland	G5	S5	SS-C
Schoenoplectus acutus	Bulrush marsh	G5	S4?	SS-C
Schoenoplectus pungens	Bulrush marsh	G3G4	S3	SS-W
Plants				
Adiantum capillus-veneris	Southern maiden-hair fern	G5	S2	SS-N
Epipactis gigantea	Giant helleborine orchid	G3	S2	SS-A,SS-C, SS-N, SS-Y
Erigeron kachinensis	Kachina daisy	G2	S1	SS-N
Mimulus eastwoodiae	Eastwood monkeyflower	G3	S2	SS-N
Platanthera sparsifolis var. *ensifolia*	Canyon bog orchid	G4G5T4?	S3	SS-C, SS-I, SS-J, SS-K, SS-L
Animals				
Hyla arenicolor	Canyon treefrog	G5	S2	SS-Y
Speyeria nokomis nokomis	Nokomis fritillary butterfly	G3T1	S1	SS-C

Additionally, 11 of the seeps and springs documented in this report occurred within a CNHP Potential Conservation Area (Table 9). Additional documentation for these CNHP Potential Conservation Areas is included in Rocchio et al. (2002) and Lyon et al. (1996). These seeps and springs represent those with the highest conservation potential and specifically warrant BLM attention.

Table 9. Seeps and springs occurring within CNHP Potential Conservation Areas.

Biodiversity Rank	Potential Conservation Area	Seep or Spring
B3	Big Dominguez Creek	SS-K, SS-L
B2	Escalante Canyon	SS-A
B2	Mee Canyon	SS-Y
B2	Salt Creek	SS-0, SS-P, SS-Q, SS-V
B2	Sewemup Mesa	SS-N
B3	Sulphur Gulch	SS-W
B2	Unaweep Seep	SS-C

Seeps and springs in Mesa County are important to regional landscape diversity, especially in western Mesa County, where most areas receive less than 20 inches of annual precipitation. Seeps and springs provide small but widely distributed source of water, food, cover, nesting habitat, and habitat for common, rare and/or unique species.

Many springs in western North America, below an elevation of 7000 feet, are isolated from other wetlands. Additionally, springsnails are generally found in springs below 6900 feet, although they do occur in mountain springs (USDI, 2001; BLM 2000). While Hershler (1998) documented 58 new species of springsnails (*Pyrgulopsis*) in spring habitats throughout Nevada and Utah, no rare or endemic macroinvertebrates were found during this project. This might be explained by the fact that many of the springs surveyed for this project were above 6500 feet, thus at the upper elevational limit for springsnails, and, although western Mesa County has a semi-arid climate and many of the springs occur below 7000 feet, most of the springs flow year round and provide base flow to numerous streams (Martinson 1980). Thus, connectivity to streams and other spring wetlands has potentially allowed macroinvertebrate species to disperse to other potential habitats in western Mesa County.

Martinson (1980) found that although many spring sources in the Piceance Basin, CO had similar water temperatures and water chemistry, they often exhibited a different suite of macroinvertebrate species than each other. Additionally, he also found that the density and biomass of macroinvertebrates in springs was greater than downstream habitats. Thus, while no rare or endemic snail or mussel species were located in any of the seeps and springs in the project area, it is likely that their populations are different than those found in other riparian/wetland habitats (streams, lakes, ponds, etc.) and represent an important aspect of biodiversity in Mesa County.

As was mentioned above, many seeps and springs in Mesa County have been altered and/or modified from their natural condition due to anthropogenic disturbances such as livestock grazing and diversions and impoundments to capture water for human or livestock use. These disturbances often result in an increase in non-native species, decrease in vegetation cover, inundation of creek habitat, replacement of species requiring flowing water with those more adapted to stagnate or slow moving water (lakes, ponds, etc.), and can cause the extirpation of endemic spring species. These disturbances could also potentially alter ecosystem functions. The 22 seeps and springs were rated as Proper Functioning Condition with four of them considered threatened by current management (downward trend) (Table 10).

Tamarisk and other non-native plants included on the Colorado Noxious Weed List are noted for the seeps and springs where they were documented (Table 10).

Table 10. Assessment of Proper Functioning Condition of seeps and springs visited.

Seep or Spring	Functional Rating	Trend	Colorado noxious weeds noted
SS-A	Proper Functioning Condition		
SS-B	Proper Functioning Condition		Tamarisk
SS-C	Proper Functioning Condition		
SS-D	Proper Functioning Condition		
SS-E	Proper Functioning Condition		
SS-F	Proper Functioning Condition		Tamarisk
SS-G	Proper Functioning Condition		Common burdock
SS-H	Functioning at Risk	No apparent trend	
SS-I	Proper Functioning Condition		
SS-J	Proper Functioning Condition		
SS-K	Proper Functioning Condition		
SS-L	Proper Functioning Condition		
SS-M	Proper Functioning Condition		Tamarisk
SS-N	Proper Functioning Condition		Tamarisk
SS-O	Proper Functioning Condition		Tamarisk
SS-P	Proper Functioning Condition		Tamarisk
SS-Q	Proper Functioning Condition		Russian knapweed, Tamarisk
SS-R	Proper Functioning Condition		Tamarisk
SS-S	Proper Functioning Condition		
SS-T	Proper Functioning Condition		
SS-U	Proper Functioning Condition		
SS-V	Proper Functioning Condition		Tamarisk
SS-W	Proper Functioning Condition		
SS-X	Proper Functioning Condition		
SS-Y	Proper Functioning Condition		
SS-Z	Functioning At Risk	Downward trend	
SS-AA	Proper Functioning Condition		Russian knapweed, Tamarisk
SS-BB	Proper Functioning Condition		

Site Profile Explanation

Each seep/spring site is described in a standard site profile report that reflects information collected during field visits. The contents of the profile report are outlined and explained below:

Seep/Spring Name

Location (including GPS point):

Legal Description:

Elevation:

Dominant Plant Species and/or Associations:

General Description (current/past land use, geology, disturbance, etc.):

Plant and Animal Species Observed:

Natural Heritage Program Element Occurrences:

Discussion of Ecological Functions:

Proper Functioning Condition Rating:

Non-native and Aggressive Species:

Restoration and Management Comments:

Water Chemistry:

Macroinvertebrates:

Photos:

SS-A (N. Fork Escalante Creek)

(within Montrose BLM District)

Location: Tributary to North Fork of Escalante Creek. About 3 miles west of Escalante Forks. GPS Point: Zone 12, 0722114E, 4279352N.

Legal Description: USGS 7.5-minute quadrangle: Escalante Forks. T51N R14W Section 32 SE4 SE4.

Elevation: 6960 feet.

Dominant Plant Species and/or Associations: Rocky Mountain maple (*Acer glabrum*) occurs near the spring source. Dominant plants within the understory include watercress (*Nasturtium officinale*) within the channel and Mancos columbine (*Aquilegia micrantha*) along the brook edges.

General Description: Springs emerge mid slope on a steep south facing slope above an unnamed tributary to the North Fork of Escalante Creek. The springs and channel are densely vegetated with Rocky Mountain maple at the source, watercress within the channel, and Mancos columbine and willowherb (*Epilobium ciliatum*) along the banks. Portions of the streambed support a dense cover of moss. The springs combine with the flow from another spring to support a globally imperiled (G3/S2) riparian community of narrowleaf cottonwood with Douglas-fir (*Populus angustifolia-Pseudotsuga menziesii*) along the unnamed tributary. The upland vegetation is dominated by pinyon pine-juniper on the the south-facing slopes and Douglas-fir on the north-facing slopes. Gambel's oak (*Quercus gambelii*) and serviceberry (*Amelanchier utahensis*) dominate nearby xeric slopes. To the north of the springs and along the canyon are cliffs of massive red sandstone. Many stands of giant helleborine orchid (*Epipactis gigantea*), a globally vulnerable (G3/S2) plant, have been documented within nearby tributaries but were not noted at this location.

Plant and Animal Species Observed: Trees in the immediate vicinity include Douglas-fir and quaking aspen (*Populus tremuloides*). Rocky mountain maple, coyote willow (*Salix exigua*), wild rose (*Rosa woodsii*), and skunkbush sumac (*Rhus trilobata*) are the primary shrubs occurring in the vicinity. Forbs and vines include watercress, Mancos columbine, wild hops (*Humulus lupulus*), wild mint (*Mentha arvense*). An unidentified species of bog orchid (*Limnorchis* sp.) (possibly *L. ensifolia*) occurs along the banks. Additionally, a stand of bracken fern occurs near the spring source.

Numerous insects were observed in the area and a stonefly nymph and caddifly larvae were collected from the spring source.

Natural Heritage Program Element Occurrences:

Table 11. Natural Heritage elements at or near SS-A.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Populus angustifolia-Pseudotsuga menziesii	Montane riparian forest	G3	S2	B
Plants				
Epipactis gigantea	Giant helleborine orchid	G3	S2	B

This spring is contained within CNHP's **Escalante Canyon Potential Conservation Area**, which is ranked as a **B2** site (Very High Significance) (see Rocchio et al. 2002; Lyon et al. 1996). The PCA extends into Montrose and Delta counties and supports several good examples of riparian plant communities and rare plants including the narrowleaf cottonwood - Douglas-fir riparian community supported by the these springs. The narrowleaf cottonwood - Douglas-fir plant association is reported from Utah, Nevada and Colorado and normally occurs as small stands. It is threatened by improper livestock grazing and stream flow alterations. The nearby giant helleborine orchid occurrences are also in good condition.

Ecological Functions: Overall, this spring is in good condition. Groundwater discharge from this and nearby springs hydrologically supports a globally imperiled riparian plant community in the adjacent unnamed tributary to the North Fork of Escalante Creek. Dense emergent vegetation provides good bank stabalization at the spring. Nutrient cycles appear to be intact. The spring and brook do not support fish as the channel is too small and steep; however, aquatic invertebrates were present. Shrubs and trees around the spring provide cover for birds and mammals. The spring provides forage and a permanent water source for wildlife.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as all ecological processes appear to be intact.

Non-native and Aggressive Species: Non-native species were not observed at the spring with the possible exception of watercress (*Nasturtium officinale*) whose native status is not well understood. Weber and Wittmann (2001) support that watercress is an alien species and the USDA PLANTS database describe it as native to the U.S. (USDA NRCS, 2001). Regardless, control of the watercress is not recommended.

Restoration and Management Comments: The spring is located on a steep slope that probably limits cattle access. The spring is thus naturally relatively protected from disturbance. On a larger scale, maintenance of the natural hydrologic regime including flooding on the nearby tributary is necessary for long-term maintenance of the globally imperiled riparian plant community as the narrowleaf cottonwood requires flooding for regeneration. The possibility of future real estate development on nearby private lands would pose additional management concerns.

Water Chemistry: The flow rate at the spring was measured as approximately 4 gpm using the drop wier. Another spring located about ten feet away was visually estimated to be flowing at 4 gpm. An additional spring located within the unnamed tributary channel was visually estimated to be flowing at about 10 gpm.
Water chemistry at the spring source was as follows:

pH	7.7
Conductivity	260 µS/cm
Temperature	12 C

Macroinvertebrates: No snails or mussels were observed, however, immature stonefly and caddisfly were collected at the spring.

Photos: Roll1 #32-36.

SS-B (John's Spring)

Location: Billings Canyon. About 2 miles west of Little Park Road about 3 air miles south of Grand Junction. GPS Point: Zone 12, 0709998E, 4320003N.

Legal Description: USGS 7.5-minute quadrangle: Grand Junction. T12S R100W Section 16 SE4 SW4.

Elevation: 5240 feet.

Dominant Plant Species and/or Associations: This intermittent creek is dominated by upland vegetation including pinyon pine and juniper. Isolated patches within the dry channel support saltgrass (*Distichlis spicata*). Scattered Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and river birch (*Betula occidentalis*) also occur along the drainage.

General Description: This creek bed was dry when visited in July and is dominated by pinyon pine and juniper that covers the adjacent rocky, steep slopes. Small patches of saltgrass and alkaline crusts in the channel indicate groundwater discharge occurs here at least seasonally. In isolated areas, alkali bulrush (*Schoenoplectus maritimus*) and threesquare bulrush (*S. pungens*) occur with the saltgrass. Small, shallow muddy puddles also occurred sporadically within the channel. Large boulders within the sandy channel indicate large flood events occur here. A flowing developed spring (Gobbo Cabin Spring) with a pipe and stock tank occurs nearby in the adjoining canyon.

Plant and Animal Species Observed: Plants within the channel include saltgrass, alkali bulrush, threesquare bulrush, foxtail barley (*Hordeum jubatum*), and a few Rio Grande cottonwood and river birch. Weedy species include curlycup gumweed (*Grindelia squarrosa*), common cocklebur (*Xanthium strumarium*), and a few scattered tamarisk (*Tamarix ramosissima*).

No aquatic invertebrates were observed within the shallow muddy pools.

Natural Heritage Program Element Occurrences:

No elements tracked by the CNHP were documented at this site and this spring was not located within a CNHP Potential Conservation Area. The saltgrass growing within the channel was not considered extensive enough to be considered for tracking as a plant community occurrence. Saltgrass (*Distichlis spicata*) (G5/S3) is a common plant association where alkaline or saline soils have been formed from the accumulation of bases and soluble salts in poorly drained areas.

Ecological Functions: The creek is probably dry with small muddy pools throughout most of the year. The pools possibly provide wildlife with a seasonal water source. Large boulders within the channel provide flood energy dissipation. Nutrient cycling is probably occurring at the low levels expected for an ephemeral sparsely vegetated creek.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as all ecological processes appear to be intact.

Non-native and Aggressive Species: There is some tamarisk (*Tamarix ramosissima*) present in the area.

Restoration and Management Comments: The seep and creek channel are in relatively good condition. The steep canyon with large boulders probably preclude cattle from going very far upstream. Removal of the few tamarisk would help ensure that this aggressive species not become more dense in the area.

Water Chemistry: There was no flow emerging from the seep. Water chemistry was not measured.

Macroinvertebrates: No aquatic invertebrates were observed in the shallow muddy pools.

Photos: Roll GD-1 #28.

SS-C (Nokomis Butterfly #1-24)

Location: Unaweep Seep. Along the north side of Highway 141 about 13 miles west of Unaweep Divide. The seeps are easily visible from Highway 141 on the slope above the north bank of West Creek. GPS Point: Zone 12, 0683367E, 4293413N.

Legal Description: USGS 7.5-minute quadrangle: Two V Basin. T15S R103W Section 3 SE4.

Elevation: 5960 feet.

Dominant Plant Species and/or Associations: Beaked spikerush (*Eleocharis rostellata*) is the dominant plant association on much of the slope with patches of common spikerush (*Eleocharis palustris*) and bulrush (*Schoenoplectus acutus*). Islands of woody vegetation throughout the wetland include coyote willow (*Salix exigua*), narrowleaf cottonwood (*Populus angustifolia*), river birch (*Betula occidentalis*), box elder (*Acer negundo*), and Rocky Mountain maple (*Acer glabrum*).

General Description: Unaweep Seep is the largest and most biologically diverse seep wetland complex observed during this survey. A 1983-84 study of the Bureau of Land Management Grand Junction Resource Area found that Unaweep Seep had the richest plant, bird, and small mammal life in the Resource Area (BLM 1999). The Audubon Society has declared this area an Important Bird Area in Colorado (National Audubon Society 2000) and Unaweep Seep has been designated a State Natural Area (Colorado Department of Natural Resources 1994).

Unaweep Seep is an unusual hillside spring ecosystem of wet sedge marshes and seeps. Dense stands of coyote willow (*Salix exigua*) occupy the seep's uppermost source area. Most of the seep is dominated by beaked spikerush (*Eleocharis rostellata*) with sporadic stands of river birch (*Betula occidentalis*) occurring on the lateral fringe of the seep. A large population of the globally vulnerable (G3/S2) giant helleborine orchid (*Epipactis gigantea*) occurs on the lower part of the slope amid spikerushes and underneath the canopy of the river birches. Near the toeslope, wet meadows and marshes support dense stands of bulrush (*Schoenoplectus acutus*), common reed (*Phragmites australis*), and common spikerush (*Eleocharis palustris*). Other species found in the wetland complex include red-osier dogwood (*Cornus sericea*), river hawthorn (*Crataegus rivularis*), poison ivy (*Toxicodendron rydbergii*), horsemint (*Monarda fistulosa*), Joe Pye weed (*Eupatorium maculatum*), cattail (*Typha latifolia*), fowl mannagrass (*Glyceria striata*), beggarstick (*Bidens frondosa*), Nebraska sedge (*Carex nebrascensis*), woolly sedge (*C. pellita*), beaked sedge (*C. utriculata*), wild mint (*Mentha arvense*), self-heal (*Prunella vulgaris*), canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*), scouring rushes (*Hippochaete* sp.), horsetail (*Equisetum arvense*), and watercress (*Nasturtium officinale*). Non-native species in the seep include reed canarygrass (*Phalaris arundinaceae*), Kentucky bluegrass (*Poa pratense*), redtop (*Agrostis gigantea*), timothy (*Phleum pratense*), white sweetclover (*Melilotus alba*), barnyard grass (*Echinochloa crus-galli*).

Most of these species do not appear to be affecting ecosystem function or displacing native vegetation.

The globally critically imperiled (G1Q/S1Q) boxelder-narrowleaf cottonwood riparian forest (*Acer negundo-Populus angustifolia/Celtis reticulata*) forest occurs in dense patches around several small channels fed by the seep. This community is known from only one stand in Colorado. The Q in the rank indicates the taxonomy is tentative and not well understood. At the base of the seep, West Creek supports a lush growth of narrowleaf cottonwood (*Populus angustifolia*), box elder (*Acer negundo*), coyote willow, and other riparian species. The entire slope is densely vegetated creating a stark contrast between the seep area and the adjacent pinyon pine-juniper covered slopes.

These seeps provide habitat for a critically imperiled (G3T1/S1) butterfly subspecies, the Nokomis fritillary (*Speyeria nokomis nokomis*). Unaweep Seep and nearby seeps support the largest known Colorado population of this butterfly. Although there is a larger population in Utah, there appears to be a genetic difference between the two populations. The Nokomis Fritillary has specific habitat needs, which are seeps and springs with permanent flowing water that support healthy populations of their host plant, the northern bog violet (*Viola nephrophylla*) (Ferris and Brown 1981). The female lays eggs near the host plant then upon hatching the caterpillar feeds on the leaves of the host plant in the spring while the adults nectar on thistles (Opler and Wright 1999). The local population of this species has one flight/year, which generally occurs between mid-July through September depending on climatic and elevational variation (Opler and Wright 1999). Nectar plants, such as Joe-pye weed and bull thistle (*Cirsium vulgare*), used by the adult butterflies, are also found here.

Rangewide, many populations of this butterfly have disappeared because of the capping of springs, lowering of water tables due to pumping and/or rerouting of water, and habitat modification, such as heavy (not light) grazing (Opler and Wright 1999; Ferris and Brown). Protecting potential Nokomis fritillary habitat from hydrological alteration and habitat modification will help ensure that viable habitat for the Nokomis Fritillary is maintained throughout its range.

Other species of interest documented at Unaweep Seep include: (1) 11 species on the BLM sensitive list including northern leopard frog (*Rana pipiens*), Bald Eagle (*Haliaeetus leucocephalus*), Cooper's Hawk (*Accipter cooperii*), Golden Eagle (*Aquila chrysaetos*), Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (whether the willow flycatcher at Unaweep Seep is the southwestern race is still being determined), white-throated woodrat (*Neotoma albigula brevicauda*), Nokomis fritillary (*Speyeria nokomis nokomis*), great purple hairstreak (*Atlides halesus*), California sister (*Adelpha bredowii*), canyon bog orchid, and the giant helleborine orchid; (2) over 67 species of butterflies (close of half those ever recorded in Mesa County, including notably disjuncts such as Canyonlands satyr (*Cyllopsis pertepida*) and California sister (*Adelpha bredowii*), species on the periphery of their range such as the Hackberry Emperor Butterfly (*Asterocampa celtis*) plus the Colorado State insect: Colorado Hairstreak (*Hypauotis crysalus*); (3) dense population (pounds per acre) of montane shrews and western

jumping mice; and (4) plant species more typical of the eastern tallgrass prairie such as Joe-pye weed (rare on west slope), switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), and panic mannagrass (*Dichanthelium acuminatum fasciculatum*) (BLM 1999).

The state rare (S3) California sister (*Adelpha bredowi*) butterfly occupies moist lowland areas and forested riparian canyons. Males congregate in puddles and moist sandy patches along streams. Adults perch at the ends of branches to sun themselves. Its host plant in Mesa County is Gambel's oak. The only Mesa County record of the species is from Unaweep Seep. The state rare (S2S3) Yuma skipper (*Ochlodes yuma*) has also been documented from this site. This skipper is found in freshwater marshes, stream courses, ponds, and seeps/springs. It is common in its limited habitat in California, Nevada, Utah, Colorado, northern New Mexico, and Arizona. Western Colorado represents the eastern periphery of this species range. It uses common reed (*Phragmites australis*) as its host plant.

The state rare (G5/S2S3) western yellowbelly racer (*Coluber constrictor mormon*) has been documented at Unaweep Seep. Rangewide, it is found in a wide variety of habitats: meadow, prairies; open chaparral, pinyon-juniper woodland; and riparian woodland. In western Colorado, it occurs below about 5500 ft., in agricultural areas, lowland riparian habitats, and occasionally in semi-desert shrublands.

Many areas in the seep have deep organic soil horizons (peat). Most of these soils are sapric material, and range in depth from a few inches to over 2 feet in some locations of the main hillside seep. This obviously indicates that the main seep has had persistent flow for hundreds, likely thousands of years. Given the aridity and relatively low elevation of this site, the amount of peat accumulation at Unaweep Seep is very unique.

The seeps and springs found at this site are not affected by flooding and fluctuation in surface water flow; however, the hydrology of the area is not completely understood. The geology of the area is complicated and is not agreed upon. Researchers have suggested that the seep may be located in a pre-Wisconsin glacier terminal moraine or that the seep is associated with alluvial material deposited in a V-shaped valley that was cut then filled by the Gunnison or the Gunnison-Colorado River (BLM 1999). A fault defining the eastern boundary of a graben exists near the seep. This fault complicates conclusions about local hydrology (BLM 1999).

Plant and Animal Species Observed: The plant diversity is extremely high at Unaweep Seep. Grasses and grasslike plants are the dominant species within the wetland and include beaked spikerush, common spikerush, bulrush, Nebraska sedge (*Carex nebrascensis*), woolly sedge (*C. pellita*), beaked sedge (*C. utriculata*), Baltic rush (*Juncus balticus*), cattail (*Typha* latifolia), scouring rush (*Hippochaete laevigata*), horsetail (*Equisetum arvense*), fowl mannagrass (*Glyceria striata*), and common reed (*Phragmites australis*).

Tree and shrub species observed included narrowleaf cottonwood, box elder, Rocky Mountain maple, river birch, hawthorn (*Crataegus rivularis*), coyote willow (*Salix exigua*), strapleaf willow (*S. ligulifolia*), red-osier dogwood (*Cornus sericea*), skunkbush sumac (*Rhus trilobata*), and wild rose (*Rosa woodsii*).

Forbs include giant helleborine orchid (*Epipactis gigantea*), canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*), Joe Pye weed (*Eupatorium maculatum*), water parsnip (*Sium suave*), self-heal (*Prunella vulgaris*), horsemint (*Mondarda fistulosa*), field mint (*Mentha arvensis*), willowherb (*Epilobium ciliatum*), St. Johnswort (*Hypericum formosum*), showy milkweed (*Asclepias speciosa*), virgin's bower (*Clematis ligusticifolia*), evening primrose (*Oenothera elata*), dogbane (*Apocynum cannabinum*), poison ivy (*Toxicodendron rydbergii*), beggarstick (*Bidens frondosa*), and watercress (*Nasturtium officinale*).

Non-native species within the wetland are noted below in the non-native section.

Dragonflies, butterflies, and numerous other insects were noted within the wetland.

Natural Heritage Program Element Occurrences:

Table 12. Natural Heritage elements at SS-C.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Acer negundo-Populus angustifolia/Celtis reticulata	Narrowleaf cottonwood riparian forest	G1Q	S1Q	A
Alnus incana/mesic forb	Thinleaf alder riparian shrubland	G3G4Q	S3	A
Eleocharis rostellata	Emergent wetland	G2G3	S2S3	A
Salix exigua/mesic graminoid	Coyote willow riparian shrubland	G5	S5	A
Schoenoplectus acutus	Bulrush marsh	G5	S4?	A
Plants				
Epipactis gigantea	Giant helleborine orchid	G3	S2	A
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T4?	S3	B
Butterflies				
Speyeria nokomis nokomis	Nokomis fritillary butterfly	G3T1	S1	A

This seep/spring complex is contained within CNHP's **Unaweep Seep Potential Conservation Area**, which is ranked as a **B2** site (Very High Biodiversity Significance) (see Rocchio et al. 2002; Lyon et al. 1996). These seeps and nearby seeps provide habitat for a critically imperiled butterfly subspecies, the Nokomis fritillary (*Speyeria nokomis nokomis*). The Unaweep seep population of the Nokomis fritillary is probably the largest and most secure population of this subspecies in Colorado, and probably second in size to the largest known colony located in Utah (Lyon et al. 1996). This butterfly uses northern bog violet (*Viola nephrophylla*) as its host plant. The seeps also support an excellent occurrence of giant helleborine orchid, perhaps the largest and best condition occurrence of this globally vulnerable (G3/S2) species in Colorado. This seep also supports a good example of a beaked spikerush community, a wet meadow community that is globally

imperiled (G2G3/S2S3). The seeps provide hydrologic support to many excellent and good examples of riparian communities along West Creek. These communities include alder with mesic forbs, narrowleaf cottonwood with red-osier dogwood, and narrowleaf cottonwood with boxelder and hackberry (*Celtis reticulata*).

Ecological Functions: This wetland is in excellent condition and has been recognized as critical habitat for the critically imperiled Nokomis fritillary butterfly. The hydrologic regime appears intact and the deep organic sapric soils indicate that these seeps have been discharging for hundreds, perhaps thousands of years. The seeps support rare plants and plant communities as well as interesting riparian communities within the West Creek riparian area. Insects are abundant thus the area is providing food chain support. Nesting or cover habitat for birds is abundant as the shrub and tree cover within the riparian area is dense. The saturated organic soils indicate that nutrient cycles are intact and that the area is likely providing some export of carbon and nutrients.

Other invertebrates observed include adult damsel and dragonflies and mayfly nymphs.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as all ecological processes appear to be intact.

Non-native and Aggressive Species: Numerous non-native species were common but not dominant. Non-native grasses noted include reed canarygrass (*Phalaris arundinacea*), timothy (*Phleum pratense*), Kentucky bluegrass (*Poa pratensis*), redtop (*Agrostis gigantea*), orchardgrass (*Dactylis glomerata*), barnyard grass (*Echinochloa crusgalli*), witchgrass (*Panicum capillare*), and common velvetgrass (*Holcus lanatus*). Non-native forbs noted include white sweetclover (*Melilotus alba*), and black medic (*Medicago lupulina*). A population of Himalayan blackberry (*Rubus discolor*) has recently been detected at the site (see Restoration Potential comments).

Restoration and Management Comments: The public land portion of the seep is in good condition and protected as a Research Natural Area (BLM 1999). A population of Himalayan blackberry (*Rubus discolor*) was recently found at this site. In the Northwest USA, this species is an aggressive non-native plant where it commonly displaces native species, especially along wetland margins. The population at this site should be intensively monitored and eradicated to ensure it does not displace native species. The population at Unaweep Seep is one of few, if not the only record of this species in Colorado. Eradicating areas infested with mature plants of Himalayan blackberry may be most effective via mechanical removal or burning (Nature Conservancy 1989). Subsequent treatment with herbicides should be conducted cautiously because: (1) Himalayan blackberry often grows in riparian areas and the herbicide may be distributed downstream by running water, and (2) some herbicides promote vegetative growth from lateral roots (Nature Conservancy 1989). Planting native shrubs or trees which are fast-growing may prevent Himalayan blackberry re-establishment, since this species is usually intolerant of shade (Nature Conservancy 1989). Other management issues including grazing, weed control, and minimizing impacts by human visitors are disussed in the Unaweep Seep Natural Area Management Plan (BLM 1999).

Water Chemistry: The flow was not measured at Unaweep seep due to the abundance of seeps and their diffuse nature. Water chemistry one of the spring sources was as follows:

pH	8.0
Conductivity	380 µS/cm
Temperature	not measured

Macroinvertebrates: No snails or mussels were observed. An interesting dragonfly adult was present as were butterflies. Mayfly nymphs were noted in the seeps but not collected.

Photos: Roll GD-1 #17-26.

SS-D (N.W.A.T Spring)

Location: About 3 miles south of Mesa and 3 miles east of Highway 65. Uphill from Mule Spring. GPS Point: Zone 12, 0751993E, 4337271N.

Legal Description: USGS 7.5-minute quadrangle: Mesa Lakes. T11S R96W Section 2 NW4 SE4.

Elevation: 7760 feet.

Dominant Plant Species and/or Associations: Dominant plant species at the spring include river birch (*Betula occidentalis*) and mountain willow (*Salix monticola*) with fowl mannagrass (*Glyceria striata*) and redtop (*Agrostis gigantea*) in the understory.

General Description: A series of springs emerges beneath a dense cover of woody shrubs including Gambel's oak (*Quercus gambelii*), serviceberry (*Amelanchier utahensis*), and snowberry (*Symphoricarpos* sp.). The spring itself supports river birch, mountain willow, aspen (*Populus tremuloides*), red-osier dogwood (*Cornus sericea*) and mixed grasses and forbs. This spring and other nearby associated springs occur on a north-facing shallow slope. The dense oak shrublands continue to the springs making access difficult but also likely protecting the spring sources from disturbance. One of the springs was visited and four other nearby springs noted on the BLM water atlas were not located among the dense oak shrublands. There was no flow noted from these other springs across the nearby dirt road, however, a muddy patch with alien thistle (*Cirsium* sp.) and chamomile (*Anthemis* sp.) occurred at the dirt road. The upland oak/serviceberry shrublands are interspersed with sagebrush (*Artemisia tridentata*) shrublands.

Plant and Animal Species Observed: Plant species observed include river birch, aspen, red-osier dogwood, wild rose (*Rosa woodsii*), northern bedstraw (*Galium septrionale*), field mint (*Mentha arvensis*), black eyed Susan (*Rudbeckia occidentalis* var. *montana*), horsemint (*Monarda fistulosa*), buttercup (*Rananculus maccouni*), false-Solomon's seal (*Maianthemum stellatum*), broadleaf plantain (*Plantago major*), redtop (*Agrostis gigantea*), and fowl mannagrass (*Glyceria striata*).

Natural Heritage Program Element Occurrences:

No elements tracked by the CNHP were documented at this site and this spring was not located within a CNHP Potential Conservation Area.

Ecological Functions: These springs discharge small volumes of groundwater that appears to reinfiltrate quickly. They are likely part of the same hydrologic system supporting Mule Spring (SS-E) located at the foot of a steep shrub-covered slope. The springs may provide wildlife with access to water. Nutrient cycling appears intact except at the dirt road where the dense shrubs have been cleared. Sediment stabilization is probably not intact at the dirt road. No insects were noted.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as all ecological processes appear to be intact.

Non-native and Aggressive Species: Thistle (bull or musk) and chamomile (*Anthemis* sp.) are abundant along the dirt road in the vicinity of the springs. Redtop and plantago were present at the spring itself, but not overly abundant.

Restoration and Management Comments: The dense shrubs probably prevent cattle from accessing the springs directly. Evidence of cattle use is evident along the roads. Weed control along the dirt road might help prevent spread of these aggressive species to the spring sources.

Water Chemistry: Flow could not be measured with the drop weir as bedrock and rocky soil limited the depth at which the weir could be used. However, flow was visually estimated to be approximately 1/2 GPM.

Water chemistry was measured as follows:

pH	8.6
Conductivity	460 µS/cm
Temperature	15 C

Macroinvertebrates: No macroinvertebrates were observed.

Photos: Roll GD-1 #12-16 and Roll GD-2 #22.

SS-E (Mule Spring)

Location: Mule Spring. At the base of a steep slope. About 3 miles south of Mesa and 2 1/2 miles east of Highway 65. GPS Point: Zone 12, 0751438E, 4334151N.

Legal Description: USGS 7.5-minute quadrangle: Mesa Lakes. T11S R96W Section 2 NE4 SW4.

Elevation: 7600 feet.

Dominant Plant Species and/or Associations: Dominant plant species include cattail (*Typha latifolia*) and bulrush (*Schoenoplectus acutus*).

General Description: This spring is located at the base of a steep, shrub-covered north-facing slope. The spring is fenced and has a vertical culvert pipe surrounding the source. The spring flows to a small (about ¼ acre) wet meadow of cattail (*Typha latifolia*) and bulrush (*Schoenoplectus acutus*). Cattle use is heavy around the marsh as evidenced by the presence of a feed trough and trampling of the ground. Plants growing at the spring source include Rocky Mountain maple (*Acer glabrum*), mountain willow (*Salix monticola*), horsetail (*Equisetum arvense*), redtop (*Agrostis gigantea*), Gambel's oak (*Quercus gambelii*), and serviceberry (*Amelanchier utahensis*). The marsh supports cattail, bulrush, redtop, common spikerush (*Eleocharis palustris*), marestail (*Hippurus vulgaris*), and monkeyflower (*Mimulus* sp.). The uplands are pinyon pine-juniper interspersed with oak thickets and sagebrush shrublands.

Plant and Animal Species Observed: Near the main spring source Rocky Mountain maple, mountain willow, horsetail, redtop, Gambel's oak, and serviceberry are dominant. The marsh supports cattail, bulrush, redtop, common spikerush, marestail, monkeyflower, beaked sedge (*Carex utriculata*), willowherb (*Epilobium ciliatum*), buttercup (*Ranunculus* sp.), rush (*Juncus saximontanus*), and red-osier dogwood (*Cornus sericea*).

Natural Heritage Program Element Occurrences: No elements tracked by the CNHP were documented at this site and this spring is not located within a CNHP Potential Conservation Area.

Ecological Functions: This spring and associated wetland appear to be in relatively good condition but have been altered by cattle use. The spring source is contained within a culvert altering natural functions and discharge. Groundwater discharge is occurring on site and is hydrologically supporting a small creek flowing north. The area provides wildlife habitat, especially as a water source. Hoof action from livestock is leading to minimum vegetation cover in some areas. This could potentially lead to erosion.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition. Ecological processes are apparently intact; however, livestock use in the area could alter/compact soils and detrimentally affect ecosystem processes.

Non-native and Aggressive Species: Canada thistle (*Breea arvensis*) grows at the spring source. Nearby populations of another non-native thistle (*Cirsium* sp.) and chamomile have the potential to spread to Mule Spring.

Restoration and Management Comments: This spring has likely been used for cattle watering for an extended period. There is evidence of heavy cattle use. Removal of the imbedded culvert could reestablish natural groundwater discharge patterns in the area. Control of non-native plants including Canada thistle at the spring source and other non-native thistles and chamomile on the road directly above the spring might help keep these invasive species from invading further. Livestock use is heavy in this area, increased use will likely lead to increased disruption of soils leading to increased changes in hydrology, further decrease in vegetative cover, altered nutrient cycles, and increased erosion.

Water Chemistry: Flow could not be measured with the drop weir as bedrock and rocky soil limited the depth at which the weir could be used. However, flow was visually estimated to be approximately 3 GPM.

Water chemistry was measured as follows:

pH	7.6
Conductivity	600 µS/cm
Temperature	10 C

Macroinvertebrates: No snails or mussels were observed. Adult common green darner dragonflies (*Anax junius*) were observed.

Photos: Roll GD-1 #15 and Roll GD-2 #20 and 21.

SS-F (King's Canyon)

(New to BLM ArcView)

Location: Kings Canyon Creek immediately north of the Tom's Canyon Spring dirt road about one mile west of Tom's Canyon Spring. GPS Point: Zone 12, 0675283E, 4314966N.

Legal Description: USGS 7.5-minute quadrangle: Bieser Creek. T12S R104W Section 35 NE4 SE4.

Elevation: 6600 feet.

Dominant Plant Species and/or Associations: The spring supports very dense cover of red-osier dogwood (*Cornus sericea*).

General Description: This spring emerges from the dripping face and base of an overhanging Wingate sandstone cliff. The spring supports a very dense patch of red-osier dogwood in this narrow shaded portion of the canyon. Other plants growing within the dogwood include chokecherry (*Padus virginiana*), wild rose (*Rosa woodsii*), virgin's bower (*Clematis ligusticifolia*), false-Solomon's seal (*Maianthemum stellatum*), and one large whiplash willow (*Salix lasiandra*). The upland vegetation includes Gambel's oak (*Quercus gambelii*) on the steep canyon walls and pinyon-juniper on the upper benches. The low flow (about ¼ gpm) of the spring supported a small pond at the base of the cliff and very short flowing creek before infiltrating below the surface. Downstream, the Kings Creek riparian area has been invaded by a variety of non-native plants including cheatgrass (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), sweetclover (*Melilotus officinalis*), and tamarisk (*Tamarix ramosissima*); no non-native plants were observed at the spring.

Plant and Animal Species Observed: The overwhelmingly dominant plant (>90% cover) at the spring is red-osier dogwood. Other plants present at low percent cover include chokecherry, wild rose, virgin's bower, false-Solomon's seal, and whiplash willow. Fresh bear and deer scat were present at the pond. Aquatic invertebrates observed include mosquito larvae, aquatic beetles, and horsehair worms (phylum Nematomorpha). A small raptor (Cooper's or sharp-shinned hawk) flushed from the pond upon approach.

Natural Heritage Program Element Occurrences:

Table 13. Natural Heritage elements at or near SS-F.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Cornus sericea	Foothills riparian shrubland	G4	S3	C

Red-osier dogwood shrublands (*Cornus sericea*) are known from many western states including Colorado, Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. This

occurrence is rated a "C" due to its small size but is in otherwise excellent condition. This occurrence is currently not contained within a CNHP Potential Conservation Area.

Ecological Functions: Overall, this spring is in relatively good condition. Groundwater discharge is occurring and supporting a small pond in an area extremely devoid of standing water. Evidence of wildlife use was unusually high at this spring as indicated by deer and bear scat and abundant birds. It is hydrologically contributing to the flow of Kings Creek. The pond likely represents a permanent water source as water was present after extended drought conditions. Stream bank stabilization is appears intact as red-osier dogwood is a very effective stream bank stabilizer due to its strong, rhizomatous root structure. Nutrient cycles appear to be intact.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as all ecological systems are intact.

Non-native and Aggressive Species: No non-native species were observed at the spring. Non-natives present downstream (closer to Little Dolores River) include cheatgrass (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), sweetclover (*Melilotus officinalis*), and tamarisk (*Tamarix ramosissima*).

Restoration and Management Comments: The spring is in good condition. The steep banks and dense shrub cover may preclude cattle from accessing the spring pond. No non-native plants were noted at the spring. Control of non-native species downstream on Kings Creek would help ensure that these species do not migrate upstream to the spring.

Water Chemistry: Flow was determined to be 1/4 gpm using the drop weir.
Water chemistry was measured as follows:

pH	8.2
Conductivity	540 µS/cm
Temperature	15 C

Macroinvertebrates: No snails or mussels were observed. Macroinvertebrates present included abundant mosquito larvae, few aquatic beetles, and few horsehair or gordian worms (phylum Nematomorpha).

Photos: Roll GD-2 #24-28.

SS-G (Tom's Canyon #3 Spring)

Location: Along Tom's Canyon Spring dirt road about 1 mile east of Tom's Canyon Spring. GPS Point: Zone 12, 0677211E, 4314994N.

Legal Description: USGS 7.5-minute quadrangle: Bieser Creek. T12S R103W Section 31 NW4 SW4.

Elevation: 6720 feet.

Dominant Plant Species and/or Associations: Skunkbush sumac (*Rhus trilobata*) is the dominant plant at the spring and along the riparian area.

General Description: An ephemeral channel with springs forming a series of small pools within the channel. Above the springs, the channel is vegetated with pinyon-juniper. At the spring, the vegetation includes skunkbush sumac, serviceberry (*Amelanchier utahensis*), redtop (*Agrostis gigantea*), American speedwell (*Veronica americana*), and willowherb (*Epilobium ciliatum*). The non-native invasive plant common burdock (*Arctium minus*) is extremely abundant on the stream banks along with a weedy mustard (*Lepidium* sp.) and broadleaf plantain (*Plantago major*). The spring and associated creek are very weedy but this is a good water source in a very dry region. The spring has been developed with pipes conveying water to a stock tank. Flow in the channel is estimated at about one gpm. Mosquito larvae are abundant in the channel and pools along with a few water striders (Gerridae), predaceous diving beetle larvae (Dytiscidae), and horsehair worms (phylum Nematomorpha). The uplands are pinyon-juniper woodland apparently seeded with the non-native crested wheatgrass (*Agropyron spicatum*).

Plant and Animal Species Observed: Plant species present include skunkbush sumac, whiplash willow (*Salix lasiandra*), serviceberry, American speedwell, willowherb, and the non-natives sweetclover (*Melilotus officinalis*), common burdock, and redtop (*Agrostis gigantea*). Accumulations of filamentous green algae are present in the channel and ponds.

Natural Heritage Program Element Occurrences: There are no element occurrences at this spring and the spring is not included within a CNHP Potential Conservation Area.

Ecological Functions: Hydrologic alterations and invasion of weedy species at this site has likely altered the ecological functions. However, some ecological functions are likely intact such as groundwater discharge and wildlife habitat. As mentioned previously, this is the only water source for a long distance. Currently, the vegetation is providing good bank stabilization functions. The invertebrate populations do not include some groups that might be expected (e.g. mayflies, caddisflies) possibly indicating that the water source is not permanent or that modifications have been too extreme. Herbaceous vegetation offers forage for larger mammals. The spring does not provide fish habitat, as the amount of water flowing within a defined channel is limited.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition. Ecological processes are apparently intact; however, the combination of flow alteration and noxious weed infestations have the potential to alter ecological processes.

Non-native and Aggressive Species: Common burdock is the primary aggressive non-native species present at this site. Other non-natives include sweetclover and redtop. Common burdock is evident in previous photos of the spring archived at the Grand Junction BLM office. Eradication of this non-native is recommended.

Restoration and Management Comments: Control of non-natives and the possibility of removing old pipes and from the creek bed may help partially restore this site.

Water Chemistry: Flow was visually estimated to be about one gpm.
Water chemistry was measured as follows:

pH	8.0
Conductivity	840 µS/cm
Temperature	18 C

Macroinvertebrates: No snails or mussels were observed at this site. Aquatic macroinvertebrates observed include mosquito larvae, predaceous diving beetle larvae (family Dytiscidae), water striders (family Gerridae), and horsehair worms (phylum Nematomorpha).

Photos: Roll GD-2 #1, Roll GD-3 #37.

SS-H (Brouse Spring)

Location: Spring Creek 1. DS Road from Glade Park west to Utah then travel south on dirt road along Colorado/Utah state line to a dirt road heading east up Spring Canyon. This spring is located roughly two miles east of the turnoff to Spring Creek. The spring is located north of Spring Creek. GPS Point: Zone 12, 0670874E, 4309109N.

Legal Description: USGS 7.5-minute quadrangle: Marble Canyon. T13S R104W Section 21 NW4 NW4.

Elevation: 6840 feet.

Dominant Plant Species and/or Associations: Coyote willow (*Salix exigua*), mixed rushes (*Juncus* spp.), and common spikerush (*Eleocharis palustris*) are the dominant plant species.

General Description: This spring/seep emerges from an old dug out rock face on a steep south-facing slope. Coyote willow (*Salix exigua*) grows at the rock face and on the slope. The slope grades to a 15-foot wide flat opening with mixed rushes (*Juncus* spp.) and common spikerush (*Eleocharis palustris*). An old mine shaft and its associated waste rock piles occur just upslope from the spring. The spring is developed in that a pipe conveys water to a lower bench. Artesian flow from the pipe on the lower bench contributes to nearby Spring Creek. Old culverts and debris are present in the area. Upland vegetation includes pinyon–juniper with rabbitbrush (*Chrysothamnus nauseosus*).

Plant and Animal Species Observed: Species present include coyote willow, common spikerush, various rushes including Baltic rush (*Juncus balticus*), Rocky Mountain rush *(Juncus saximontanus*), roundfruit rush (*Juncus compressus*), and Torrey's rush (*Juncus torreyi*), Tracy's thistle (*Cirsium tracyi*), American speedwell (*Veronica americana*), and western wheatgrass (*Pascopyrum smithii*). Aquatic plants present included hornwort (*Ceratophyllum demersum*) and alkali crowfoot (*Halerpestes cymbalaria*). Non-native plants present are noted in the non-native plant section.

Numerous butterflies and dragonflies were observed in the area.

Natural Heritage Program Element Occurrences:

Table 14. Natural Heritage elements at SS-H

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Populus angustifolia/ Salix exigua	Narrowleaf cottonwood riparian forest	G4	S4	B
Pinus edulis/Cercocarpus montanus (uplands)	Mesic western slope pinyon-juniper woodland	G5	S4	B

The narrowleaf cottonwood/coyote willow riparian forest occurs downstream from the spring near the Utah border and is supported hydrologically by this spring and others (e.g.

SS-I and J). The uplands on the south facing slope above the spring are part of a large, good occurrence of pinyon pine with mountain mahogany. This spring is currently not contained within a CNHP Potential Conservation Area.

Ecological Functions: Groundwater discharge is occurring at the spring but is hydrologically altered by the pipe conveying water to a lower bench. The alteration likely effects nutrient cycles and changes the areal extent of the wetland vegetation. The spring discharge contributes to flow in Spring Creek.

Proper Functioning Condition Rating: This spring is rated as Functioning At Risk with no apparent trend. The hydrologic regime is altered by spring development possibly altering ecological processes and the steep slopes appear vulnerable to erosion.

Non-native and Aggressive Species: Non-native plant species present include the grasses redtop (*Agrostis gigantea*) and rabbitfoot grass (*Polypogon monspeliensis*), the plantains broadleaf plantain (*Plantago major*) and narrowleaf plantain (*Plantago lanceolata*), and the peas sweetclover (*Melilotus officinalis*) and alfalfa (*Medicago sativa*).

These non-natives were present, but their abundance was not great enough to be displacing native species at this time. However, populations of these species should be closely monitored to ensure that they do not spread.

Restoration and Management Comments: Removal of the pipe and associated debris would likely help to reestablish the natural hydrologic regime at this site and would likely increase the areal extent of the wetlands.

Water Chemistry: Flow from the pipe located on the downstream bench was not measured. No flow was noted at the upstream bench but puddled water was present in sections of the wetland.
Water chemistry within a puddle on the upper bench was measured as follows:

pH	7.3
Conductivity	640
Temperature	25 C

Water chemistry flowing from the pipe on the lower bench was measured as follows:

pH	7.4
Conductivity	520 µS/cm
Temperature	15 C

Macroinvertebrates: No snails or mussels were noted at the spring.

Photos: Roll GD-2 #14-18.

SS-I (Pleasant Spring)

Location: Spring Creek 2. DS Road from Glade Park west to Utah then travel south on dirt road along Colorado/Utah state line to a dirt road heading east up Spring Canyon. This spring is located roughly three miles east of the turnoff to Spring Creek. GPS Point: Zone 12, 0672270E, 4308778N.

Legal Description: USGS 7.5-minute quadrangle: Marble Canyon. T13S R104W Section 21 SE4 NE4.

Elevation: 7120 feet.

Dominant Plant Species and/or Associations: Chokecherry (*Padus virginiana*) and red-osier dogwood (*Cornus sericea*) are dominant at the spring source and beaked spikerush (*Eleocharis rostellata*) is dominant along the brook.

General Description: This spring emerges from a west-facing slope near the head of Spring Creek canyon. The spring source is densely vegetated with shrubs including chokecherry, Gambel's oak (*Quercus gambelii*), red-osier dogwood, and wild *rose (Rosa woodsii*). The understory is moss-covered rocks and mixed forbs and graminoids. The channel is open (no overhaning shrubs) and has a rocky/sandy bottom. Decaying leaf litter is abundant in the creek providing habitat for a range of aquatic invertebrates. The estimated flow in the creek is 5 gpm. The spring and creek are relatively unaltered; some pipe remnants are present but not in service. Also, some European pasture species are present. The uplands are vegetated with pinyon-juniper and big sagebrush.

Plant and Animal Species Observed: Shrub species present include chokecherry, red-osier dogwood, Gambel's oak, mountain willow (*Salix monticola*), and strapleaf willow (*Salix eriocephala*). Graminoids present include beaked spikerush, common spikerush (*Eleocharis palustris*), Baltic rush (*Juncus balticus*), Rocky Mountain rush (*Juncus saximontanus*), field horsetail (*Equisetum arvense*), and fowl mannagrass (*Glyceria striata*). Forbs include canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*), green gentian (*Frasera speciosa*), a thistle (*Cirsium* sp.), goldenrod (*Solidago canadensis*), American speedwell (*Veronica americana*), and false Solomon's seal (*Mainthemum stellatum*). Non-natives include a variety of pasture species and are listed in the non-native plant section.

Natural Heritage Program Element Occurrences:

Table 15. Natural Heritage elements at SS-I.

Element	Common Name	Global Rank	State Rank	EO Rank
Plants				
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T4?	S3	C
Plant Communities				
Populus angustifolia/ Salix exigua	Narrowleaf cottonwood riparian forest	G4	S4	B

Element	Common Name	Global Rank	State Rank	EO Rank
Quercus gambelii-Amelanchier utahensis (upland)	Mixed mountain shrubland	G4G5	S4	B

The narrowleaf cottonwood/coyote willow riparian forest occurs downstream from the spring near the Utah border and is supported hydrologically by this spring and others (e.g. SS-H and J). The state vulnerable (S3) canyon bog orchid grows at the spring and along the associated brook. The uplands surrounding the spring are part of a large Gambel's oak-serviceberry community that is in good condition. This spring is currently not contained within a CNHP Potential Conservation Area.

Ecological Functions: Overall, this wetland is in good condition. Groundwater discharge is occurring on site and is contributing to the flow of Spring Creek. Permanent groundwater discharge and subsequent organic matter accumulation produces dissolved organic carbon sources that eventually make their way downstream and provide carbon for macroinvertebrates and nutrients for plant growth. Currently, the spring wetland is providing good bank stabilization functions. Herbaceous vegetation offers forage for larger mammals and habitat for numerous invertebrates. The shrub canopy, plus the presence of permanent water provide excellent habitat for birds. The spring does not provide fish habitat.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as current ecological processes appear to be intact.

Nonnative and Aggressive Species: Non-native plant species present include the grasses redtop (*Agrostis gigantea*) and Kentucky bluegrass (*Poa pratensis*), broadleaf plantain (*Plantago major*), and the peas black medic (*Medicago lupulina*) and clover (*Trifolium pratense*). Most of these species were probably introduced to the area as pasture species.

Restoration and Management Comments: The site is in good condition. The primary issue appears to be non-native species, none of which are known to be particularly aggressive.

Water Chemistry: Flow from the spring was visually estimated to be about 5 gpm. Water chemistry was measured as follows:

pH	7.4
Conductivity	390 µS/cm
Temperature	10 C

Macroinvertebrates: No mussels or aquatic snails were noted. Aquatic macroinvertebrates collected include mayfly nymphs, caddisfly larvae, and leeches. A land snail, broad-banded forest snail (*Allogna profunda*) (G5/S?), was collected at the site (J. Cordiero, NatureServe, pers. comm.).

Photos: Roll GD-2 #10-13.

SS-J (Spring Creek 3)

(New to BLM ArcView)

Location: Spring Creek 3. DS Road from Glade Park west to Utah then travel south on dirt road along Colorado Utah state line to a dirt road heading east up Spring Canyon. This spring is located roughly 2 1/2 miles east of the turnoff to Spring Creek. GPS Point: Zone 12, 0671661E, 4308749N.

Legal Description: USGS 7.5-minute quadrangle: Marble Canyon. T13S R104W Section 21 SW4 NE4.

Elevation: 6960 feet.

Dominant Plant Species and/or Associations: Chokecherry (*Padus virginiana*) and red-osier dogwood (*Cornus sericea*) are dominant at the spring source and Baltic rush (*Juncus balticus*) dominates in the adjacent wet meadow.

General Description: The spring emerges from a moss-covered rocks on a densely shrubby slope. Very quickly, the slope opens up into a small wet meadow supporting primarily Baltic rush and redtop (*Agrostis gigantea*). Canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) grows along the stream channel. Dominant shrubs at the spring include chokecherry and red-osier dogwood. The spring brook has a narrow rocky channel with abundant leaf litter and woody debris. The channel is about 3' wide and 3" deep with the rocks covered with a calcium carbonate-like coating. Upslope a small grove of aspen and chokecherry is probably hydrologically related to this spring. Gambel's oak is the dominant cover outside of the small aspen grove with mountain mahogany and wild rose. Bear scat is abundant on the upland slope.

Plant and Animal Species Observed: Shrubby species present include red-osier dogwood, chokecherry, Gambel's oak, wild rose, snowberry (*Symphoricarpos* sp.), coyote willow (*Salix exigua*), and mountain willow (*Salix monticola*). Native graminoids noted include Baltic rush, Rocky Mountain rush (*Juncus saximontanus*), Torrey's rush (*Juncus torreyi*), common spikerush (*Eleocharis palustris*), field horsetail (*Equisetum arvense*), and scouring rush (*Hippochaete laevigata*). Native forbs present include canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*), willowherb (*Epilobium ciliatum*), American speedwell (*Veronica americana*), false Solomon seal (*Maianthemum stellatum*), and northern bedstraw (*Galium septentrionale*). Non-native plants present are noted in the non-natives section. Wildlife sign observed included abundant bear scat and aquatic insects.

Natural Heritage Program Element Occurrences:

Table 16. Natural Heritage elements at SS-J.

Element	Common Name	Global Rank	State Rank	EO Rank
Plants				
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T4?	S3	C

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Populus angustifolia/ Salix exigua	Narrowleaf cottonwood riparian forest	G4	S4	B
Quercus gambelii-Amelanchier utahensis	Mixed mountain shrubland	G4G5	S4	B

The narrowleaf cottonwood/coyote willow riparian forest occurs downstream from the spring near the Utah border and is supported hydrologically by this spring and others (e.g. SS-I and H). The uplands surrounding the spring are part of a large Gambel's oak-serviceberry occurrence that is in good condition. This spring is currently not contained within a CNHP Potential Conservation Area.

Ecological Functions: Overall, this wetland is in good condition. Groundwater discharge is occurring on site and is contributing to the flow of Spring Creek via seepage to the creek channel. Semi-permanent groundwater discharge and subsequent organic matter accumulation produces dissolved organic carbon sources that eventually make their way downstream and provide carbon for macroinvertebrates and nutrients for plant growth. Currently, the spring wetland is providing good bank stabilization functions. Herbaceous vegetation offers forage for larger mammals and habitat for numerous invertebrates. The sporadic tree canopy, plus the presence of semi-permanent water provides good habitat for birds. The spring does not provide fish habitat.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as current ecological processes appear to be intact.

Nonnative and Aggressive Species: Non-native species present include sparse redtop (*Agrostis gigantea*) and Kentucky bluegrass (*Poa pratensis*), clover (*Trifolium pratense*), and broadleaf plantain (*Plantago major*). None of these species are particularly egregious and their control is not recommended.

Restoration and Management Comments: The site is in good condition, except for the presence of redtop and Kentucky bluegrass.

Water Chemistry: Flow from the spring was visually estimated to be about 5 gpm. Water chemistry was measured as follows:

pH	7.5
Conductivity	400 µS/cm
Temperature	8 C

Macroinvertebrates: No snails or mussels were noted. Macroinvertebrates collected include stonefly and mayfly nymphs, caddisfly larvae, and various fly larvae.

Photos: Roll GD-2 #6-9.

SS-K (Solar Spring)

Location: Dominguez Creek at Smith Point. From Divide Road follow signs to Dominguez Campground. At base of canyon follow small dirt road west to Smith Point. GPS Point: Zone 12, 0711265E, 4291694N.

Legal Description: USGS 7.5-minute quadrangle: Keith Creek. T15S R100W Section 16 SW4 NE4.

Elevation: 7440 feet.

Dominant Plant Species and/or Associations: River birch (*Betula occidentalis*) and giant angelica (*Angelica ampla*) are the dominant plants at the spring and along the associated brook.

General Description: This spring emerges from a steep south-facing sandstone slope and flows in a narrow rocky channel to Dominguez Creek. The spring and associated brook are densely vegetated with river birch and giant angelica. Canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) also grows along the brook. The uplands are pinyon-juniper woodlands with ponderosa pine (*Pinus ponderosa*), mountain mahogany (*Cercocarpus montanus*), bitterbrush (*Purshia tridentata*), and Gambel's oak (*Quercus gambelii*). The riparian corridor along Dominguez Creek is in excellent condition and supports several excellent examples of plant communities and an excellent population of canyon bog orchid. A collection basin near the spring collects water which is then pumped uphill to supply cattle watering troughs.

Plant and Animal Species Observed: Tree and shrub species present include juniper (*Juniperus* spp.), river birch, wild rose (*Rosa woodsii*), skunkbush sumac (*Rhus trilobata*), red-osier dogwood (*Cornus sericea*), and Gambel's oak. Prevalent forbs include giant angelica, canyon bog orchid, virgin's bower (*Clematis ligusticifolia*), and Mancos columbine (*Aquilegia micrantha*). Graminoids include fowl mannagrass (*Glyceria striata*), baltic rush (*Juncus balticus*), and an unidentified sedge (*Carex* sp.).

Natural Heritage Program Element Occurrences:

Table 17. Natural Heritage elements at SS-K.

Element	Common Name	Global Rank	State Rank	EO Rank
Plants				
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T4?	S3	A
Plant Communities				
Alnus incana-Cornus sericea	Alder-red-osier dogwood riparian shrubland	G3Q	S3	B
*Betula occidentalis/*mesic forb	Foothills riparian shrubland	G4?	S2	A
Picea pungens/Cornus sericea	Blue spruce/Red-osier dogwood	G4	S2	B
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood riparian forest	G4	S3	A

This spring is contained within CNHP's **Big Dominguez Creek Potential Conservation Area**, which is ranked as a **B3** site (High Biodiversity Significance) (see Rocchio et al. 2002; Lyon et al. 1996). The high biodiversity rank is based on the concentration of good to excellent occurrences of riparian plant communities along Dominguez Creek as well as occurrences of Uinta Basin hookless cactus (*Sclerocactus glaucus*) (G3/S3), a federally threatened species, and Grand Junction milkvetch (*Astragalus linifolius*) (G3Q/S3), on the uplands. Dominguez Creek supports several rare plant communities including the river birch/ mesic forb community present at SS-K. Dominguez Creek and SS-K also provide excellent habitat for the canyon bog orchid.

Ecological Functions: Overall, this spring and the brook are in good condition. The removal of some water and transport upstream did not appear to have visibly altered the vegetation (no non-natives were noted). Groundwater discharge is occurring on site. Nutrient cycles appear to be intact. The spring and brook likely provide forage for wildlife. Food chain export is occurring as evidenced by decomposition of leaves of branches within the creek and a good diversity of aquatic macroinvertebrates. Dense moss covering on the rocks at the spring and along the brook contribute to soil stabilization ability.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as current ecological processes appear to be intact.

Non-native and Aggressive Species: No non-native species were noted at the spring or along the brook.

Restoration and Management Comments: The site was in good condition. The pump box and pipes conveying water uphill may be operated sporadically enough to not significantly alter the natural hydrologic processes. Some cattle droppings were present indicating the area may be occasionally grazed.

Water Chemistry: Flow from the spring was visually estimated to be about 5 gpm. Water chemistry was measured as follows:

pH	7.8
Conductivity	300 µS/cm
Temperature	10 C

Macroinvertebrates: No mussels or aquatic snails were noted. Aquatic insects collected include stonefly and mayfly nymphs, and caddisfly, beetle, cranefly, and midge larvae. Land snails collected at the site include silky vallonia (*Vallonia cyclophorella*) (G?/S?) and glossy pillar (*Cionella lubrica*) (G4G5/S?) (J. Cordiero, NatureServe, pers. comm.).

Photos: Roll GD-3 #30-36.

SS-L (E. Dominguez Campground Spring)

Location: Dominguez Creek Campground. From Divide Road follow signs to Dominguez Campground. The spring is near the base of the canyon on the north side of the road about ¼ mile west of the Dominguez Creek Campground. GPS Point: Zone 12, 0712444E, 4291422N.

Legal Description: USGS 7.5-minute quadrangle: Keith Creek. T15S R100W Section 15 NE4 SW4.

Elevation: 7280 feet.

Dominant Plant Species and/or Associations: The dominant plant species near the spring and associated brook are narrowleaf cottonwood (*Populus angustifolia*), Douglas-fir (*Pseudotsuga menziesii*), and giant angelica (*Angelica ampla*).

General Description: A series of springs emerges from a densely wooded steep south-facing slope above Dominguez Creek. At least three springs are in close proximity forming a series of wet areas and small channels. The area is vegetated with a variety of trees including narrowleaf cottonwood, Douglas-fir, and Rocky Mountain juniper (*Juniperus scopulorum*), and shrubs including river birch (*Betula occidentalis*), red-osier dogwood (*Cornus sericea),* skunkbush sumac (*Rhus trilobata*), wild rose (*Rosa woodsii*), coyote willow (*Salix exigua*), and mountain willow (*Salix monticola*). The state rare canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) grows along the stream banks. The wide range of vegetation forms an interesting mosaic of plant communities. The small drainage channels contain abundant woody and leafy vegetative debris providing good habitat for a range of macroinvertebrates. The creeks have rocky and sandy substrates with moss-covered rocks common. There is also some carbonate coating on the rocks in the stream.

Plant and Animal Species Observed: Tree and shrub species present include narrowleaf cottonwood, Douglas-fir, red-osier dogwood, river birch, wild rose, coyote willow, mountain willow, Rocky Mountain juniper, and skunkbush sumac. Forbs present include canyon bog orchid, false Solomon's seal (*Maianthemum stellatum*), giant angelica (*Angelica ampla*), Mancos columbine (*Aquilegia micrantha*), willowherb (*Epilobium ciliatum*), and goldenrod (*Solidago canadensis*). Graminoids include Rocky Mountain rush (*Juncus saximontanus*) and fowl mannagrass (*Glyceria striata*). The non-native grass, redtop (*Agrostis gigantea*), is also present

Natural Heritage Program Element Occurrences:

Table 18. Natural Heritage elements at SS-L.

Element	Common Name	Global Rank	State Rank	EO Rank
Plants				
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T4?	S3	A

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Alnus incana-Cornus sericea	Alder-red-osier dogwood riparian shrubland	G3Q	S3	B
*Betula occidentalis/*mesic forb	Foothills riparian shrubland	G4?	S2	A
Picea pungens/Cornus sericea	Blue spruce/red-osier dogwood	G4	S2	B
Populus angustifolia/ Cornus sericea	Narrowleaf cottonwood riparian forest	G4	S3	A

This spring is contained within CNHP's **Big Dominguez Creek Potential Conservation Area**, which is ranked as a **B2** site (Very High Biodiversity Significance) (see Rocchio et al. 2002, Lyon et al. 1996). The high biodiversity rank is based on the concentration of good to excellent occurrences of riparian plant communities along Dominguez Creek as well as occurrences of Uinta Basin hookless cactus (*Sclerocactus glaucus*) (G3/S3), a federally threatened species, and Grand Junction milkvetch (*Astragalus linifolius*) (G3Q/S3), on the uplands. Dominguez Creek and SS-L also provide excellent habitat for the canyon bog orchid.

Ecological Functions: Overall, these springs are in good condition. Groundwater discharge is occurring on site. Nutrient cycles appear to be intact. The springs and brooks likely provide forage for wildlife. Food chain export is occurring as evidenced by decomposition of leaves of branches within the creek and a good diversity of aquatic macroinvertebrates. Dense moss covering on the rocks at the spring and along the brook contribute to soil stabilization ability.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as current ecological processes appear to be intact.

Non-native and Aggressive Species: The only non-native species noted at this location was the European pasture grass, redtop.

Restoration and Management Comments: The site was in relatively good condition. An apparently defunct concrete culvert installed at one spring could perhaps be removed to aid in restoration of the natural flow regime. There is some evidence that suggests trampling of vegetation by cattle.

Water Chemistry: Flow from the springs was visually estimated to be about 2 gpm. Water chemistry was measured as follows:

pH	8.0
Conductivity	400 µS/cm
Temperature	10 C

Macroinvertebrates: No macroinvertebrates were collected but populations are likely similar to those observed at SS-K.

Photos: Roll GD-3 #20-21.

SS-M (Horse Mesa Spring)

Location: Horse Mesa. From Divide Road follow signs to Dominguez Campground. Before heading down into Dominguez Canyon, follow Tabawache Trail 7.5 miles east to Horse Mesa. GPS Point: Zone 12, 0717875E, 4298215N.

Legal Description: USGS 7.5-minute quadrangle: Triangle Mesa. T14S R99W Section 30 SE4 NE4.

Elevation: 7040 feet.

Dominant Plant Species and/or Associations: Greasewood (*Sarcobatus vermiculatus*) with saltgrass (*Distichlis spicata*) is the dominant plant community.

General Description: Saltgrass and greasewood are the predominant plants in this dry seepage area occurring as an opening in a pinyon pine-juniper (*Pinus edulis-Juniperus* sp.) vegetated slope. Below the seepage area, ephemeral drainages convey runoff to Gibbler Gulch. Alkaline crust occurs on the soils in parts of the seepage area. Cryptobiotic crusts are well developed in the area. Other shrubs present include spiny saltbush (*Atriplex confertifolia*) and rabbitbrush (*Chrysothamnus* spp.). The soils are fine sand with some clay. The sparsely vegetated pinyon-juniper uplands include quite a bit of Mormon tea (*Ephedra* sp.).

Plant and Animal Species Observed: Species present include saltgrass, greasewood, spiny saltbush, and rabbitbrush. Foxtail barley (*Hordeum jubatum*), and Kentucky bluegrass (*Poa pratensis*) are also present. A few tamarisk (*Tamarix ramosissima*) are also present.

Natural Heritage Program Element Occurrences:

No elements tracked by the CNHP were documented at this site and this spring was not located within a CNHP Potential Conservation Area. The greaswood and saltgrass growing at the seep was not considered extensive enough to be considered for tracking as a plant community occurrence. Greaswood with saltgrass (*Sarcobatus vermiculatus/ Distichlis spicata*) (G4/S1) is a globally common plant association that is rare in Colorado. It can occur where alkaline or saline soils have been formed from the accumulation of bases and soluble salts in poorly drained areas.

Ecological Functions: Overall, this wetland is in good condition. Groundwater discharge is occurring on site as evidenced by accumulations of salt crust and the presence of saltgrass. Nutrient cycles appear to be intact.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as current ecological processes appear to be intact.

Non-native and Aggressive Species: A few tamarisk are present.

Restoration and Management Comments: The site was in good condition except for the presence of tamarisk. Efforts should be given to eradicating this species as soon as possible as it has the potential to quickly displace native species and alter ecosystem functions.

Water Chemistry: Water chemistry and flow were not measured at this site, as there was no standing or flowing water from which to collect data. Salinity is assumed to be high based on the vegetation growing in the area.

Macroinvertebrates: No macroinvertebrates were observed in the area.

Photos: Roll GD-3 #25-29.

SS-N (Sewemup Mesa)

(New to BLM ArcView)

Location: Dolores River Canyon. The east cliff of Sewemup Mesa about two miles north of Montrose County and south about 4 miles into Montrose County. Seeps occur sporadically along the cliff. GPS Point: Zone 12, 0683550E, 4265688N.

Legal Description: USGS 7.5-minute quadrangle: Juanita Arch. T49N R18W Sections 8 and 17.

Elevation: 4900 feet.

Dominant Plant Species and/or Associations: The dominant plant association at the seeps on the cliff face is Mancos columbine (*Aquilegia micrantha*) with Eastwood monkeyflower (*Mimulus eastwoodiae*).

General Description: The Dolores River snakes between sheer, red sandstone cliffs creating one of the most scenic canyons in Mesa County. On the sheer sandstone face west of the Dolores River a series of seeps emerge from the contact of the Wingate and Chinle formations. These seeps are easily visible from Highway 145 as whitish salt deposits high up on the cliff. Growing at the seeps is a unique hanging garden community of Mancos columbine with Eastwood monkeyflower (*Aquilegia micrantha*-(*Mimulus eastwoodiae*)) (G2G3/S2S3). Growing within this unique community are several rare plants. The red Eastwood monkeyflower is a rare plant itself (G3/S2) and giant helleborine orchid (*Epipactis gigantea*) (G3/S2) and southern maiden-hair fern (*Adiantum capillaris-veneris*) (G5/S2) are also present on the seeps in Mesa County. An additional rare plant documented on the same type of seep just to the south in Montrose County is Kachina daisy (*Erigeron kachinensis*) (G2/S1). Ditchgrass (*Calamagrostis scopulorum*) and common reed (*Phragmites australis*) are common species found near these seeps.

Uplands on Sewemup Mesa have pinyon and juniper woodlands, with some excellent patches of native bunchgrasses. Typical grasses here are needle-and-thread (*Hesperostipa comata*), blue grama (*Bouteloua gracilis*), alkali sacaton (*Sporobolus airoides*), galleta (*Hilaria jamesii*), Indian ricegrass (*Achnatherum hymenoides*), and sand dropseed (*Sporobolus cryptandrus*). Common shrub species of the mesa include snakeweed (*Gutierrezia sarothrae*), Mormon tea (*Ephedra* sp.), yucca (*Yucca harrimaniae*), four-wing saltbush (*Atriplex canescens*), single leaf ash (*Fraxinus anomala*), antelope bitterbrush (*Purshia tridentata*), cliff rose (*P. stansburiana*), serviceberry (*Amelanchier utahensis*), and mountain mahogany (*Cercocarpus montanus*). Soil crusts of mosses, lichens and micro-organisms are well developed on the red sandy soils.

Plant and Animal Species Observed: Species present include Mancos columbine, Eastwood monkeyflower, giant helleborine orchid, southern maiden-hair fern, wild

privet, common reed, ditchgrass, tamarisk (*Tamarix ramosissima*), and a thistle (*Cirsium calcareum*).

The Peregrine Falcon, a state species of special concern, is also found at this site. Since 1947, its eggshell thickness was reduced 15 to 20 percent, probably due to the introduction of chemicals such as DDT in the food chain. In recent years, the species has been recovering, and in 1999, was removed from the endangered species list. The cliffs around Sewemup Mesa provide habitat for nests and foraging.

Natural Heritage Program Element Occurrences:

Table 19. Natural Heritage elements at SS-N.

Element	Common Name	Global Rank	State Rank	EO Rank
Plants				
Adiantum capillus-veneris	Southern maiden-hair fern	G5	S2	B
Epipactis gigantea	Giant helleborine orchid	G3	S2	B
Erigeron kachinensis	Kachina daisy	G2	S1	B
Mimulus eastwoodiae	Eastwood monkeyflower	G3	S2	A
Plant Communities				
Aquilegia micrantha-(*Mimulus eastwoodiae*)	Hanging gardens	G2G3	S2S3	A

These seeps are contained within CNHP's **Sewemup Mesa Potential Conservation Area**, which is ranked as a **B2** site (Very High Biodiversity Significance) (see Rocchio et al. 2002, Lyon et al. 1996). The high biodiversity rank is based on the rarity of the hanging garden plant community and the abundance and diversity of rare plants growing in these seep communities. The Kachina daisy occurrence is one of only two known locations for this species in Colorado. The Kachina daisy occurrence is on seeps in Montrose County but could very well be found on similar seeps in Mesa County with further survey. Peregrine Falcon are also known at this site.

Ecological Functions: The seeps are in excellent condition and provide excellent habitat for a range of rare plants. There are a very few non-native plants present. Groundwater discharge is occurring on site. Shrubs and taller grasses likely provide good habitat for birds and the herbaceous vegetation offers forage for larger mammals. The water discharging from the seeps rapidly infiltrates the eroded material at the base of the cliff. In some areas soil development has occurred at the base of the seeps and supports a different, more mesic plant community than the drier areas.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as current ecological processes appear to be intact.

Non-native and Aggressive Species: Surprisingly, one tamarisk was noted at the northernmost seep. The Dolores River at the base of the cliff is heavily infested with tamarisk and windblown seed likely found its way up the cliff. Control of this species at the seep is recommended to prevent its spread.

Restoration and Management Comments: The inaccessibility of the seeps likely limits impact from humans and grazers. Control of the lone tamarisk noted is recommended. It is important to ensure that the recharge area for these seeps (Sewemup Mesa) remains hydrologically intact (no withdrawls/diversions) to ensure maintenance of the seeps.

Water Chemistry: Only a very slow drip occurred from the seeps at the time of our visit. Water chemistry of the drip was as follows:

pH:	8.2
Conductivity:	400 µS/cm
Temperature:	18 C

Macroinvertebrates: No macroinvertebrates were observed in the seeps.

Photos: Rocchio, Roll B #21 through 26 and #31 through 34.

SS-O (Copper Rivet Spring)

Location: Salt Creek spring 1. At Sinbad Valley, about five miles west of Highway 141 on road Z6 toward Sinbad Valley. GPS Point: Zone 12, 0676199E, 4265806N.

Legal Description: USGS 7.5-minute quadrangle: Juanita Arch. T49N R19W Section 9 NE4 SE4.

Elevation: 5400 feet.

Dominant Plant Species and/or Associations: The dominant plant association at this spring is alkali bulrush (*Schoenoplectus maritimus*). Alkali muhly (*Muhlenbergia asperfolia*) and sea-blite (*Suaeda* sp.) are also prevalent.

General Description: This spring discharges from a south-facing rock face near the base of a hill at the edge of Sinbad Valley. The spring feeds into a small, inundated marsh dominated by alkali bulrush and alkali muhly with tamarisk abundant on slightly higher ground. Other species present in the area include seablite (*Suaeda* spp.), greasewood (*Sarcobatus vermiculatus*), rabbitbrush (*Chrysothamnus nauseosus*), threesquare bulrush (*Schoenoplectus pungens*), saltgrass (*Distichlis spicata*), common reed (*Phragmites australis*), white sweetclover (*Melilotus alba*), and rabbitfoot grass (*Polypogon monspeliensis*). The spring discharges to Salt Creek and the downstream end of the wetland is impounded by an old depositional bar of Salt Creek. The associated uplands are pinyon-juniper woodlands with big sagebrush (*Artemisia tridentata*) on terraces.

Salt Creek drains east out of Sinbad Valley, although most flow is derived from the numerous springs that discharge within the canyon between Sinbad Valley and the Dolores River. Riparian vegetation along Salt Creek is sparse and consists of scattered cottonwoods (*Populus* sp.), coyote willow (*Salix exigua*), skunkbrush (*Rhus trilobata*), and tamarisk (*Tamarix ramosissima*).

Plant and Animal Species Observed: Species present include alkali bulrush, alkali muhly, seablite, greasewood, rabbitbrush, threesquare bulrush, saltgrass, and common reed, and the non-natives tamarisk, white sweetclover, and rabbitfoot grass.

Natural Heritage Program Element Occurrences:

Table 20. Natural Heritage elements at SS-O.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Schoenoplectus maritimus	Alkali bulrush wetland	G4	S2	C

Alkali bulrush communities are abundant in Montana and not well documented in Colorado. This plant association occurs in wet swales and along narrow channels, spring-fed creeks, and back-water eddies of larger rivers. This occurrence is “C-ranked”

because of its small size and the abundance of tamarisk. This spring is located within CNHP's **Salt Creek Potential Conservation Area** which is ranked as a **B2** (Very High Biodiversity Significance) site (Rocchio et al. 2002). The Salt Creek PCA contains at least three additional springs (SS-P, SS-Q, SS-V) that support a range of rare plant communities. The high CNHP biodiversity rank is based on wild privet (*Foresteira pubescens*) shrublands (G1G2/S1S2) located at springs SS-P and SS-Q.

Ecological Functions: Overall, this wetland is in relatively good condition with the exception of the abundance of tamarisk. Groundwater discharge occurs here as evidenced by the vegetation and the presence of carbonate salts on the rock face. The dense vegetation likely creates good bank stabilization potential during high flow events on Salt Creek. The high salt content of the water likely limits the use by large mammals. Nutrient cycles may have been altered due to the tamarisk. Alkali bulrush is a prolific seed producer. Its rhizomes spread quickly into exposed areas and colonize mudflats and drawdown areas.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition. However, current ecological processes have been disrupted by the abundance of tamarisk.

Non-native and Aggressive Species: Tamarisk is the most aggressive of the non-native species present at the site. It is abundant along the length of Salt Creek. Efforts should be given to eradicating this species be considered as it has the potential to displace native species and alter ecosystem functions.

Restoration and Management Comments: Control of tamarisk on Salt Creek should be considered as a possible restoration action.

Water Chemistry: Water emerged from the rock face at a very slow seep. Water chemistry was as follows:

pH: 8.1
Conductivity: 9200 µS/cm
Temperature: 25 C (temperature likely artificially high due to high air temperature)

Macroinvertebrates: No snails or mussels were seen at the spring. Adult dragonflies (family Libellulidae) and damselflies were present in the area.

Photos: Roll GD-3 #7-10.

SS-P (Salt Creek 2)

(New to BLM ArcView)

Location: Salt Creek spring 2. About two miles west of Highway 141 on road Z6 toward Sinbad Valley. GPS Point: Zone 12, 0678521E, 4268272N.

Legal Description: USGS 7.5-minute quadrangle: Juanita Arch. T49N R19W Section 2 NE4 NW4.

Elevation: 5000 feet.

Dominant Plant Species and/or Associations: The dominant plant association near the spring source is common reed (*Phragmites australis*) and the dominant plant association downstream along the brook is wild privet (*Forestiera pubescens*), a critically imperiled (G1G2) shrubland community.

General Description: This spring occurs in a side canyon tributary to Salt Creek. The spring was dry during our site visit but groundwater is near the surface as evidenced by vigorous growth of common reed. Additional common reed occurs downstream at the confluence with Salt Creek. A dense thicket of wild privet, a critically imperiled (G1G2) shrubland, occurs along the brook. Scattered narrowleaf cottonwood (*Populus angustifolia*) saplings also occur along the brook. The associated uplands are pinyon-juniper woodlands with big sagebrush (*Artemisia tridentata*) on terraces.

Salt Creek drains east out of Sinbad Valley, although most flow is derived from the numerous springs that discharge within the canyon between Sinbad Valley and the Dolores River. Riparian vegetation along Salt Creek is sparse and consists of scattered cottonwoods (*Populus* sp.), coyote willow (*Salix exigua*), skunkbrush (*Rhus trilobata*), and tamarisk (*Tamarix ramosissima*).

Plant and Animal Species Observed: Plant species present include common reed, wild privet, narrowleaf cottonwood, coyote willow (*Salix exigua*), skunkbush sumac (*Rhus trilobata*), big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus nauseosus*), dogbane (*Apocynum cannabinum*), wild licorice (*Glycyrrhiza lepidota*), aster (*Heterotheca villosa*), goldenrod (*Solidago canadensis*), virgin's bower (*Clematis ligusticifolia*), wild rose (*Rosa woodsii*), and a thistle (*Cirsium calcareum*).

Natural Heritage Program Element Occurrences:

Table 21. Natural Heritage elements at SS-P.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Forestiera pubescens	Wild privet shrubland	G1G2	S1	B
Phragmites australis	Common reed wetland	G4	S3	B

This spring is located within CNHP's **Salt Creek Potential Conservation Area** which is ranked as a **B2** (Very High Biodiversity Significance) site (Rocchio et al. 2002). The Salt Creek PCA contains at least three additional springs (SS-O, SS-Q, SS-V) that support a range of plant communities. The high CNHP biodiversity rank is based on wild privet (*Foresteira pubescens*) shrublands (G1G2/S1S2) located at springs SS-P and SS-Q.

The wild privet (*Forestiera pubescens*) plant association is a medium tall (3-5 ft., 1-1.5 m) shrubland, often occuring as dense thickets. It grows at the interface between the riparian area and the adjacent upland in desert areas of the southwest. In Colorado, this association is known only from the Dolores and San Miguel Rivers. The common reed community (*Phragmites australis*) was once thought to be widespread throughout western Colorado. Now, it occurs only in small, isolated patches where water has become impounded, such as adjacent to raised railroad beds, irrigation ditches, oxbow lakes, and other low-lying swampy areas. It is threatened by stream flow alterations, road building and maintenance. This species has strong rhizomes that allow it to out compete all but the most aggressive weedy species. Although this grass is a common weedy invader of wetlands in the eastern U.S it is considered a native to western Colorado.

Ecological Functions: This spring is in relatively good condition. The hydrological functions appear intact and invasion by non-native plants has not seemed to occur. Groundwater discharge occurs here even though no discharge was occurring at the time of the site visit. The dense thicket of wild privet likely helps with bank and soil stabilization during high flow conditions.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: Non-native plants were not seen at the spring. Tamarisk occurs nearby along Salt Creek and has the potential to spread into this side canyon.

Restoration and Management Comments: This spring is in relatively good condition. There were no apparent hydrologic alterations nor invasion by non-native plants.

Water Chemistry: Flow nor water chemistry were measured at this site as the spring was dry.

Macroinvertebrates: No aquatic habitat present; dry conditions.

Photos: Roll GD-3 #4-6.

SS-Q (Pepper Spring)

Location: Salt Creek spring 3. About two miles west of Highway 141 on road Z6 toward Sinbad Valley. GPS Point: Zone 12, 0678750E, 4268432N.

Legal Description: USGS 7.5-minute quadrangle: Juanita Arch. T50N R19W Section 35 SW4 SE4.

Elevation: 4960 feet.

Dominant Plant Species and/or Associations: Dominant plants at the spring source include and common reed (*Phragmites australis*), skunkbush sumac (*Rhus trilobata*), wild rose (*Rosa woodsii*), and strapleaf willow (*Salix ligulifolia*). The dominant plants within the riparian area include Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and wild privet (*Forestiera pubescens*).

General Description: Dry seeps and springs along this tributary to Salt Creek support a dense vegetative community dominated by common reed, wild rose, and strapleaf willow. Rio Grande cottonwood and wild privet dominate along the associated stream channel. The channel has many scattered pools containing unidentified tadpoles and aquatic insects including water striders (family Gerridae) and predaceous diving beetle larvae (family Dytiscidae). Adult dragonflies are also abundant. A bench of the creek supports a dense stand of scouring rush with a cottonwood overstory. Evidence of huge floods remains in the canyon as herbaceous vegetation lying flat and debris suspended in shrubs. The associated uplands are pinyon-juniper woodlands with big sagebrush (*Artemisia tridentata*) on terraces.

Plant and Animal Species Observed: Trees and shrubs present include cottonwood (*Populus deltoides* ssp. *wislizeni* and *P. acuminata*), coyote willow (*Salix exigua*), skunkbush sumac, big sagebrush (*Artemisia tridentata*), wild rose (*Rosa woodsii*), wild privet (*Forestiera pubescens*), and Utah juniper (*Juniperus osteosperma*). Native forbs include goldenrod (*Solidago canadensis*), aster (*Heterotheca villosa*), virgin's bower (*Clematis ligusticifolia*), dogbane (*Apocynum cannabinum*), Indian paintbrush (*Castilleja linarifolia*), and a thistle (*Cirsium calcareum*). Graminoids include scouring rush (*Hippochaete laevigata*), saltgrass (*Distichlis spicata*), and sideoats grama (*Bouteloua curtipendula*). A small patch of the aggressive non-native Russian knapweed (*Acroptilon repens*) occurs on a bench just above Salt Creek. Tamarisk (*Tamarix ramosissima*) grows at the mouth of the tributary and along Salt Creek but has not spread upstream along the tributary.

Unidentified tadpoles were moderately abundant in the scattered pools of the tributary. Also present were water striders (family Gerridae) and predaceous diving beetle larvae (family Dytiscidae). Adult dragonflies are also abundant.

Natural Heritage Program Element Occurrences:

Table 22. Natural Heritage elements at SS-Q.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Forestiera pubescens	Foothills riparian shrubland	G1G2	S1	C
Phragmites australis	Common reed wetland	G4	S3	B

This spring is located within CNHP's **Salt Creek Potential Conservation Area** which is ranked as a **B2** (Very High Biodiversity Significance) site (Rocchio et al. 2002). The Salt Creek PCA contains at least three additional springs (SS-O, SS-P, SS-V) that support a range of plant communities. The high CNHP biodiversity rank is based on wild privet (*Foresteira pubescens*) shrublands (G1G2/S1S2) located at springs SS-P and SS-Q.

The wild privet (*Forestiera pubescens*) plant association is a medium tall (3-5 ft., 1-1.5 m) shrubland, often occuring as dense thickets. It grows at the interface between the riparian area and the adjacent upland in desert areas of the southwest. In Colorado, this association is known only from the Dolores and San Miguel Rivers. The common reed community (*Phragmites australis*) was once thought to be widespread throughout western Colorado. Now, it occurs only in small, isolated patches where water has become impounded, such as adjacent to raised railroad beds, irrigation ditches, oxbow lakes, and other low-lying swampy areas. It is threatened by stream flow alterations, road building and maintenance. This species has strong rhizomes that allow it to out compete all but the most aggressive weedy species. Although this grass is a common weedy invader of wetlands in the eastern U.S it is considered a native to western Colorado.

Ecological Functions: This spring is in relatively good condition. The hydrological functions appear intact and invasion by non-native plants has not seemed to occur except at the mouth of the tributary. Groundwater discharge occurs here even though no discharge was occurring at the time of the site visit, but pools were present in the stream channel supporting canyon treefrog larvae and a variety of aquatic insects. The dense thicket of wild privet likely helps with bank and soil stabilization during high flow conditions.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: A small patch of the aggressive non-native Russian knapweed (*Acroptilon repens*) occurs on a bench just above Salt Creek. Tamarisk (*Tamarix ramosissima*) grows at the mouth of the tributary and along Salt Creek but has not spread upstream along the tributary. Russian knapweed is presently addressed in Mesa County under the Colorado Noxious Weed Act (CRS 35-5.5).

Restoration and Management Comments: This spring is in relatively good condition. There were no apparent hydrologic alterations. Control of the Russian knapweed near the confluence with Salt Creek is highly recommended.

Water Chemistry: No flow was occurring from the springs or within the creek. The water chemistry measured within a pool (may be accumulated spring discharge or stored surface runoff) was as follows:

pH: 8.4
Conductivity: 460 µS/cm
Temperature: 28 C

Macroinvertebrates: No snails or mussels were observed. Water striders (family Gerridae), predaceous diving beetle larvae (family Dytiscidae), and adult dragonflies were present.

Photos: Roll GD-3 #2-3.

SS-R (Korn Cabin Spring)

Location: Little Book Cliffs spring 1. About nine miles west-northwest of Island Acres State Park in Cottonwood Canyon. GPS Point: Zone 12, 0719532E, 4343192N.

Legal Description: USGS 7.5-minute quadrangle: Round Mountain. T10S R99W Section 5 SE4 SE4.

Elevation: 6200 feet.

Dominant Plant Species and/or Associations: Dominant plants include Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and coyote willow (*Salix exigua*).

General Description: The spring emerges within the stream channel in multiple locations. No discernible flow was observed from any one source, rather multiple pools appear in the channel until they finally start flowing downstream. The channel upstream from the spring is dry and dominated by big sagebrush (*Artemisia tridentata*) and rabbitbrush (*Chrysothamnus* sp.). Rio Grande cottonwood and coyote willow are dominant downstream from the spring.

Plant and Animal Species Observed: Trees and shrubs present include Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), coyote willow (*Salix exigua*), skunkbrush (*Rhus trilobata*), big sagebrush (*Artemisia tridentata*), Russian olive (*Elaeagnus angustifolia*), and wild rose (*Rosa woodsii*). Forbs include virgin's bower (*Clematis ligusticifolia*), aster (*Aster foliaceus*), common dandelion (*Taraxacum officinale*), water speedwell (*Veronica catenata*), white sweetclover (*Melilotus officinalis*), and thistle (*Cirsium* sp.). A few individuals of tamarisk (*Tamarix ramosissima*) were observed just downstream from the spring.

Butterflies were abundant.

Natural Heritage Program Element Occurrences:

No elements tracked by the CNHP were documented at this site and this spring was not located within a CNHP Potential Conservation Area. Rio Grande cottonwood with coyote willow (*Populus deltoides* ssp. *wislizeni/Salix exigua*) (GU/S1S2) is tracked by CNHP but the community at this location was not considered extensive enough to be considered for tracking as a plant community occurrence. This community is an early seral association with a mix of sapling and pole-sized Rio Grande cottonwood intermixed with coyote willow. It is recognized as the younger stage of older cottonwood associations that have more widely spaced trees. This association is often located on low stream banks and islands, but can also occur on overflow channels away from the main stream channel. It typically has a fairly dense tree canopy with little herbaceous ground cover.

Ecological Functions: This spring is in relatively good condition. An overstory of cottonwoods and a dense understory of shrubs provides good habitat for birds. Wild horses use the area frequently mainly as a watering hole as there is very little ground cover underneath the shrub layer. Groundwater discharge is occurring within the channel. The spring is likely associated with a local aquifer as opposed to alluvial groundwater given the obvious change in vegetation in the channel (sagebrush and rabbitbrush upstream of spring and cottonwood and willow downstream of spring). Streambank stabilization is good in most areas, however one portion of the spring is void of vegetation due to the fact that it appears to be a watering hole for wild horses. Nutrient cycling appears to be in balance.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: A small patch of tamarisk occurs approximately 50 feet downstream of the spring. Common dandelion and white sweetclover are also present on site.

Restoration and Management Comments: This spring is in relatively good condition. There are no apparent hydrologic alterations. Eradication of the tamarisk needs to occur before it spreads to additional areas.

Water Chemistry: Flow was visually estimated to be 1/2 GPM. The water chemistry measured within a pool was as follows:

pH:	7.3
Conductivity:	1100 µS/cm
Temperature:	10 C

Macroinvertebrates: No snails or mussels were observed.

Photos: Rocchio, Roll C #24-27.

SS-S (Brillo Spring)

Location: Little Book Cliffs spring 2. About nine miles west-northwest of Island Acres State Park in Cottonwood Canyon. GPS Point: Zone 12, 0720109E, 4343206N.

Legal Description: USGS 7.5-minute quadrangle: Round Mountain. T10S R99W Section 4 SW4 SW4.

Elevation: 6200 feet.

Dominant Plant Species and/or Associations: Dominant plants include narrowleaf cottonwood (*Populus angustifolia*), coyote willow (*Salix exigua*), and red-osier dogwood (*Cornus sericea*).

General Description: The spring discharges from a north-facing sandstone slope, forming a relatively large seep wetland. Groundwater discharge also occurs within the stream channel. The area is in a narrow sandstone canyon. The hillside seep is dominated by red-osier dogwood and moss covers much of the sandstone. The hillside seep was dry during the site visit, but given the amount of moss and density of red-osier dogwood, it is obviously much wetter during most of the year. The within channel spring was dominated by narrowleaf cottonwood and coyote willow.

Plant and Animal Species Observed: Trees and shrubs present in the hillside seep include red-osier dogwood (*Cornus sericea*), wild rose (*Rosa woodsii*), Utah serviceberry (*Amelanchier utahensis*), and Gambel's oak (*Quercus gambelii*). Forbs include aster (*Aster foliaceus*) and Canada goldenrod (*Solidago canadensis*). An abundance of unidentified moss also covers much of the exposed sandstone. Trees and shrubs present in the stream channel spring include narrowleaf cottonwood (*Populus angustifolia*) and coyote willow (*Salix exigua*). Forbs include virgin's bower (*Clematis ligusticifolia*), aster (*Aster foliaceus*), Canada goldenrod, Baltic rush *(Juncus balticus*), alkali crowfoot (*Halerpestes cymbalaria*), water speedwell (*Veronica catenata*), and willowherb (*Epilobium ciliatum*).

Natural Heritage Program Element Occurrences:

No elements tracked by the CNHP were documented at this site and this spring was not located within a CNHP Potential Conservation Area. Red-osier dogwood (*Cornus sericea*) riparian shrublands (G4/S3) are tracked by CNHP but the community is globally common and only occurrences in excellent condition are considered for tracking as a plant community occurrence. This plant association occurs adjacent to stream channels and near seeps on moist toeslopes of canyon walls. It also occurs on narrow benches in ravines and on narrow terraces of wider valleys. This association is a common riparian type that occurs in several western states, however, it is threatened by improper livestock management.

Ecological Functions: This spring is in good condition. An overstory of cottonwoods and a dense understory of shrubs provides good vegetation structure for bird habitat. Lush growth of wetland vegetation also provides browse for other species. Wild horses use the area but evidence of use in the channel spring is minimal and access to the hillside seep is very difficult due the steepness of the slope. Groundwater discharge is occurring within the channel and occurs semi-permanently in the hillside seep. Lush vegetation growth on the hillside and within the stream channel are providing streambank stabilization. Nutrient cycles appear to be intact.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: None observed.

Restoration and Management Comments: This spring is in relatively good condition. There are no apparent hydrologic alterations.

Water Chemistry: Using the weir, flow was estimated to be 5 GPM in the stream channel spring. Flow could not be measured in the hillside seep as it was dry. The water chemistry measured in the stream channel spring was as follows:

pH: 7.8
Conductivity: 1000 µS/cm
Temperature: 9 C

Macroinvertebrates: No snails or mussels were observed.

Photos: Rocchio, Roll C #30 and 31.

SS-T (Tutti Fruita Spring)

Location: Little Book Cliffs spring 3. About nine miles west-northwest of Island Acres State Park in Cottonwood Canyon. GPS Point: Zone 12, 0720280E, 4343152N.

Legal Description: USGS 7.5-minute quadrangle: Round Mountain. T10S R99W Section 4 SW4 SW4.

Elevation: 6200 feet.

Dominant Plant Species and/or Associations: Dominant plants include red-osier dogwood (*Cornus sericea*) and scouring rush (*Hippochaete hyemalis* ssp. *affinis*).

General Description: The seep discharges out of a steep sandstone wall, from underneath a white sandstone layer then flows downstream through a stand of coyote willow (*Salix exigua*) and a few narrowleaf cottonwood (*Populus angustifolia*). No discernible flow occurs until approximately 30 feet downstream, however the entire seep was very wet.

Plant and Animal Species Observed: Shrubs present in the seep include red-osier dogwood (*Cornus sericea*) and wild rose (*Rosa woodsii*). Forbs include aster (*Aster foliaceus*), Canada goldenrod (*Solidago canadensis*), water speedwell (*Veronica catenata*), and false-Solomon's seal (*Maianthemum stellata*). Graminoids present include scouring rush (*Hippochaete hyemalis* ssp. *affinis*) and Nebraska sedge (*Carex nebrascensis*). Downstream from the main seep, coyote willow (*Salix exigua*) and a few narrowleaf cottonwood (*Populus angustifolia*) trees line the streambank.

Natural Heritage Program Element Occurrences:

No Natural Heritage element occurrences were observed.

The spring is currently not contained within a CNHP Potential Conservation Area.

Ecological Functions: This spring is in good condition. Lush growth of wetland vegetation provides browse, although the topographic position of the seep does not allow easy access. Wild horses use the area. Groundwater discharge is occurring. Lush vegetation growth on the hillside is providing streambank stabilization. Nutrient cycles appear to be intact. The seep likely supports healthy invertebrate populations.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: None observed.

Restoration and Management Comments: This spring is in relatively good condition. There are no apparent hydrologic alterations.

Water Chemistry: Flow and water chemistry measurements were taken, as there was no place from which to collect data. Although, the entire area was wet, there was no discernible flow until approximately 30 ft downstream from the seep.

Macroinvertebrates: No snails or mussels were observed.

Photos: Rocchio, Roll C #28 and 29.

SS-U (Little Book Cliffs 4)

(New to BLM ArcView)

Location: Little Book Cliffs spring 4. About 9 miles west-northwest of Island Acres State Park in Cottonwood Canyon. GPS Point: Zone 12, 0719504E, 4342910N.

Legal Description: USGS 7.5-minute quadrangle: Round Mountain. T10S R99W Section 4 SE4 SE4.

Elevation: 6200 feet.

Dominant Plant Species and/or Associations: Dominant plants include alkali aster (*Brachyactis* sp.) and unidentified moss.

General Description: Groundwater seeps out of a steep sandstone alcove within a small meander of a side drainage to Cottonwood Canyon. The seep is north-facing and is shaded and cool. An unidentified moss is growing on the seepage face and is very thick, suggesting that seepage is permanent. A large cottonwood is growing above the seep, obviously tapping into the same water source that is discharging. There is very little herbaceous vegetation growing along the stream channel due to minimal soil development. Large woody debris is scattered along the stream course.

Plant and Animal Species Observed: Wild rose (*Rosa woodsii*) is the only shrub present in the seep area. Narrowleaf cottonwood *(Populus angustifolia*) saplings and coyote willow are scattered along the stream. Alkali aster (*Brachyactis* sp.) and an unidentified moss are the only plants growing in the seep.

Natural Heritage Program Element Occurrences:

No Natural Heritage element occurrences were observed.

The spring is currently not contained within a CNHP Potential Conservation Area.

Ecological Functions: This spring is in good condition. Lush growth of wetland vegetation provides browse, although the topographic position of the seep does not allow easy access. Wild horses use the area. Groundwater discharge is occurring. Lush vegetation growth on the hillside is providing streambank stabilization. Nutrient cycles appear to be intact. The seep likely supports healthy invertebrate populations.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: None observed.

Restoration and Management Comments: This spring is in relatively good condition. There are no apparent hydrologic alterations.

Water Chemistry: Flow and water chemistry measurements were taken, as there was no place from which to collect data. Although, the entire area was wet, there were no pools deep enough to extract a water sample.

Macroinvertebrates: No snails or mussels were observed.

Photos: Rocchio, Roll C #32-37.

SS-V (Salt Creek 4)

(New to BLM ArcView coverage)

Location: Salt Creek spring 4. Side drainage to Salt Creek, near Sinbad Valley in the southwest corner of Mesa County. GPS Point: Zone 12, 0679105E, 4269119N.

Legal Description: USGS 7.5-minute quadrangle: Round Mountain. T50N R19W Section 35 NE4 S2.

Elevation: 5200 feet.

Dominant Plant Species and/or Associations: Dominant plants include common reed (*Phragmites australis*), ditch reedgrass (*Calamagrostis scopulorum*), and beaked spikerush (*Eleocharis rostellata*) in the wettest areas.

General Description: This area consists of a large hillside seep on a west-facing slope surrounded by pinyon-juniper. The seep is dominated by common reed (*Phragmites australis*) and ditch reedgrass (*Calamagrostis scopulorum*), except in the wettest patches which are dominated by beaked spikerush (*Eleocharis rostellata*). Ditch reedgrass is a montane species, but is a principal component of hanging gardens in southern Utah and southwest Colorado (Welsh et al. 1993). Water seeps down the hillside and infiltrates into the colluvium only to reappear sporadically along the slope until finally draining into the stream channel below. Small pools occur in the stream channel as a result of this seepage, otherwise the channel is dry. A similar but smaller seep discharges from the opposite slope on a low bench above the main stream channel.

Salt Creek drains east out of Sinbad Valley, although most flow is derived from the numerous springs that discharge within the canyon between Sinbad Valley and the Dolores River. Riparian vegetation along Salt Creek is sparse and consists of scattered cottonwoods (*Populus* sp.), coyote willow (*Salix exigua*), skunkbrush (*Rhus trilobata*), and tamarisk (*Tamarix ramosissima*).

Plant and Animal Species Observed: Skunkbrush (*Rhus trilobata*) is the only shrub present in the seep. Other species include common reed, ditch reedgrass (*Calamagrostis scopulorum*), beaked spikerush (*Eleocharis rostellata*), and bottle gentian (*Pneumonanthe affinis*).

Numerous dragonflies were observed. Tadpoles were observed in many of the small pools.

Natural Heritage Program Element Occurrences:

Table 23. Natural Heritage elements at SS-V.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Eleocharis rostellata	Beaked spikerush emergent wetland	G2G3	S2S3	C

The beaked spikerush emergent wetland is an uncommon plant association and is found in wetlands with permanent flowing water including calcareous wet meadows, seeps, stream margins, and near mineral springs. This occurrence is very small and thus ranked as a "C" occurrence.

This spring is located within CNHP's **Salt Creek Potential Conservation Area** which is ranked as a **B2** (Very High Biodiversity Significance) site (Rocchio et al. 2002). The Salt Creek PCA contains at least three additional springs (SS-O, SS-P, SS-Q) that support a range of plant communities. The high CNHP biodiversity rank is based on wild privet (*Foresteira pubescens*) shrublands (G1G2/S1S2) located at springs SS-P and SS-Q.

Ecological Functions: This spring is in good condition. Lush growth of wetland vegetation provides browse, although the topographic position of the seep does not allow easy access for many species. Groundwater discharge is occurring. Lush vegetation growth on the hillside is providing streambank stabilization. Nutrient cycles appear to be intact. The seep likely supports healthy invertebrate populations and provides permanent flow to an otherwise intermittent stream.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: None observed.

Restoration and Management Comments: This spring is in relatively good condition. There are no apparent hydrologic alterations.

Water Chemistry: Did not collect flow or water quality data as there was no visible surface water in the seep area. Small pools occurred in the stream channel (where the seep drains into the channel) but due to the stagnant nature of the water and the possibility that the pools also held rainwater data was not collected under the assumption that the readings would not reflect water quality of the seep.

Macroinvertebrates: No snails or mussels were observed.

Photos: Rocchio, Roll D #1-6.

SS-W (Sulphur Gulch)

(New to BLM ArcView coverage)

Location: Sulphur Gulch. From DeBeque, follow "Designated ORV Route" and Wild Horse Area signs south about five miles to edge of Sulphur Gulch. GPS Point: Zone 12, 735065E, 4350945N.

Legal Description: USGS 7.5-minute quadrangle: Wagon Track Ridge. T9S R98W Section 13 NW4 NE4.

Elevation: 4920 feet.

Dominant Plant Species and/or Associations: The dominant plant association is threesquare bulrush (*Schoenoplectus pungens*).

General Description: Sulphur Gulch is a steep sided canyon carved within the Utah juniper (*Juniperus osteosperma*) and big sagebrush (*Artemisia tridentata tridentata*) dominated uplands. The canyon slopes also support scattered ponderosa pine (*Pinus ponderosa*). Within the gulch a spring supports a marsh community of threesquare bulrush (*Schoenoplectus pungens*) (G3G4 S3). The wetland is large relative to others found at similarly low elevations in Mesa County. A thick crust of alkaline salts coats the soils in the vicinity of the springs and seeps. In addition to threesquare bulrush, the sandy alkaline floodplain soils support saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*), seepwillow (*Baccharis salicina*), and greasewood (*Sarcobatus vermiculatus*). Tadpoles were observed within the channel and adult damselflies and dragonflies were abundant.

The uplands and alkaline floodplain also support two rare plants: the federally listed threatened Uinta Basin hookless cactus (*Sclerocactus glaucus*) and the BLM sensitive species Debeque milkvetch (*Astragalus debequaeus*). The nearby BLM designated Pyramid Rocky ACEC (Area of Critical Environmental Concern) and state designated Natural Area contains populations of these two rare species as well. These areas are within the CNHP Pyramid Rock Potential Conservation Area summarized in Lyon et al. (1996).

The proposed Sulphur Gulch Reservoir would inundate the wetland and rare plants.

Plant and Animal Species Observed: Trees and shrubs within the riparian area include greasewood, seepwillow, broom snakeweed (*Gutierrezia sarothrae*), rubber rabbitbrush (*Chrysothamnus nauseosus*), big sagebrush, and tamarisk (*Tamarix ramosissima*). Graminoids include threesquare bulrush, alkali sacaton, saltgrass, and Baltic rush (*Juncus balticus*).

Tadpoles were observed in the small flowing channel. Many damselflies and dragonfly adults were present.

Natural Heritage Program Element Occurrences:

Table 24. Natural Heritage elements at SS-W.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Schoenoplectus pungens	Bulrush marsh	G3G4	S3	B
Plants				
Astragalus debequaeus	Debeque milkvetch	G2	S2	C
Sclerocactus glaucus (uplands)	Uinta Basin hookless cactus	G3	S3	C

The threesquare bulrush (*Schoenoplectus pungens*) plant association forms small low stature (1-3 ft) marshes in low-lying swales, abandoned channels, and overflow channels where the soils remain saturated. This association is characterized by pure stands of threesquare bulrush and occasionally with a few other graminoid species.

This spring is located within CNHP's **Sulphur Gulch Potential Conservation Area** which is ranked as a **B3** (High Biodiversity Significance) site (Rocchio et al. 2002). The high CNHP biodiversity rank is based on the good example of bulrush marsh wetland (*Schoenoplectus pungens*) (G3G4/S3) at spring SS-W. Additionally, this site supports fair occurrences of two rare plants: Debeque milkvetch (*Astragalus debequaeus*) (G2 S2) and Uinta Basin hookless cactus (*Sclerocactus glaucus*) (G3 S3). Larger populations of these rare plants and others occur nearby at Pyramid Rock within a BLM designated Area of Critical Environmental Concern and state designated Natural Area (see **Pyramid Rock Potential Conservation Area** in Lyon et al. 1996).

Ecological Functions: This spring is in good condition. The wetland likely attenuates flood flow within the channel and aids in sediment stabilization. Groundwater discharge appears to be perennial and provides a water source for wildlife in an otherwise very dry region. Nutrient cycles appear to be intact. This reach is not fish habitat due to the intermittent nature of the stream both upstream and downstream of the spring. Tadpoles and aquatic insects including damselflies and dragonflies were present. There is no surface outflow from the gulch, except during precipitation events, indicating little opportunity for production export. This wetland is one of the largest known wetlands (not associated with the Colorado River) occurring at low elevation within Mesa County.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: A few young tamarisk are present. Some cheatgrass (*Bromus tectorum*) is also present.

Restoration and Management Comments: This spring is in good condition and appears hydrologically intact. Restoration actions could include tamarisk control. The primary management issue is the proposed Sulphur Gulch Reservoir that would inundate the wetland and rare plants.

Water Chemistry: Flow was visually estimated at approximately 1 gpm in the creek. The water chemistry measured at the spring was as follows:

pH: 8.3
Conductivity: 1200 µS/cm
Temperature: 14 C

Macroinvertebrates: No snails or mussels were observed. Adult damselflies and dragonflies were abundant.

Photos: Doyle, 2002 Roll 1, #35-37.

SS-X (Bear, Robertson, and Ravine Springs)

Location: From Glade Park, take DS Road into Utah then turn south on dirt road for about five miles. North of Granite Creek. Hike up canyons to springs. We mistakenly visited a spring in the same drainage as Bear Spring but further downstream and in Utah. The vegetation and functioning condition of the Utah spring is likely similar to those of the nearby Bear, Robertson, and Ravine springs. The following GPS point was taken at the spring in Utah. GPS Point: Zone 12, 668551E, 4303315N.

Legal Description: USGS 7.5-minute quadrangle: Steamboat Mesa. Utah Spring: T22S R26E Section 29. Bear Spring: T14S R104W Section 5. Robertson Spring: T14S R104W Section 7. Ravine Spring: T14S R104W Section 9. The locations for Bear, Robertson, and Ravine springs are taken from the BLM Water Atlas.

Elevation: Utah spring 6600 feet. Bear Spring: 7120 feet. Robertson Spring: 7180 feet. Ravine Spring: 7080 feet.

Dominant Plant Species and/or Associations: Dominant plants along the creek include Rio Grande cottonwood saplings (*Populus deltoides* ssp. *wislizeni*), lanceleaf cottonwood (*Populus acuminata*), and coyote willow (*Salix exigua*).

General Description: This spring emerges from cracks within granite outcrops within a steep, narrow, southwest-facing canyon. The vegetation along the creek is sparse with scattered cottonwoods, coyote willow, skunkbush sumac (*Rhus trilobata*), and Wood's rose (*Rosa woodsii*). Moss and green algae coat much of the smooth rock within the narrow rivulet and small pools. The adjacent slopes are vegetated with pinyon and juniper with sagebrush and blackbrush (*Coleogyne ramosissima*).

Plant and Animal Species Observed: Trees, saplings, and shrubs present include Rio Grande cottonwood, lanceleaf cottonwood,Gambel's oak (*Quercus gambelii*) skunkbush, and Wood's rose. Grasses noted include squirreltail (*Elymus elymoides*), basin wildrye (*Leymus cinereus*), and the non-natives cheatgrass (*Bromus tectorum*) and Kentucky bluegrass (*Poa pratensis*).

The only aquatic insects observed were diving beetles in the small pools. No snails or mussels were noted.

Natural Heritage Program Element Occurrences: No elements tracked by the CNHP were documented at this site and this spring was not located within a CNHP Potential Conservation Area. The springs are located less than two miles north of CNHP's Granite Creek Potential Conservation Area. The Granite Creek PCA is rated as High Biodiversity Significance (B3) and contains good examples of a variety of riparian and upland communities (Rocchio et al. 2002).

Ecological Functions: This spring is in good condition. Groundwater discharge occurs along the canyon. There is no downstream transport of organic matter/nutrients during

base flow conditions as all the flow reinfiltrates before it reaches the base of the slope. The pools within the channel provide water for wildlife.

Proper Functioning Condition Rating: This spring is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: Non-native grasses observed include cheatgrass and Kentucky bluegrass.

Restoration and Management Comments: This spring is in relatively good condition. There are no apparent hydrologic alterations. Cheatgrass is the main non-native invasive species present.

Water Chemistry: Flow was estimated at less than 1 gpm in the creek. The water chemistry measured in the stream channel was as follows:

pH:	7.8
Conductivity:	620 µS/cm
Temperature:	10 C

Macroinvertebrates: No snails or mussels were observed.

Photos: Doyle, 2002 Roll 1 #30-32.

SS-Y (Mee Canyon)

(New to BLM ArcView coverage)

Location: Near the west (Glade Park) entrance to the Colorado National Monument, turn west at the sign to the Black Ridge Wilderness access roads. Travel the upper access road about 6 miles to the Mee Canyon trailhead. Hike 2.8 miles down into the canyon following trail often marked only by cairns. Hike up the creek to the seeps. Unable to measure UTM from canyon bottom.

Legal Description: USGS 7.5-minute quadrangle: Battleship Rock. T11S R103W Section 23.

Elevation: 5600 feet.

Dominant Plant Species and/or Associations: The seeps themselves support hanging gardens of Mancos columbine (*Aquilegia micrantha*) with various moss species. Riparian communities along the creek inlcude box elder with scouringrush horsetail (*Acer negundo/Hippochaete hyemalis*) and coyote willow with scouringrush horsetail (*Salix exigua/Hippochaete hyemalis*).

General Description: This scenic sandstone canyon contains an enormous, 300 foot deep cavern cut by a meander of a small stream that drains to the Colorado River. The canyon is rimmed with red Entrada sandstone, and has steep sides of the Kayenta and Wingate formations. Not far from the cavern is a grotto with seeping walls covered by mosses and yellow Mancos columbine (*Aquilegia micrantha*). Below the dripping seep is a pool and a stand of the non-native reed canarygrass (*Phalaris arundinacea*). Also growing around the pool are Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), singleleaf ash (*Fraxinus anomala*), strapleaf willow (*Salix eriocephala* var. *ligulifolia*), virgin's bower (*Clematis ligusticifolia*), and scouringrush horsetail (*Hippochaete hyemalis*). A second set of seeps occurs around the bend. This second set has a large plunge pool below and supports Mancos columbine and mosses but has little other vegetation.

The narrow riparian area in the canyon bottom has scattered box elders that are regenerating. The stream bank has a dense growth of scouring rushes with hundreds of giant helleborine orchids (*Epipactis gigantea*) growing among them. Other riparian species include Baltic rush (*Juncus balticus*), skunkbush sumac (*Rhus trilobata*), coyote willow (*Salix exigua*), strapleaf willow (*Salix eriocephala* var. *ligulifolia*), and cattails (*Typha* sp.). The bottom is ungrazed, and difficulty of access to the upper reaches has probably protected it from human impacts.

Dry slopes on the side of the canyon have scattered Utah juniper (*Juniperus osteosperma*), Fremont barberry (*Mahonia fremontii*), and cliffrose (*Cowania mexicana*). The mesa at the head of the canyon supports an excellent example of the Utah juniper/Salina wild rye (*Juniperus osteosperma/Leymus salinus*) association. Other

species on the mesa include black sage (*Artemisia nova*), Indian ricegrass (*Achnatherum hymenoides*), and needle-and-thread grass (*Hesperostipa* sp.). Raptors nest in the Wingate sandstone cliffs, and the canyon treefrog (*Hyla arenicolor*) inhabits various ponds along the stream. A few tamarisk were noted in the upper reach of the canyon. Mee Canyon occurs within the BLM Colorado Canyons National Conservation Area and the Black Ridge Canyons Wilderness (designated October 2000).

Plant and Animal Species Observed: Tree species observed within the canyon include Rio Grande cottonwood, Rocky Mountain juniper (*Juniperus scopulorum*), boxelder, strapleaf willow and singleleaf ash. Shrub and forb species noted include skunkbush sumac, coyote willow, Oregon grape (*Mahonia repens*), barberry (*Berberis fendleri*), snowberry (*Symphoricarpos* sp.), poison ivy (*Toxicodendron rydbergii*), Mancos columbine, virgin's bower, false Solomon's seal (*Maianthemum stellatum*), milkweed (*Asclepias* sp.) and giant helleborine orchid. Graminoids include Baltic rush, sedges (*Carex* spp.), and cattail (*Typha* sp.).

Birds noted included abundant violet green swallows and a canyon wren. Aquatic insects observed were water striders (Families Gerridae and Microvelidae) and whirligig beetles (Family Gyrinidae). No snails or mussels were noted.

Natural Heritage Program Element Occurrences:

Table 25. Natural Heritage elements at SS-Y.

Element	Common Name	Global Rank	State Rank	EO Rank
Plant Communities				
Aquilegia micrantha- (*Mimulus eastwoodiae*)	Hanging gardens	G2G3	S2S3	B
Acer negundo/Hippochaete hyemalis	Riparian woodland	GU	SU	B
Salix exigua/Hippochaete hyemalis	Riparian shrubland	GU	S2S4	B
Juniperus osteosperma/Leymus salinus (uplands)	Mesic Western Slope pinyon-juniper woodlands	GU	SU	B
Plants				
Epipactis gigantea	Giant helleborine orchid	G3	S2	A
Animals				
Hyla arenicolor	Canyon treefrog	G5	S2	E

This spring is located within CNHP's **Mee Canyon Potential Conservation Area** which is ranked as a **B2** (Very High Biodiversity Significance) site (Rocchio et al. 2002). The high biodiversity rank is based on the rarity of the hanging garden plant community. The range of good condition riparian and upland communities and the presence of giant helleborine orchids and canyon treefrogs add to the biodiversity significance of the site. Eastwood monkeyflower (*Mimulus eastwoodiae*) is not found growing with Mancos columbine at the Mee Canyon seeps. However, because the Mee Canyon seeps appear very similar to seeps on Sewemup Mesa in Mesa County and others in Delta, Montrose,

and San Miguel counties where the monkeyflower does grow, the Mee Canyon seeps are grouped into the same plant association.

Ecological Functions: The seeps are in excellent condition. They discharge groundwater to the creek supporting a range of wetland vegetation. The vegetation aids in flood attenuation as evidenced by flood debris suspended in trees and shrubs. The seeps have a high uniqueness factor and are very striking along with the nearby alcove. The pools and channel within the channel provide water for wildlife.

Proper Functioning Condition Rating: These seeps are rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: Non-natives noted include tamarisk (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), and reed canarygrass (*Phalaris arundinaceae*). The few tamarisk and Russian olive noted were scattered along the riparian area.

Restoration and Management Comments: The seeps are in excellent condition. Restoration activities within the riparian area could include control of non-native species including tamarisk, Russian olive, and reed canarygrass.

Water Chemistry: Flow was visually estimated at less than 1/2 gpm from each of the seeps and about 2 gpm in the creek. The water chemistry measured at a seep was as follows:

pH:	8.5
Conductivity:	500 µS/cm
Temperature:	13 C

Macroinvertebrates: No snails or mussels were observed. Water striders (Families Gerridae and Microvelidae) and whirligig beetles (Family Gyrinidae) were observed in many of the small pools at the base of the seeps and along the creek.

Photos: Doyle 2002, Roll 1 #19-27.

SS-Z (Wright Spring)

Location: North side of Highway 141 approximately five miles east of Gateway. Small stone house at base of hill. Follow brook up hill to spring. GPS Point: Zone 12, 681216E, 4288074N.

Legal Description: USGS 7.5-minute quadrangle: Gateway. T15S R103W Section 28. NW4NW4.

Elevation: 5150 feet.

Dominant Plant Species and/or Associations: The spring and associated brook are dominated by the non-native Kentucky bluegrass. Trees and shrubs include Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), skunkbrush sumac (*Rhus trilobata*), and coyote willow (*Salix exigua*).

General Description: The spring emerges from from granite boulders on the side of a hill. The creek flows downhill to a small meadow with a small stone house. There is no outflow from the meadow. A heavily grazed cow trail follows the creek down the hill and into the meadow. Non-natives are dominant including Kentucky bluegrass, alfalfa (*Medicago sativa*), dandelion (*Taraxacum officinale*), common plantain (*Plantago major*), and cheatgrass (*Bromus tectorum*). Trees and shrubs include Rio Grande cottonwood, skunkbrush sumac, and coyote willow. The uplands are pinyon-juniper woodlands. A state rare plant in the gentian family, Great Bain centaury (*Centaurium exaltatum*) (G5 S1), was documented at this site in 1996.

Plant and Animal Species Observed: Tree and shrub species observed include Rio Grande cottonwood, skunkbrush sumac, and coyote willow. Aquatic plants include watercress (*Nasturtium officinale*) and alkali crowfoot (*Halerpestes cymbalaria*). Native forbs observed include virgin's bower (*Clematis ligusticifolia*), annual sunflower (*Helianthus annuus*), poison ivy (*Toxicodendron rydbergii*), and wild licorice (*Glycyrrhiza lepidota*). Native graminoids include Baltic rush (*Juncus balticus*), Nebraska sedge (*Carex nebrascensis*), spikerush (*Eleocharis palustris*).

Damselfly nymphs and adults were observed. No snails or mussels were noted.

Natural Heritage Program Element Occurrences:

Table 26. Natural Heritage elements at SS-Z.

Element	Common Name	Global Rank	State Rank	EO Rank
Plants				
Centaurium exaltatum	Great Basin centaury	G5	S1	D

Great Basin centaury is a tall (up to 20 cm) plant in the gentian family. It is typically found along seasonal pools and blooms in late summer. A small population of the plant was documented at this location in July 1996. The plants were not noted during our site visit in May 2002 but may be present later in the season. This spring is not located within a CNHP Potential Conservation Area.

Ecological Functions: The spring and brook function as a water source for wildlife. Groundwater discharge is likely perennial. The water flows down the hill and infiltrates or evaporates at the base of the hill. The spring provides habitat for a state rare plant (Great Basin centaury).

Proper Functioning Condition Rating: These seeps are rated as Functioning at Risk with a downward trend. The ecological functioning of the spring and brook hasve been altered by hoof action and heavy grazing.

Non-native and Aggressive Species: Non-natives noted include Kentucky bluegrass, cheatgrass, alfalfa, watercress, common plantain, and dandelion.

Restoration and Management Comments: The spring and brook are in fair to poor condition. The spring has not been developed (non-functioning black pipe present) but hoof action and grazing have altered the hydrologic regime. Restoration activities could include grazing exclosures and control of non-native species.

Water Chemistry: Flow measured using weir: 1.5 gpm. The water chemistry measured at a spring was as follows:

pH:	7.8
Conductivity:	1400 µS/cm
Temperature:	not measured

Macroinvertebrates: No snails or mussels were observed. Damselfly larvae observed along with adult damselflies.

Photos: Doyle 2002, Roll 1 #17-18.

SS-AA (Gateway Spring)

Location: North of Gateway. Take 4.1 road about 1.5 miles north of Gateway. Walk up dry canyon to spring. GPS Point: Zone 12, 673410E, 4283389N.

Legal Description: USGS 7.5-minute quadrangle: Gateway. T51N R19W Section 17. SE4.

Elevation: 4720 feet.

Dominant Plant Species and/or Associations: Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and skunkbrush sumac (*Rhus trilobata*) are dominant in the dry canyon bottom in the vicinity of the spring. At the spring itself dominant plants include Baltic rush (*Juncus balticus*), smooth horsetail (*Hippochaete laeviagata*), and common spikerush (*Eleocharis palustris*).

General Description: The spring occurs within Gateway Canyon across the Dolores River from the monolithic Palisade. The spring was dry during our May 2002 visit but evidenced by wetland vegetatation and small pools of ponded water. Wetland vegetation growing at the spring includes Baltic rush, field horsetail (*Equisetum arvense*), smooth horsetail, common spikerush, cattail (*Typha* sp.), the non-native grass common reed (*Phragmites australis*), and scattered young tamarisk (*Tamarix ramosissima*). In the vicinity of the spring the dry wash supported riparian vegetation including Rio Grande cottonwood, skunkbrush sumac, and tamarisk. The spring appears to be fenced. Near the downstream end of the fence and a rusted stock tank is a small stand of the non-native Russian knapweed.

The gently sloping uplands support a community of pinyon pine with blackbrush (*Pinus edulis/Coleogyne ramosissima*) (G4/S2). Peregrine falcon are known to nest in the vertical Wingate sandstone cliffs.

The nearby Dolores River riparian area is dominated by scattered Rio Grande cottonwood, coyote willow (*Salix exigua*), tamarisk, big sagebrush (*Artemisia tridentata*), skunkbrush (*Rhus trilobata*), and wild privet (*Forestiera pubescens*). The largest cottonwood gallery along the Dolores River in Mesa County occurs just north of Gateway. Tamarisk is fairly prevalent in the stand. The wild privet stand occurs on a sandy bench above the river and forms an impenetrable thicket. Coyote willow and skunkbush also occur in the stand. There is very little herbaceous understory in this stand.

North of Gateway, along the roads along the east and west sides of the Dolores River, in the alluvial soils deposited by the river, are found two of the rarest plants in Colorado, the Dolores skeletonplant (*Lygodesmia doloresensis*) and the Fisher Towers milkvetch (*Astragalus piscator*). They grow among the common desert shrub species shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), prickly pear cactus (*Opuntia polyacantha*), and Indian rice grass (*Oryzopsis hymenoides*). Hay meadows dot the floodplain on a few benches. This stretch of the river is heavily infested with tamarisk

and Russian knapweed (*Acroptilon repens*) and is heavily grazed by domestic livestock. Roundtail chub and flannelmouth sucker are found in this stretch of the Dolores River (Bureau of Land Management, 1990). However, records of these fish are not in CNHP's database.

Plant and Animal Species Observed: Tree and shrub species observed include Rio Grande cottonwood, singleleaf ash (*Fraxinus anomala*), skunkbrush sumac, sagebrush (*Artemisia tridentata*), cliffrose (*Purshia stansburiana*), and tamarisk. Graminoids observed include Baltic rush, field horsetail, smooth horsetail, common reed, common spikerush, cattail, and cheatgrass.

No aquatic insects, snails or mussels were noted.

Natural Heritage Program Element Occurrences:

Table 27. Natural Heritage elements at SS-AA.

Element	Common Name	Global Rank	State Rank	EO Rank
Plants				
Pinus edulis/ Coleogyne ramosissima (uplands)	West Slope pinyon woodland	G4	S2	E

This spring is located just west of CNHP's **Gateway Potential Conservation Area** which is ranked as a **B1** (Outstanding Biodiversity Significance) site (Rocchio et al. 2002). The PCA contains multiple occurrences of the globally critically imperiled (G1) Dolores skeletonplant (Lygodesmia doloresensis). The Dolores skeletonplant is known only from Mesa County. It occurs on the reddish alluvial soils on both sides of the Dolores River between Gateway and the Utah border. The globally imperiled (G2G3) Fisher Tower milkvetch is also found within the Gateway PCA.

Ecological Functions: The spring functions as an ephemeral source of water for wildlife. The vegetation along the riparian area likely attenuates seasonal floods.

Proper Functioning Condition Rating: This seep is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: Non-native species include tamarisk, Russian knapweed, common reed, and cheatgrass (*Bromus tectorum*).

Restoration and Management Comments: Tamarisk removal and control of Russian knapweed is needed at this site.

Water Chemistry: There was standing water at this spring but no flow. The water chemistry measured within a pool of standing water was as follows:

pH: 7.8
Conductivity: 1200 µS/cm
Temperature: 25 C

Macroinvertebrates: No snails or mussels were observed.

Photos: Doyle 2002, Roll 1 #14-16.

SS-BB (Beehive #1 Spring)

Location: North of Molina. From Mesa, take KE.00 road approximately 2.8 miles east to BLM Road 51.1. Take 51.1 road approximately 2.3 miles south to the spring. GPS Point: Zone 12, 751279E, 4337424N.

Legal Description: USGS 7.5-minute quadrangle: Molina. T10S R96W Section 27. SE4SW4.

Elevation: 6320 feet.

Dominant Plant Species and/or Associations: Dominant plants at the spring include serviceberry (*Amelanchier utahensis*), Wood's rose (*Rosa woodsii*), clustered field sedge (*Carex praegracilis*), and Kentucky bluegrass (*Poa pratensis*).

General Description: A small fenced spring on a south-facing hillside. The spring emerges from cobble sized volcanic rocks and flows under the adjacent dirt road in a culvert to a small flat opening below. Vegetation growing at the spring includes serviceberry, clustered field sedge, Kentucky bluegrass, Wood's rose, big sagebrush (*Artemisia tridentata tridentata*), Baltic rush (*Juncus balticus*), and moss. The flat wet meadow below supports clustered field sedge, Baltic rush, Kentucky bluegrass, alkali crowfoot (*Halerpestes cymbalaria* subsp. *saximontana*).

The uplands are pinyon juniper woodlands with greasewood (*Sarcobatus vermiculatus*) and big sagebrush.

No aquatic insects, snails or mussels were noted.

Natural Heritage Program Element Occurrences:

No elements tracked by the CNHP were documented at this site and this spring was not located within a CNHP Potential Conservation Area.

Ecological Functions: The spring functions as a source of water for wildlife and cattle in a dry region.

Proper Functioning Condition Rating: This seep is rated as Proper Functioning Condition as ecological processes appear to be intact.

Non-native and Aggressive Species: Non-native species include Kentucky bluegrass, dandelion, and a weedy mustard (*Lepidium* sp.).

Restoration and Management Comments: The spring source has been fenced and the water channeled through a culvert. No restoration/management recommendations.

Water Chemistry: The flow at the spring was visually estimated at 1 gpm. The water chemistry measured at the spring was as follows:

pH: 8.6
Conductivity: 720 µS/cm
Temperature: 10 C

Macroinvertebrates: No snails or mussels were observed.

Photos: Doyle 2002, Roll 1 #12-13.

REFERENCES CITED

Adamus, P. R., L.T. Stockwell, E.J. Jr. Clairain, M.E. Morrow, L.P. Pozas, and R.D. Smith. 1991. Wetland Evaluation Technique (WET) Vol. 1: Literature Review and Evaluation Rationale. U.S. Army Corps of Engineers, Springfield, VA.

Anderson, M., P. Bougeron, M.T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin, D.H. Goodman, S. Landaal, K.D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A.S. Weakley. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume II. The National Vegetation Classification System: list of types. The Nature Conservancy, Arlington, Virginia.

Aplet, G.H., R.D. Laven, and F.W. Smith. 1988. Patterns of community dynamics in Colorado Engelmann spruce-subalpine fir forests. Ecology 69:312-319.

Bailey, R.G., P.E. Avers, T. King, and W.H. McNab. 1994. Ecoregions and Subregions of the United States (Map). Scale 1:75,000,000; Colored. U.S. Geological Survey, Washington D.C.

Blaisdell, J.P. and R.C. Holmgren. 1984. Managing Intermountain Rangelands--Salt-Desert Shrub Ranges. Gen. Tech. Report INT-163. U. S. D. A. Forest Service, Intermountain Forest and Range Experiment Station, Ogden UT.

Burdick, B.D. 1995. Ichthyofuanal Studies of the Gunnison River, Colorado, 1992-1994. Aspinall Unit Umbrella Studies, Recovery Program Project No. 42, Final Report. Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. U.S. Department of Interior, Fish and Wildlife Service, Grand Junction, CO.

Bureau of Land Management. 1990. Dolores River Instream Flow Assessment, Project Report. U.S. Department of Interior. Report # BLM/YA?PR-900/003+7200. Denver, CO.

Bureau of Land Management. 1993. *Process for Assessing Proper Functioning Condition*, U.S. Department of the Interior, Bureau of Land Management, Service Center, Denver, CO.

Bureau of Land Management. 1994. *Process for Assessing Proper Functioning Condition for Lentic Riparian-Wetland Areas*. TR 1737-11, U.S. Department of the Interior, Bureau of Land Management, Service Center, Denver, CO.

Bureau of Land Management. 1998. *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas.*. TR 1737-15, U.S. Department of the Interior, Bureau of Land Management, National Applied Resources Sciences Center, Denver, CO.

Bureau of Land Management. 1999. Unaweep Seep Natural Area Management Plan, including the Environmental Assessment. United States Department of Interior. BLM, Grand Junction Resource Area.

Bureau of Land Management. 2000. A Handbook for the Management of Seeps and Springs in the Great Basin. Sada, D.W. (editor), JE. Williams, J.C. Silvey, A. Halford, J. Ramakka, P. Summers, and L. Lewis.

Carsey, K. D. Cooper, K. Decker, and G. Kittel. 2001. Comprehensive Statewide Wetlands Classification and Characterization, Wetland Plant Associations of Colorado. Report prepared for Colorado Department of Natural Resources, Denver, CO by Colorado Natural Heritage Program, Fort Collins, CO.

Chronic, H. 1980. Roadside Geology of Colorado. Mountain Press Publishers, Missoula, MT.

Cooper, D.J. and C. Severn. 1994. Ecological Characteristics of Wetlands at the Moab Slough, Moab, UT. Unpublished report prepared for: Recovery Program of the Endangered Fishes of the Upper Colorado River Basin U.S. Department of Interior, Fish and Wildlife Service, Denver, CO.

Erdman, J.A. 1970. Pinyon-Juniper Succession after Natural Fires on Residual Soils of Mesa Verde, Colorado. Brigham Young University Science Bulletin, Biological Series, Volume XI, Number 2.

Ferris C.D. and F.M. Brown. 1981. Butterflies of the Rocky Mountain States. University of Oklahoma Press. Norman, OK.

Flahault, C. and C. Shroter. 1910. Rapport sur la nomenclature phytogeographique. Proceedings of the Third International Botanical Congress, Brussels 1: 131-164.

Graf, W.L. 1978. Fluvial adjustments to the spread of tamarisk in the Colorado Plateau region. Bulletin of the Geological Society of America 89: 1491-1501.

Hershler, R. 1998. A sytematic review of the Hydrobiid Snails (Gastropoda: Rissooidea) of the Great Basin, Western United States. Part 1. Genus *Pyrgulopsis*. Veliger pp. 1-132.

Hendrickson, D.A. and W.L. Minckley. 1984. Cienegas-Vanishing Climax Communities of the American Southwest. Desert Plants. Volume 6. Number 3.

Hynes, H.B.N. 1970. The Ecology of Running Waters, University of Toronto Press, Toronto, Ontario.

Irving, D.B. and B.D. Burdick. 1995. Reconnaissance Inventory and Prioritization of Existing and Potential Bottomlands in the Upper Colorado River Basin 1993-1994. Colorado River Fishery Project, U.S. Fish and Wildlife Service, Grand Junction, CO.

Johnston, B.C. 1987. Plant Associations of Region Two. 4th ed. USDA Forest Service R2-ECOL-87-02. Rocky Mountain Region, Lakewood, CO.

Knight, D. H. 1994. Mountains and Plains: The Ecology of Wyoming Landscapes. Yale University Press: New Haven and London. 338 pp.

Knopf, F.L., R.R. Johnson, T. Rich, F. B. Samson, and R. C. Sears. 1988. Conservation of riparian ecosystems in the United States. Wilson Bull. 10(2):272-284.

Lyon, P., C. Pague, R. Rondeau, L. Renner, C. Slater, and C. Richard. 1996. Natural Heritage Inventory of Mesa County, Colorado. Prepared for Mesa County Commissioners. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Martinson, R.J. 1980. Macroinvertebrate Community Structure of Springbrook Habitats in the Piceance Basin, Colorado. Masters Thesis. Colorado State University, Fort Collins, CO.

McCabe, D.J. 1998. Studies in Crenobiology: The Biology of Springs and Springbrooks. (Edited by L. Botosaneana, Bckhuys Publishers, Leiden, The Netherlands.

Miller, R.F. and P.E. Wigand. 1994. Holocene changes in semiarid pinyon-juniper woodlands. Bioscience 44(7):465-474.

Mutel, C.F. and J.C. Emerick. 1992 (2nd ed.). From Grasslands to Glacier: The Natural History of Colorado and the Surrounding Region. Johnson Books: Boulder, Colorado.

Myers, M.J. and V.H. Resh. 1999. Spring-Formed Wetlands of the Arid West: Islands of Aquatic Invertebrate Biodiversity. In Invertebrates in Freshwater Wetlands of North America: Ecology and Management (Edited by D.P Batzer, R.B. Rader, and S.A. Wissinger) John Wiley & Sons, Inc.

National Audubon Society. 2000. Important Bird Areas of Colorado. Compiled by K.A. Cafaro. Audubon-Colorado, Boulder, CO.

Nature Conservancy, The. 1989. Element Stewardship Abstract for *Rubus discolor*, (*Rubus procerus*) (Himalayan blackberry). Prepared by Marc Hoshovsky for The Nature Conservancy, Arlington, VA.

Nature Conservancy, The. 1999. An Allicance Level Classification of Vegetation of the Conterminous Western United States. Submitted to the University of Idaho, Cooperative Fish and Wildlife Research Unit.

Opler, P.A. and A.B. Wright. 1999. Peterson Field Guides. Western Butterflies.

Houghton Mifflin Company, New York, NY.

Osmundson, D.B. 2001. Flow Regimes for Restoration and Maintenance of Sufficient Habitat to Recover Endangered Razorback Sucker and Colorado Pikeminnow in the Upper Colorado River: Interim Recommendations for the Palisade-to-Rifle Reach. Final Report. Recovery Implementation Program, Project No. 74. Colorado River Fishery Project, U.S. Fish and Wildlife Service, Grand Junction, CO.

Pague, C.A., and M. Carter. 1996. Unpublished data.

Peet, R.K. 1988. Forests of the Rocky Mountains. In M. G. Barbour and W. D. Billings (eds.) North American Terrestrial Vegetation. Cambridge Univ. Press, New York.

Rocchio, J., J. Sovell, and P. Lyon. 2001. Survey of Seeps and Springs within the Bureau of Land Management's Grand Junction Field Office Management Area (Garfield County, CO). Unpublished report submitted to Bureau of Land Management, Grand Junction Field Office. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Rocchio, J., G. Doyle, P. Lyon, and D. Culver. 2002. Survey of Critical Wetlands and Riparian Areas in Mesa County, Colorado. Unpublished report submitted to Colorado Department of Natural Resources and Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Sada, D. W. and G.L. Vinyard. In press. Anthropogenic Changes in Biogeography of Great Basin Aquatic Biota. Smithsonian Contributions of the Earth Sciences.

Sada, D.W. and J.L. Nachlinger 1996. Spring Mountains Ecosystem: Vulnerability of Spring-Fed Aquatic and Riparian Systems to Biodiversity Loss. Unpublished report to the U.S. Fish and Wildlife Service, Reno, NV, Reno, NV.

Singh, T. and N.E. West. 1971. Comparison of some multivariate analyses of perennial Atriplex vegetation in southeastern Utah. Vegetatio 23:5-6(289-313).

Tisdale, E.W., M. Hironaka, and M.A. Fosberg. 1969. The Sagebrush Region in Idaho. University of Idaho Agricultural Experiment Station bulletin 512. Moscow, Idaho.

United States Department of Agriculture (USDA) Soil Conservation Service, 1978. Soil Survey of Mesa County Area, Colorado. United State Department of Agriculture, Soil Conservation Service.

United States Department of Agriculture (USDA) Soil Conservation Service. 1989. Colorado Climate. Temperature, Precipitation, Frost, and Growth Data. SCS, Ecological Sciences and Snow Survey, Lakewood, CO.

United States Department of Agriculture (USDA), NRCS 2001. The PLANTS database, Version 3.1 (http://plants.usda.gov/plants). National Plant Data Center, Baton Rouge, LA 70874-4490 USA (for common names, distributions) www.fs.fed.us/database/feis/

United States Department of Interior (USDI) Bureau of Land Management, Grand Junction Resource Area. 1985. Resource Management Plan and Environmental Impact Statement. pp. 123, 124.

United States Department of Interior (USDI) Bureau of Land Management. 2001a. Riparian Area Management: A Guide to Managing, Restoring, and Conserving Springs in the Western United States. Technical Reference 1737-17. Bureau of Land Management, Denver, Colorado. BLM/ST/ST-01/001+1737.

United States Department of Interior (USDI) Bureau of Land Management. 2001b. Biological Soil Crusts: Ecology and Management. Technical Reference 1730-2. Bureau of Land Management Printed Materials Distribution Center, Denver, CO.

United State Geological Survey (USGS). 1995. Groundwater Atlas of the United States. HA 730-C, Arizona, Colorado, New Mexico, and Utah. Online version: http://sr6capp.er.usgs.gov/gwa/ch_c/index.html

Weber, W.A. and R.C. Wittmann. 2001. Colorado Flora: Western Slope. 3rd ed. University Press of Colorado, Niwot, CO.

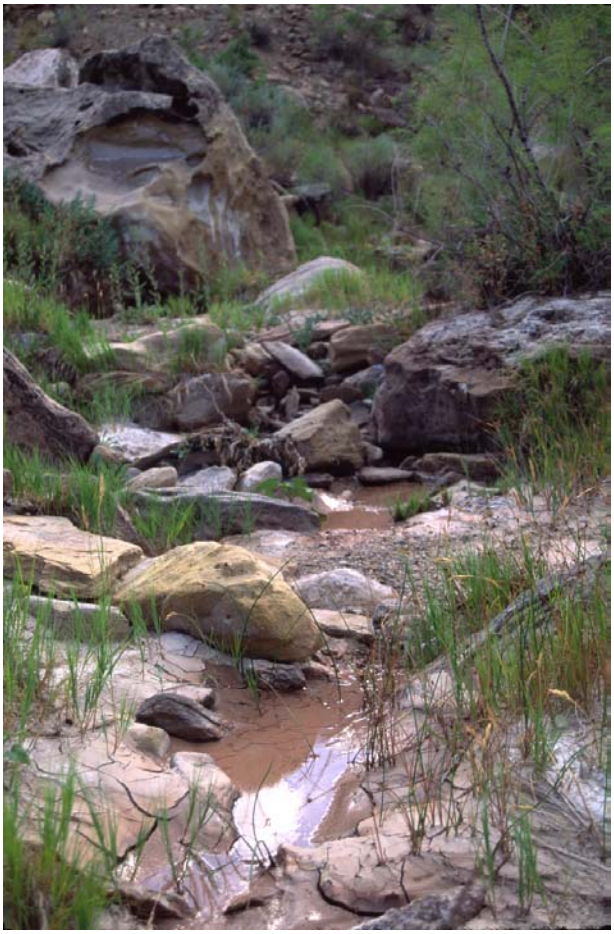
Welsh, S.L, N.D. Atwood, S. Goodrich, L.C. Higgins. 1993. A Utah Flora. Second Edition. Jones Endowment Fund, Brigham Young University, Provo, UT.

Wilson, E. O. (1988) *Bio Diversity*, National Academy Press.

Woods, C.P. and C.E. Braun. 1995. Sage Grouse Investigations Glade Park and Pinon Mesa, Mesa County, Colorado. Unpublished Report to the Colorado Division of Wildlife. Fort Collins, CO.

APPENDIX: SELECTED PHOTOS OF SEEPS AND SPRINGS

SS-A (N. Fork Escalante Creek)



SS-B (John's Spring)

SS- C (Nokomis Butterfly #1-24) (Unaweep Seep)

Speyeria nokomis nokomis
Photo by Phyllis Pineda

SS-D (N.W.A.T. Spring)

SS-E (Mule Spring)

SS-F (King's Canyon)

SS-G (Tom's Canyon #3 Spring)

SS-H (Brouse Spring)

SS-I (Pleasant Spring)

SS-J (Spring Creek 3)

SS-K (Solar Spring)

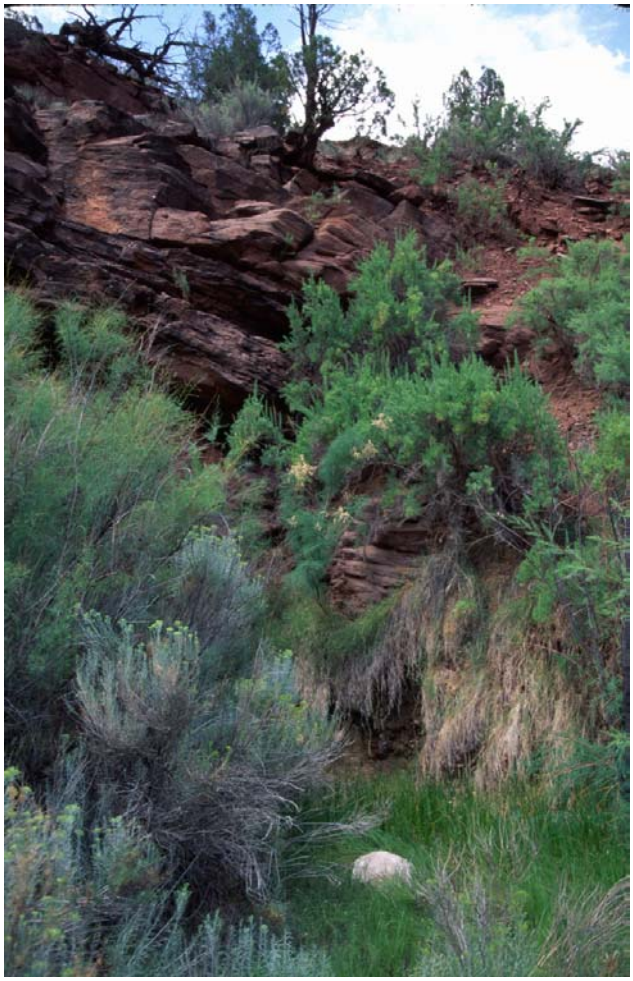
SS-L (E Dominguez Campground Spring

SS-M (Horse Mesa Spring)

SS-N (Sewemup Mesa)

SS-N Eastwood monkeyflower (*Mimulus eastwoodiae*) at Sewemup Mesa

SS-N (Sewemup Mesa)

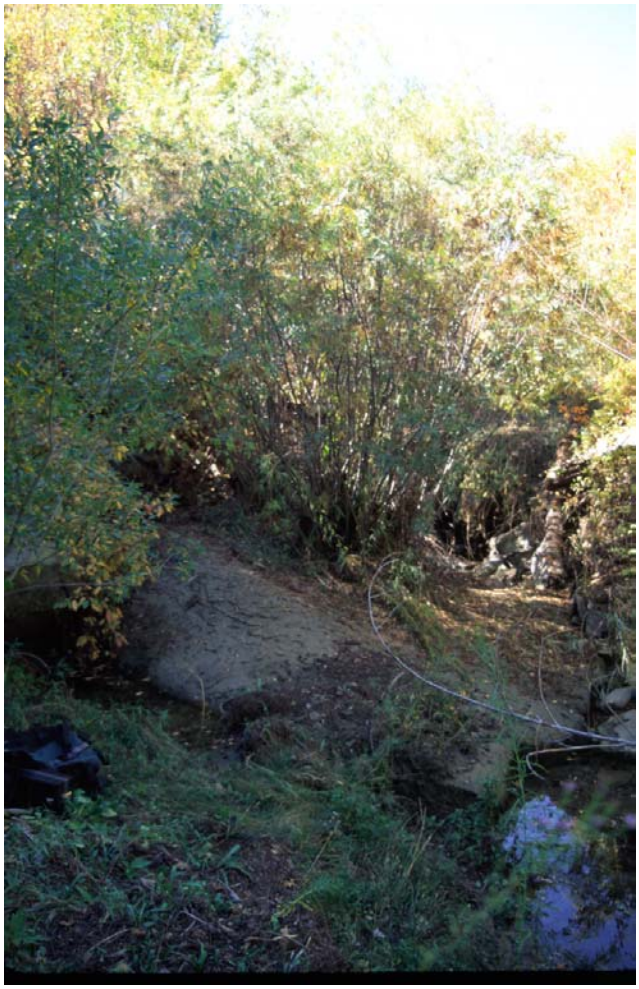


SS-O (Copper Rivet Spring)

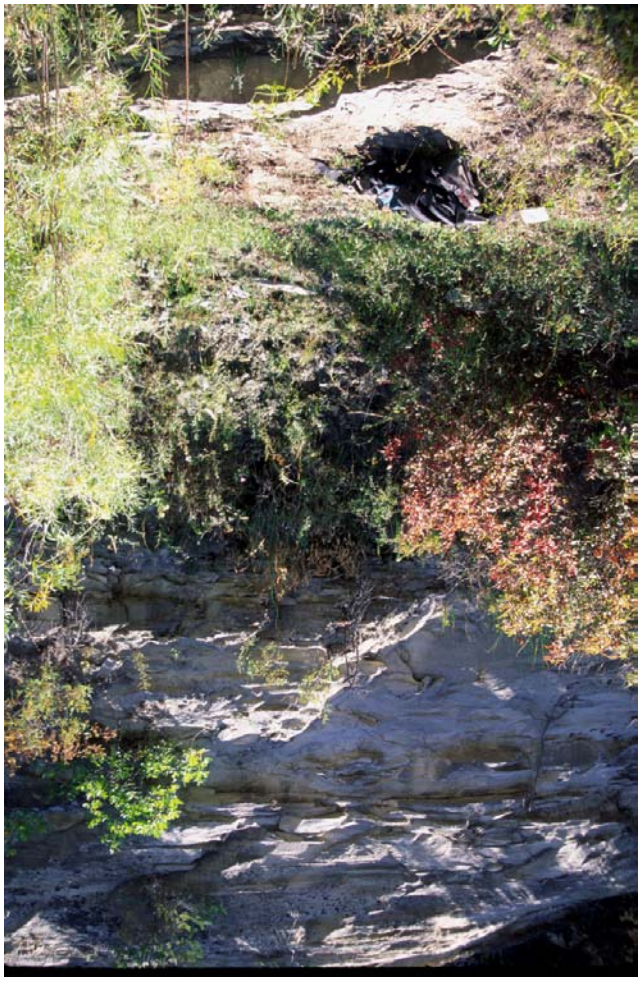
SS-P (Salt Creek 2)

SS-Q (Pepper Spring) (see also report cover)

SS-R (Korn Cabin Spring)

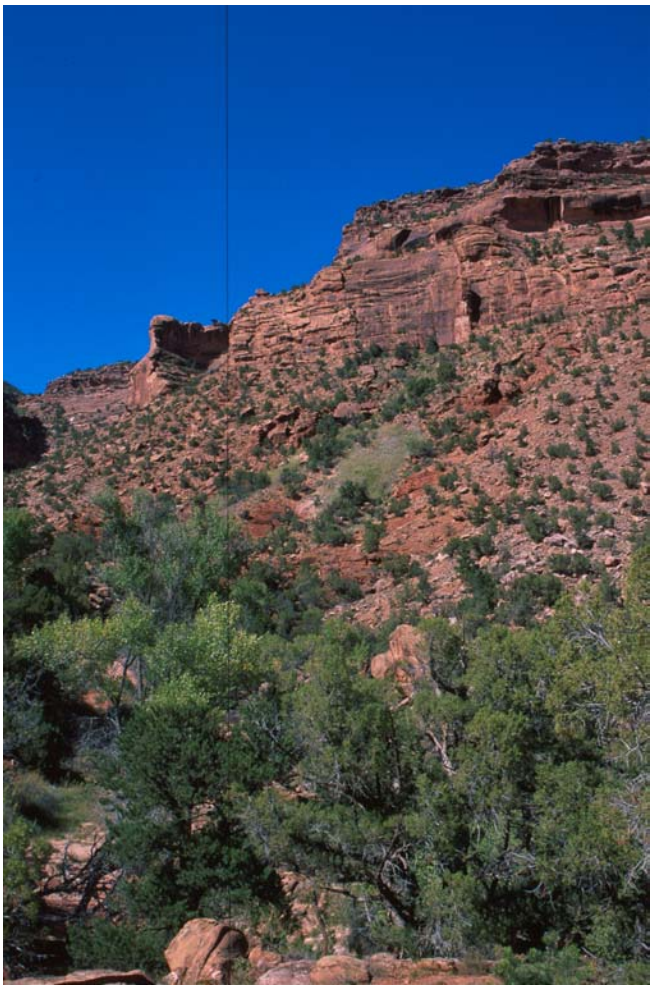


SS-S (Brillo Spring)



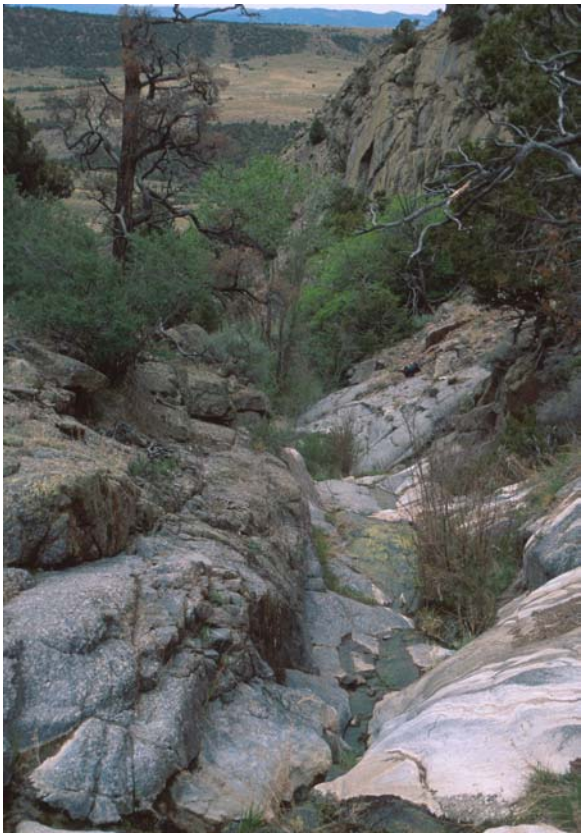
SS-T (Tutti Fruita Spring)

SS-U (Little Book Cliffs 4)



SS-V (Salt Creek 4)

SS-W (Sulphur Gulch)



SS-X (near Bear, Robertson, and Ravine Springs)

SS-Y (Mee Canyon)

SS-Z (Wright Spring)

SS-BB (Beehive #1 Spring)

SS-AA (Gateway Spring)