vertical bare banks and increasing depositional features. These characteristics are indicative of channel instability resulting from elevated bed load resulting from riparian vegetation alteration coupled with hydrologic erosive energy.

Muldoon Creek, and Lake Creek are 2nd order streams that flow through parallel, course glacial trough valleys, valley type V, in B channels, to their confluence with Star Hope Creek. These valleys are the result of glacial scouring where the resultant trough is a wide "u"-shaped valley with wide valley floor slopes generally less than 4 percent (Rosgen 1996). High bedload from Muldoon Creek and Lake Creek, which enters 1.75 miles below Muldoon Creek, combined with progressive streamside degradation of channel stabilizing riparian vegetation have aggraded, or raised the stream channel through deposition of course materials, and created accelerated lateral instability in the Star Hope Channel. Rain-on-snow events in winter of 1997, 1998, and spring of 2002, coupled with the reduced streamside riparian diversity and vigor have significantly eroded predisposed stream channels and increased the width to depth ratio of Muldoon Creek, and Star Hope Creek. Increased width and reduced depth result in increased deposition of course materials from the erosion of streambanks in tributaries and streambanks in the Star Hope channel further worsening stability problems. Fine sediment, and sand must accumulate on gravel and cobble to give stabilizing vegetation a foundation as the stream re-establishes its flood plain. Recovery can take a number of years and must be managed carefully to not increase sediment loads and allow propagation of riparian vegetation.

Bellas Canyon Creek (1st order), Broad Canyon Creek (2nd order), and Ramey Creek (2nd order) enter from northern type II valleys in A, B, and A channels respectively. Flow is low in these tributaries compared with Muldoon and Lake Creeks, and their stability is much higher with less contribution of bed materials. The Starhope Creek assessment units are shown in Figure 9.

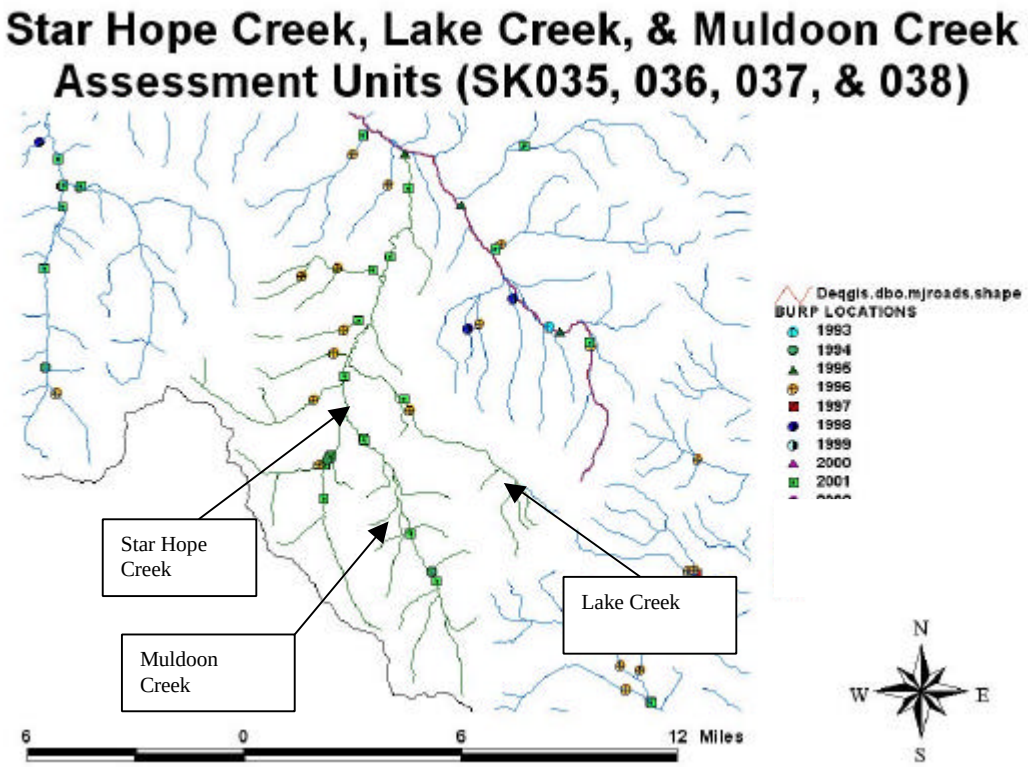

Figure 9. Starhope Creek subbasin assessment units.

Channel conditions remain remarkably consistent in Star Hope Creek to its confluence with the East Fork of the Big Lost River and on to the confluence with the North Fork of the Big Lost River. The flow in Star Hope Creek is significantly greater than in the upper East Fork throughout the hydrologic cycle. Water quality conditions below the confluence are primarily a function of conditions in Star Hope Creek.

Land use in the Star Hope Creek sub-watershed consists of livestock grazing and recreation. There is an abandoned mine in the headwaters reach of Star Hope Creek but it does not appear to have a hydrologic connection with the stream. There is a developed campground at the mouth of Star Hope Creek Canyon and Bear Canyon Creek Canyon. Effects of recreational use are visible here. There are off road vehicle trails up Star Hope Creek Canyon, and a hiking and pack trail up Bear Canyon Creek Canyon. Muldoon Creek Canyon hosts a four wheel drive road to the upper valley. There are multiple road crossings across the loose alluvial channel that have contributed to channel braiding and increased instability. Lake Creek Canyon, Bellas Canyon Creek Canyon, and Broad Canyon Creek Canyon host hiking and pack trails to higher elevations. Lake Creek and Muldoon Creek feature alpine lakes in the headwaters reach that are very popular with anglers. There is a cow camp with associated corrals on Star Hope Creek near the confluence of Bellas Canyon Creek, and there are two angler access points between the developed Star Hope Campground and the Cow Camp. The Copper Basin Loop Road traverses the mouths of the major canyons and extends from the Copper Basin Guard Station to the mouth of Star Hope Creek and intersects the Copper Basin Forest Road just below the confluence of

Star Hope Creek and the East Fork of the Big Lost River. Road density averages less than 1 mile per square mile on the watershed scale, however road density in riparian areas is greater.

Below the confluence of Star Hope Creek the East Fork flows northwest through a narrower composite valley constrained by high relief rocky hill slopes to the east and pronounced Holocene terraces to the west. The major tributary in this reach is Wild Horse Creek, which enters from the west just above the North Fork Big Lost River confluence. Boone Creek is the largest tributary that enters from the east. Fox Creek is the only other eastern tributary that is 2nd order over this reach. Rider Creek is diverted just above the Copper Basin Road to private land below the road.

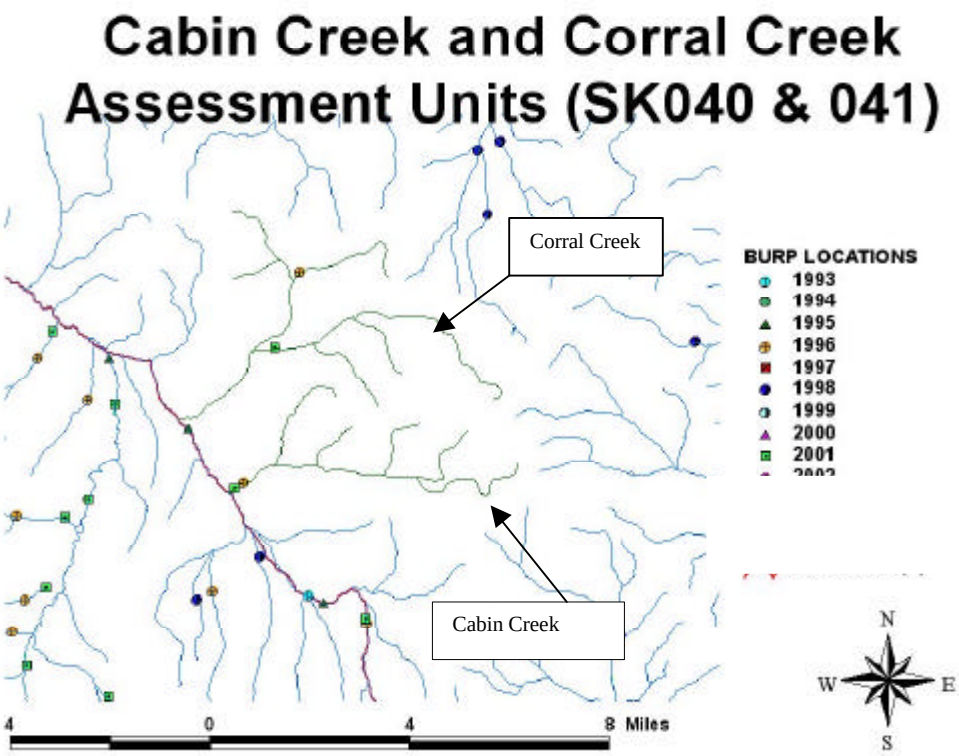

Figure 10. Upper East Fork tributary assessment units.

Little Boone Creek is the remaining 303(d) listed stream over the lower reach (Figure 11). It is a fishless ephemeral stream that flows only during snowmelt. Its source is a wetland that has been degraded by grazing. The water table has been lowered in the wetland by the formation of hummocks that has greatly reduced the storage capacity of this feature eliminating surface flow.

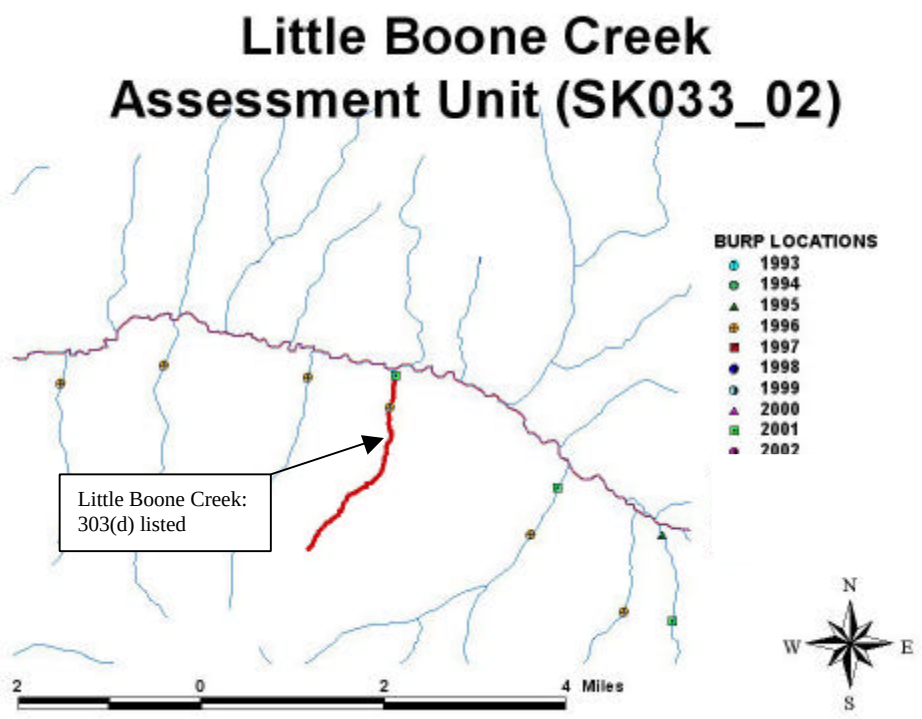

Figure 11. Little Boone Creek assessment unit.

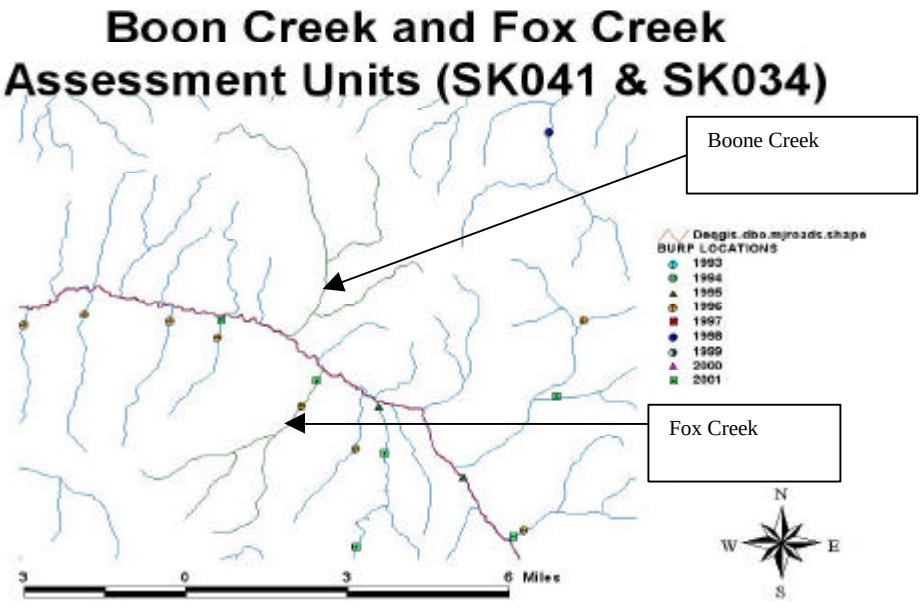

Figure 12. Boon and Fox Creek assessment units.

The Wild Horse Creek subbasin (Figure 13) bears similar geology and morphology to the Star Hope Creek subbasin. Fall Creek and Burnt Aspen Creek contribute flow from glacial trough valleys in B and Aa+ channels. The Aa+ channel describes a single thread entrenched channel with low width to depth ratio (<12) with low sinuosity and gradient over 10% (Rosgen 1996). Wild Horse Creek flows in an A channel and transitions into a B channel after picking up the 1st order A channel flow from the Left Fork of Wild Horse Creek. The valley is type VIII. The Wild Horse stream channel is less aggraded than the Star Hope Creek channel though significant streambank erosion is evident.

Land use is comprised of livestock grazing and recreation. There are trails in each of the major tributaries to alpine lakes. Roads extend to the upper reach of the main canyon, and there is a developed campground in the upper reach. There is a Forest Service Guard Station just above the mouth of the canyon. Land ownership is primarily public land managed by the Forest Service with a private cow camp inholding.

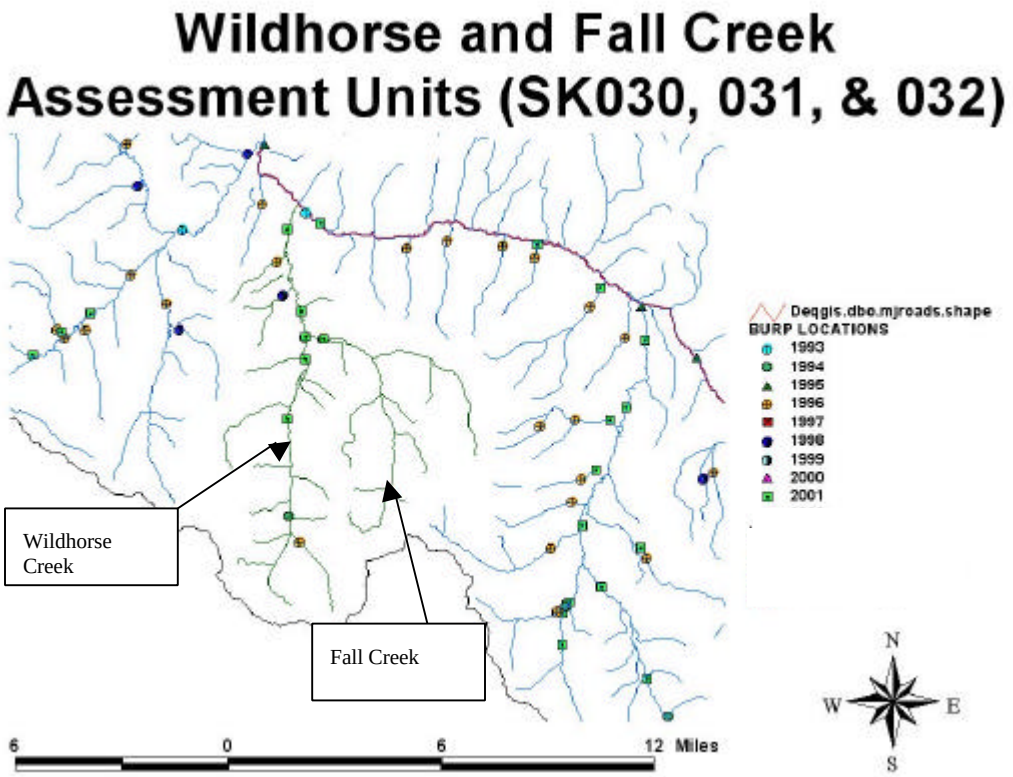

Figure 13. Wildhorse Creek assessment units.

North Fork Big Lost River

The North Fork of the Big Lost River has a watershed area of 345 km^2 with major tributaries consisting of Bartlett Creek, Creek, Bear Canyon, Chicken Creek, Corral Creek, Grasshopper Creek, Horse Creek, Hunter Creek, Miller Canyon Creek, Park Canyon Creek, Slide Canyon Creek, Toolbox Creek, and Summit Creek. The location of the North Fork subbasin is shown

in Figure 14. Summit Creek contributes the greatest flow to the North Fork Big Lost River and has major tributaries that include Kane Creek, Phi Kappa Creek, Little Fall Creek, and Park Creek. The subbasin is located in the northwest of the Big Lost River watershed.

Springs, snowmelt runoff, and storm events drive flow in the North Fork Big Lost River watershed. There are no 303(d) listed streams in the North Fork Big Lost River watershed. Tributaries to the upper North Fork start in the small segments of the Boulder Mountains and Salmon River Mountains within the watershed.

The Right Hand and Left Hand Forks of the North Fork of the Big Lost River begin in alpine cirques near the watershed boundary. They flow through Type II valleys in A and subsequently B channels. They combine as 2nd order streams to create the North Fork Big Lost River in a 3rd order B channel stream in a Type II valley to the confluence of Hunter, Blind, Bear, Squib, and Miller Canyon Creeks. The valley widens slightly below this series of confluences, but remains Type II to just above the confluence with Summit Creek.

Hunter, Blind, Bear and Squib Creeks come in as 1st order A channels, and Miller Canyon comes in as a 2nd order B channel. Park Canyon Creek comes in from the north as a 1st order A channel and Slide Canyon enters as a 2nd order A channel from the south.

The result of the succession of high gradient snowmelt driven channels is a rapid increase in stream power under runoff conditions. Riparian vegetation changes with an increasingly wide valley from lodge pole and Douglas fir with shrubs and herbaceous understory to predominantly willows with some alder. The valley remains relatively narrow, however increasing beaver activity is noted.

Below Park Canyon and Corral Creek the valley widens further and Toolbox Creek and Chicken Creek come in as 1st and 2nd order A channels respectively. The valley transitions to greater width with lower gradient, which increases the sinuosity of the North Fork Big Lost River. With increasing sinuosity and lower gradient deposition increases. The Stream channel becomes a C channel with gravel and cobble point bars. Degradation of riparian vegetation from grazing over utilization has reduced stream bank stability below Toolbox Creek, Chicken Creek and Zipper Creek. Below Zipper Creek increased sediment load from streambank erosion has caused instability in beaver impoundments and has resulted in lateral migration of stream channels and overall down valley meander migration due to aggradation of the stream channel. The resulting in increased instability and channel migration have further removed riparian vegetation which has resulted in elevated sediment and temperature loading.

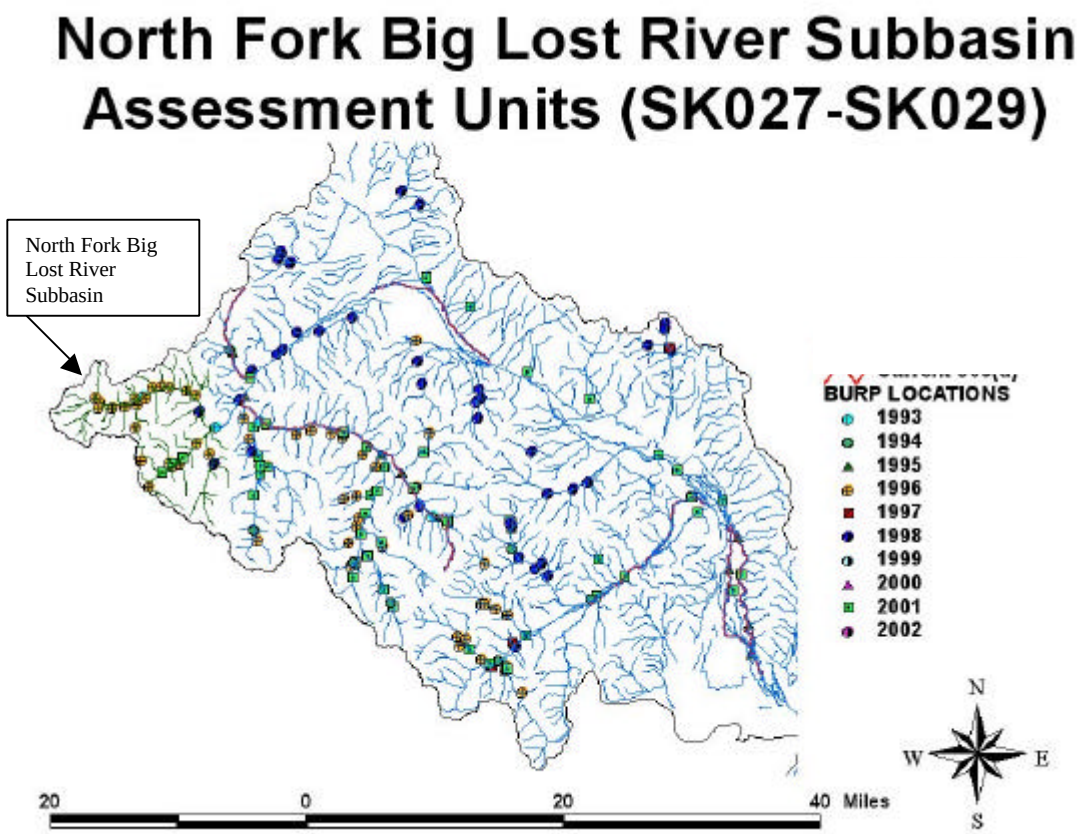

Figure 14. Location of the North Fork Big Lost River subbasin in the Big Lost watershed.

Land use in the North Fork canyon is primarily grazing with recreation focused on the upper watershed. There is a trailhead at Toolbox Creek that leads to the watershed divide with East Pass Creek in the East Fork Salmon River watershed. Road density is moderate within the valley bottom though most of the canyon spur roads are gated. Timber harvest has been limited in the watershed due to the steep nature of the watershed though historic timber harvests have been conducted in the upper watershed. Mining is limited to historic activity with a number of addits present in the middle to upper elevations. The North Fork Big Lost River assessment unit is shown in Figure 15.

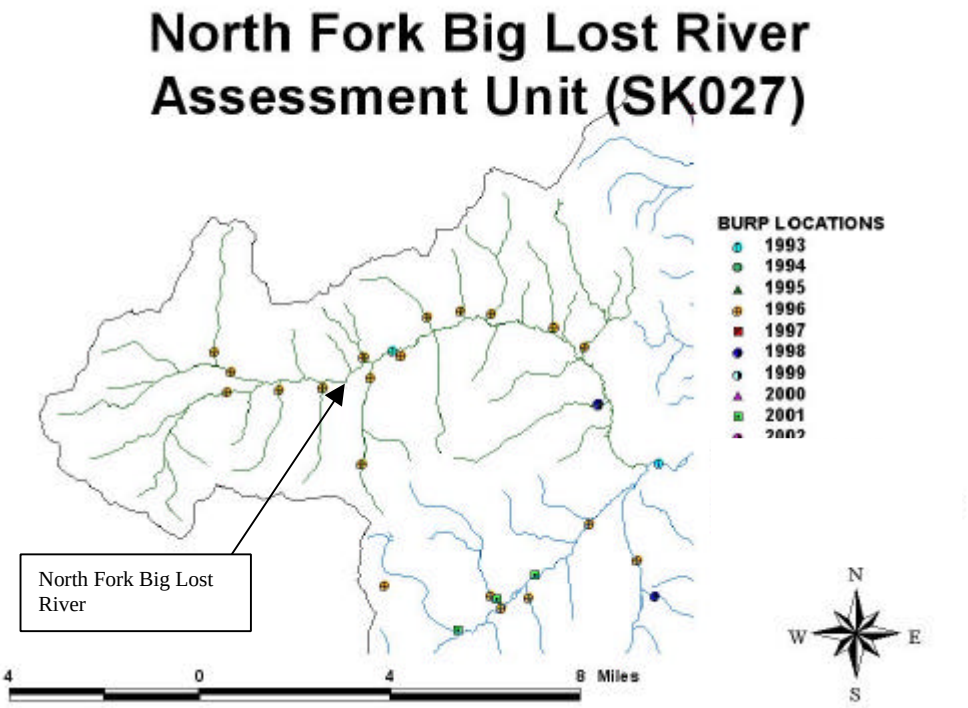

Figure 15. North Fork Big Lost River assessment unit.

Summit Creek makes its confluence with the North Fork Big Lost below the mouth of the North Fork canyon (Figure16). The orientation of the Summit Creek watershed is parallel to the North Fork Big Lost River and has similar geomorphology. Its origins lie in the flanks of the Boulder Mountains to the North in Summit Creek, and in the Pioneer Mountains. Summit Creek enters the main valley as a 3rd order B channel and flows eastward toward its confluence with the North Fork. Other tributaries to Summit Creek include Kane Creek (Figure 17), Phi Kappa Creek, Little Fall Creek, Big Fall Creek, and Park Creek. These tributaries all flow through glacial trough canyons in 1st order A channels with the exception of Kane Creek which transitions to a 2nd order B channel before making its confluence.

Land use in the Summit Creek watershed includes livestock grazing and recreation. Recreation land use consists of fishing access, a developed campground, off-road vehicle trails and hiking trails. Historic mining was more prevalent in the Summit Creek watershed than the North Fork watershed, though little remains of previous activities. Land ownership is exclusively public and managed by the USDA Forest Service.

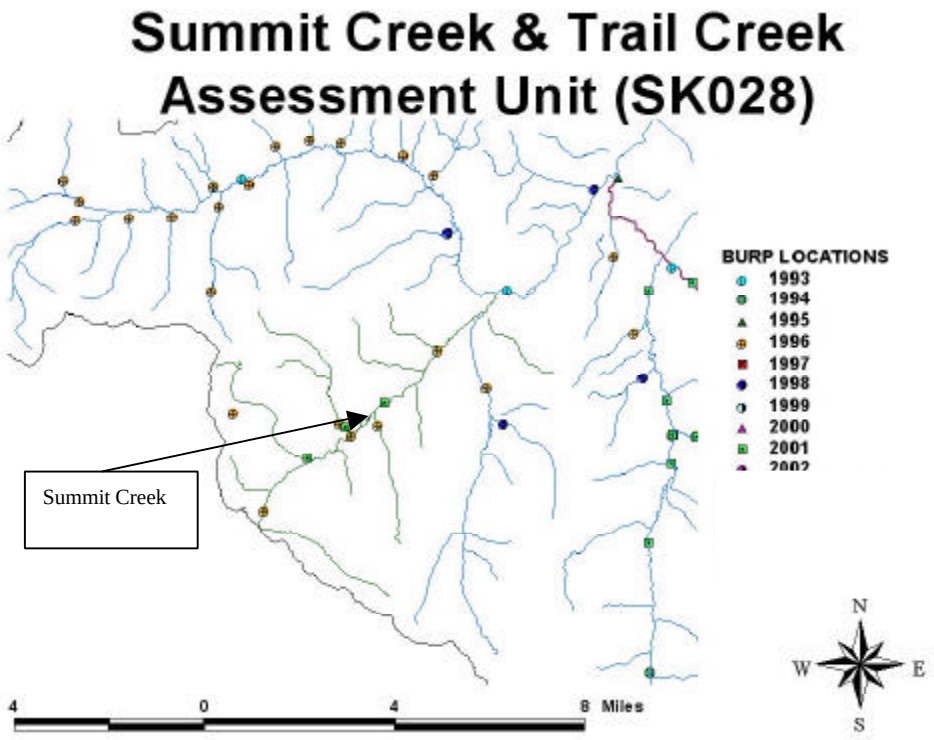

Figure 16. Summit Creek assessment unit.

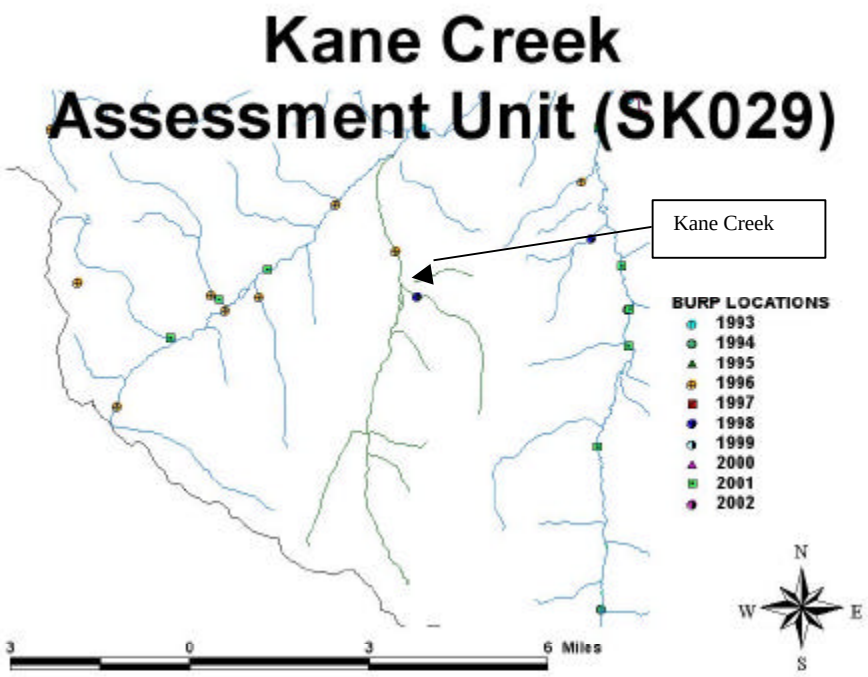

Figure 17. Kane Creek assessment unit.

Upper Big Lost River

The upper Big Lost River includes the watershed above Mackay Dam (Figure 18). For the purpose of this assessment the watershed will be dealt with in two groupings. This grouping is to address the issues of the listed reach, from Chilly Buttes to the Reservoir, but also to separate the reach that is not listed, from Mackay Reservoir Dam to the Moore Diversion. This lower reach from Mackay Reservoir to the Moore Diversion has been determined to fully support its Cold Water Aquatic Life Beneficial Use including the macroinvertebrate community and salmonid spawning. It will be dealt with in the Lower Big Lost River Subwatershed section. Below the Moore Diversion the Big Lost River is a dry channel that only sporadically carries water to the sinks, located on the lava flows. Flow duration and frequency are not adequate to support aquatic life and the impairment is flow alteration.

The upper Big Lost River watershed has an area of 2385 km^2 and includes the Big Lost River from the confluence of the North Fork and East Fork to the Mackay Reservoir. This reach includes the tributaries of Burnt Creek, Twin Bridges Creek, Pinto Creek, Garden Creek, Burnt Creek, Bartlett Creek, Grant Creek, Thousand Springs Creek, Sage Creek, Lone Cedar Creek, Upper Cedar Creek, and Lower Cedar Creek. The Big Lost River is impounded by Mackay Dam to create Mackay Reservoir, which has a primary perennial source of water from Warm Springs Creek, which enters from the western upper Big Lost River subwatershed. Navarre Creek is intermittent and sporadically contributes flow to the Reservoir. Tributaries will be presented according to assessment units and the nature of flow conditions will be described.

Land use throughout the upper Big Lost River Subwatershed is primarily agricultural with grazing and forage crop production the main use followed by animal feeding operations and CRP lands. Grazing occurs throughout the Subbasin with limited identifiable riparian-directed grazing management or best management practices on public or private land. Recreation land use occurs in 1 developed BLM campground near Garden Creek, with dispersed camping throughout the watershed. The heaviest recreational use is related to the Mt. Borah trailhead near Rock Creek. Off-road vehicle use is evident throughout the Subbasin on private and public land as evidenced by improvised trails and hill slope roads in most drainages. There is a proposal by the Idaho Department of Parks and Recreation, the Bureau of Land Management and Forest Service to establish the Lost River Trail System for off road vehicles in the watershed. Residential use is generally affiliated with ranches with home sites distributed throughout the area including riparian areas. Most tributaries are on public land.

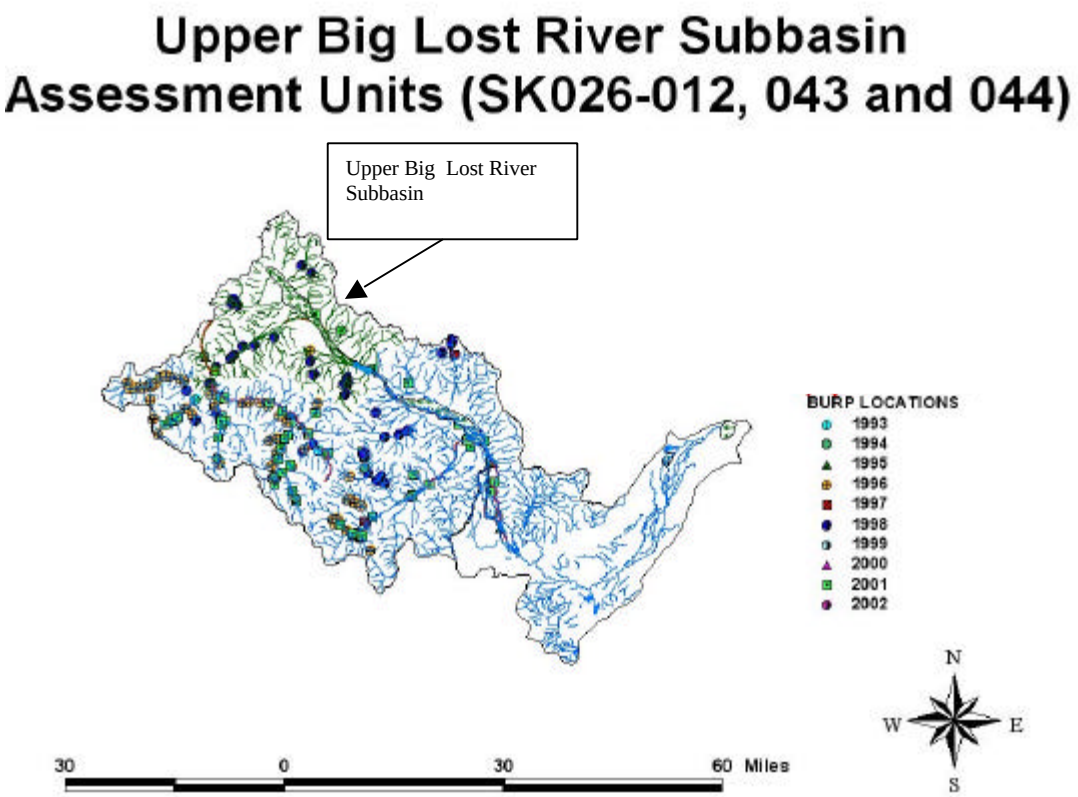

Figure 18. Location of the upper Big Lost River subbasins in the Big Lost watershed.

Twin Bridges Creek has its confluence with the main Big Lost River 1.5 miles below the confluence of the North Fork and East Fork of the Big Lost River (The Forks) (Figure 19). Its watershed is composed of two assessment units within the Bridges Creek Assessment Unit: SK026_02 which corresponds to the upper ephemeral watershed and SK026_03 which corresponds to the lower single thread discharge below a narrow wetland complex on private land above the mouth of the canyon. Flow across public land managed by BLM has been short duration with flow below 1 cfs much of the year. In 2002 BLM measured flow in Twin Bridges Creek below the private property boundary (Table 2) using a specialized weir to quantify low flow. Flow regime in 2003 was similar with the stream channel dry by 8/15/2003. The middle private reach of Twin Bridges Creek extends approximately 4 miles above the BLM/private boundary, through the wetland reach, to the confluence of an unnamed ephemeral tributary.

Table 2. Flow Measurements in Twin Bridges Creek.

Location	Date	Time (hrs)	Flow (cfs)
Twin Bridges Creek	7/2/2002	14:00	1.44
	7/8/2002	11:15	0.89
	7/17/2002	11:00	0.46
	7/30/2002	11:05	0.18
	8/11/2002	12:15	Too low to measure

Twin Bridges Creek is a third order C channel that flows through a narrow valley bottom that has historically had beaver dams before infiltrating into the alluvium above the mouth of its canyon on private land. Historic grazing practices have resulted in downcutting and incision of the stream channel. This has led to a drop in the water table that has reduced off channel storage that would likely provide flow for longer periods of the year and better habitat for riparian vegetation and aquatic life. Combined with the effects of surface diversion for livestock watering, flow vanishes by mid to late August after initiating in early to mid May. Between May and June flow may be above 1 cfs but does not have enough duration to benefit aquatic life communities throughout the year.

Land ownership in the Twin Bridges Assessment Unit is BLM over the lower 1.25 miles to the confluence. Private land extends approximately 4 miles above the BLM boundary, and the Forest Service manages the upper 4 miles above private land. Grazing occurs throughout the watershed and is the primary land use.

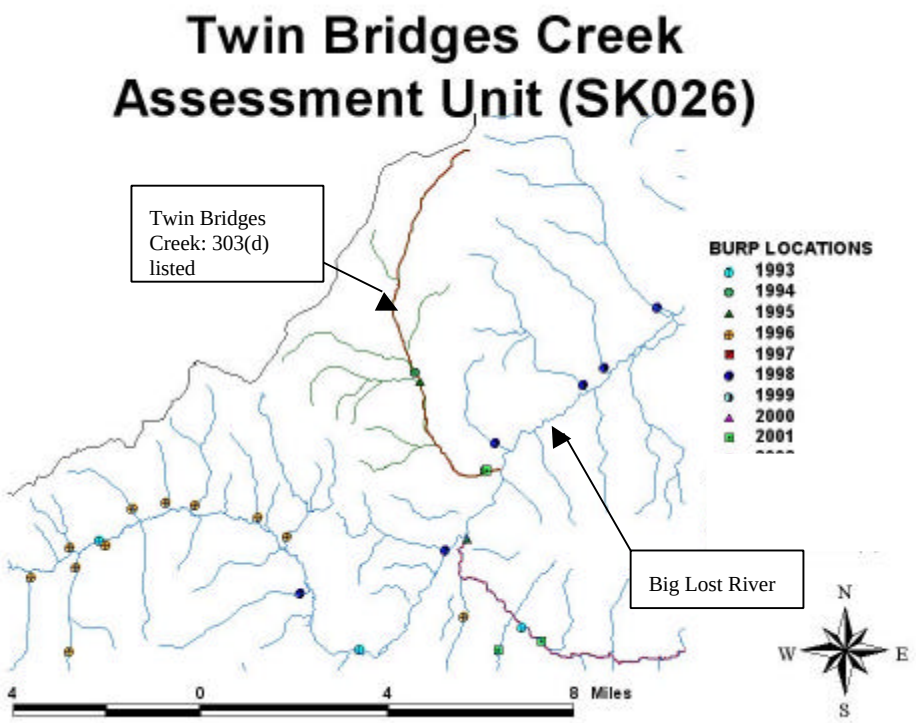

Figure 19. Twin Bridges Creek assessment units.

Burnt Creek and Garden Creek are included in assessment unit SK025, with Deep Creek, and Lake Creek (Figure 20). All of these creeks are ephemeral with short duration flows less than 1cfs throughout their course for all but the peak of snowmelt runoff. Their connection with the Big Lost River is limited and sporadic. In 2002 BLM measured flow in Burnt Creek, Deep Creek, and Garden Creek (Table 3) using a specialized weir to quantify low flow. Flow regime in 2003 was similar with the stream channel dry by 8/15/2003. Public land grazing occurs throughout the year in each of the subbasins.

Land management over the lower mile of Burnt Creek is BLM. Forest Service manages approximately two miles of stream above BLM. Grazing occurs throughout the watershed.

Table 3. Flow Measurements in Assessment Unit SK025.

Location	Date	Time (hrs)	Flow (cfs)
Burnt Creek	7/8/2002	12:00	0.44
	7/30/2002	11:25	0.09
	8/11/2002	12:30	Too low to measure
Deep Creek	7/08/2002	10:45	0.14
	7/17/2002	14:00	0.08
	7/30/2002	11:15	Too low to measure
Garden Creek	7/08/2002	11:45	Dry
	7/30/2002	11:20	Dry

The Forest Service manages approximately 3 miles of land adjacent to the main channel above the confluence of Deep Creek and BLM manages approximately 5 miles to the confluence of Burnt Creek where private land begins. Land use in this Assessment Unit is primarily grazing. There are two developed recreation sites in this reach: The Deep Creek Recreation Area and the Garden Creek Recreation area.

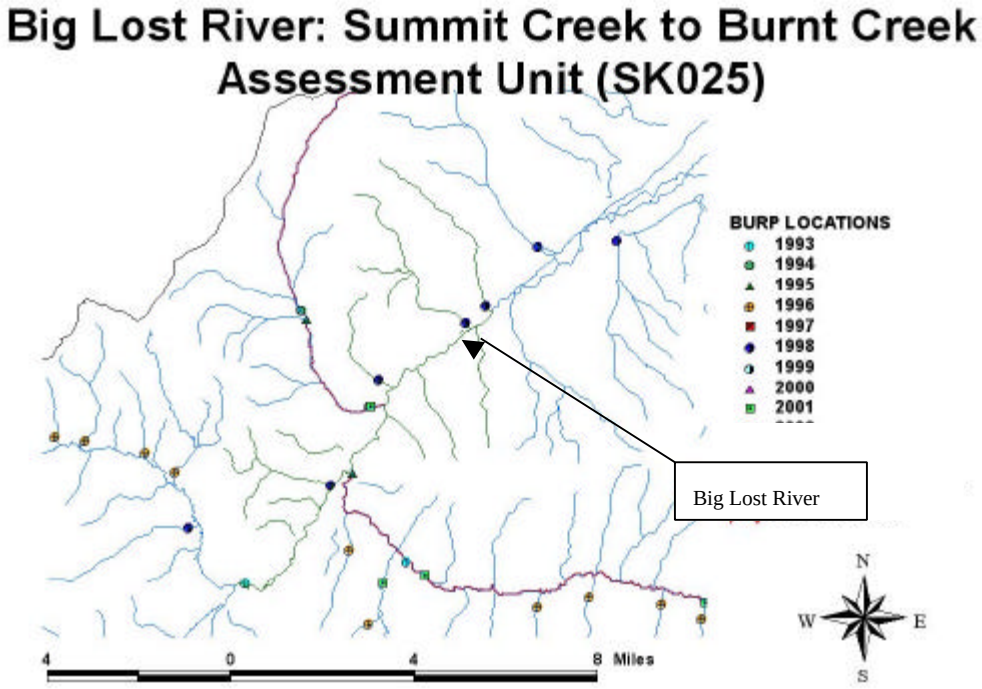

Figure 20. Big Lost River Summit Creek to Burnt Creek assessment units.

The Big Lost River from the confluence of Burnt Creek to Thousand Springs Creek comprises the Big Lost River-Burnt Creek to Thousand Springs assessment unit, SK024. This includes Bady Creek, Grant Creek, Pinto Creek, Rock Creek, Talman Creek and Bartlett Creek. These

tributaries exhibit similar flow pattern to the streams in SK025: they are ephemeral with flow duration of not more than four months of the year, however they exhibit lower annual flow. The Pinto Creek watershed enters from the north through a steep walled canyon as an A channel that becomes a B channel about ½ mile above the mouth of the canyon. Pinto Creek does support a viable fish population in the upper watershed, protected by the steep canyon. Bady, Grant, Rock and Bartlett Creeks have similar channel transitions and enter the Big Lost River Valley from the White Knob Mountains from the south. Each of the southern watersheds is intercepted by an ephemeral ditch system before they contribute seasonal runoff to the Big Lost River.

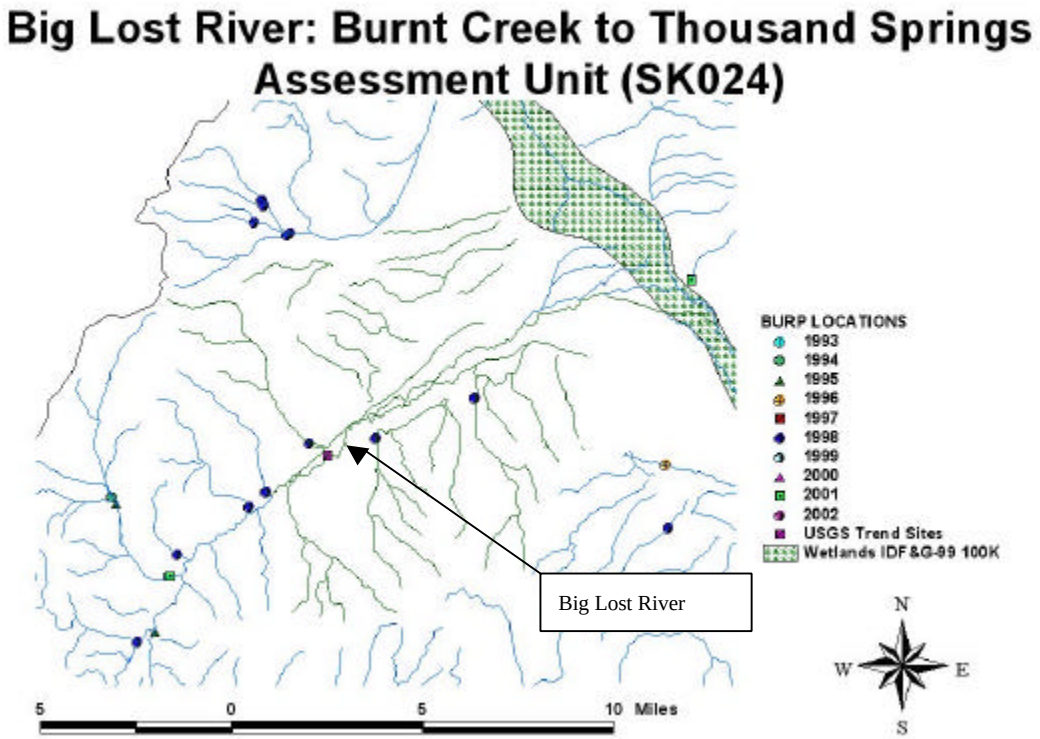

Figure 21. Upper Big Lost River, Burnt Creek to Thousand Springs assessment unit.

Land management is primarily private along the main channel with approximately 4 miles of BLM management interspersed with private. The lower 1.25 miles of Bady Creek is privately owned. BLM manages much of the land adjacent to tributaries.

Further downstream the Parsons Creek channel of the Big Lost River splits from the main channel (Figure 22). This is the Parson's Creek Assessment Unit. Parson's Creek is an ephemeral reach below source springs that produce a short flowing reach that is actually a cutoff channel of the Big Lost River and it only carries water to its confluence with Warm Springs Creek during peak flow from snowmelt runoff. It has some ground water recharge to the channel over short reaches and it functions as an irrigation delivery conduit for a short period when the Big Lost River is at peak flow. Like the Big Lost River below Chilly Butte the flow in Parson's Creek infiltrates beyond a subsurface geologic feature in the alluvium between Bartlett Point and

the upper Chilly Butte, and the channel is dry for 8 or more months per year. Management is mostly private.

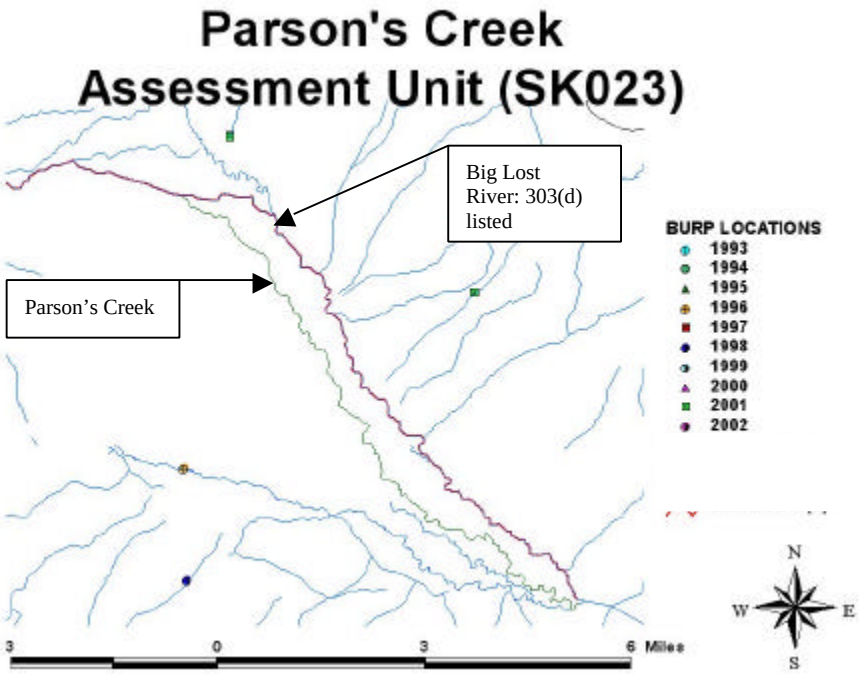

Figure 22. Parson's Creek Channel of the Big Lost River assessment unit.

Below the Parsons Creek cutoff channel the flow from the Thousand Springs subwatershed comes in to the Big Lost River Channel (Figure 23). The primary source of water to Thousand Springs Creek is the complex of springs that flow in Chilly Slough. Chilly Slough is a marsh complex that covers approximately 9,110 acres and the through-flow is referred to as Thousand Springs Creek. Below upper Chilly Butte this is usually the only flow available to the Big Lost River between Chilly Butte and Mackay Reservoir, where the perennial flow from Warm Springs Creek enters the Reservoir. Thousand Springs Creek would be important refuge to any aquatic species that would populate the main channel, though the Thousand Springs Creek channel and riparian habitat are highly degraded from over grazing. Land ownership along the main channel is primarily private with interspersed BLM management along the main channel and lower tributaries. Grazing occurs around the periphery of the marsh and extends onto wet meadows surrounding the marsh. Season-long livestock grazing occurs on the private land below the marsh to the confluence of Thousand Springs Creek with the main Big Lost River.

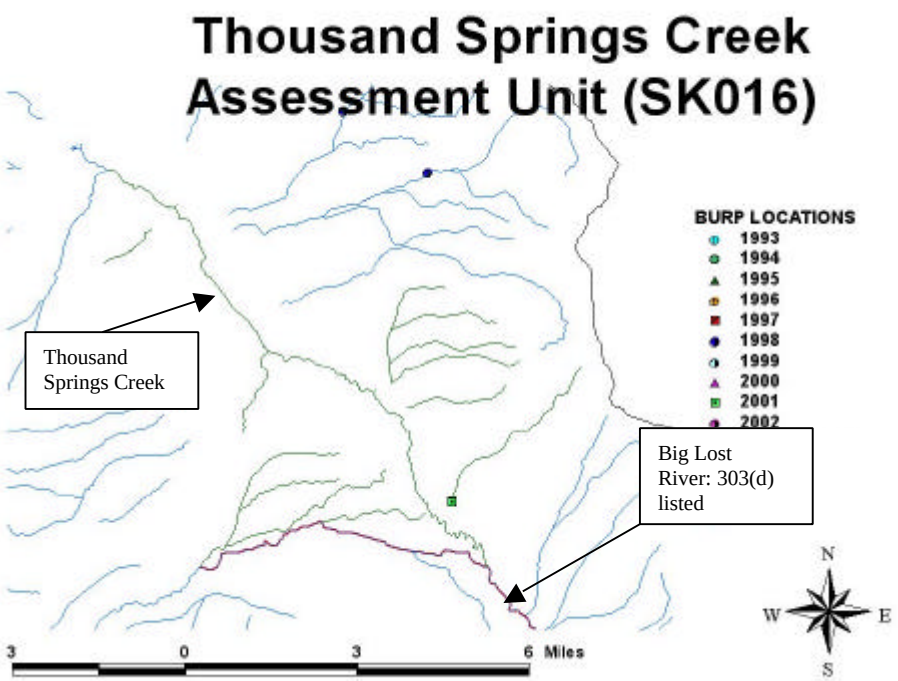

Figure 23. Thousand Springs assessment unit.

Above Thousand Springs Creek and Chilly Slough is an ephemeral subwatershed that centers on Sage Creek (Figure 24). The Sage Creek watershed is primarily managed by BLM. Flow seldom extends below the confluence of the North Fork of Sage Creek, Sage Creek and Corral Creek (Table 4). A permanent diversion takes flow above 1 cfs throughout the year. This area is heavily grazed with visible impacts to streambanks and riparian vegetation. The North Fork of Sage Creek is included in a Wilderness Study Area that is roaded and grazed. A significant timber sale was conducted in the Sage Creek watershed in the 1950s resulting in sediment impacts that have been compounded by grazing practices since that period with channel downcutting and bank erosion. Though the sum of flows shown in Table 4 below is greater than 1cfs, the flow is heavily diverted and any remaining flow rapidly infiltrates below the confluence of the two streams before the channel reaches Chilly Slough and Thousand Springs Creek.

Table 4. Flow Measurements in Assessment Unit SK022.

Location	Date	Time (hrs)	Flow (cfs)
Sage Creek	7/1/2002	13:00	0.96
	7/8/2002	13:30	0.65
	7/30/2002	12:10	0.19
	8/11/2002	12:30	0.17
North Fork Sage Creek	7/1/2002	13:30	0.61
	7/08/2002	13:15	0.5
	7/30/2002	12:00	0.24
	8/11/2002	13:00	0.31

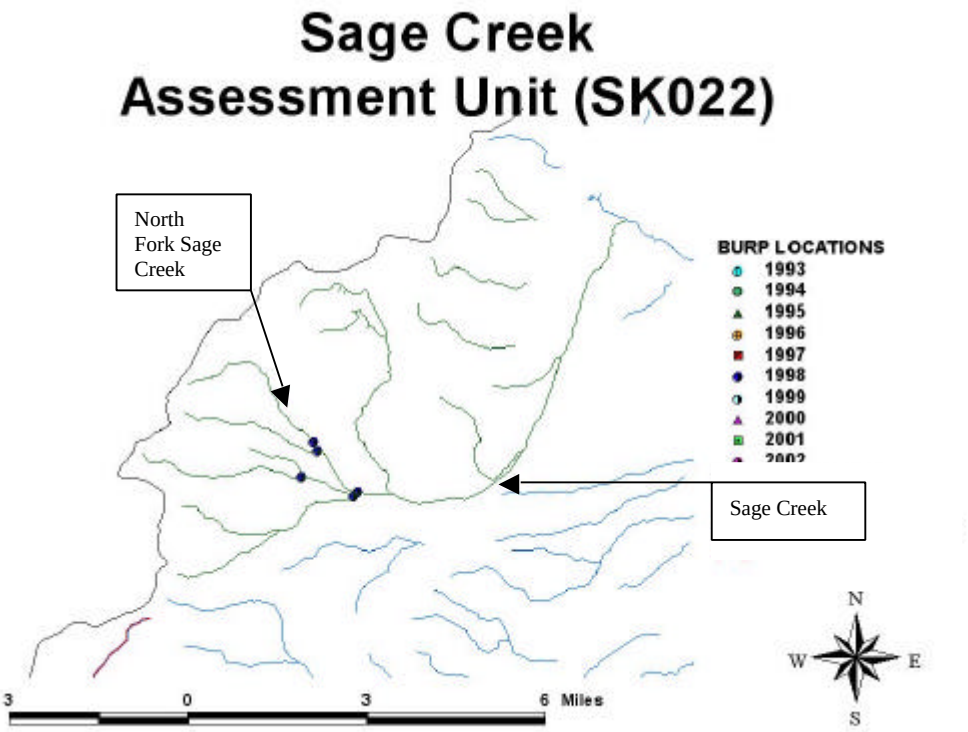

Figure 24. Sage Creek assessment unit.

In the Northern-most part of the watershed there are ephemeral seasonal washes and isolated spring seeps affiliated with Arentson Gulch (Figure 25). These Arroyo type channels are defined by high width to depth ratio with little or no riparian vegetation, other than sedges affiliated with spring seeps. Land ownership adjacent to the channels is primarily private with BLM managed lands outside the private corridor. Actual surface flow is for brief periods during early snowmelt and significant summer thunderstorms. These streams are primarily B channels that drain dry gulches over alluvial fans and infiltrate long before any confluence is made with perennial flow. Any available surface flow is captured in water tanks or livestock watering depressions in the spring and early summer. Grazing occurs throughout the subbasins of Arentson Gulch and Willow Creek and is the primary land use in addition to transportation along Highway 93 and the Doublesprings Pass Road. There is an Earthquake Visitor Center along Doublesprings Pass Road. Recreational use is primarily dispersed camping and off-road vehicle use.

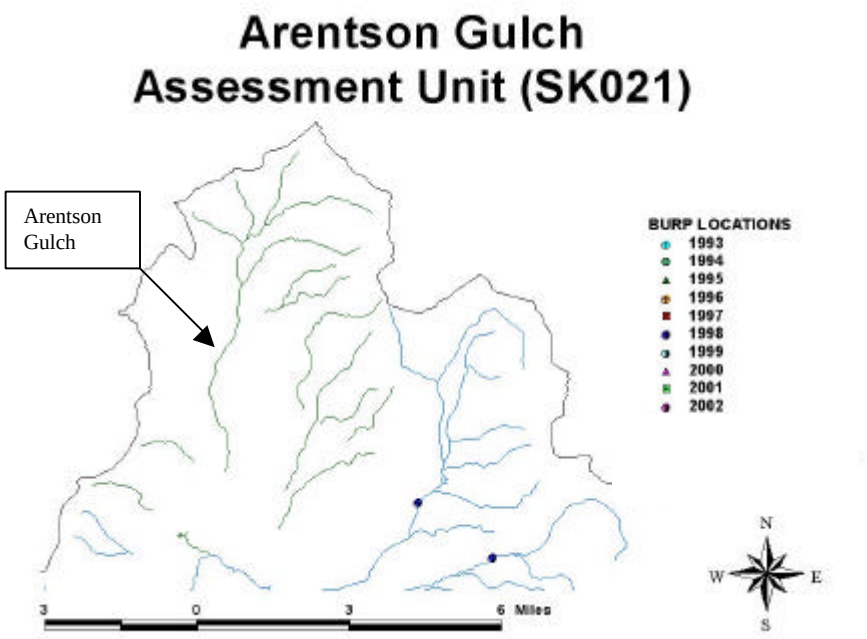

Figure 25. Arentson Gulch assessment unit.

Double Springs Pass joins the Big Lost River watershed with the Pahsimeroi watershed. Willow Creek flows from springs on the Big Lost River side of Double Springs Pass. Willow Creek is completely diverted about a mile below its source and flows from the Pass toward Thousand Springs Creek in a system of ditches below the point of diversion until it is consumed. Any available flow after diversion during the runoff period of peak flow infiltrates before a confluence is made with Thousand Springs Creek. The subwatersheds in the eastern section of the Big Lost River watershed drain the flanks of the Lost River Range over large alluvial fans in A and B channels. Flow below the point of infiltration is during brief periods of early snowmelt and intense sporadic thunderstorms. These ephemeral streams do not support aquatic life other than areas adjacent to the springs and seeps. Many of the ephemeral streams are fishless, while some that are close to roads have been stocked with brook trout in upper perennial reaches. Brook trout are no longer stocked and any brook trout populations within the watershed are self-sustaining.

Land management in the Willow Creek subbasin is an even split between BLM and Forest Service. Land use is primarily grazing. The Willow Creek assessment unit is shown in Figure 26.

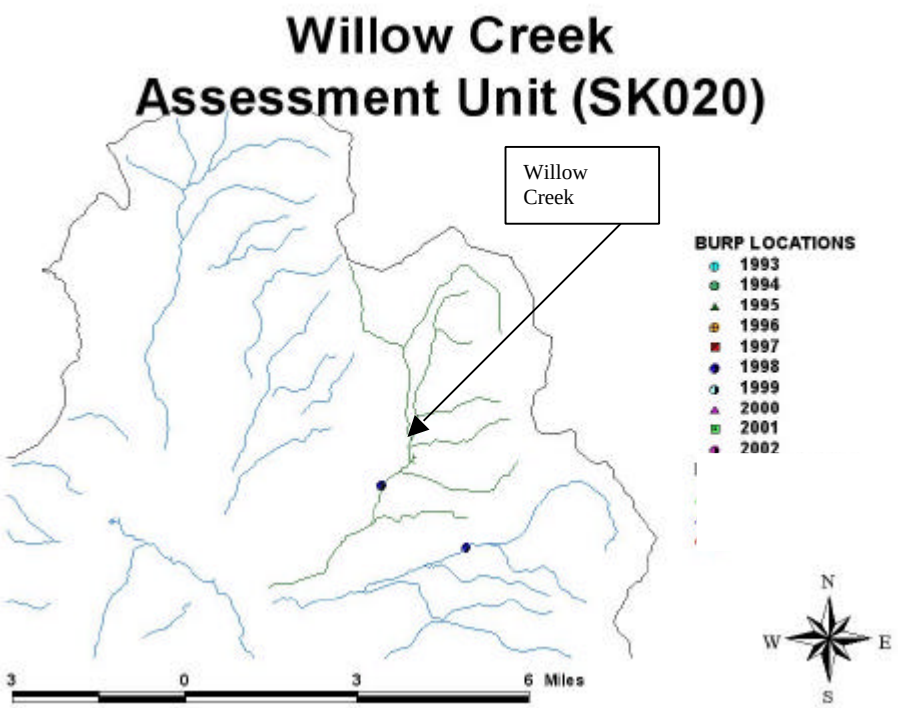

Figure 26. Willow Creek assessment unit.

Rock Creek is a perennial stream that flows from the flanks of Mount Borah, then infiltrates into alluvium long before it makes a confluence with the Big Lost River (Figure 27). It is not to be confused with the Rock Creek in Assessment Unit 024. Flow below the point of infiltration lasts for brief periods during early snowmelt and thunderstorms. The upper channel is an A channel that transitions to a B channel at the top of the alluvial fan and then infiltrates before any confluence is made with the Big Lost River.

Land management is primarily Forest Service with BLM managing the lower ephemeral reach. Land use is primarily grazing with recreation occurring at the Mt. Borah trailhead. Off-road vehicle trails and pioneered ghost roads branching through the subbasin.