APPENDIX C
2004 AERIAL PHOTO REVIEW AND FIELD SOURCE ASSESSMENT, UPPER JEFFERSON RIVER WATERSHED

1.0 INTRODUCTION

The Montana Department of Environmental Quality (DEQ) is required to develop a TMDL water quality restoration plan by 2005 for all threatened or impaired waters within the Upper Jefferson TMDL planning unit, in order to satisfy state law as well as federal court requirements. The Upper Jefferson planning unit includes the mainstem Jefferson River to the confluence with the Boulder River (42 miles) and the tributary drainages: Big Pipestone, Cherry, Dry Boulder, Fish, Fitz, Halfway, Hells Canyon, Little Pipestone, and Whitetail creeks. The Jefferson River and some portion of all of the above listed tributaries were included on DEQ's *1996 303(d) List of Impaired and Threatened Waterbodies in Need of Water Quality Restoration*. In 2000, 2002, and 2004, Big Pipestone, Fish, Hells Canyon, Little Pipestone, and Whitetail creeks and the Jefferson River were included on DEQ's 303(d) List as requiring TMDLs. Cherry, Dry Boulder, Fitz, and Halfway creeks have been listed as waters requiring reassessment (sufficient credible data).

1.1 Upper Jefferson Watershed 2004 Aerial Photo Review and Field Source Assessment

In 2004, Land & Water conducted an aerial photo and field source assessment with the intent of identifying pollution sources and the magnitude and locations of water quality impairments associated with sediment, nutrients, metals, water temperature, and riparian and aquatic habitat degradation. Project goals included 1) identifying major sources of pollution to the 303(d) Listed streams, 2) detecting channel, riparian, and landuse changes over time, 3) creation of a spatial database for inventorying photo availability and the source assessment, and 4) field verification and further refinement of source identification. The investigation consisted of two phases: 1) an assessment of available current and historic aerial photographs, digital imagery and topographic maps, and 2) photo and field data collection.

1.1.1 Assessment Methodology

The first phase of the project involved the collection of historic and current aerial photographs and relevant GIS data, including digital imagery and data layers pertaining to the Upper Jefferson Watershed. Many GIS layers for the project area were compiled during Land & Water's 2003 Jefferson River Watershed Characterization and Water Quality Status Review effort, so that much of the effort focused on gathering historic and current images of the 303(d) Listed streams in the Upper Jefferson Watershed. Photographs were sought from the Beaverhead-Deer Lodge National Forest, the Jefferson River Watershed Council, the Montana Natural Resources Conservation Service (Whitehall Field Office), the Montana Department of Natural Resources and Conservation, the USDA Historic Photo Repository, the Montana Natural Resource Information Service, and the Montana Department of Transportation.

The second phase of the project entailed the actual aerial and field source assessment of the 303(d) Listed streams in the Upper Jefferson Watershed. The source assessment methodology followed protocols established in the *Upper Jefferson River Water Quality Monitoring Project Quality Assurance Project Plan* (Land & Water, 2004). The focus of the aerial inventory was to detect pollution sources and quantify changes in stream channel features and riparian vegetation for the 303(d) Listed streams on a stream reach basis. Previously collected data, such as published reports and GIS layers (i.e. geomorphology, potential pollution sources), were used to aid the evaluation. All of the assessment generated data were assembled in a GIS database, a geodatabase. The geodatabase allowed for the information to be analyzed for changes over time; provided for attribute mapping of the information; and can also be used to store future information.

Portions of all the 303(d) Listed streams were visited in the field in October of 2004, except for the Jefferson River. No field assessment was done on the Jefferson River due to the detailed Jefferson River Riparian Inventory conducted by Hoitsma Ecological in 2003. The purpose of the field based source assessment was to 1) ground truth and add further detail to the results of the air-photo interpretation, 2) to rank and prioritize source categories affecting each stream segment and impaired water uses, 3) to refine the delineation of impaired stream segments and, where appropriate, 4) to identify stream segments and source categories that may warrant additional source quantification work.

1.1.2 Photo Years and Source Assessment

For the photo collection effort, photos dating from 1942 to 2002 were acquired for some portion or all of the 303(d) Listed streams Upper Jefferson Watershed. In consideration of photo coverage, as well as budget and time constraints, only two time periods of imagery were analyzed, a 2000 time period and a 1980 time period. Photo inventory began with the photos from 2001 and 2002, because the recent period was expected to have the most accurate portrayal of existing stream conditions and pollution sources. **Table 1.1** lists the 303(d) stream segments, corresponding photo analysis years, and stream portions analyzed. Lack of complete photo coverage was the reason that some streams were not analyzed for their entire length.

Table 1-1. 303(d) Streams and Corresponding Photo Year Inventory

Stream	Photo Year	Scale	Portion of Stream Surveyed
Big Pipestone Creek	2001	1:15,840	Delmoe Lake to I-90 Crossing
	1982-1983	1:12,000	Delmoe Lake to Mouth
Cherry Creek	2001	1:15,840	Headwaters to Mouth
	1982-1983	1:12,000	Headwaters to Mouth
Dry Boulder Creek	2001	1:15,840	Headwaters to Mouth
	1982-1983	1:12,000	Headwaters to Mouth
Fish Creek	2001	1:15,840	Headwaters to Lowermost BLM Property (≈10 Miles)
	1982-1983	1:12,000	Headwaters to Jefferson Canal
Fitz Creek	1995	1:15,840	Headwaters to Mouth
	1983	1:12,000	Headwaters to Mouth
Halfway Creek	2001	1:15,840	Headwaters to Mouth
	1982-1983	1:12,000	Headwaters to Mouth

Table 1-1. 303(d) Streams and Corresponding Photo Year Inventory

Stream	Photo Year	Scale	Portion of Stream Surveyed
Hells Canyon Creek	2001	1:15,840	Headwaters to Mouth
	1983	1:12,000	Headwaters to Mouth
Little Pipestone Creek	2001	1:15,840	Headwaters to Beaverhead-Deerlodge NF Boundary (≈7 Miles)
	1982-1983	1:12,000	Headwaters to Mouth
Whitetail Creek	2001	1:15,840	Whitetail Reservoir to Boundary of State Owned Land (≈11 Miles)
	1983	1:12,000	Whitetail Reservoir to Mouth
Upper Jefferson River	2002	1:10,000*	Headwaters to the Boulder River
	1982-1983	1:12,000	≈2 Miles Below the Headwaters to the Boulder River

*Photo images were digital at 1 meter per pixel and 1 foot/pixel, but analysis was conducted in GIS at 1:10,000 scale.

1.1.3 Assessment Data Validation

Data validation for the aerial photo and field assessment data followed protocols established in the *Upper Jefferson River Preliminary Source Assessment Quality Assurance Project Plan* (Land & Water, 2004). Quality control for the data generated during the photo review involved accuracy checking of the planimeter, conducting repeat measurements, and ground truthing of selected reach segments during the field source assessment. Topographic maps and digital orthophotoquadrangles were used to assure that the proper streams were being assessed. Field quality control involved use of a differentially corrected GPS receiver. A database dictionary was developed that established standardized codes for collection of GPS source data in the field.

Measurement quality objectives for this project were set at a precision of ± 15 percent and an accuracy of ± 25 percent for all photo review data; while field generated data accuracy was set at ± 10 percent. Differences between measurements of different photos years should be evaluated with scale in mind. While the larger scale photos displayed more details, displacement and distortion of measurements were greater at larger scales (due to the greater effect of the curvature of the surface of the Earth). For guidance, the 1:12,000 scale photos are about 25 percent larger scale than the 1:15,840 scale photos, while measurements made in GIS at 1:10,000 are 20 percent larger scale than the 1:12,000 scale photos.

2.0 AERIAL PHOTO REVIEW AND FIELD SOURCE ASSESSMENT DATA RESULTS

2.1 Results of the Aerial Photo Collection and Compilation

Photos from 1942 to 2002 were acquired in digital format, scanned to digital format, or hard copies were ordered from the USDA Historic Photo Repository. In total 436 photo-image files and 34 hard copy photos were acquired for the Upper Jefferson Watershed. **Figures 2-1** to **2-6** display the results of the photo collection effort and corresponding photo coverage.

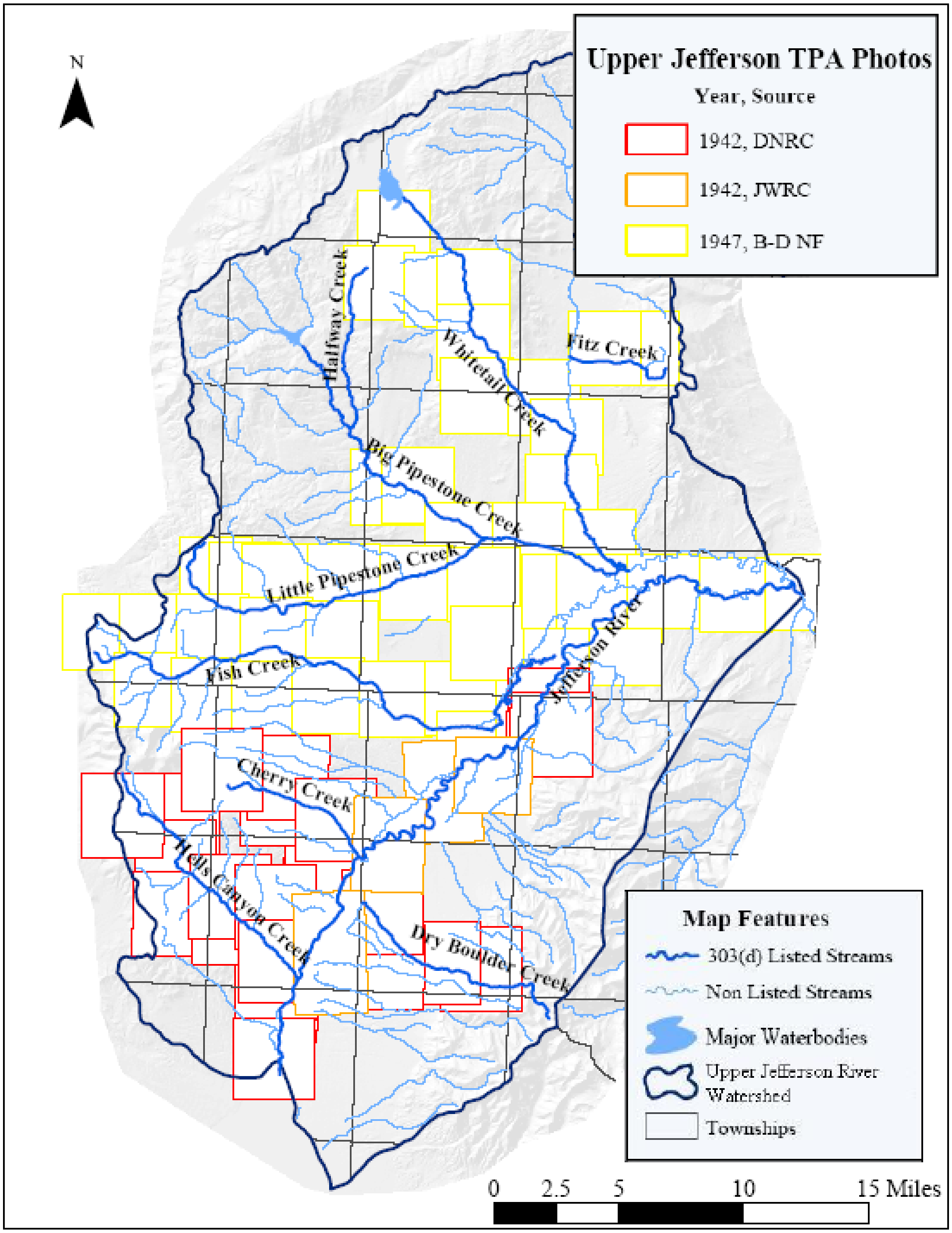

Figure 2-1. ***1940's Vintage Aerial Photo Coverage for the Upper Jefferson Watershed***

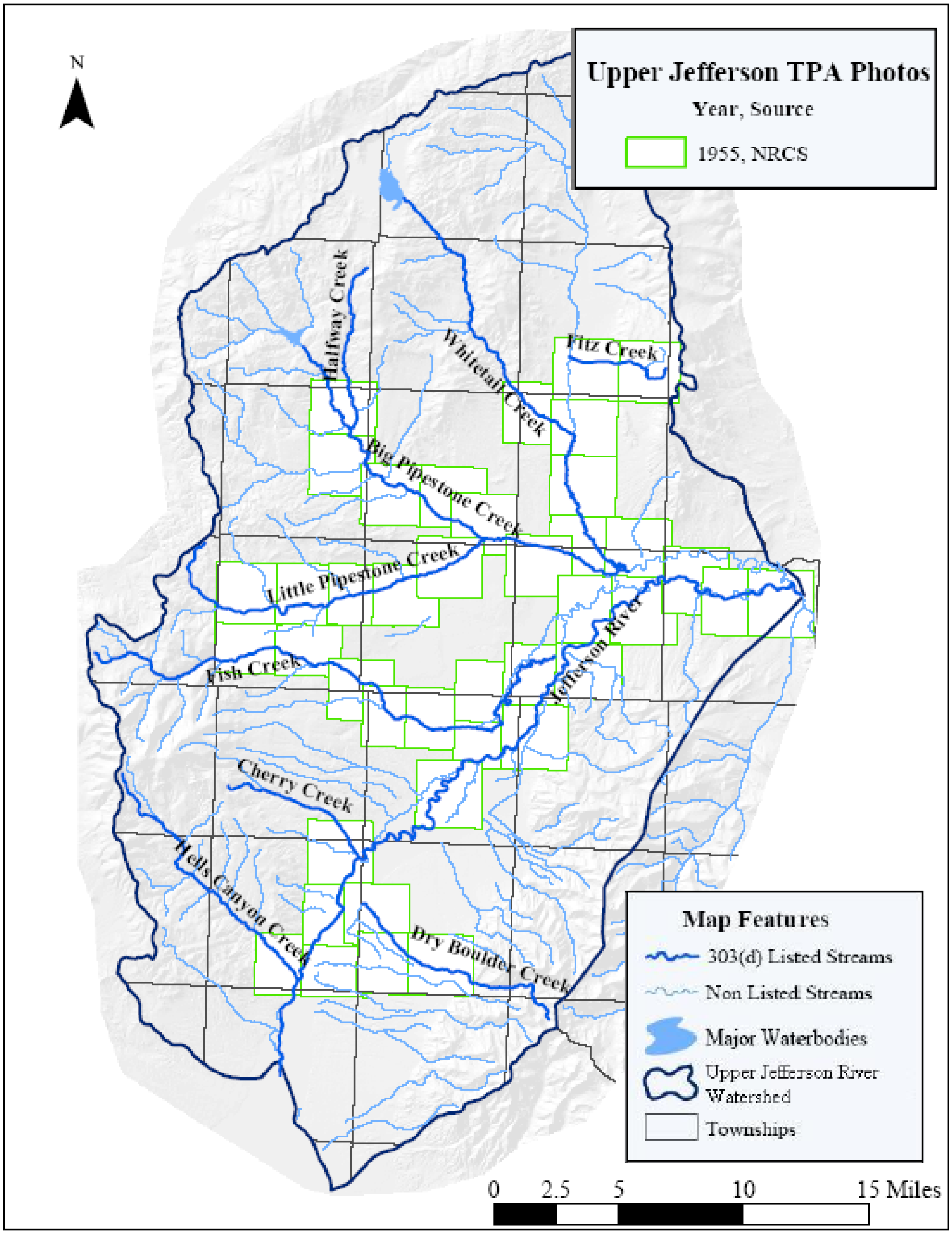

Figure 2-2. 1950's Vintage Aerial Photo Coverage for the Upper Jefferson Watershed

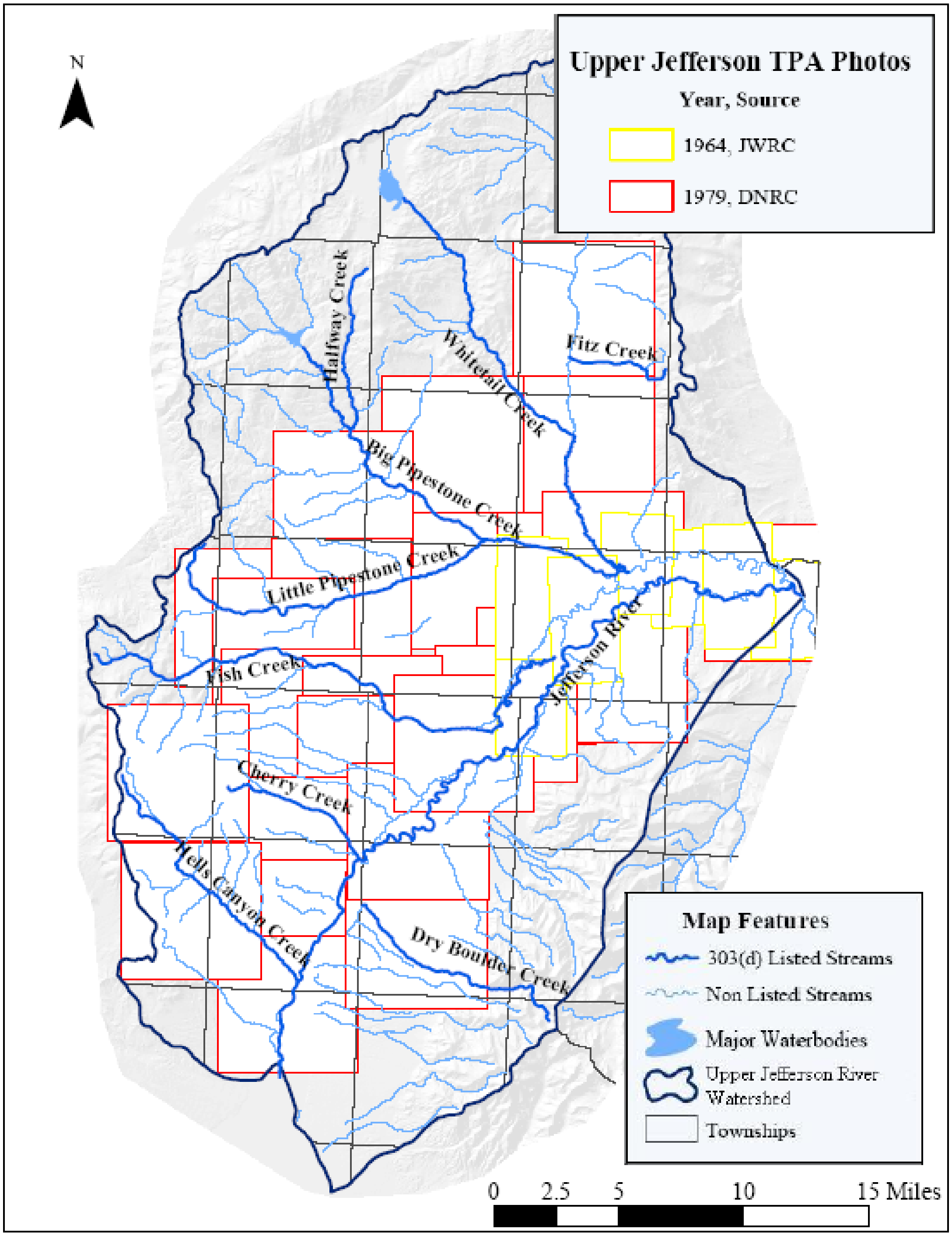

Figure 2-3. 1960's and 1970's Vintage Aerial Photo Coverage for the Upper Jefferson Watershed

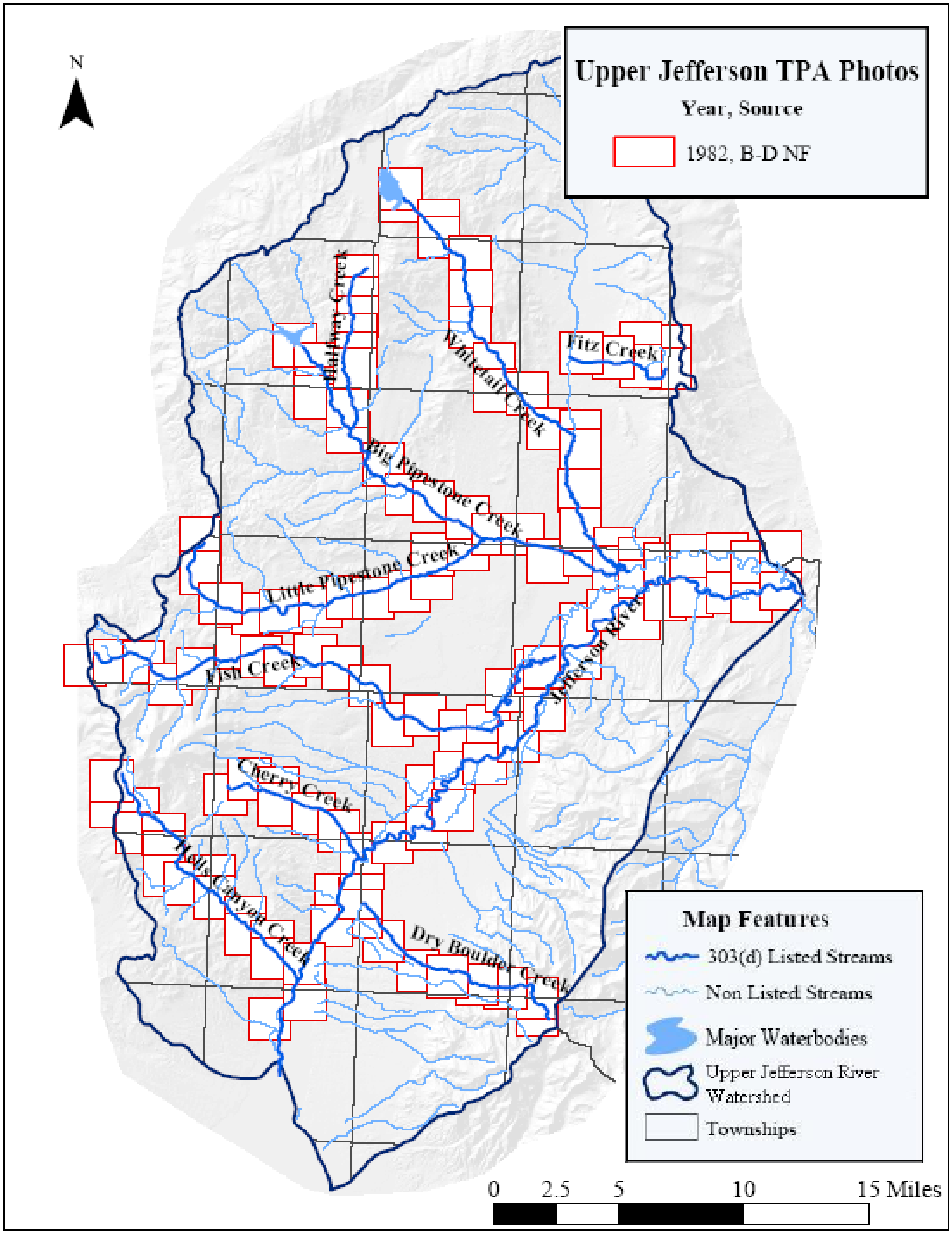

Figure 2-4. 1980's Vintage Aerial Photo Coverage for the Upper Jefferson Watershed

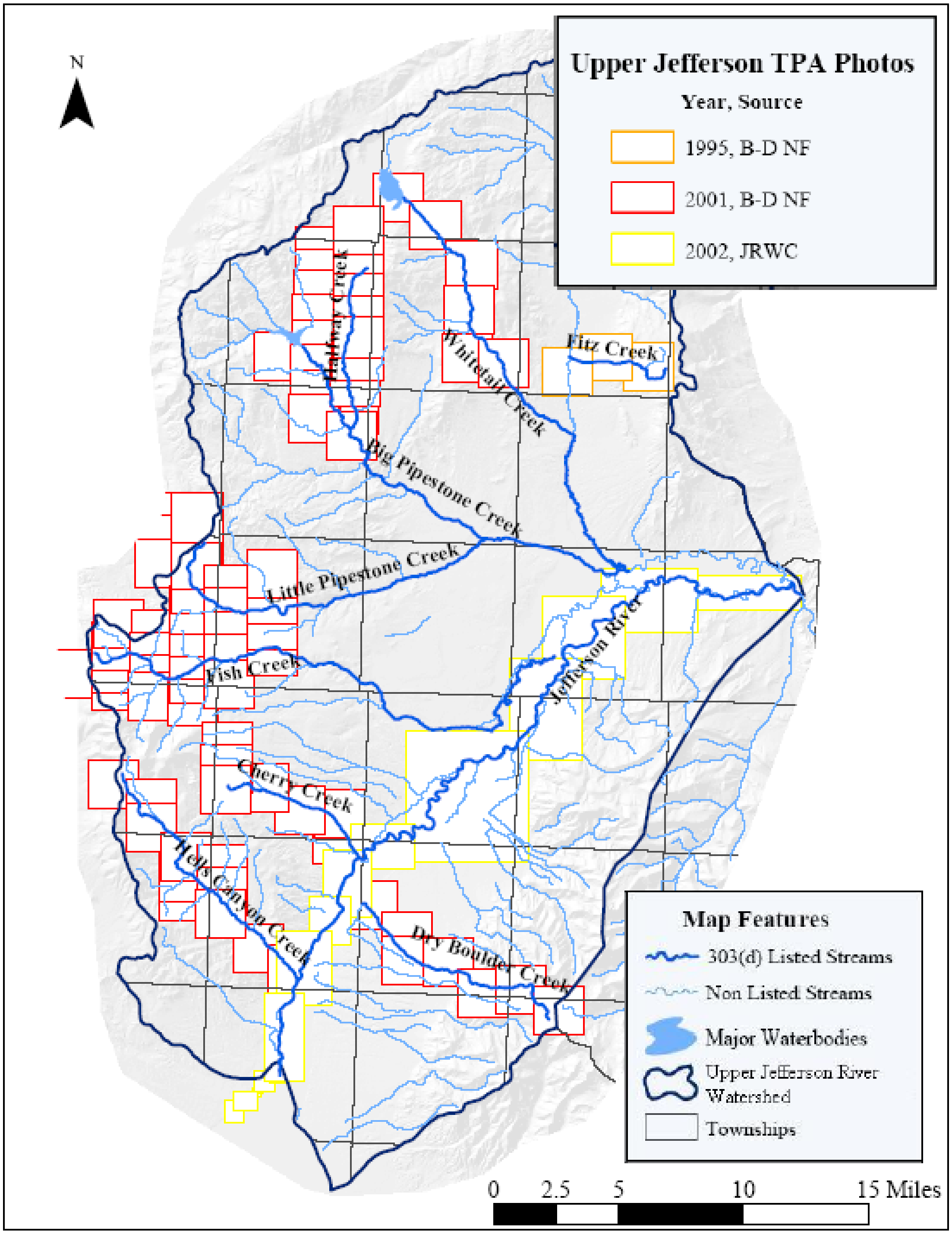

Figure 2-5. 1990's and 2000's Vintage Aerial Photo Coverage for the Upper Jefferson Watershed

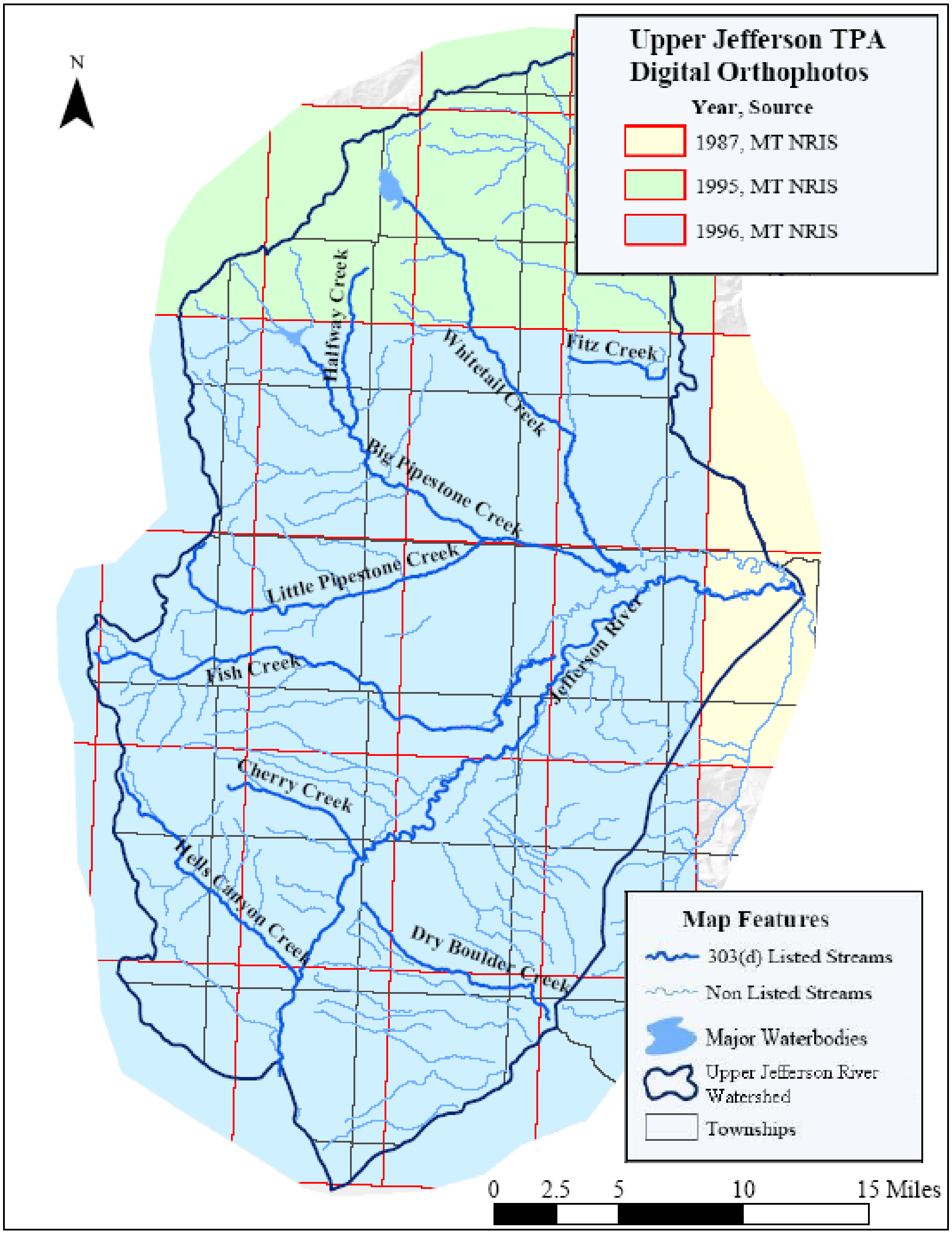

Figure 2-6. Digital Orthophoto Quadrangle Coverage for the Upper Jefferson Watershed

2.2 Results of the Aerial Photo Review and Field Source Assessment

The array of pollutant sources affecting the 303(d) Listed streams in the Upper Jefferson Watershed are a result of historic and current land use practices, as well as natural processes. The magnitude of problems range from high to low severity and are found upslope from, adjacent to, and within the stream channels. The results of the 2004 aerial photo inventory and field source assessment data are presented in the following sections.

2.2.1 Big Pipestone Creek

Big Pipestone Creek forms at the outlet of Delmoe Lake on the Beaverhead-Deerlodge National Forest. It flows for approximately 20 miles to where it meets Whitetail Creek.
The suspected causes of impairment to Big Pipestone Creek are bank erosion, channel incisement, habitat degradation/alteration, nutrients, riparian degradation, suspended sediment, and thermal modifications. Suspected pollution sources to Big Pipestone Creek include agriculture, channelization, grazing related sources, habitat modification, hydromodification, municipal point sources, removal of riparian vegetation, road related sources, and silviculture. According to the 2004 303(d) List, cold water fisheries and associated aquatic life, industry, and primary contact recreation are partially supported uses.

For the purposes of the source assessment, Big Pipestone Creek was broken into 16 reaches (**Figures 2-7** to **2-12**). During the 2004 water quality monitoring project (May to September) and the October field source assessment, 9 of the 16 reaches were visited in the field (**Table 2-1**). Where available, field information was incorporated within the results of the source assessment.

Table 2-1. Field Assessment of Big Pipestone Creek Reaches

Big Pipestone Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 1	Field Survey	10%
Reach 2	Field Survey, Water Quality Monitoring	10%
Reach 7	Water Quality Monitoring	Less than 10%
Reach 10	Field Survey	45%
Reach 11	Field Survey	Less than 10%
Reach 12	Field Survey	25%
Reach 13	Field Survey, Water Quality Monitoring	40%
Reach 14	Field Survey	40%
Reach 16	Water Quality Monitoring	5%

2.2.1.1 Big Pipestone Creek Rosgen Stream Types

The channel forms of Big Pipestone Creek above Interstate 90 are predominantly controlled by landform structure, as well as reservoir releases from Delmoe Lake (**Figure 2-7**). The prominent landform geology, the Boulder Batholith, has resulted in valley bottom formation along weathered joints. Narrow valley bottoms dominated by granitic boulders (B-type reaches), as well as less confined valley bottom areas are found (C-type reaches). Portions of Reaches 1 and 2 viewed during the field survey exhibited B and F channel types. B-type sections were found where the stream was more structurally controlled (lower W/D ratio and less entrenched). After the field review, it was noted that Reach 1 could probably have been broken into 2 reaches as most of the reach appeared unconfined on the air photos, but only the upper 10 percent of the reach was viewed in the field (mostly F-type). The portion of Reach 7 viewed in the field exhibited a C-type channel. Delmoe Lake releases have greatly increased the flow of the creek. It is the professional opinion of the surveyor that without the lake releases natural channel form would alternate between B and Eb stream types. There were no significant changes in channel form between 1983 and 2001.

Many of the channel forms of Big Pipestone Creek below Interstate 90 are controlled by historical and current landuse activities (**Figure 2-8**). The predominant valley type (VIII) would typically result in an unconfined stream type (C or E), yet water level alterations for flow diversions and channelization have resulted in stream types out of balance with the valley type. Portions of Reaches 10, 12, and the upper part of Reach 13 viewed during the field survey exhibited C-type channels, while the portion of Reach 11 viewed, and some areas of Reach 12 exhibited E-type stream channels. Channel form in the valley was variable, with many areas observed as incised. Remnants of beaver dams were found in Reaches 10, 11, 12 and 13. From about the middle of Reach 13 to the mouth, numerous alterations to the channel have occurred, such that Rosgen stream typing is somewhat inapplicable (constructed channel versus alluvial channel). However, F-type sections were noted in Reaches 13 and 14. Reach 14 is where the stream was channelized for the railway. The channelization was probably the cause of extreme headcutting observed in this reach. At Reach 15, the stream appeared to return to its natural channel, while over half of Reach 16 appeared to be a constructed channel. The portion of Reach 16 viewed in the field appeared to be more of an E-type channel (low W/D ratio, no point bars), however stream type was classified as an F due to the large area of the reach not observed in proximity to the channelized reach (14). For the valley portion of Big Pipestone Creek, only one time period was analyzed so significant changes in channel form since 1983 could not be determined.

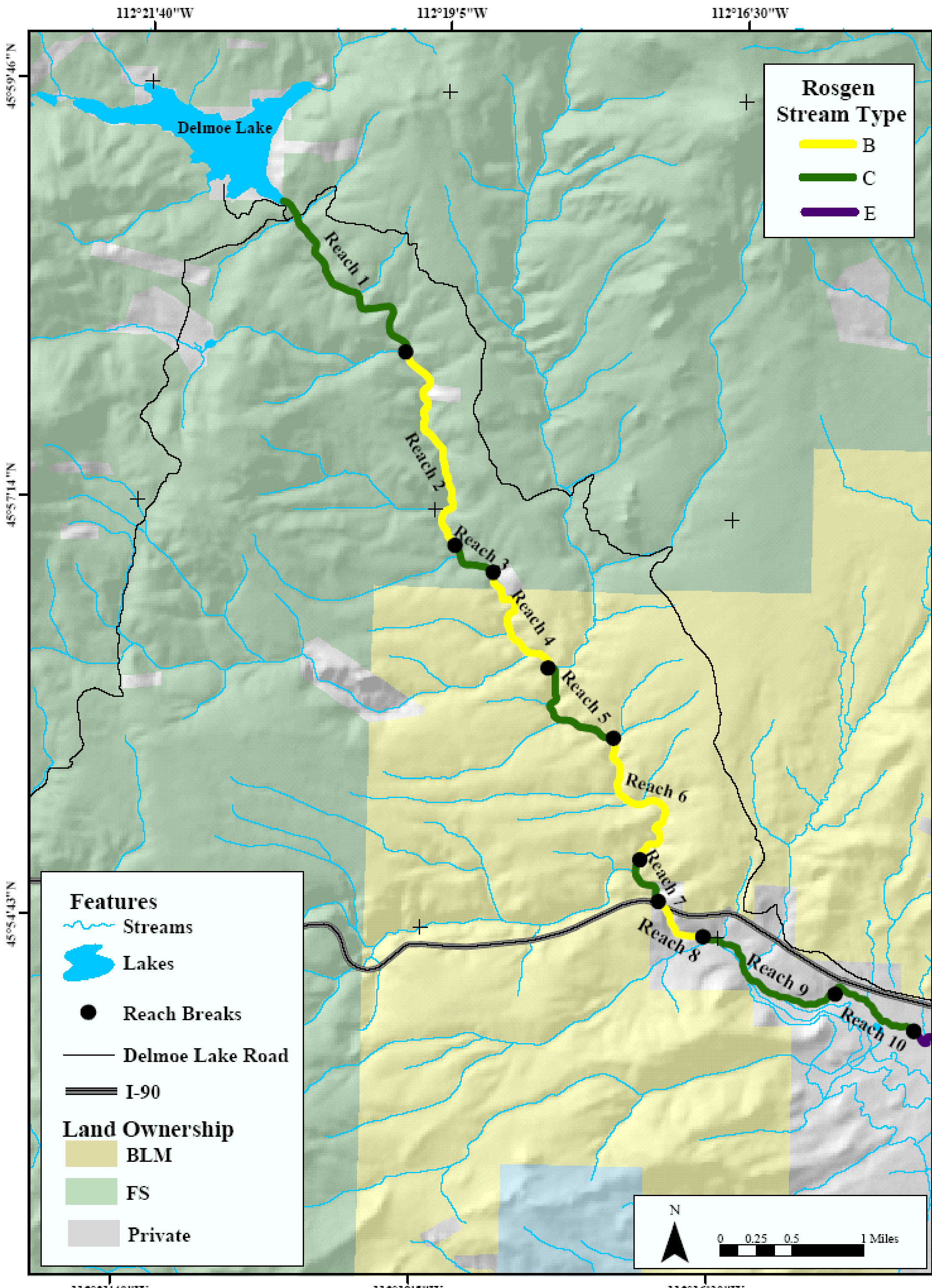

Figure 2-7. Upper Big Pipestone Creek Rosgen Stream Types

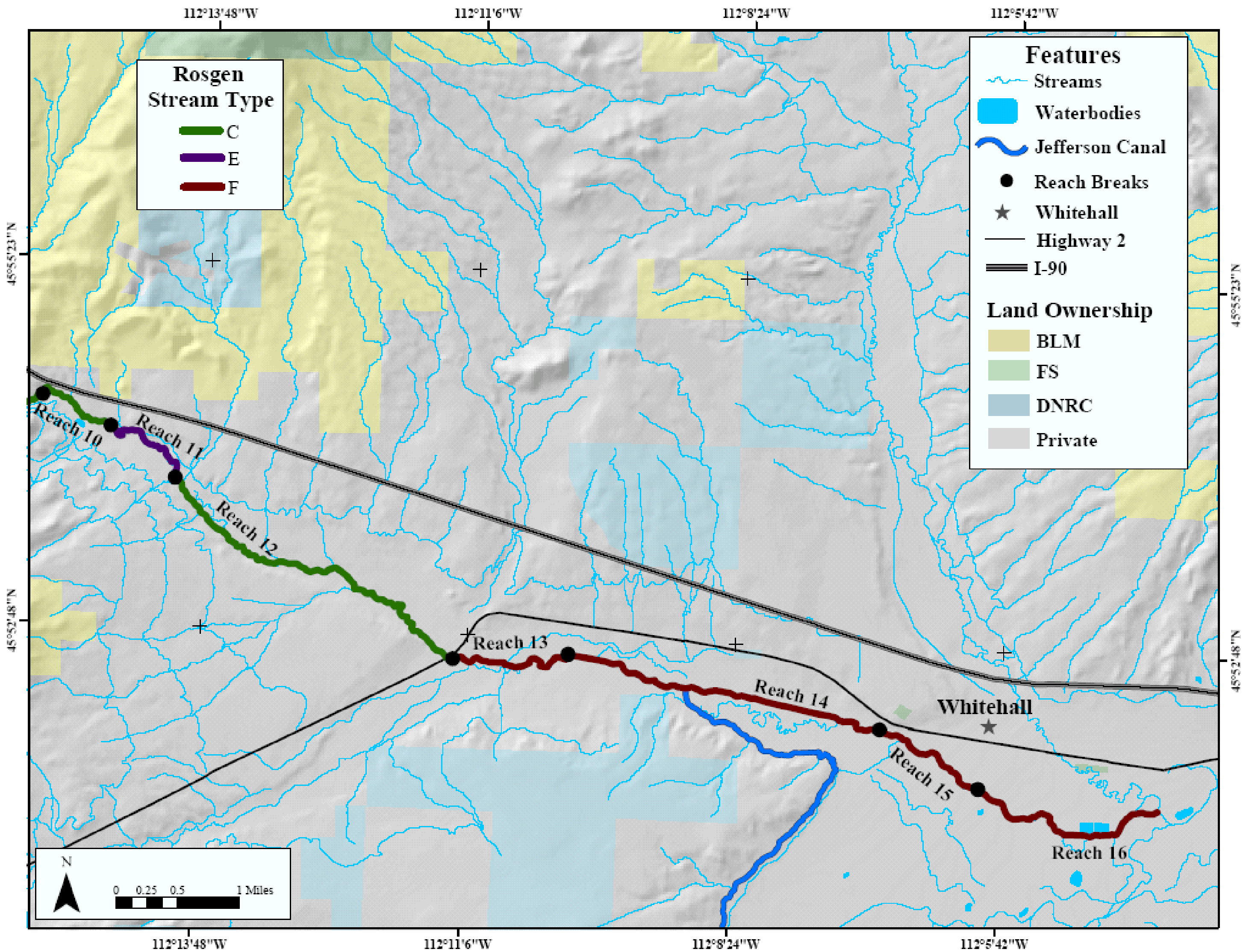

Figure 2-8. Lower Big Pipestone Creek Rosgen Stream Types

2.2.1.2 Big Pipestone Creek Riparian Vegetation

The dominant riparian cover along Big Pipestone Creek above Interstate 90 was mixed coniferous forest with upland shrubs (**Figure 2-9**). Buffer widths were generally greater than 100 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed, as opposed to the actual width of 'wet' vegetation (alders, willows, etc.). The relative health category assigned to all of the upper reaches was: 'Fair. Vegetation appears healthy, but some disturbance is present.' During the field review, willows, alders, rose, red osier, and grasses were noted as extending to a maximum of 30 feet from the channel within the conifer forest. Some areas of thistle infestation were present. Between 1983 and 2001, the riparian buffer widths in Reaches 4 and 7 appeared to increase by an average of 25 percent.

The dominant riparian cover along Big Pipestone Creek below Interstate 90 was herbaceous; whereby, the grasses or forbs were being grown into the riparian and almost no woody vegetation was present (**Figure 2-10**). The one exception to this was Reach 11, which dominantly exhibited wetland characteristics. The buffer widths of these lower reaches represented the actual width of 'wet' vegetation (alders, willows, etc.). Buffer widths were generally less than 100 feet wide along both sides of the stream. The relative health category assigned to most of the valley reaches was: 'Fair. Vegetation appears healthy, but some disturbance is present.' Reaches 13, 14, and 16 were assigned a rating of 'Poor' due to notable disturbance. During the field review, willows, cottonwood, rose, and grasses were noted as extending generally to a maximum of 40 feet from the channel in Reaches 10 and 12. In Reaches 13 and 14, grasses, decadent willows, and roses were the predominant vegetation. Some areas of thistle and knapweed infestations were present. For the valley portion of Big Pipestone Creek, only one time period was analyzed so significant changes in riparian vegetation since 1983 could not be determined.

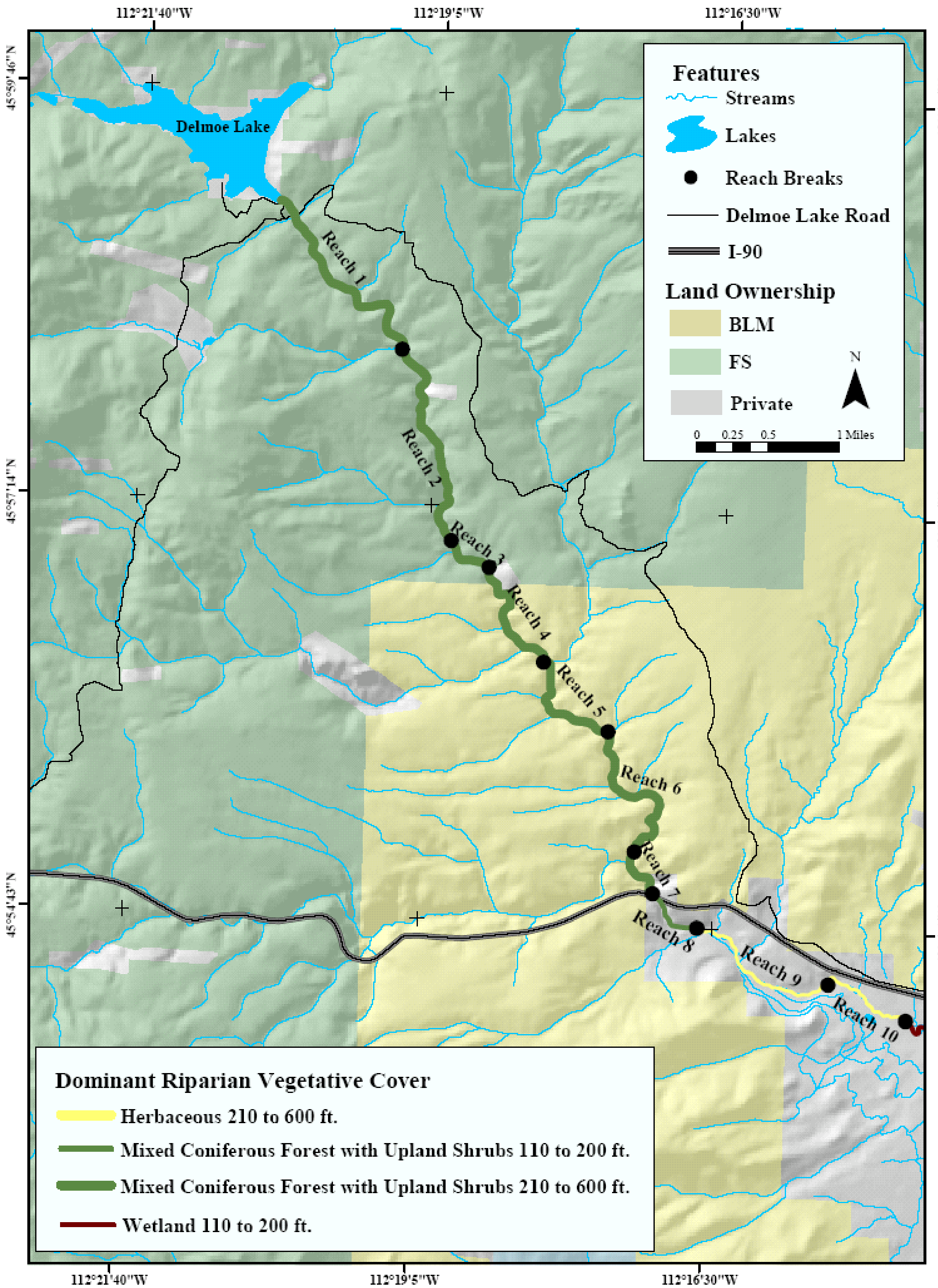

Figure 2-9. Upper Big Pipestone Creek Riparian Vegetation

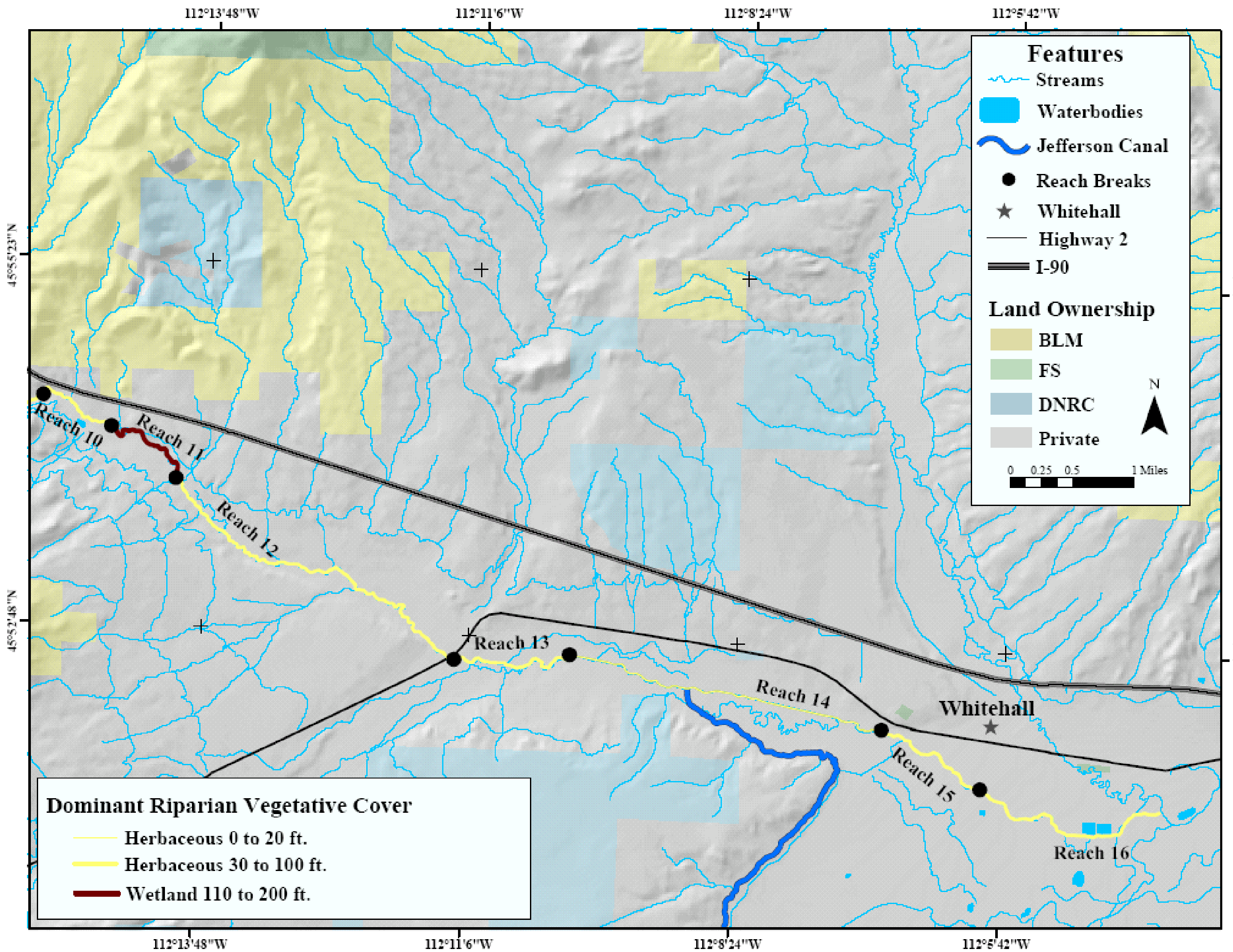

Figure 2-10. Lower Big Pipestone Creek Riparian Vegetation

2.2.1.3 Big Pipestone Creek Pollution Sources

Figure 2-11 displays the pollution sources assigned to the upper reaches of Big Pipestone Creek. Many pollution sources observed along Big Pipestone Creek above Interstate 90 were related to the operation of Delmoe Lake Dam, and unpaved roads and trails. In many instances, the sources of flow alterations from water diversions and impacts from abandoned mine lands were taken from GIS layers which located water rights claims and abandoned mines. The GIS identified sources have generally not been field verified. During the field source assessment, heavy algal growth just below the Delmoe lake outlet, road sediment delivery sites, and channelization from rock walls were observed in Reach 1. In Reach 2, sediment delivery sites from ATV/motorcycle trails, and trash from an old mining operation (wood, metal, tires, furniture) were observed in the stream. The portion of Reach 7 that was surveyed looked fairly healthy, with vigorous riparian vegetation. There were no significant changes in pollution sources between 1983 and 2001.

Figure 2-12 displays the pollution sources assigned to the lower reaches of Big Pipestone Creek. Many pollution sources observed along Big Pipestone Creek below Interstate 90 were related to agricultural operations. During the field source assessment, grazing impacts (trampled banks, overwidened channel, channel braids) were observed in all of the field surveyed reaches, except for Reach 11. Alterations for irrigation diversions were observed in Reaches 11, 13, 14, and 16. In general, stream condition deteriorates in a downstream manner from Reach 10 to Reach 14. For the valley portion of Big Pipestone Creek, only one time period was analyzed so significant changes in pollution sources since 1983 were not determined.

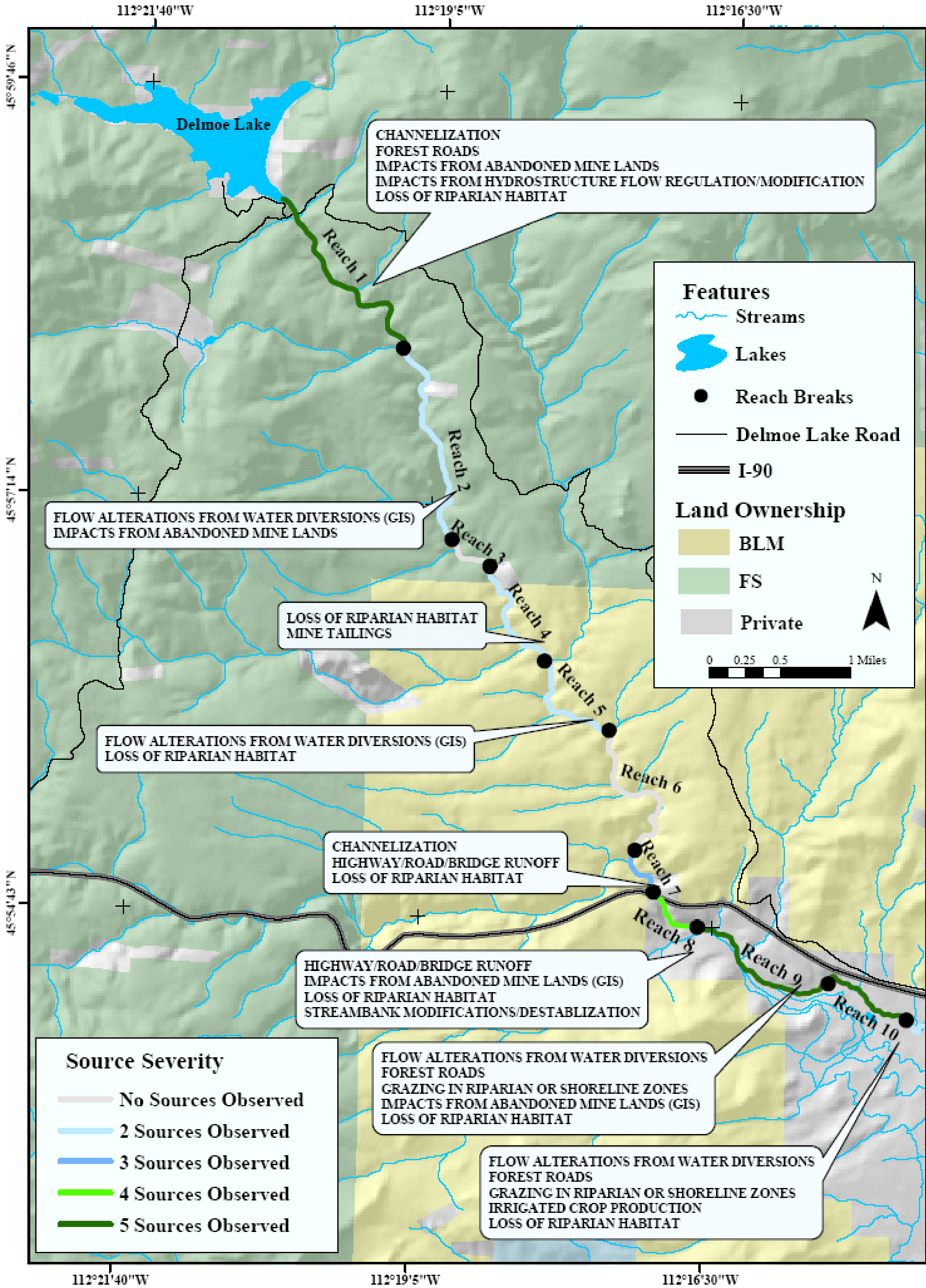

Figure 2-11. Upper Big Pipestone Creek Pollution Sources

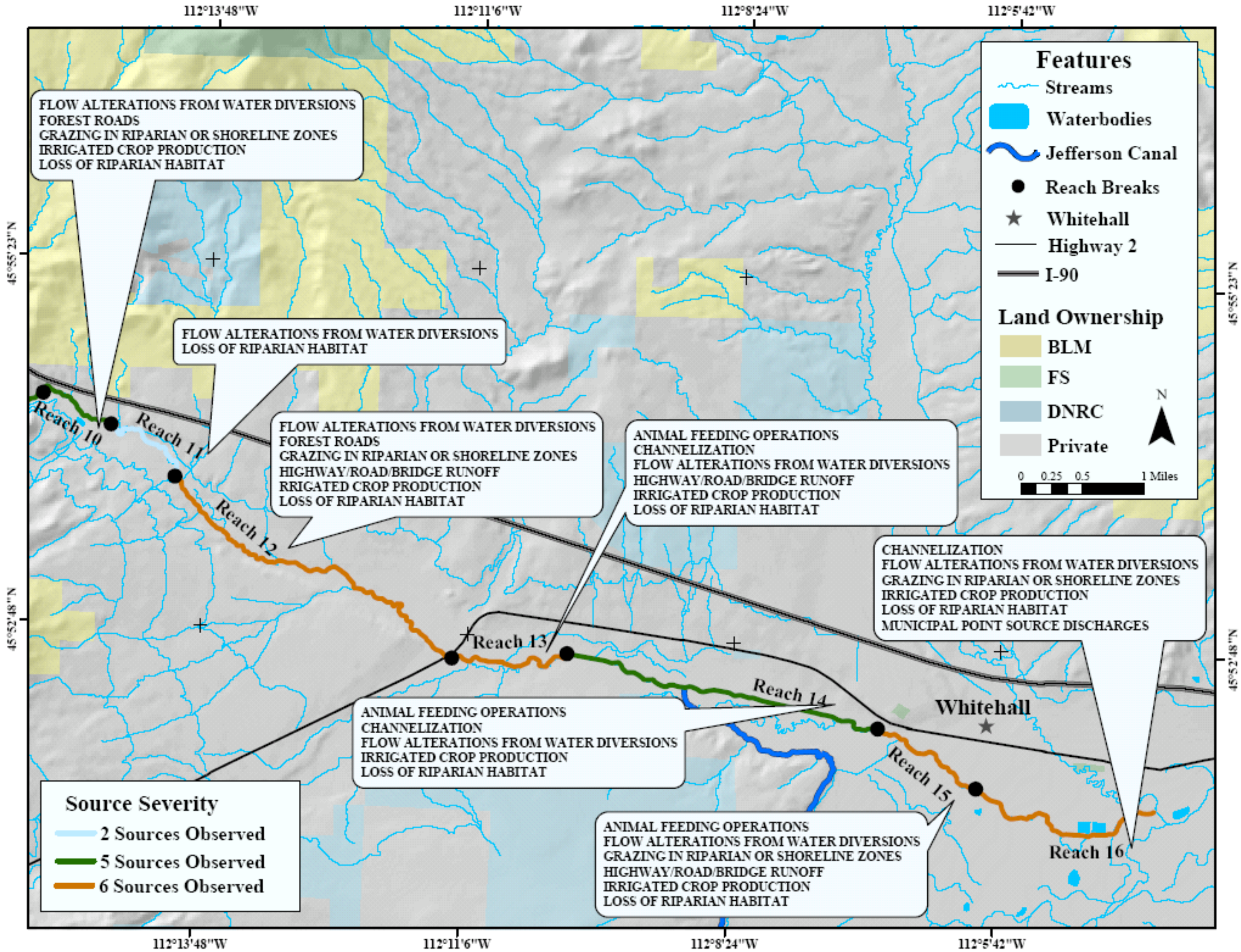

Figure 2-12. Lower Big Pipestone Creek Pollution Sources

2.2.2 Cherry Creek

Cherry Creek headwaters at Little Cherry Creek Spring on the Beaverhead-Deerlodge National Forest. It flows for approximately 7 miles to where it meets the Jefferson River. During the summer irrigation season, landowners report that the stream goes dry on the lower alluvial fan before reaching the Jefferson River. In 1996, the DEQ listed flow alteration as the suspected cause of impairment to Cherry Creek, with agriculture and flow regulation/modification as the suspected pollution sources. According to the 1996 303(d) List, cold water fisheries and associated aquatic life are threatened uses.

For the purposes of the source assessment, Cherry Creek was broken into 6 reaches (**Figures 2-13** to **2-15**). During the 2004 October field source assessment, 3 of the 6 reaches were visited in the field (**Table 2-2**). Stream access on private property was somewhat limited. Where available, field information was incorporated within the results of the source assessment.

Table 2-2. Field Assessment of Cherry Creek Reaches

Cherry Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 2	Field Survey	40%
Reach 3	Field Survey	10%
Reach 6	Field Survey	10%

2.2.2.1 Cherry Creek Rosgen Stream Types

The channel forms of Cherry Creek are primarily controlled by landform structure (**Figure 2-7**). The prominent landform geology, the Boulder Batholith, has resulted in valley bottom formation along weathered joints. The stream headwaters on relatively steep slopes (A-type) and then progresses downstream to more moderate slopes. The valley bottom is fairly confined (B-type reaches) until exiting the canyon to the alluvial fan (B and Eb reaches). The portion of Reach 2 viewed during the field survey exhibited A, Ea, and G channel types. The Ea section was observed in a steep aspen meadow area, while the stream alternated between G (grazing impacts) and A type sections where the stream was more confined. Reach 3 was surveyed from the confluence of the North Fork of Cherry Creek downstream. Reach 3 exhibited B and Ba-type sections. The portion of Reach 6 viewed in the field exhibited an Eb-type channel. The section of Reach 6 surveyed was below a large irrigation diversion, but diminished flow effects were not observed. According to the property owner, flow is fairly constant; however a landowner further downstream reported that the stream often goes dry during the irrigation season (section not observed). There were no significant changes in channel form between 1983 and 2001.

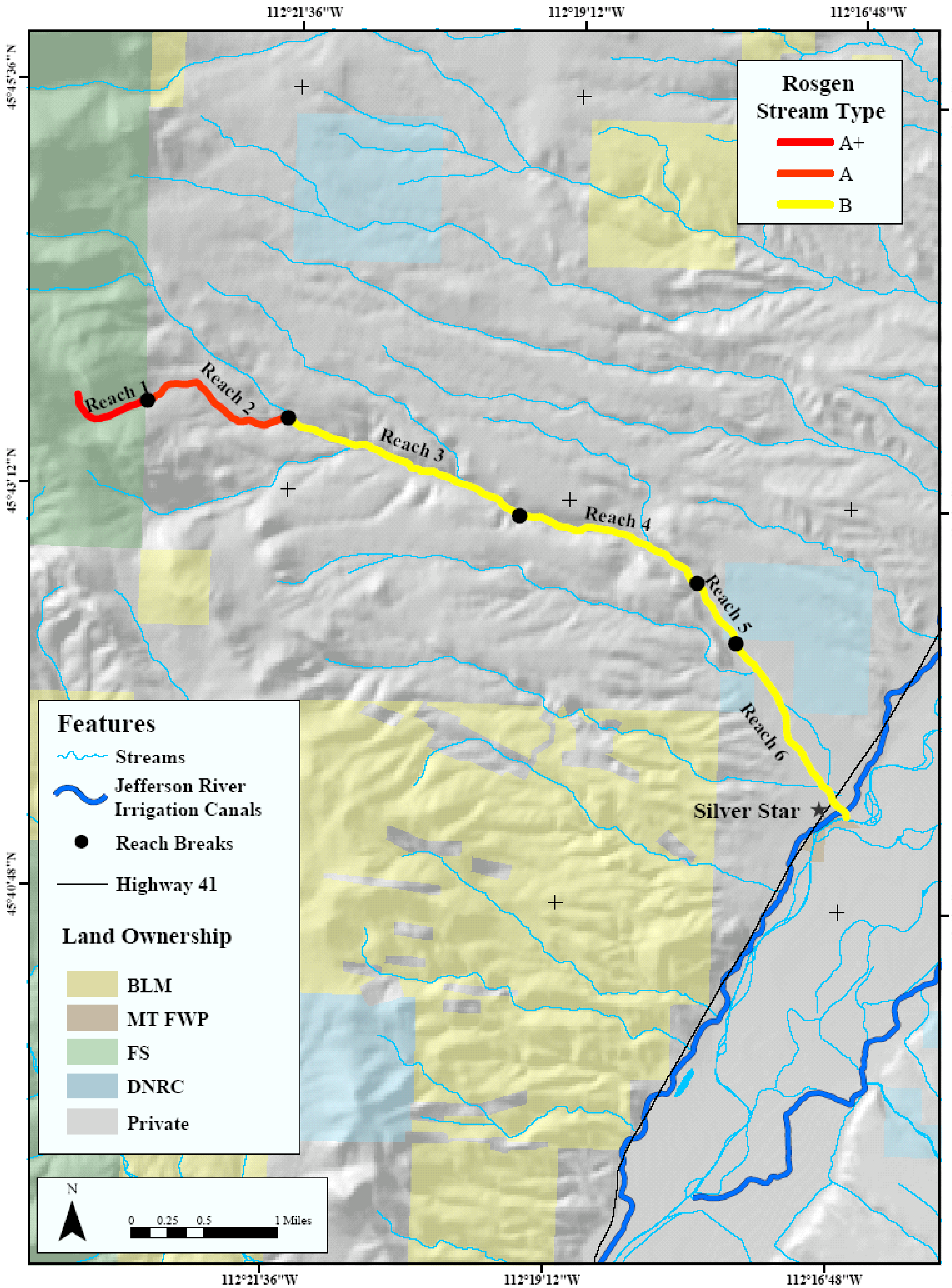

Figure 2-13. Cherry Creek Rosgen Stream Types

2.2.2.2 Cherry Creek Riparian Vegetation

The dominant riparian cover in the headwaters of Cherry Creek was mixed coniferous forest with upland shrubs (**Figure 2-14**). Buffer widths were generally greater than 300 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed, as opposed to the actual width of 'wet' vegetation (alders, willows, etc.). The relative health category assigned to Reach 1 was: 'Excellent. Vegetation appears to be vigorous, with various age classes present (little or no disturbance).'

The dominant riparian cover along the canyon sections of Cherry Creek was mixed coniferous, dominantly deciduous forest. Buffer widths were generally greater than 60 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed, or vegetation type changed. Buffer widths were generally limited by valley bottom width, as opposed to unnatural factors. During the field review, willows, apsen, current, alder, and sedges were noted as extending to a maximum of 20 feet from the channel. Some areas of thistle, leafy spurge, and mullein were present. The relative health category assigned to Reaches 2 to 4 was: 'Fair. Vegetation appears healthy, but some disturbance is present.' Between 1983 and 2001, the riparian buffer widths in Reaches 3 and 4 appeared to increase by an average of 40 percent and 25 percent respectively.

The dominant riparian cover along the alluvial fan portion of Cherry Creek was herbaceous, whereby, the grasses or forbs were being grown into the riparian and almost no woody vegetation was present (**Figure 2-14**). The buffer widths of these lower reaches represent the actual width of 'wet' vegetation. Buffer widths were generally less than 50 feet wide along both sides of the stream. The relative health category assigned to Reach 5 was 'Fair'; while the relative health category assigned to Reach 6 was 'Poor' due to notable disturbance. During the field review in Reach 6, cottonwood (regenerating), willows, alder, rose, and sedges were noted as extending generally to a maximum of 20 feet from the channel. Between 1983 and 2001, the riparian buffer width in Reach 6 appeared to increase by an average of 25 percent.

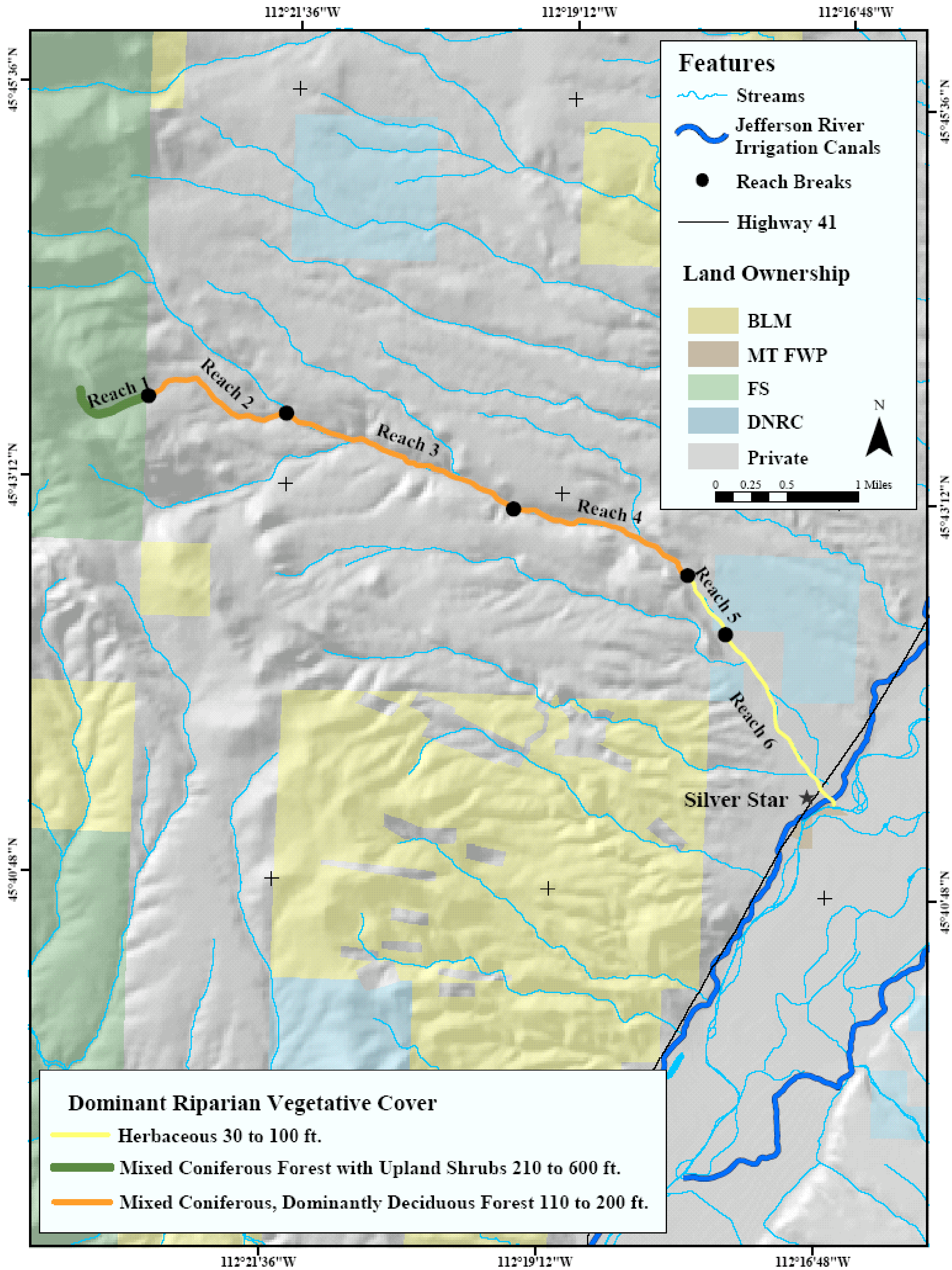

Figure 2-14. Cherry Creek Riparian Vegetation

2.2.2.3 Cherry Creek Pollution Sources

Figure 2-15 displays the pollution sources assigned to Cherry Creek. Many pollution sources observed along Cherry Creek were related to riparian grazing and unpaved roads. In the upper reaches of the creek, the source of flow alterations from water diversions was taken from a GIS layer which located water rights claims. In Reach 6 the impacts from abandoned mine lands was also taken from a GIS layer. The GIS identified sources have not been field verified. Silviculture harvest has occurred upslope from Cherry Creek (south side) and any runoff associated with the harvest would enter in Reaches 2 and 3. Again harmful effects from this impact were not field verified. Grazing impacts observed in the field were more detrimental in Reach 2 than in any of the other reaches observed. Sediment input from unpaved roads was fairly minimal. Loss of riparian habitat was associated with development in the floodplain (roads, crops, housing). There were no significant changes in pollution sources between 1983 and 2001.

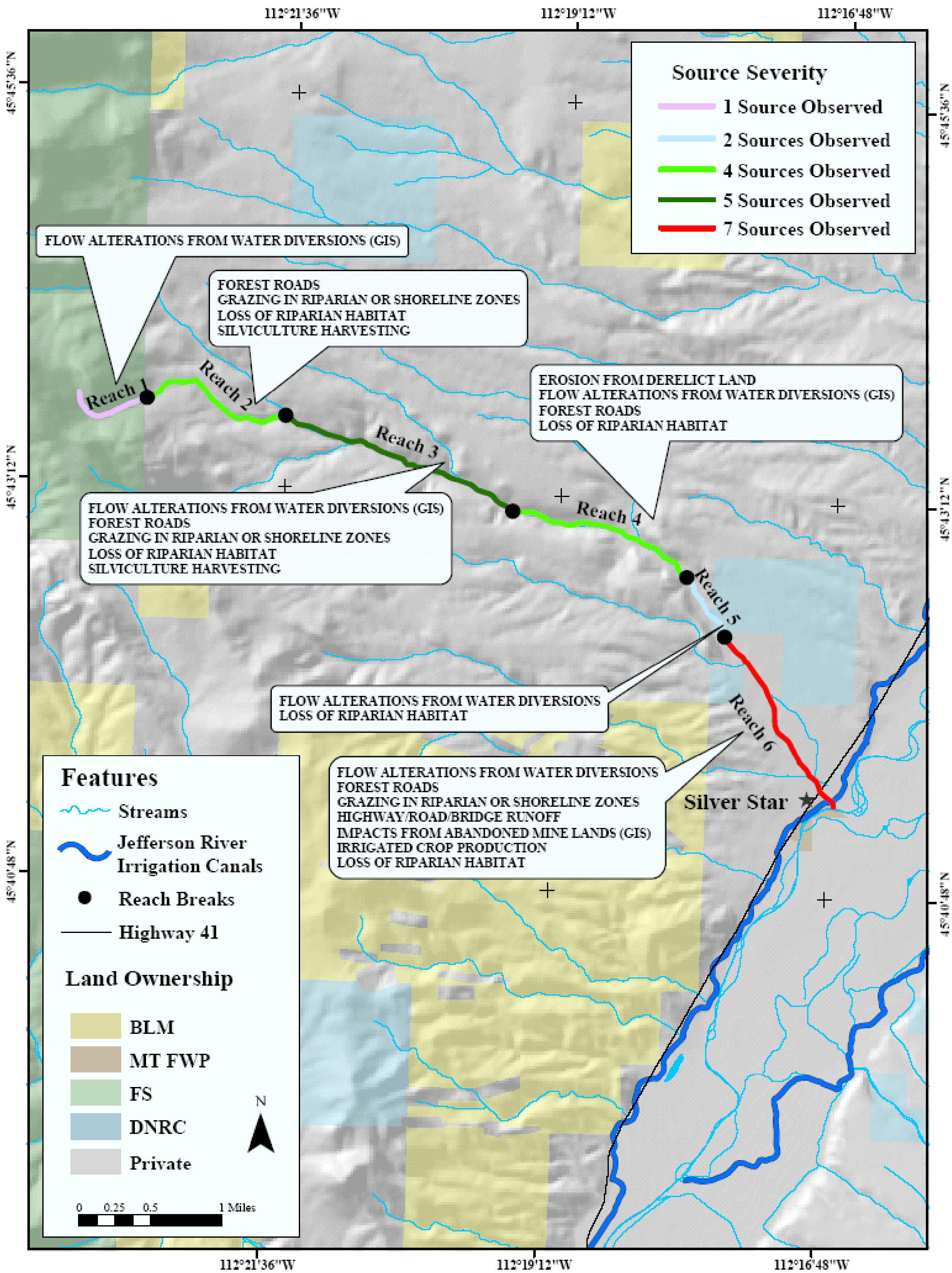

Figure 2-15. Cherry Creek Pollution Sources

2.2.3 Dry Boulder Creek

Dry Boulder Creek forms at the outlet of Boulder Lakes in the Tobacco Root Mountains on the Beaverhead-Deerlodge National Forest. It flows for approximately 11 miles to where it meets the Jefferson River. The stream goes dry for much of the year before it reaches the alluvial fan at the mountain front. In 1996, the DEQ listed flow alteration and siltation as the suspected causes of impairment to Dry Boulder Creek, with agriculture, flow regulation/modification, and resource extraction as the suspected pollution sources. According to the 1996 303(d) List, cold water fisheries and associated aquatic life, drinking water and primary contact recreation are threatened uses.

For the purposes of the source assessment, Dry Boulder Creek was broken into 4 reaches (**Figures 2-16** to **2-18**). During the 2004 October field source assessment, portions of all of the reaches were visited in the field (**Table 2-3**). Where available, field information was incorporated within the results of the source assessment.

Table 2-3. Field Assessment of Dry Boulder Creek Reaches

Dry Boulder Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 1	Field Survey	10%
Reach 2	Field Survey	70%
Reach 3	Field Survey	10%
Reach 16	Field Survey	Less than10%

2.2.3.1 Dry Boulder Creek Rosgen Stream Types

Figure 2-16 displays the Rosgen channel types assigned to Dry Boulder Creek. The structural controls on the channel forms of Dry Boulder Creek have led to diverse channel types in the headwaters. For this reason, the channel classifications for Reaches 1 and 2 were 'unclassified' after the field review. Channel forms in Reaches 1 and 2 are influenced by past glaciation. In Reach 1, many Rosgen channel types exist. Most likely the channel starts at the mouth of Upper Boulder Lake as an E or C type stream (not observed in field), but then changes type where the stream hits a nickpoint (A-type, observed). At the base of the falls (A), the channel quickly changes to a Ba type, then to an E type, but with multiple channels and areas of braiding where the stream flows into Lower Boulder Lake. Reach 2 is also difficult to type in areas because of the steep gradient, high entrenchment ratio, and braiding. Ea, A, Ba, and E (meadow area) channel types were observed in this reach. The portions of Reaches 3 and 4 observed in the field exhibited B and Ba type channels. After the field review, it was noted that Reach 4 should have probably be broken into at least two reaches on the alluvial fan, possibly around the 5400’ contour interval where contour spacing starts to spread further apart (slope and substrate size probably change here). There were no significant changes in channel form between 1983 and 2001.

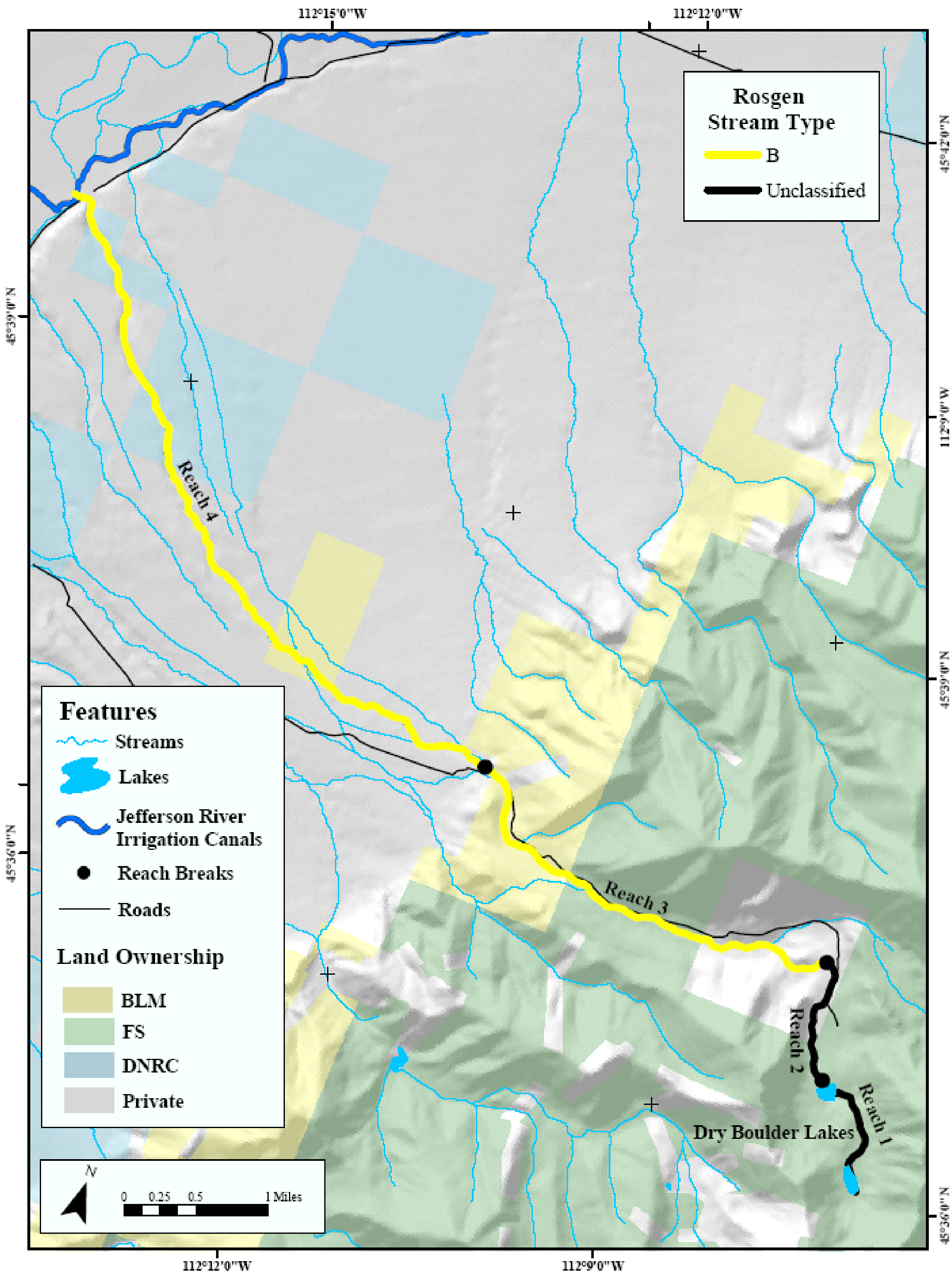

Figure 2-16. Dry Boulder Creek Rosgen Stream Types

2.2.3.2 Dry Boulder Creek Riparian Vegetation

The dominant riparian cover along Dry Boulder Creek was mixed coniferous forest with upland shrubs (**Figure 2-17**). In the headwaters reaches (1 and 2), vegetative width was generally limited by natural factors and could probably be classified as alpine wetland. During the field review, sedges, alpine flowers, and conifers were observed in Reaches 1 and 2. In Reach 3, buffer widths were generally greater than 100 feet wide along both sides of the stream. In Reaches 3 and 4, the riparian vegetation was mostly conifers with some deciduous vegetation growth (cottonwood, chokecherry, maple). Near the mouth, more deciduous vegetation was observed. Along the areas observed in Reach 4, riparian vegetative width was limited by moisture. The relative health category assigned to all of the reaches was: 'Fair. Vegetation appears healthy, but some disturbance is present.' There were no significant changes in riparian vegetation between 1983 and 2001.

2.2.3.3 Dry Boulder Creek Pollution Sources

Figure 2-18 displays the pollution sources assigned to Dry Boulder Creek. Few pollution sources were observed in the field. The most detrimental source observed was a road sediment delivery site near the end of Reach 3. In some instances, the sources of flow alterations from water diversions and impacts from abandoned mine lands were taken from GIS layers which located water rights claims and abandoned mines. The GIS identified sources have generally not been field verified. Some habitat disturbance in the vicinity of an old mine site in Reach 1 was visible on the aerial photos, but this section of the stream was difficult to access and not field observed. Unfortunately, the canal diversion to Coal Creek (Reach 3) was not noted before the field assessment, and thus it could not be determined if this canal takes all of the stream's flow. It is suspected that the change in lithology from crystalline rocks to porous carbonate rocks in Reach 3 may contribute to natural stream dewatering. On the alluvial fan (Reach 4) the stream goes distributary and probably does not carry flow, except during spring runoff and intense rainfall events (fairly characteristic of streams on alluvial fans in arid environments). There were no significant changes in pollution sources between 1983 and 2001.

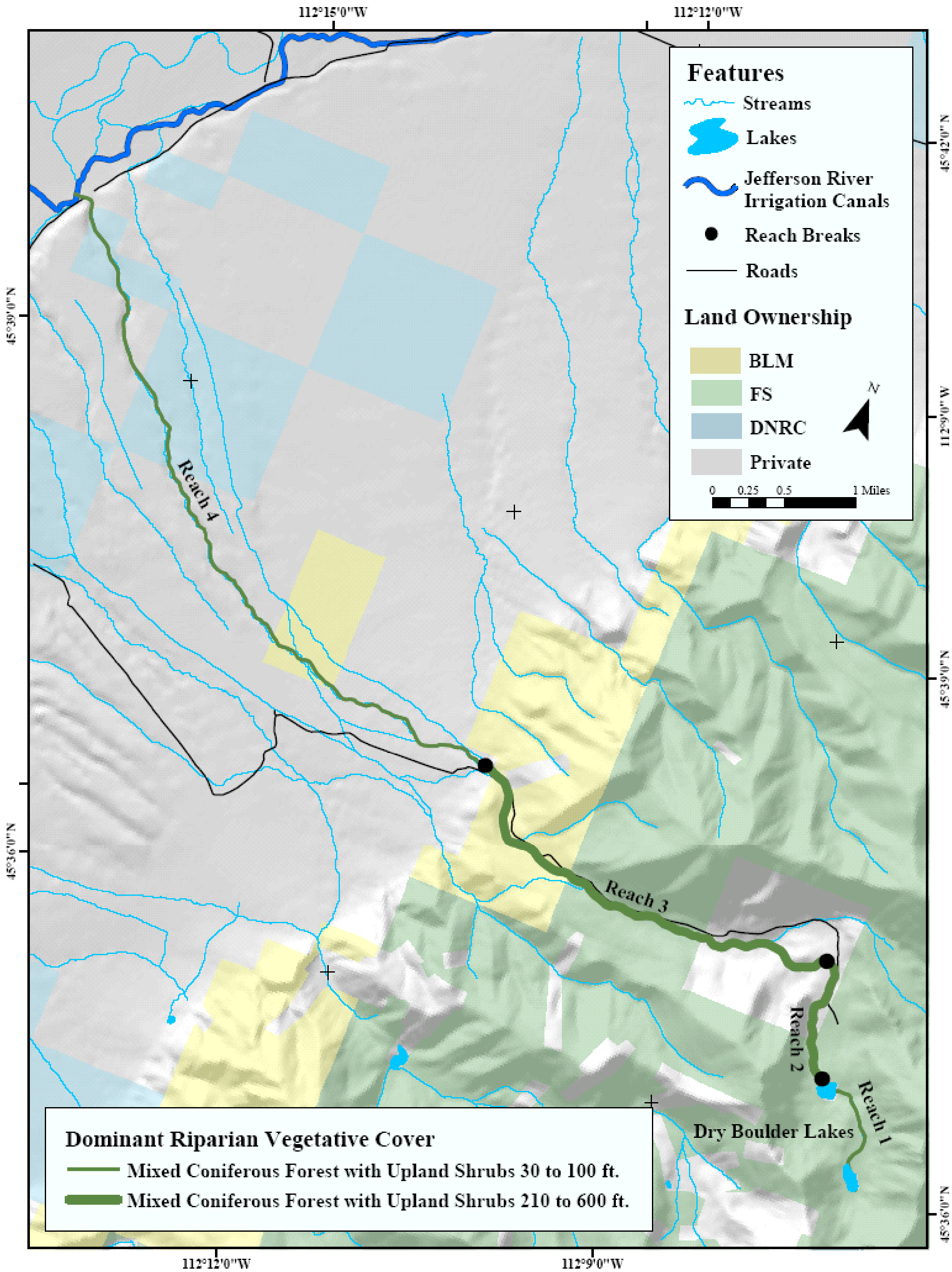

Figure 2-17. Dry Boulder Creek Riparian Vegetation

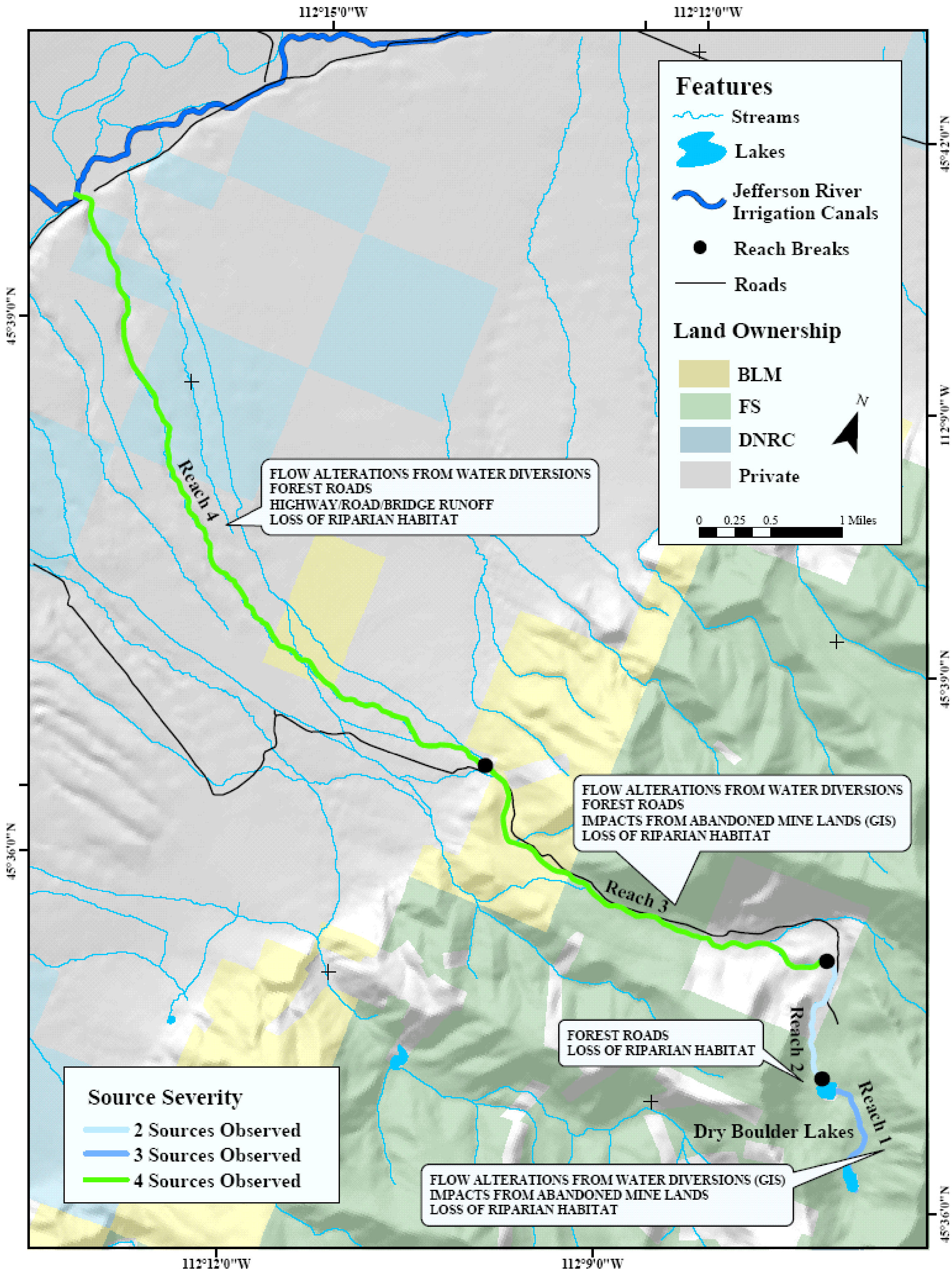

Figure 2-18. Dry Boulder Creek Pollution Sources

2.2.4 Fish Creek

Fish Creek headwaters in the Highland Mountains on the Beaverhead-Deerlodge National Forest. It flows for approximately 20 miles to where it meets the Jefferson Canal, one of the major irrigation canals in the Jefferson Valley. For much of the year the creek goes dry before reaching the Jefferson Canal due to water withdrawals. The suspected causes of impairment to Fish Creek are cadmium, flow alteration, habitat alterations, and siltation. Suspected pollution sources to Fish Creek include abandoned mines, acid mine drainage, agriculture, channelization, flow regulation/modification, and resource extraction. According to the 2004 303(d) List, drinking water supply is an impaired water use; primary contact recreation is a fully supported use, while all other uses have not been assessed.

For the purposes of the source assessment, Fish Creek was broken into 18 reaches (**Figures 2-19** to **2-24**). During the 2004 water quality monitoring project (May to September) and the October field source assessment, 9 of the 18 reaches were visited in the field (**Table 2-4**). Where available, field information was incorporated within the results of the source assessment.

Table 2-4. Field Assessment of Fish Creek Reaches

Fish Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 2	Field Survey, Water Quality Monitoring	Less than 5%
Reach 3	Field Survey	100%
Reach 4	Field Survey, Water Quality Monitoring	95%
Reach 5	Field Survey, Water Quality Monitoring	Less than 5%
Reach 6	Field Survey	25%
Reach 7	Field Survey	Less than 5%
Reach 8	Field Survey, Water Quality Monitoring	Less than 5%
Reach 14	Field Survey	20%
Reach 15	Water Quality Monitoring	Less than 5%

2.2.4.1 Fish Creek Rosgen Stream Types

The channel forms of Fish Creek within the Highland Mountains are predominantly controlled by landform structure, as well as historical land uses (**Figure 2-19**). The upper reaches have been affected by faulting and glaciation, and more recently by placer mining and logging related activities. The entire length of Reach 3 was surveyed and channel form was found to be variable. The reach begins with transition from a B-type to C-type stream, close to the middle of the reach the stream is channelized and exhibits a G-type channel. There were areas of Reach 3 and Reach 4 that were not classifiable, mostly due to the effects of placer mining. Reach 5 was noted as a good potential for a reference B-type channel. Reach 6 appeared to have been altered by the removal of beaver dams (straightened, incised) and had characteristics of C and Bc type channels. From Reach 7 to 13 (**Figure 2-20**), the Boulder Batholith geology has weathered into narrow valley bottom sections (B-type reaches), as well as less confined valley bottom areas (C-type reaches). There were no significant changes in channel form between 1983 and 2001.

Many of the channel forms of Fish Creek in the Jefferson Valley are controlled by landform structure, and historical and current landuse activities (**Figure 2-20**). Channel form on the alluvial fan (Reaches 14 to 17) tended to be more unconfined than expected (C-type versus B-type). Portions of Reaches 14 and 15 viewed during the field survey exhibited C-type channels. Reach 17 was typed as a G channel due to the lack of water and vegetation, however this was not field verified. Fish Creek usually goes dry before entering Fish Creek Canal (Reach 18). Reach 18 was not classified due to the fact that it is part of a major irrigation canal system in the Jefferson Valley, and probably carries flow from the Jefferson River versus Fish Creek. For the valley portion of Fish Creek, only one time period was analyzed so significant changes in channel form since 1983 could not be determined.

2.2.4.2 Fish Creek Riparian Vegetation

The dominant riparian cover along Fish Creek within the Highland Mountains was mixed coniferous forest with upland shrubs (**Figure 2-21**). Reach 13 is also within the Highland Mountains (**Figure 2-22**). Buffer widths were generally greater than 100 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed, as opposed to the actual width of 'wet' vegetation (alders, willows, etc.). Healthy riparian vegetation was virtually absent in Reaches 3 and 4, and could probably be attributed to many sources (grazing, logging, placer mining, and roads). The relative health categories in the upper reaches varied from 'Excellent' to 'Poor' depending on the amount of disturbance visible. In Reach 6, the willows were decadent and dying and a thistle infestation was present. Between 1983 and 2001, the riparian buffer widths in Reach 2 appeared to decrease by an average of 20 percent, but in Reach 10 appeared to increase by an average of 90 percent.

The dominant riparian plants along Fish Creek in the Jefferson Valley were wetland species (**Figure 2-22**). The exception to this was Reach 17, where vegetation was basically absent. The buffer widths of these lower reaches represented the actual width of 'wet' vegetation (alders, willows, etc.). Buffer widths were generally less than 100 feet wide along both sides of the stream. The relative health category assigned to most of the valley reaches was: 'Fair'. During the field review in Reach 14, service berry, alder, rose, red osier, and willows were noted as extending generally to a maximum of 50 feet from the channel. Some areas of knapweed and leafy spurge were observed in Reaches 14 and 15. For the valley portion of Fish Creek, only one time period was analyzed so significant changes in riparian vegetation since 1983 could not be determined.

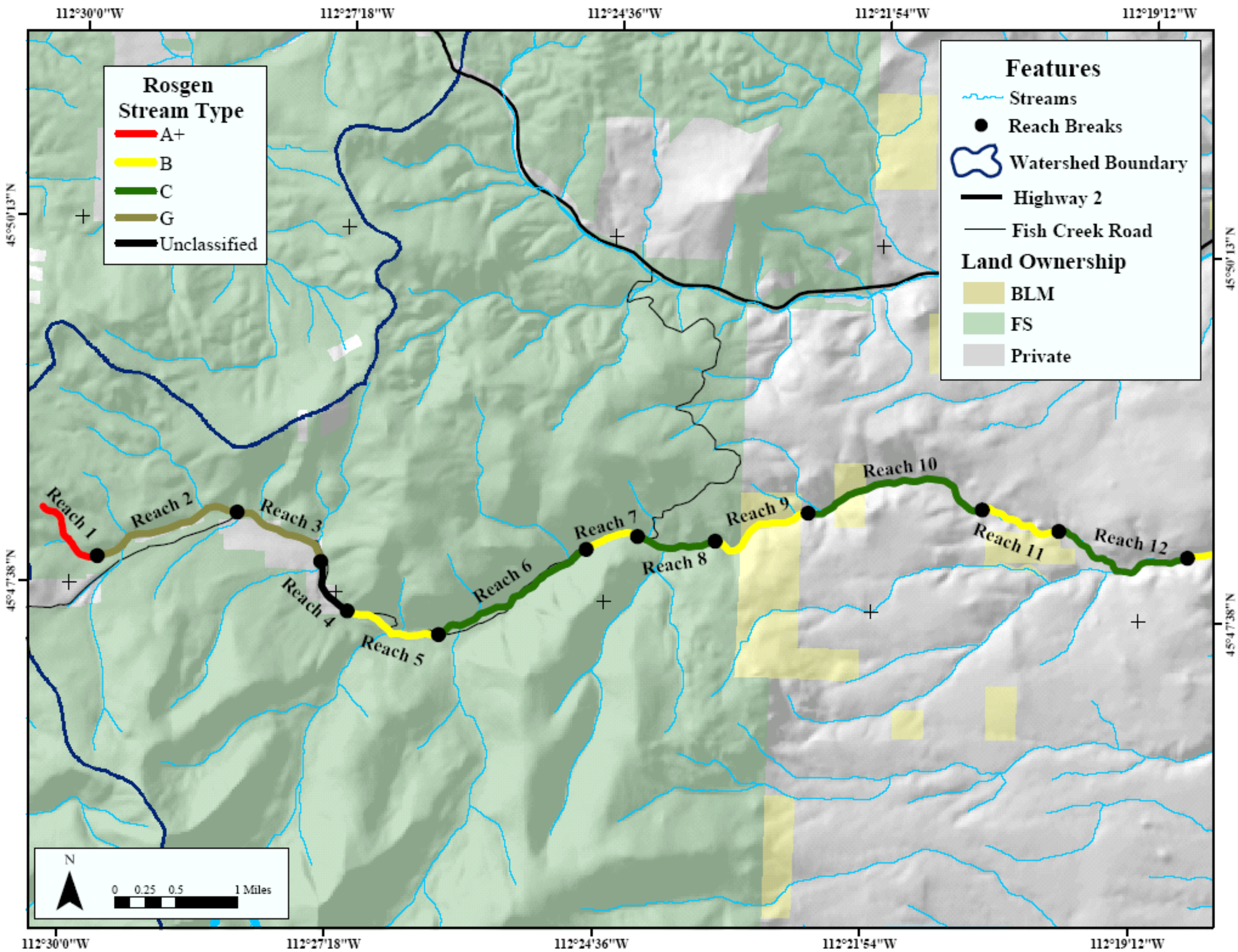

Figure 2-19. Upper Fish Creek Rosgen Stream Types

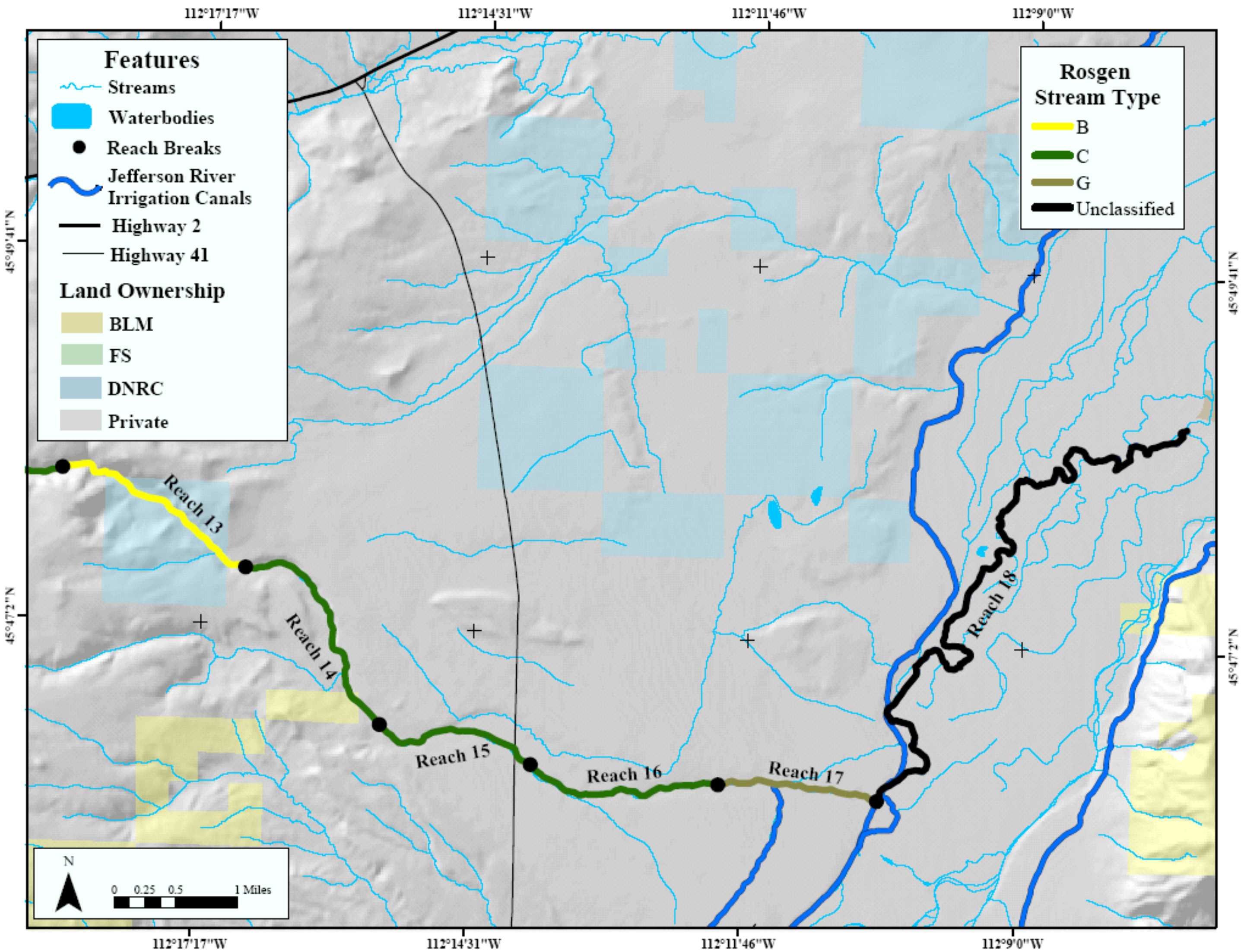

Figure 2-20. Lower Fish Creek Rosgen Stream Types

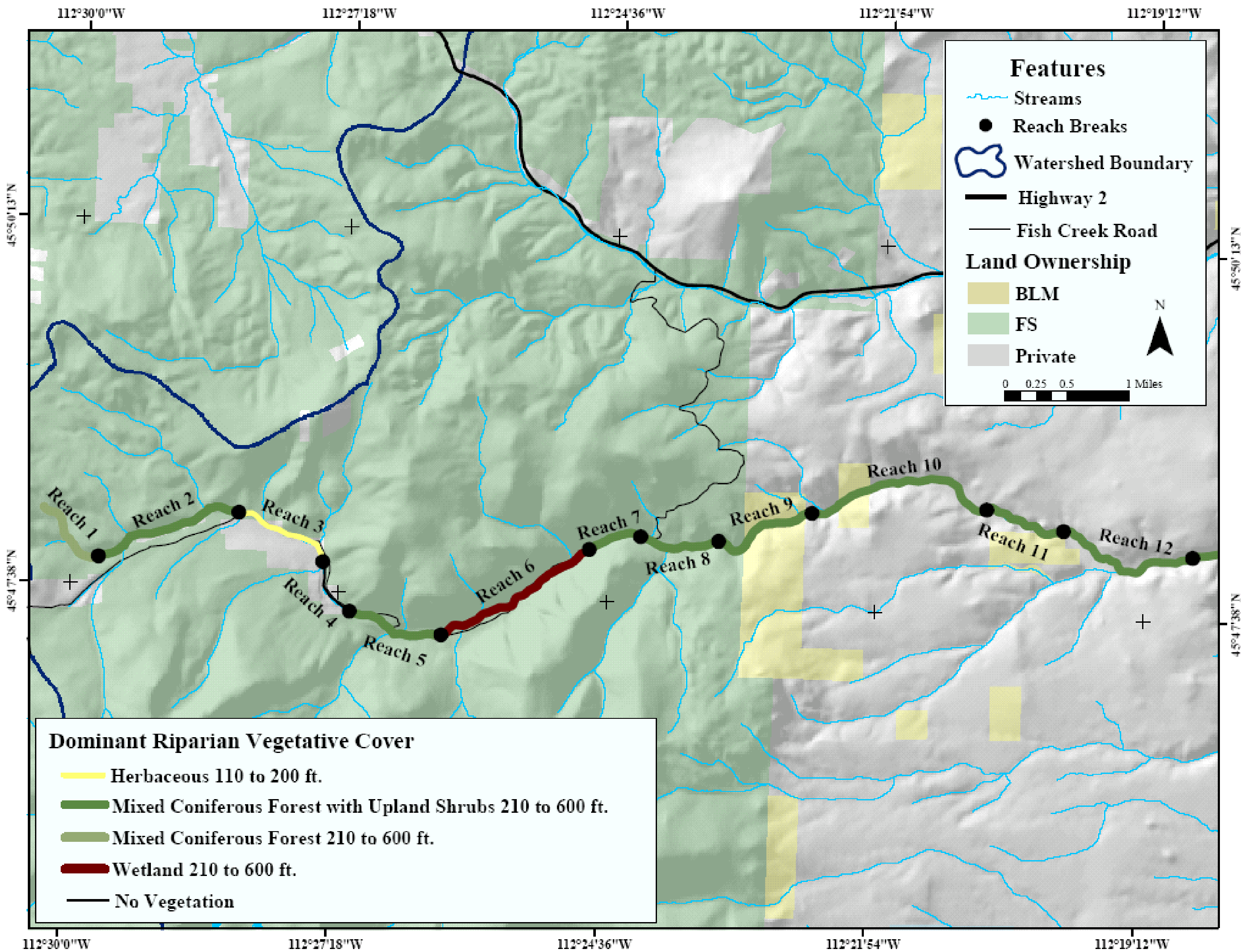

Figure 2-21. Upper Fish Creek Riparian Vegetation

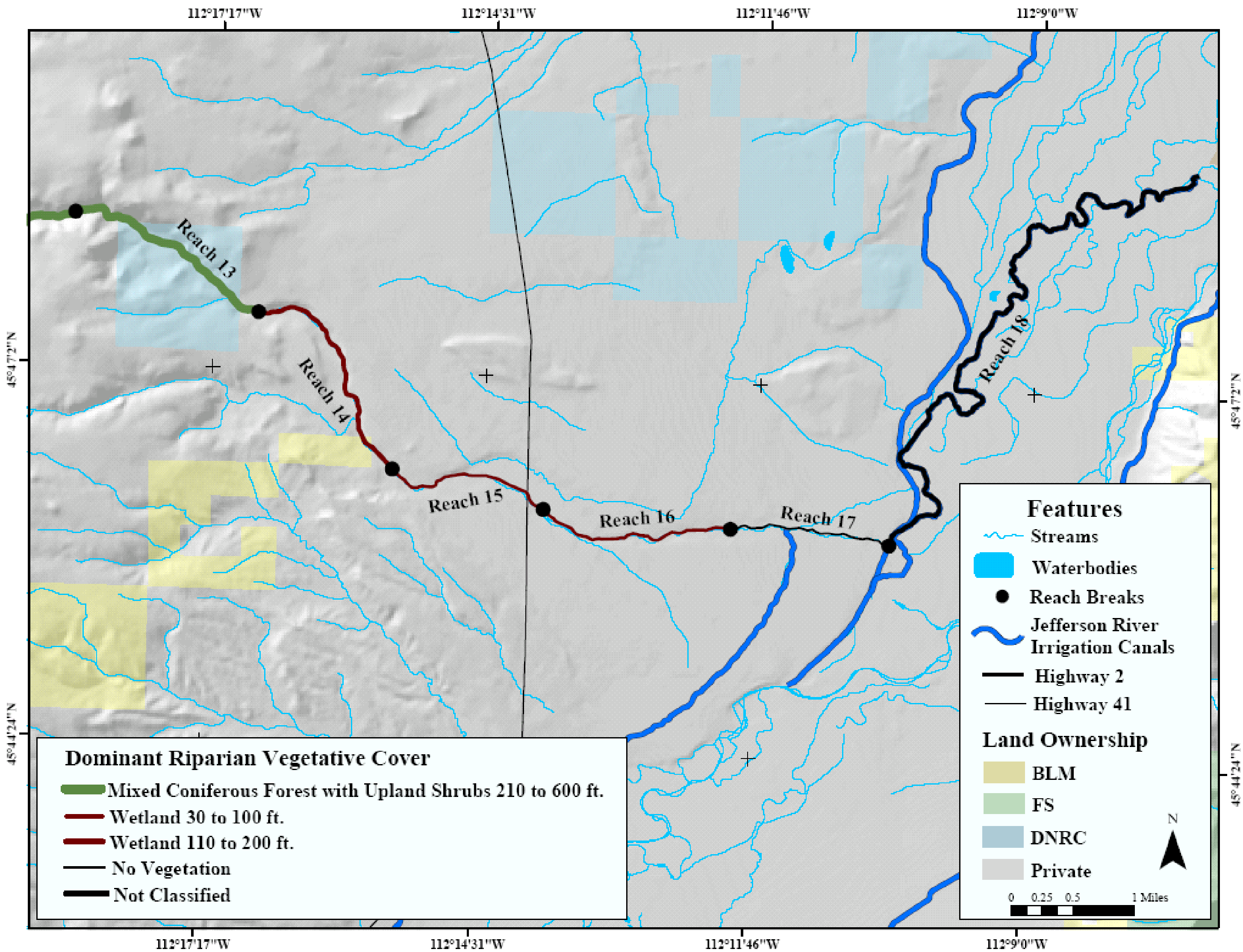

Figure 2-22. Lower Fish Creek Riparian Vegetation

2.2.4.3 Fish Creek Pollution Sources

Figure 2-23 displays the pollution sources assigned to the upper reaches of Fish Creek. Many pollution sources observed along upper Fish Creek were related to placer mining, riparian grazing, and unpaved roads. In many instances, the sources of flow alterations from water diversions and impacts from abandoned mine lands were taken from GIS layers which located water rights claims and abandoned mines. The GIS identified sources have generally not been field verified. Silviculture harvests before 1983 have occurred upslope from and adjacent to Fish Creek. Any runoff associated with the harvests would enter in Reaches 1 through 5. Harmful effects from this impact were not observed in the field. An interesting observation was made during the field survey that the extreme channel modifications in Reach 4, which have lowered the base level for this reach, actually benefit the creek because a lot of the sediment generated in Reach 3 is not able to flow into Reach 4. There were no significant changes in pollution sources between 1983 and 2001.

Figure 2-24 displays the pollution sources assigned to the lower reaches of Fish Creek. Many pollution sources observed on the aerial photographs for lower Fish Creek were related to agricultural operations (irrigation diversions, cropping, and loss of riparian area). During the field source assessment, active beaver dams were observed in Reach 14. The landowner did not eradicate beavers on the property in order to help to maintain flow levels and soil moisture. Discussions with the landowner revealed that dewatering of the creek results in isolation of a genetically pure westslope cutthroat trout population, which apparently thrives in the reaches above the alluvial fan. For the valley portion of Fish Creek, only one time period was analyzed so significant changes in pollution sources since 1983 were not determined.

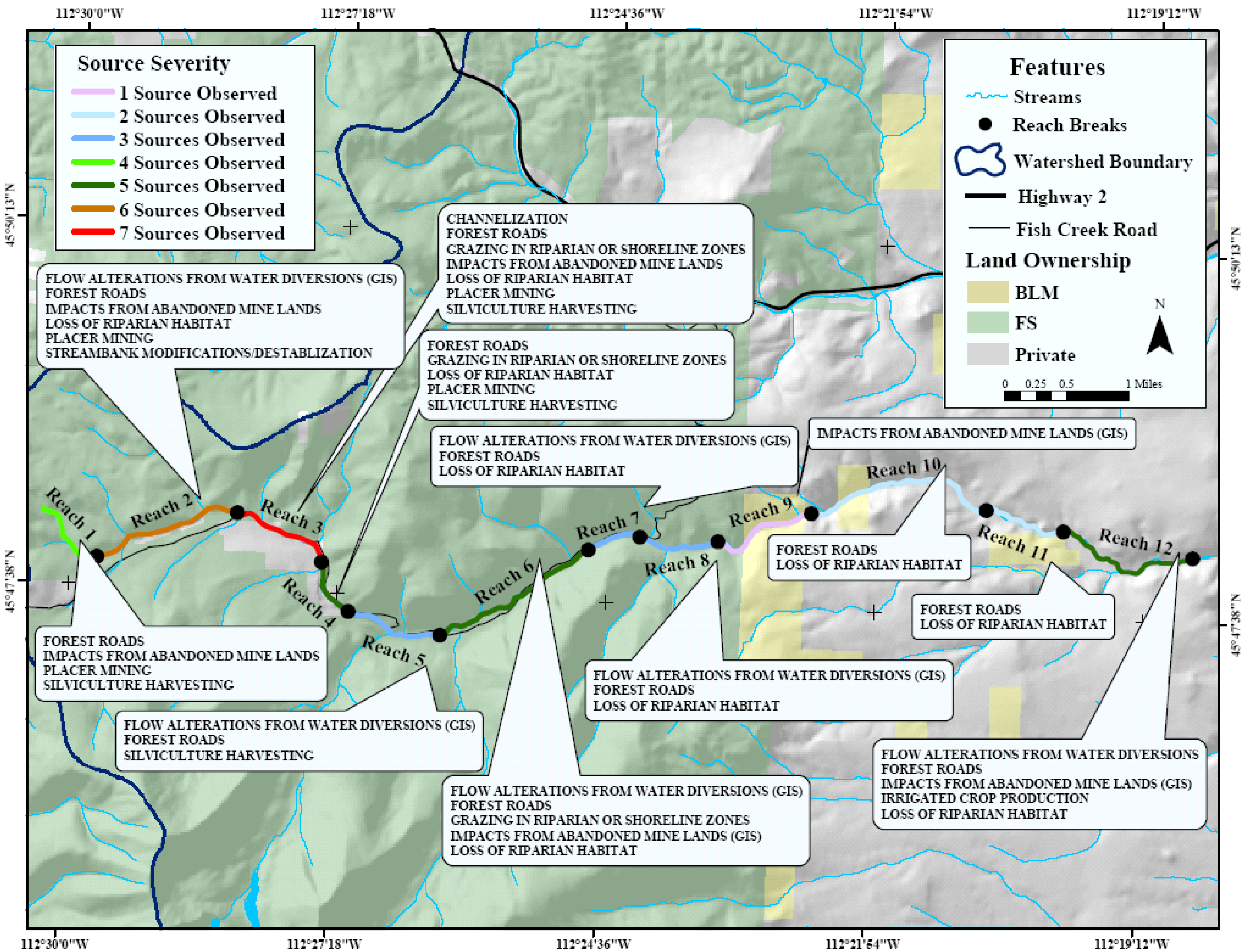

Figure 2-23. Upper Fish Creek Pollution Sources

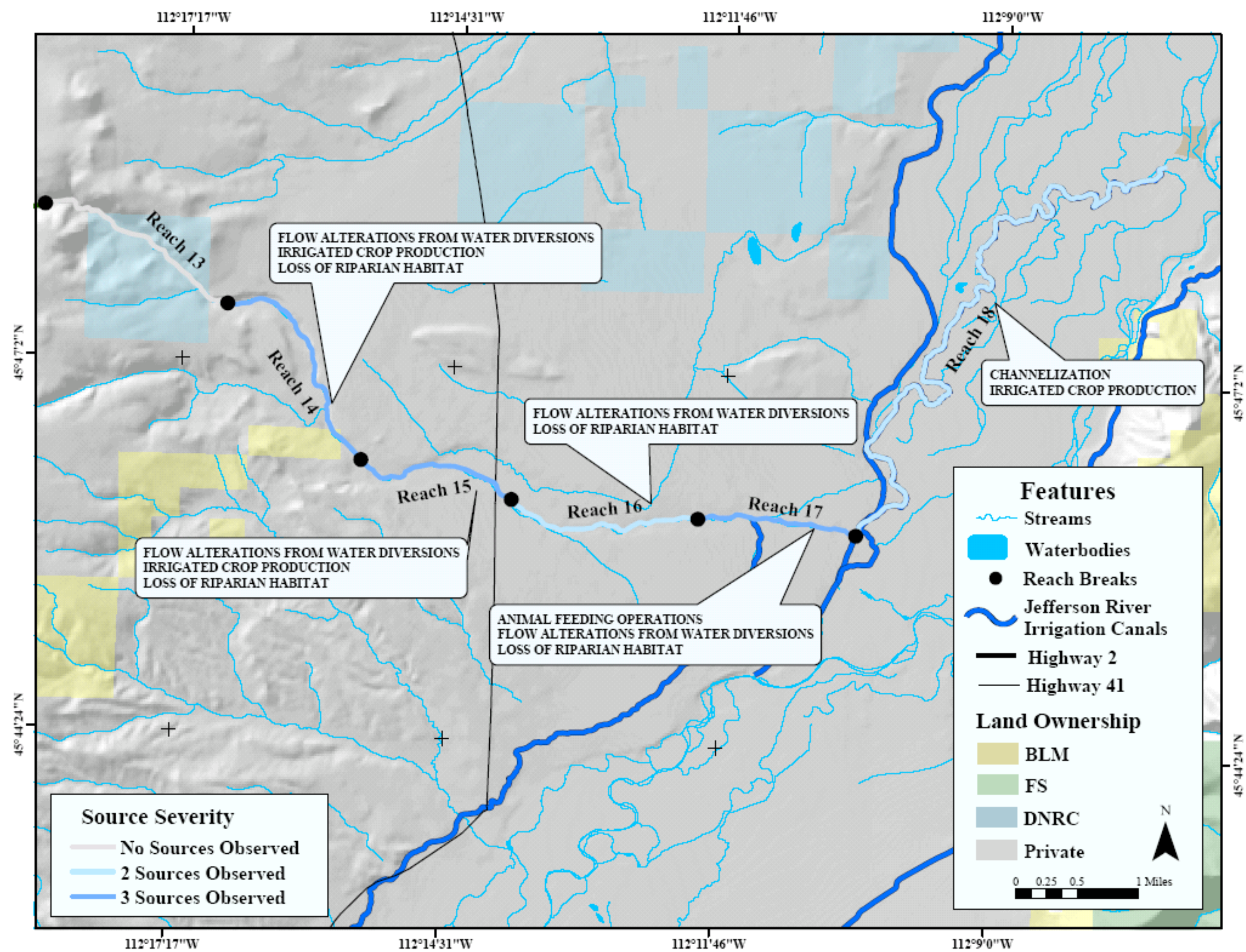

Figure 2-24. Lower Fish Creek Pollution Sources

2.2.5 Fitz Creek

Fitz Creek headwaters in Bull Mountain on the Beaverhead-Deerlodge National Forest. It flows for approximately 5 miles to where it meets Little Whitetail Creek. For much of the year the creek goes dry on the alluvial fan before reaching Little Whitetail Creek. In 1996, the DEQ listed siltation as the suspected cause of impairment to Fitz Creek, with agriculture and road related sources as the suspected pollution sources. According to the 1996 303(d) List, cold water fisheries and associated aquatic life are threatened uses.

For the purposes of the source assessment, Fitz Creek was broken into 6 reaches (**Figures 2-25** to **2-27**). During the 2004 October field source assessment, 2 of the 6 reaches were visited in the field (**Table 2-1**). Stream access on private property was somewhat limited. Where available, field information was incorporated within the results of the source assessment.

Table 2-5. Field Assessment of Fitz Creek Reaches

Fitz Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 4	Field Survey	Less than 5%
Reach 5	Field Survey	80%

2.2.5.1 Fitz Creek Rosgen Stream Types

The channel forms of Fitz Creek are primarily controlled by landform structure (**Figure 2-25**). The stream headwaters on relatively steep slopes (A-type) and then progresses downstream to more moderate slopes. The valley bottom is fairly confined (B-type reaches) along the canyon and alluvial fan sections, until entering the floodplain of Little Whitetail Creek. The small section of Reach 4 observed in the field appeared to transition from an Eb to B-type channel near the head of the alluvial fan. On the alluvial fan, the stream goes distributary and definition of the main channel was tenuous at best. For this reason, the channel classification for Reach 5 was changed to 'unclassified' after the field review. During the field review, the largest channel walked in, Reach 5 exhibited characteristics of B and mostly G-type channels. Reach 6 was not classified either due to the difficulty of locating the channel on recent photos for this small section of the stream. In 1983, Reaches 3 and 6 were observed as having stream flow. This led to a significant decrease in active channel width between 1983 and 1995.

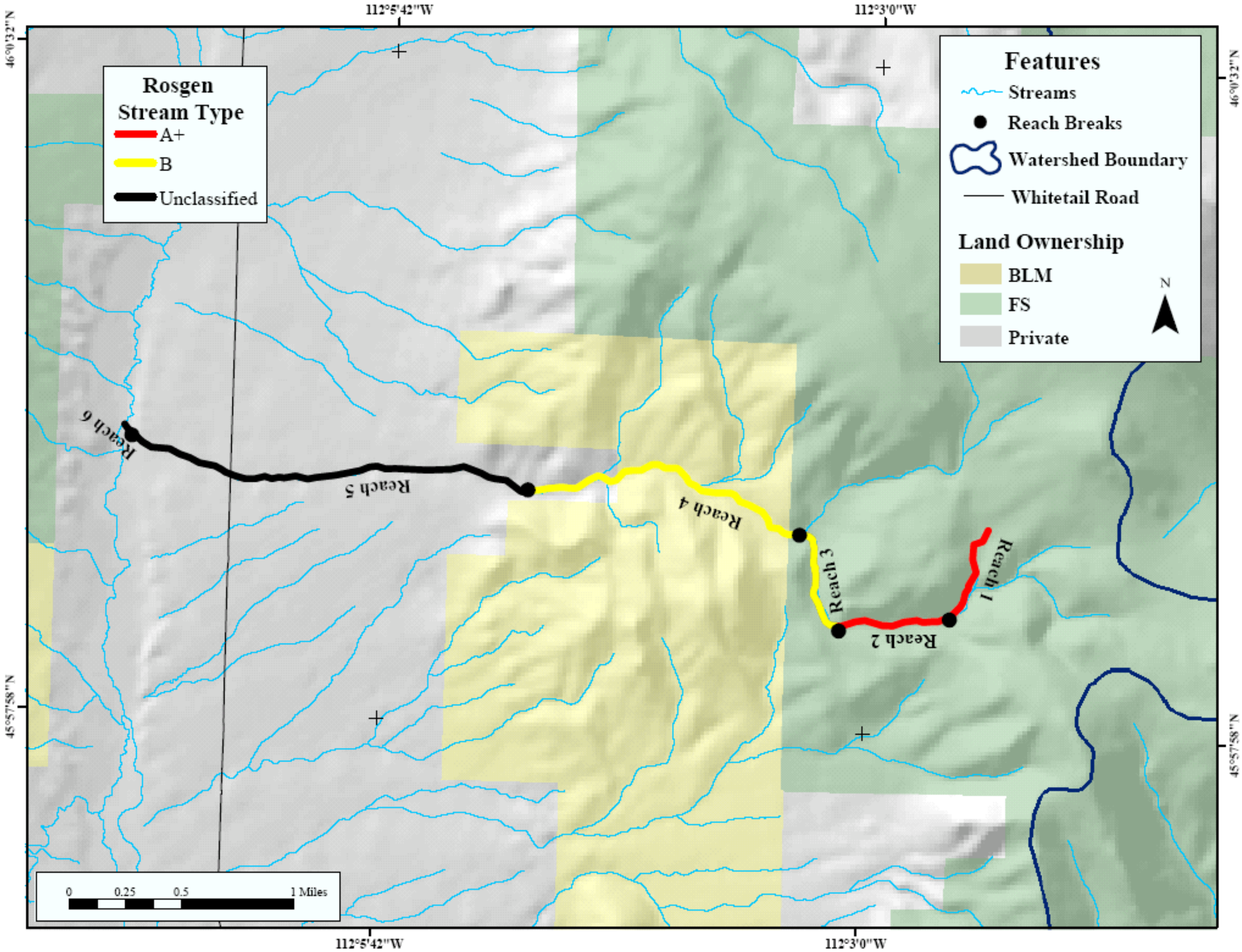

Figure 2-25. Fitz Creek Rosgen Stream Types

2.2.5.2 Fitz Creek Riparian Vegetation

The dominant riparian cover in the headwaters of Fitz Creek was mixed coniferous forest with upland shrubs (**Figure 2-26**). Buffer widths were generally greater than 300 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed, as opposed to the actual width of 'wet' vegetation (alders, willows, etc.). The relative health category assigned to Reaches 1 and 2 was: 'Fair', due to the presence of an unpaved road.

The dominant riparian cover along Reach 4 was mixed coniferous, dominantly deciduous forest. Buffer width was generally greater than 50 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed, or vegetation type changed. Buffer widths were generally limited by valley bottom width. During the field review, aspen, rose, sedges, and grasses were observed in the field. The relative health category assigned to Reach 4 was: 'Fair', due to the presence of an unpaved road. Between 1983 and 2001, the riparian buffer width in Reach 4 appeared to increase by an average of 20 percent.

The dominant riparian cover along the Reaches 3, 5, and 6, was herbaceous, whereby, the grasses or forbs were being grown into the riparian and almost no woody vegetation was present (**Figure 2-26**). The buffer widths of these lower reaches represent the actual width of 'wet' vegetation. Buffer widths were generally less than 10 feet wide along both sides of the stream. The relative health category assigned to all of the reaches was 'Fair'. The riparian area in Reach 5 appeared to be limited by moisture. In 1983, Reaches 3 and 6 were observed as having stream flow. This led to a significant decrease in riparian buffer width between 1983 and 1995.

2.2.5.3 Fitz Creek Pollution Sources

Figure 2-27 displays the pollution sources assigned to Fitz Creek. Most of the pollution sources observed on the aerial photos were related to flow alterations and unpaved roads. In many instances, the source of flow alterations from water diversions was taken from a GIS layer, and was not field verified. Grazing was observed along much of Reach 5, but the impacts were fairly minimal due to the lack of water. During the field source assessment the stream was observed as naturally going dry at the head of the alluvial fan. On the alluvial fan (Reach 5) the stream goes distributary and probably does not carry flow, except during spring runoff and intense rainfall events (fairly characteristic of streams on alluvial fans in arid environments). There were no significant changes in pollution sources between 1983 and 2001.

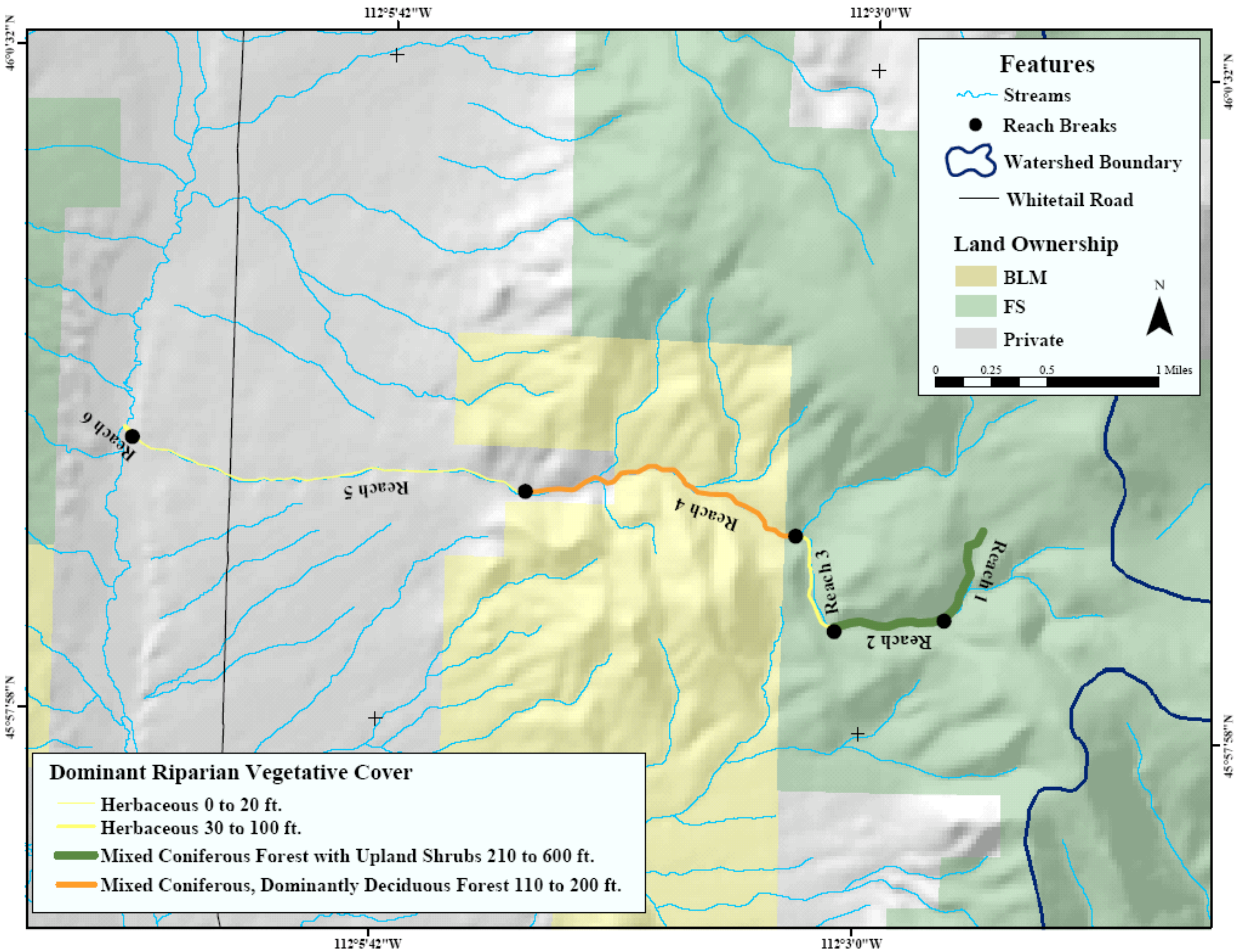

Figure 2-26. Fitz Creek Riparian Vegetation

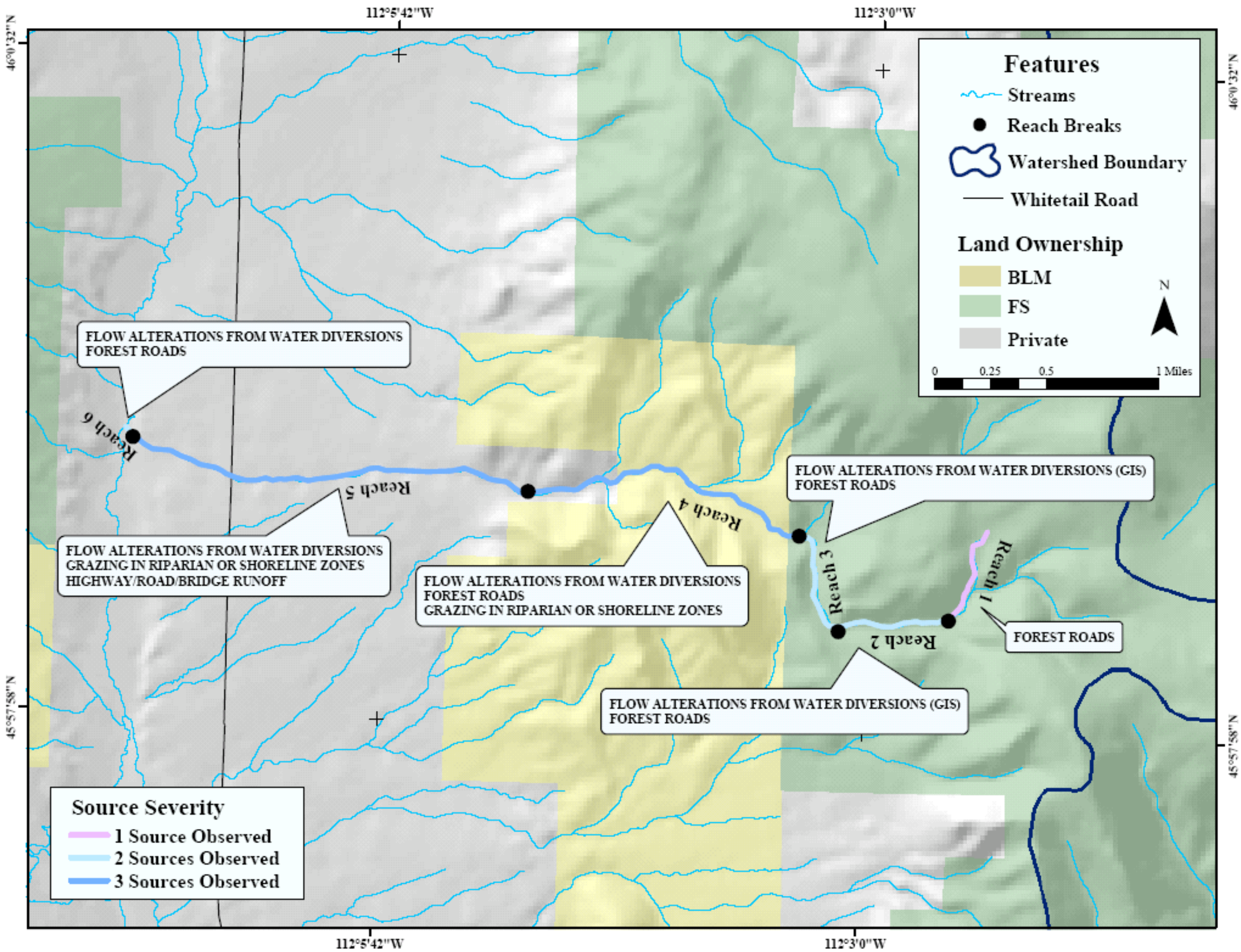

Figure 2-27. Fitz Creek Pollution Sources

2.2.6 Halfway Creek

Halfway Creek headwaters in Halfway Park on the Beaverhead-Deerlodge National Forest. It flows for approximately 8 miles to where it meets Big Pipestone Creek. In 1996, the DEQ listed habitat alterations and siltation as the suspected causes of impairment to Halfway Creek, with agriculture related sources as the suspected pollution sources. According to the 1996 303(d) List, cold water fisheries and associated aquatic life are threatened uses.

For the purposes of the source assessment, Halfway Creek was broken into 7 reaches (**Figures 2-28** to **2-30**). During the 2004 October field source assessment, 2 of the 7 reaches were visited in the field (**Table 2-6**). Stream access was somewhat limited due to impassable roads. Where available, field information was incorporated within the results of the source assessment.

Table 2-6. Field Assessment of Halfway Creek Reaches

Halfway Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 6	Field Survey	15%
Reach 7	Field Survey	15%

2.2.6.1 Halfway Creek Rosgen Stream Types

The channel forms of Halfway Creek are predominantly controlled by landform structure (**Figure 2-28**). Halfway Park, the headwater area, is a broad wetland meadow with fairly gentle slopes. Channel form here is thought to be an E-type channel. Reach 2 was broken into a separate reach due to an unknown disturbance, which has resulted in a widening of the channel and ponding at the end of the reach. Once the stream leaves Halfway Park, gradient steepens (A-type) and flow is confined to the canyon. From Reaches 4 to 7 the Boulder Batholith geology has weathered into less confined valley bottom sections (Ea and Eb-type reaches), as well as narrow valley bottom areas (B-type reaches). A portion of Reach 6 viewed during the field survey exhibited a B-type channel, with some sections trending toward Eb form. The portion of Reach 7 viewed in the field exhibited a slightly incised, B-type channel. There were no significant changes in channel form between 1983 and 2001.

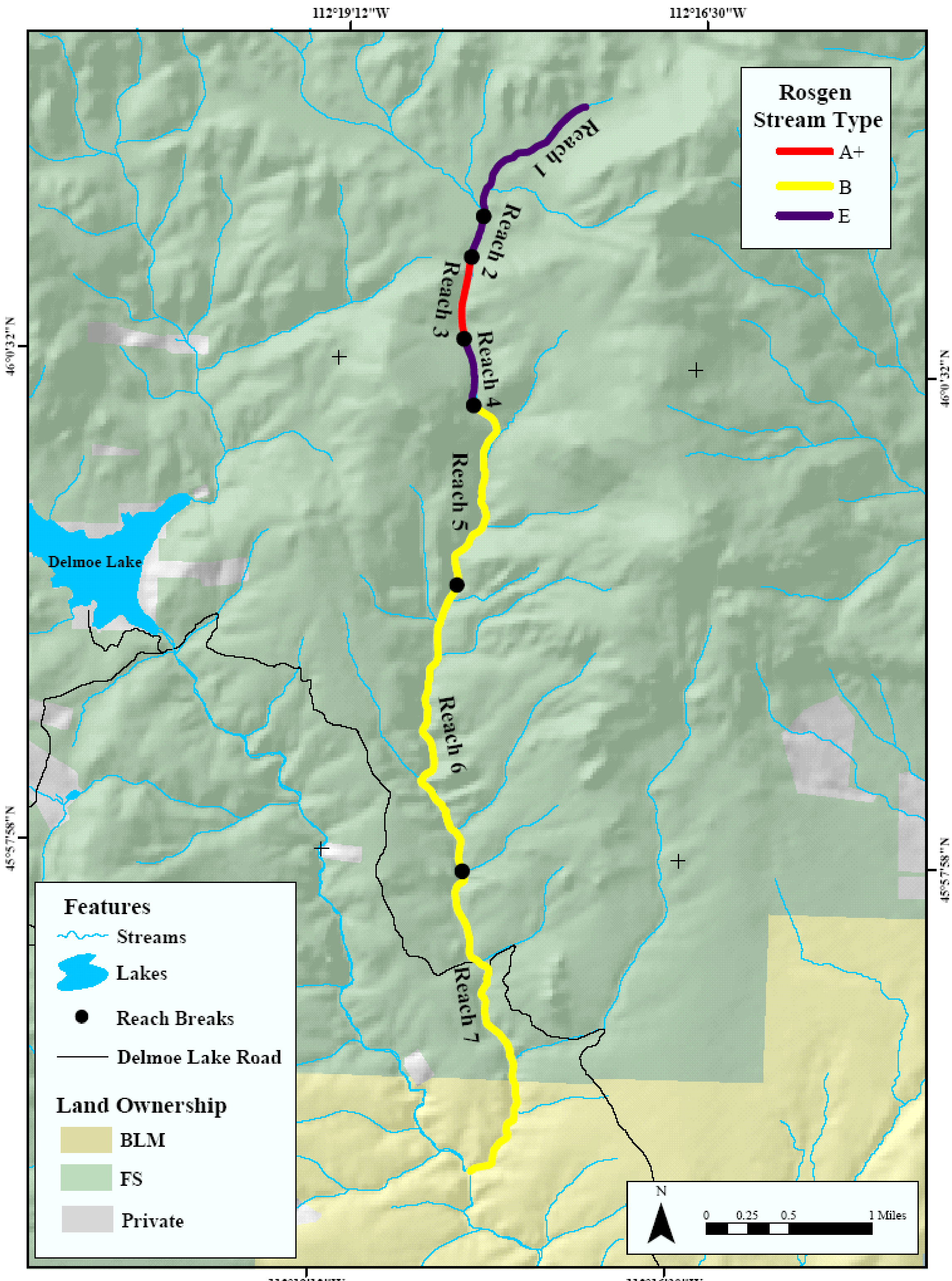

Figure 2-28. Halfway Creek Rosgen Stream Types

2.2.6.2 Halfway Creek Riparian Vegetation

The dominant riparian cover along Halfway Creek in the headwaters was wetland, while the canyon sections were predominantly mixed coniferous forest with upland shrubs (**Figure 2-29**). The headwater wetland buffer widths were generally greater than 100 feet wide along both sides of the stream. The wetland buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed, and included some area of mixed coniferous forest with upland shrubs. The relative health category assigned to the wetland dominated reaches was 'Fair', due to disturbance from unpaved roads. Mixed coniferous forest buffer widths were generally greater than 200 feet wide along both sides of the stream. GIS layers indicated that no roads exist from Reaches 3 to 5. During the field observation of Reaches 6 and 7, unpaved ATV/motorcycle trails were observed less than 100 feet from the stream, but often were not visible on the aerial photos. During the field review, alder, willows, red osier, rose, current, sedges, and grasses were noted as extending to a maximum of 40 feet from the channel within the conifer forest. The relative health category assigned to the mixed coniferous forest dominated reaches was 'Excellent' in Reaches 3 to 6, but ‘Fair’ in Reach 7 due to disturbance from unpaved roads. Some areas of thistle and mullein infestation were present. Between 1983 and 2001, the riparian buffer widths in Reaches 6 and 7 appeared to increase by an average of 30 percent and 15 percent respectively.

2.2.6.3 Halfway Creek Pollution Sources

Figure 2-30 displays the pollution sources assigned to Halfway Creek. The sources of flow alterations from water diversions and impacts from abandoned mine lands were taken from GIS layers which located water rights claims and abandoned mines. The GIS identified sources have not been field verified. Loss of riparian habitat was associated with road development and grazing. Many pollution sources observed along Halfway Creek were related to riparian grazing and unpaved roads and trails (overwidened channel, bank erosion, loss of vegetation). During the field source assessment, channel condition appeared to degrade in a downstream manner. There were no significant changes in pollution sources between 1983 and 2001.

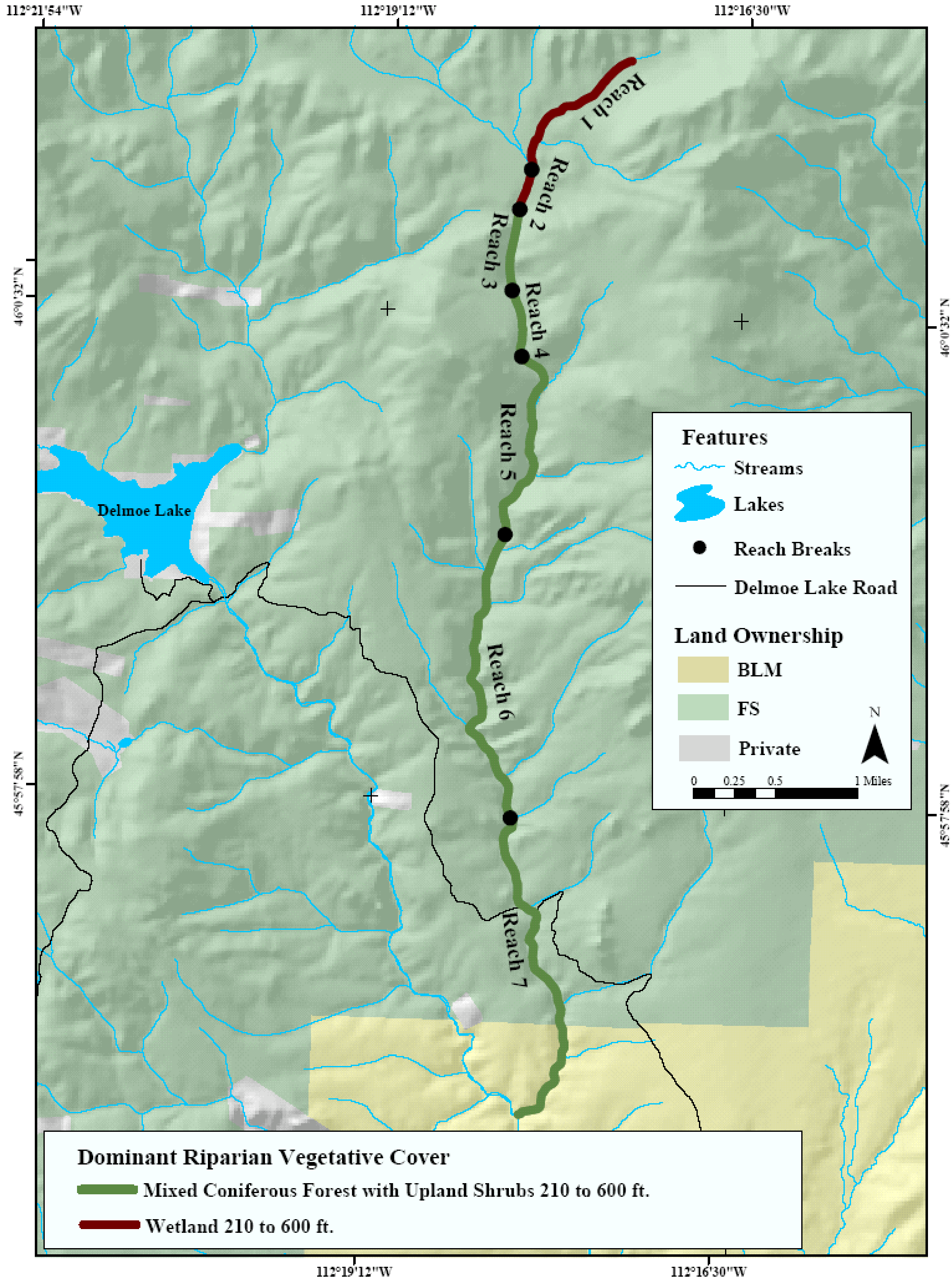

Figure 2-29. Halfway Creek Riparian Vegetation

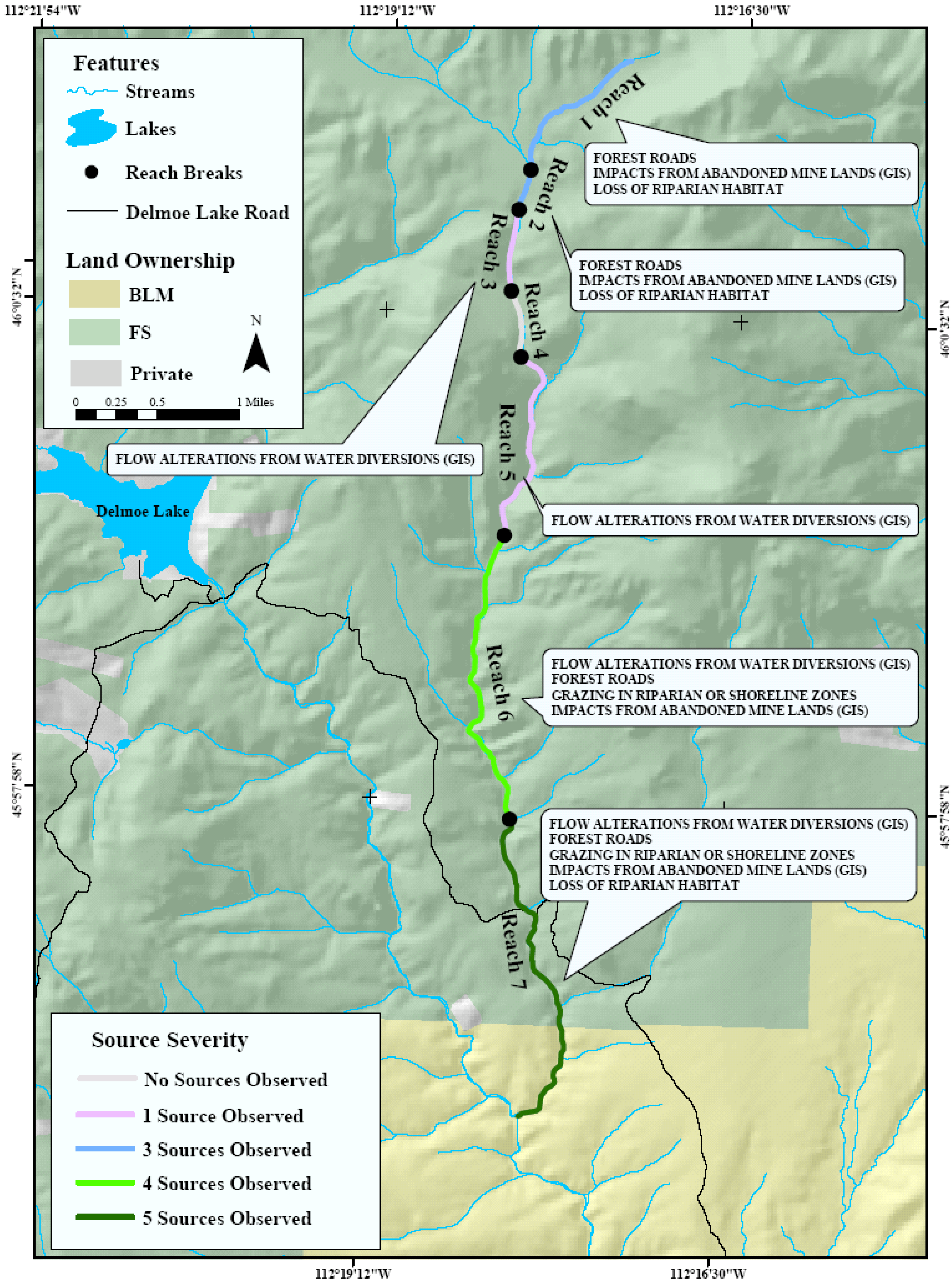

Figure 2-30. Halfway Creek Pollution Sources

2.2.7 Hells Canyon Creek

Hells Canyon Creek headwaters in the Highland Mountains on the Beaverhead-Deerlodge National Forest. It flows for approximately 13 miles to where it meets the Jefferson River. The suspected causes of impairment to Hells Canyon Creek are dewatering/flow alteration, habitat alterations, and siltation. Suspected pollution sources to Hells Canyon Creek include agriculture, grazing related sources, hydromodification, road related sources, and silviculture. According to the 2004 303(d) List, cold water fisheries and associated aquatic life, and primary contact recreation are partially supported uses.

For the purposes of the source assessment, Hells Canyon Creek was broken into 9 reaches (**Figures 2-31** to **2-33**). During the 2004 October field source assessment, 5 of the 9 reaches were visited in the field (**Table 2-7**). Where available, field information was incorporated within the results of the source assessment.

Table 2-7. Field Assessment of Hells Canyon Creek Reaches

Hells Canyon Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 3	Field Survey	Less than 5%
Reach 4	Field Survey	45%
Reach 5	Field Survey	30%
Reach 6	Field Survey	40%
Reach 9	Field Survey	45%

2.2.7.1 Hells Canyon Creek Rosgen Stream Types

The channel forms of Hells Canyon Creek are predominantly controlled by landform structure, as well as historic and current land uses (**Figure 2-31**). The prominent landform geology, the Boulder Batholith, has resulted in valley bottom formation along weathered joints. The stream headwaters on steep slopes (A-type) and then progresses downstream to more moderate slopes. The canyon valley bottom alternates between confined (B-type) and unconfined sections (C-type). In Reach 9, the stream is also fairly confined within the alluvial fan until reaching the floodplain of the Jefferson River. The portion of Reach 4 viewed during the field survey exhibited C and Bc channel types. Reach 5 exhibited a B-type channel. The portion of Reach 6 viewed in the field exhibited C, Bc, and B-type channel sections. Remnants of beaver dams were observed in Reach 4 and Reach 6. It is suspected that the removal of beaver dams has altered channel form (straightened, incised), and that channel type would probably have naturally trended towards an E-type stream in these reaches. The section of Reach 9 surveyed exhibited a somewhat incised B-type channel on the alluvial fan but was unconfined at the mouth. There was one significant difference in channel measurements between 1983 and 2001. For the 1983 analysis a series of ponds were visible in Reach 2, but in 2001 no ponds were visible.

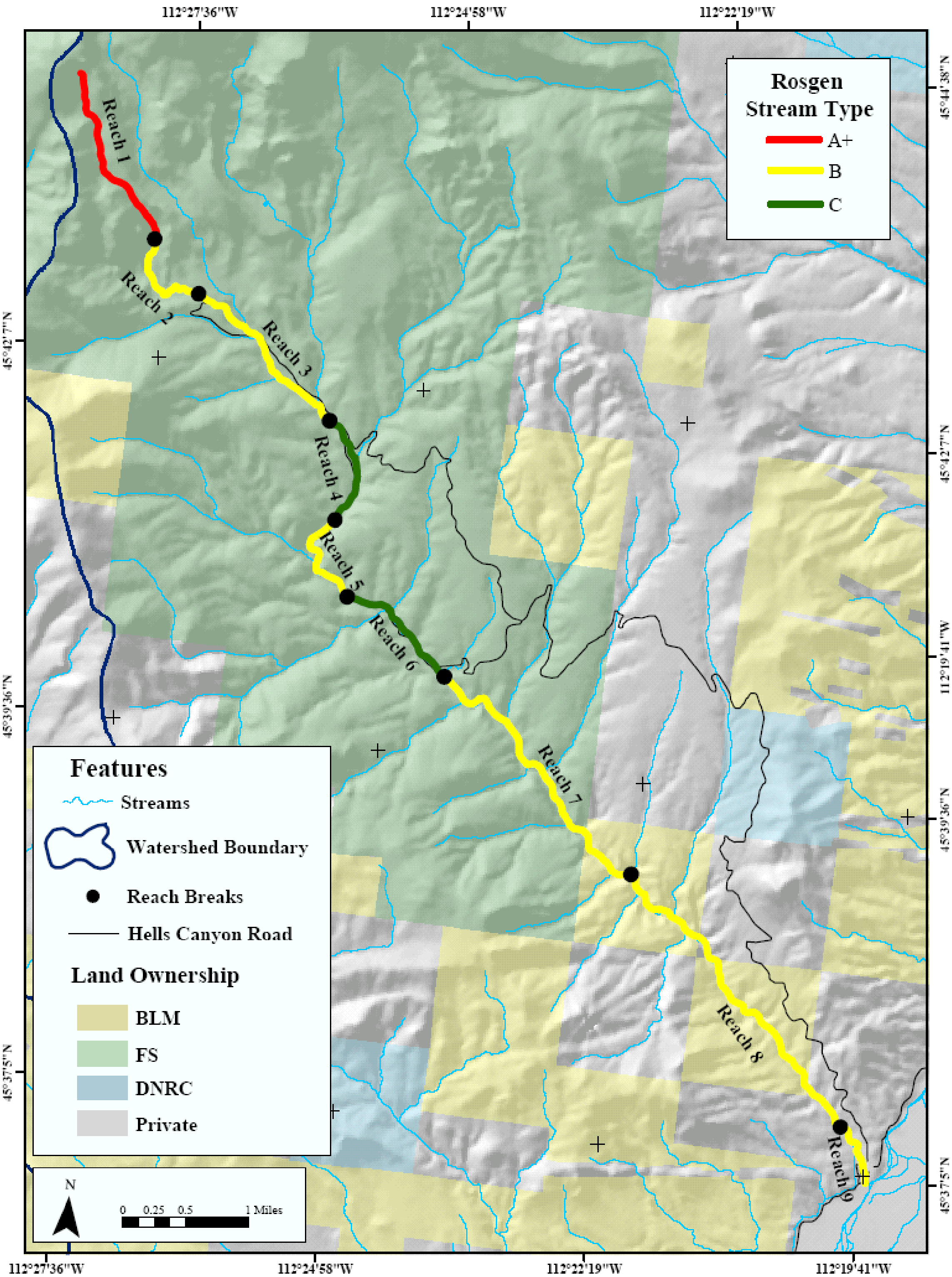

Figure 2-31. Hells Canyon Creek Rosgen Stream Types

2.2.7.2 Hells Canyon Creek Riparian Vegetation

The dominant riparian cover along Hells Canyon Creek in Reaches 1 to 6 alternated between mixed coniferous forest with upland shrubs (confined valley bottom areas) and wetland (less confined valley bottom areas) (**Figure 2-32**). Buffer widths were generally greater than 100 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before any disturbance was observed. The relative health category assigned to Reach 1 was 'Excellent', while the relative health category assigned to Reaches 2, 3, 4, and 6 was 'Fair' due to road disturbance. Reach 5 received a rating of 'Poor' in 2001 due to notable areas of bare ground associated with a road failure that occurred sometime after 1983. During the field review in Reach 4, willows, alders, sedges, and grasses were noted as extending to a maximum of 150 feet from the channel in the Hell's Canyon Creek Riparian Project area (fenced off from grazing). There was a significant difference in vegetative health outside of the riparian project area. Between 1983 and 2001, the coniferous buffer width in Reach 3 appeared to increase by an average of 45 percent; however, in Reach 5 buffer width appeared to decrease by 60 percent (associated with road failure). Between 1983 and 2001, the wetland buffer widths in Reaches 2, 4 and 6 appeared to increase by an average of 15 percent, 40 percent and 35 percent respectively.

The dominant riparian cover along the lower canyon sections of Hells Canyon Creek was mixed deciduous, dominantly coniferous forest (**Figure 2-32**). Buffer widths were generally greater than 100 feet wide along both sides of the stream. The buffer widths represented the distance of vegetation surrounding the stream before vegetation type changed. Buffer widths appeared to be limited by valley bottom width. The relative health category assigned to Reach 7 was 'Excellent', while Reach 8 was assigned 'Fair' due to suspected disturbance from unpaved roads.

The dominant riparian cover along the alluvial fan (Reach 9) portion of Hells Canyon Creek was mixed coniferous, dominantly deciduous forest (**Figure 2-32**). Buffer width was generally less than 50 feet wide along both sides of the stream. The relative health category assigned to Reach 9 was 'Fair' due to development near the floodplain. During the field review, cottonwood (with some runners), willows, alder, rose, and grasses were noted as extending generally to a maximum of 40 feet from the channel. Thistles were also present. Between 1983 and 2001, the riparian buffer width in Reach 9 appeared to increase by an average of 15 percent.

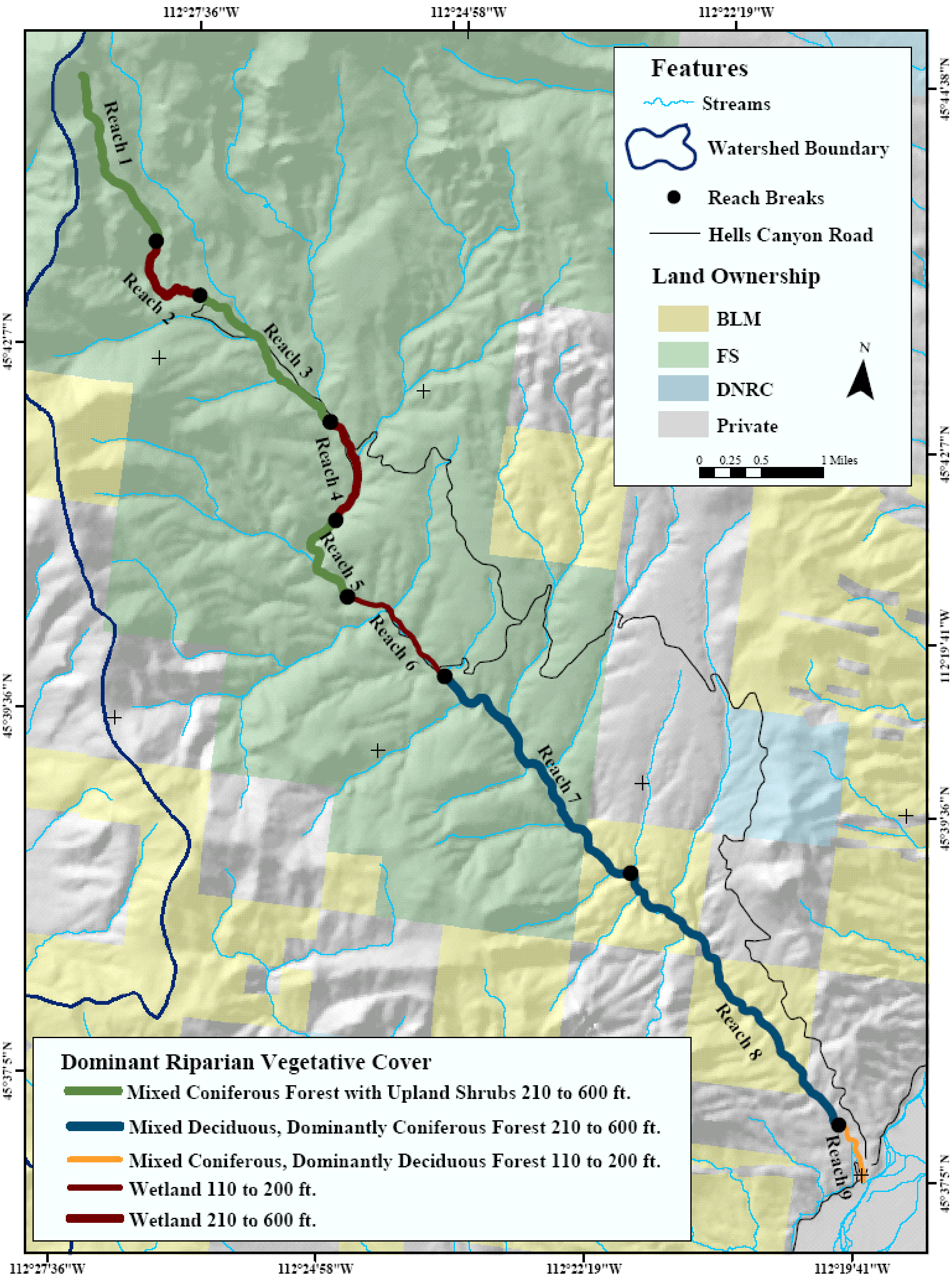

Figure 2-32. Hells Canyon Creek Riparian Vegetation

2.2.7.3 Hells Canyon Creek Pollution Sources

Figure 2-33 displays the pollution sources assigned to Hells Canyon Creek. Most pollution sources observed along upper Hells Canyon Creek were related to riparian grazing and unpaved roads. The sources of flow alterations from water diversions and impacts from abandoned mine lands were taken from GIS layers which located water rights claims and abandoned mines. The GIS identified sources were not field verified. Silviculture harvests occurred before 1983, upslope from and adjacent to Hells Canyon Creek. Any runoff associated with the harvests would enter in Reaches 2 through 4. Harmful effects from this impact were not observed in the field. Loss of riparian habitat was generally associated with road development and grazing. There were no significant changes in pollution sources between 1983 and 2001.

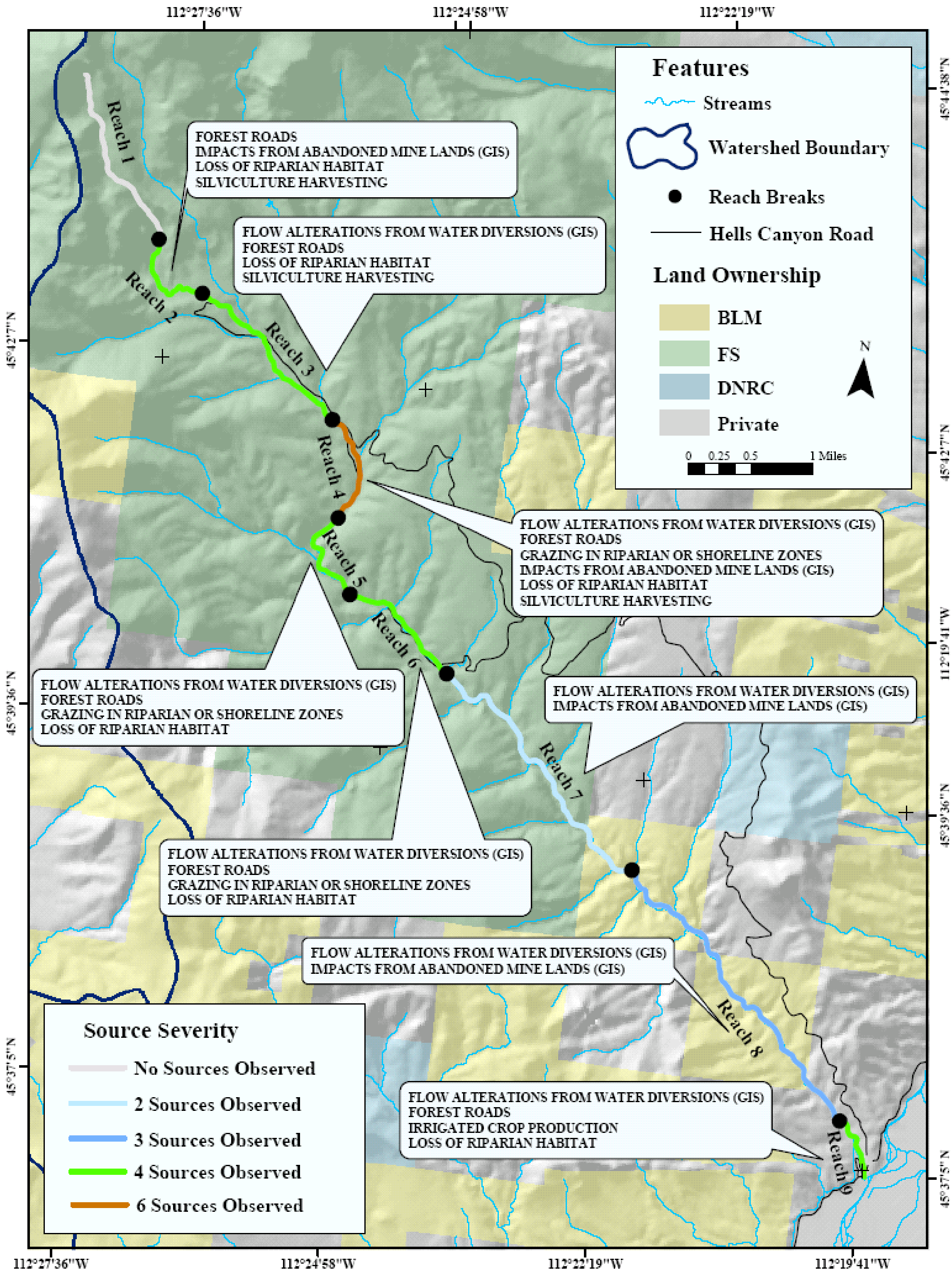

Figure 2-33. Hells Canyon Creek Pollution Sources

2.2.8 Little Pipestone Creek

Little Pipestone Creek headwaters on the Continental Divide in the Beaverhead-Deerlodge National Forest. It flows for approximately 16 miles to where it meets Big Pipestone Creek. The suspected causes of impairment to Little Pipestone Creek are bank erosion, habitat alteration, riparian degradation, and siltation. Suspected pollution sources to Little Pipestone Creek include agriculture, channelization, grazing related sources, and hydromodification. According to the 2004, 303(d) List, cold water fisheries and associated aquatic life are partially supported uses.

For the purposes of the source assessment, Little Pipestone Creek was broken into 10 reaches (**Figures 2-34** to **2-39**). During the October field source assessment, 5 of the 10 reaches were visited in the field (**Table 2-8**). Stream access on private property was somewhat limited. Where available, field information was incorporated within the results of the source assessment.

Table 2-8. Field Assessment of Little Pipestone Creek Reaches

Little Pipestone Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 1	Field Survey	20%
Reach 2	Field Survey	Less than 20%
Reach 3	Field Survey	10%
Reach 8	Field Survey	Less than 5%
Reach 10	Field Survey	25%

2.2.8.1 Little Pipestone Creek Rosgen Stream Types

The channel forms of Upper Little Pipestone Creek are predominantly controlled by landform structure, as well as historical and current landuse activities (**Figure 2-34**). The channel forms of Little Pipestone Creek in Reaches 1 to 3 were difficult to type in areas because of channelization and grazing impacts. As well during the aerial review, the channel was not visible until Reach 4. For these reasons, the channel classifications for Reaches 1, 2, and 3 were changed to 'unclassified' after the field review. The area surveyed in Reach 1 was more of a flooded wet meadow than an actual stream. There were ponded areas from earthen dams, and some areas of multiple threads with E-type channel characteristics. Reach 2 was affected by channelization between Highway 2 and the railway. Channel forms observed in Reach 2 were characteristic of E and mostly G-type streams. The portion of Reach 3 observed in the field trended from an Eb to a B-type channel. The channel was less confined in Reaches 4, 5, and 7, and was thought to have characteristics on an E-type channel. Structural controls in Reach 6 led to the classification of a B-type reach. The Boulder Batholith is the prominent geology of the upper reaches. There were no significant changes in channel form between 1983 and 2001.

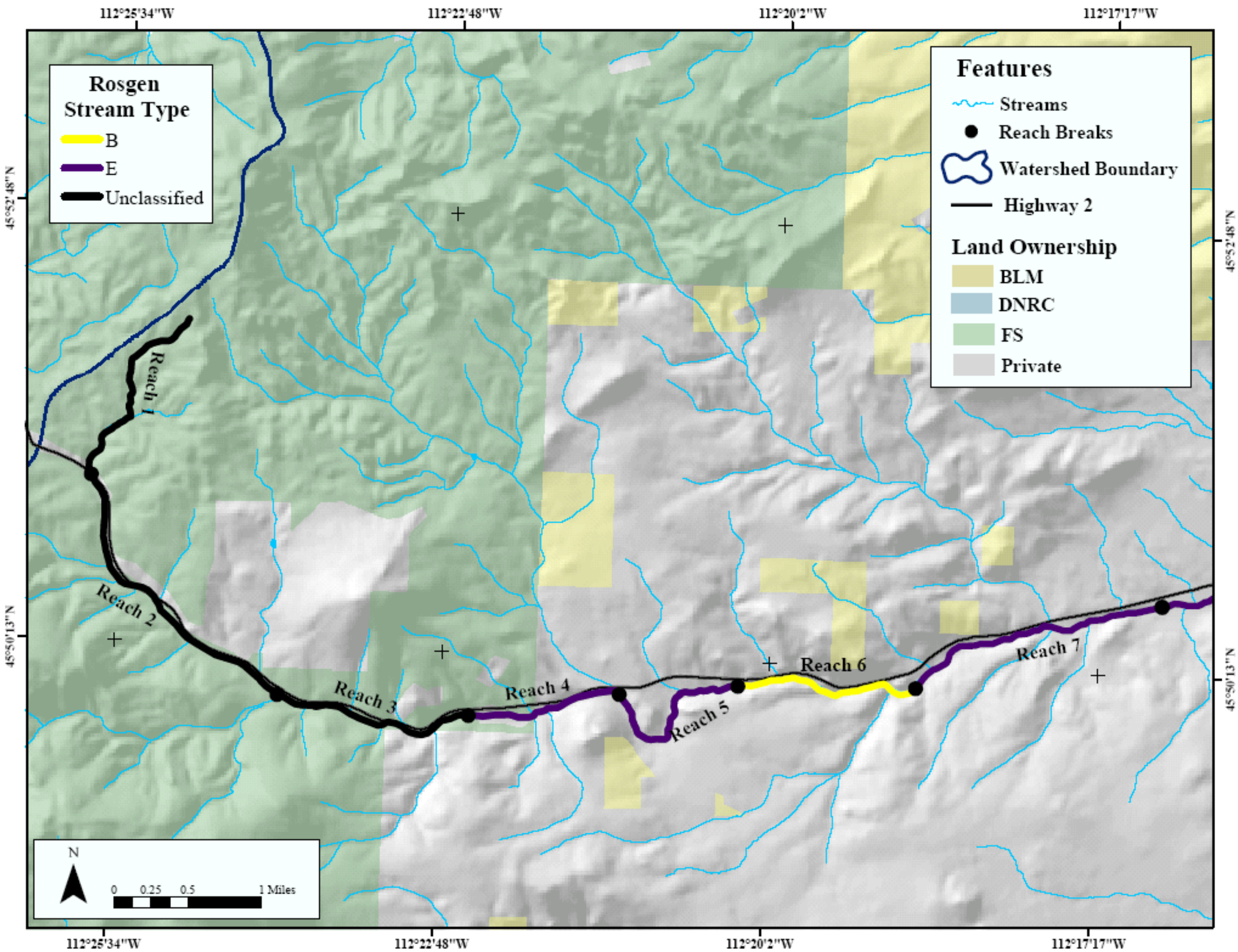

Figure 2-34. Upper Little Pipestone Creek Rosgen Stream Types

The channel forms of Lower Little Pipestone Creek are also predominantly controlled by landform structure, and historical and current landuse activities (**Figure 2-35**). The predominant valley type (VIII) would typically result in an unconfined stream type (C or E), yet channel alterations have resulted in stream types out of balance with the valley type (directly observed in Reach 10). The small section of Reach 8 viewed in the field exhibited E-type channel characteristics. Active beaver dams were observed on the creek above Highway 41 in this reach. It is suspected that channel form in Reach 9 could possibly be an F-type due to the Delmoe Ditch irrigation diversion and disruption of riparian habitat in this reach. Observed channel forms in Reach 10 were variable, but an overall classification of F-type was given to this reach. Areas of braiding were observed, along with overwidened sections, as well as a large downcut section. For the lower portion of Little Pipestone Creek, only one time period was analyzed so significant changes in channel form since 1983 could not be determined.

2.2.8.2 Little Pipestone Creek Riparian Vegetation

Riparian cover along Upper Little Pipestone Creek was variable (**Figure 2-36**). The predominant cover in Reaches 1 and 2 was wetland vegetation. Field assessment in Reaches 1 and 2 revealed that the willows were decadent from heavy browsing, and dying in areas due to ponding. Buffer widths were limited in Reaches 2, 3, and 6 by proximity to the highway. Riparian vegetation type in Reaches 3 and 6 was mixed coniferous forest with upland shrubs. Development in Reaches 4 and 5 resulted in a loss of woody vegetation, and the classification was changed to predominantly herbaceous. Woody vegetation generally extended to a maximum of 20 feet on either side on the channel in these reaches. The relative health category assigned to the riparian vegetation progressed from excellent to poor in a downstream manner. There were no significant changes in riparian vegetation between 1983 and 2001.

Riparian vegetative cover along Lower Little Pipestone Creek progressed from predominantly deciduous, to wetland, to herbaceous (**Figure 2-37**). Buffer widths were generally less than 50 feet wide along both sides of the stream, except for in Reach 8. The relative health category assigned to the lower reaches progressed from ‘Fair’ to ‘Poor’ in a downstream manner. During the field review, decadent hedged willows and sedges were noted as extending to a maximum of 20 feet from the channel in Reach 10. For the lower portion of Little Pipestone Creek, only one time period was analyzed so significant changes in riparian vegetation since 1983 could not be determine

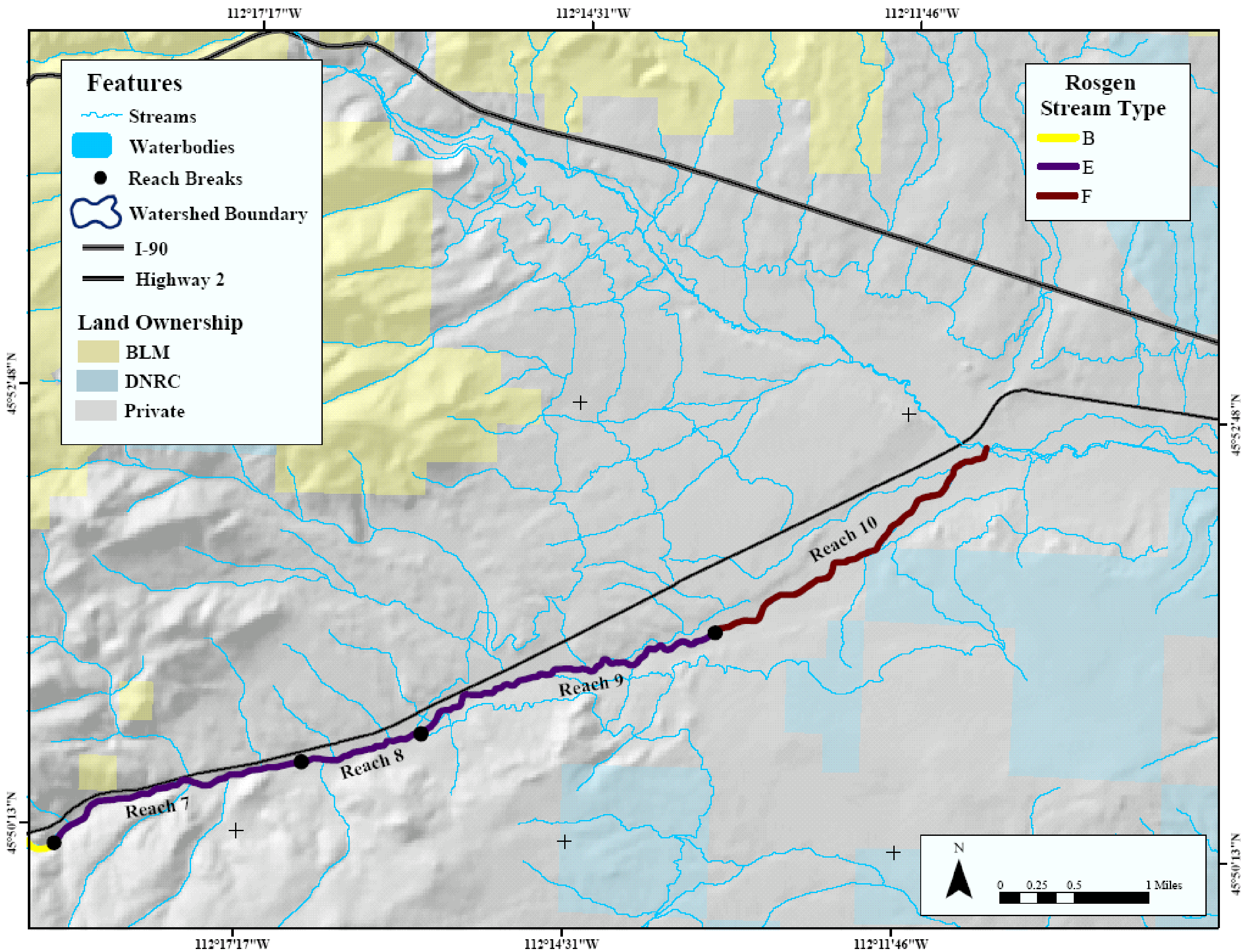

Figure 2-35. Lower Little Pipestone Creek Rosgen Stream Types

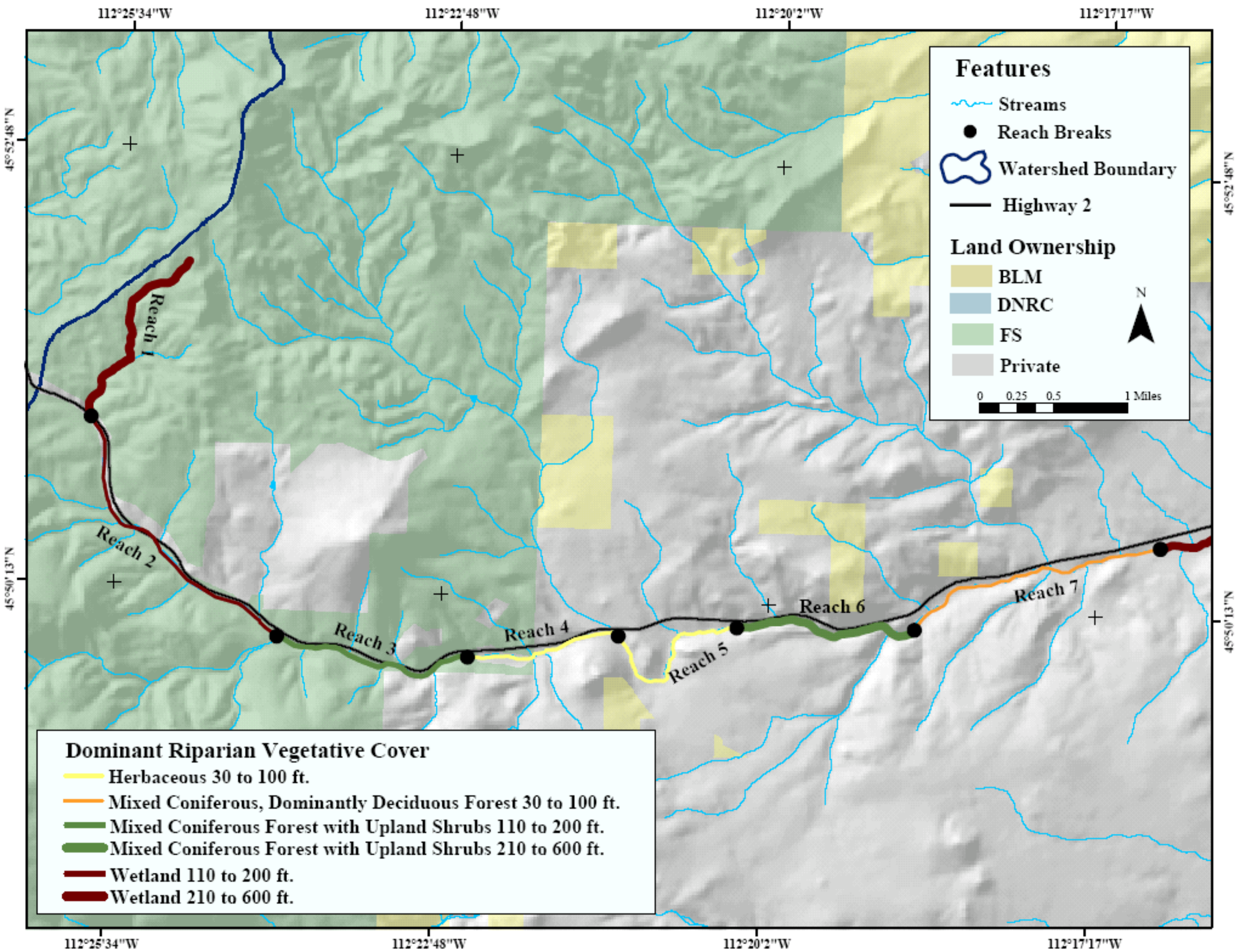

Figure 2-36. Upper Little Pipestone Creek Riparian Vegetation

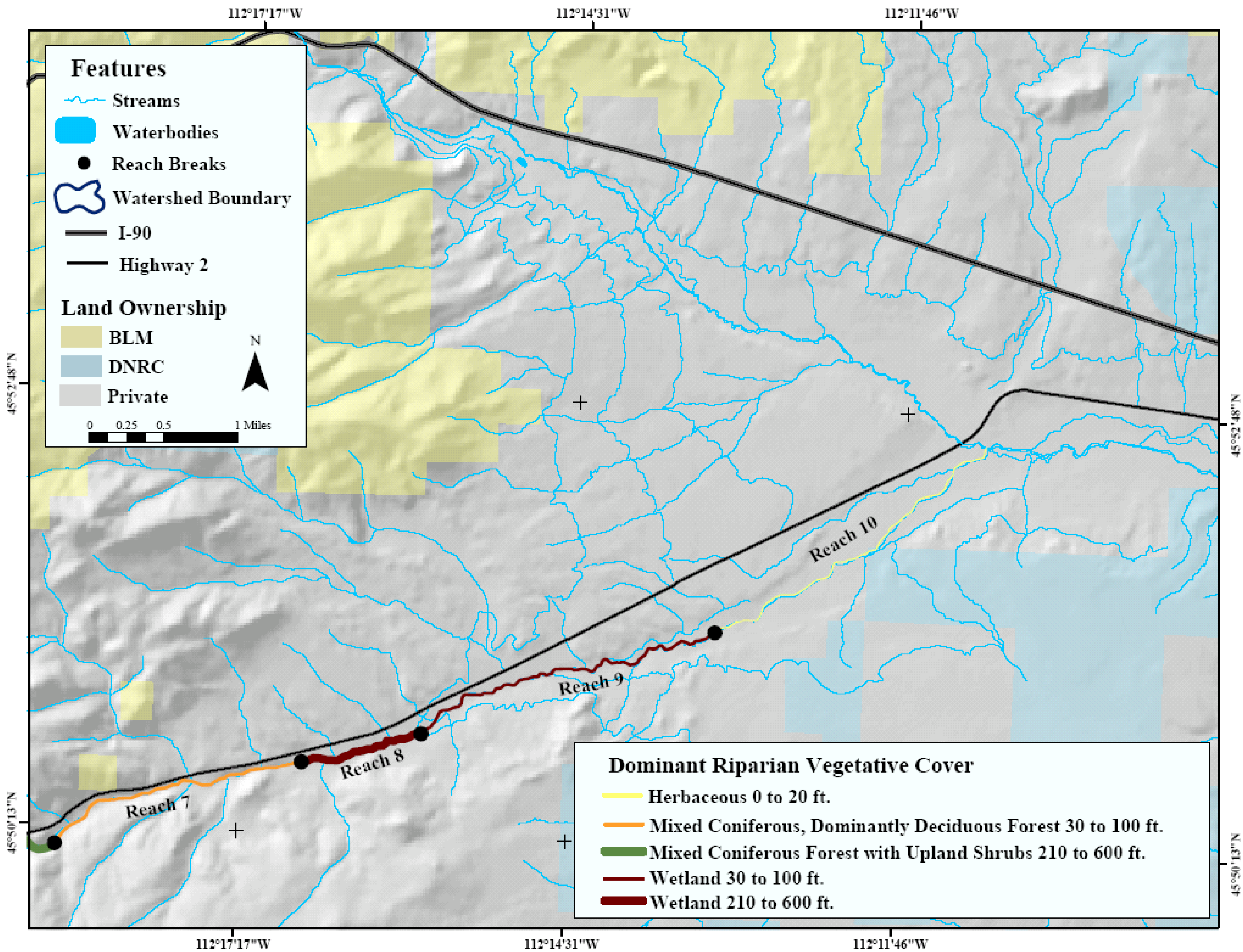

Figure 2-37. Lower Little Pipestone Creek Riparian Vegetation

2.2.8.3 Little Pipestone Creek Pollution Sources

Figure 2-38 displays the pollution sources assigned to the upper reaches of Little Pipestone Creek. Many pollution sources observed along Upper Little Pipestone Creek were related to roads and riparian grazing. In many instances, the sources of flow alterations from water diversions and impacts from abandoned mine lands were taken from GIS layers which located water rights claims and abandoned mines. The GIS identified sources were not field verified, except in Reach 1 where 3 earthen dams have obstructed the channel. A large road sediment source was observed entering the creek in Reach 2. Channelization effects were prominent in Reaches 2 and 3. There were no significant changes in pollution sources between 1983 and 2001.

Figure 2-39 displays the pollution sources assigned to the lower reaches of Little Pipestone Creek. Many pollution sources observed along Lower Little Pipestone Creek were related to agricultural operations and rural housing development. Alterations for irrigation diversions were observed in reaches 9 and 10. During the field source assessment, grazing impacts and flow alterations were observed in Reach 10. In general, stream condition deteriorates in a downstream manner from Reach 8 to Reach 10. For the lower portion of Little Pipestone Creek, only one time period was analyzed so significant changes in pollution sources since 1983 were not be determined.

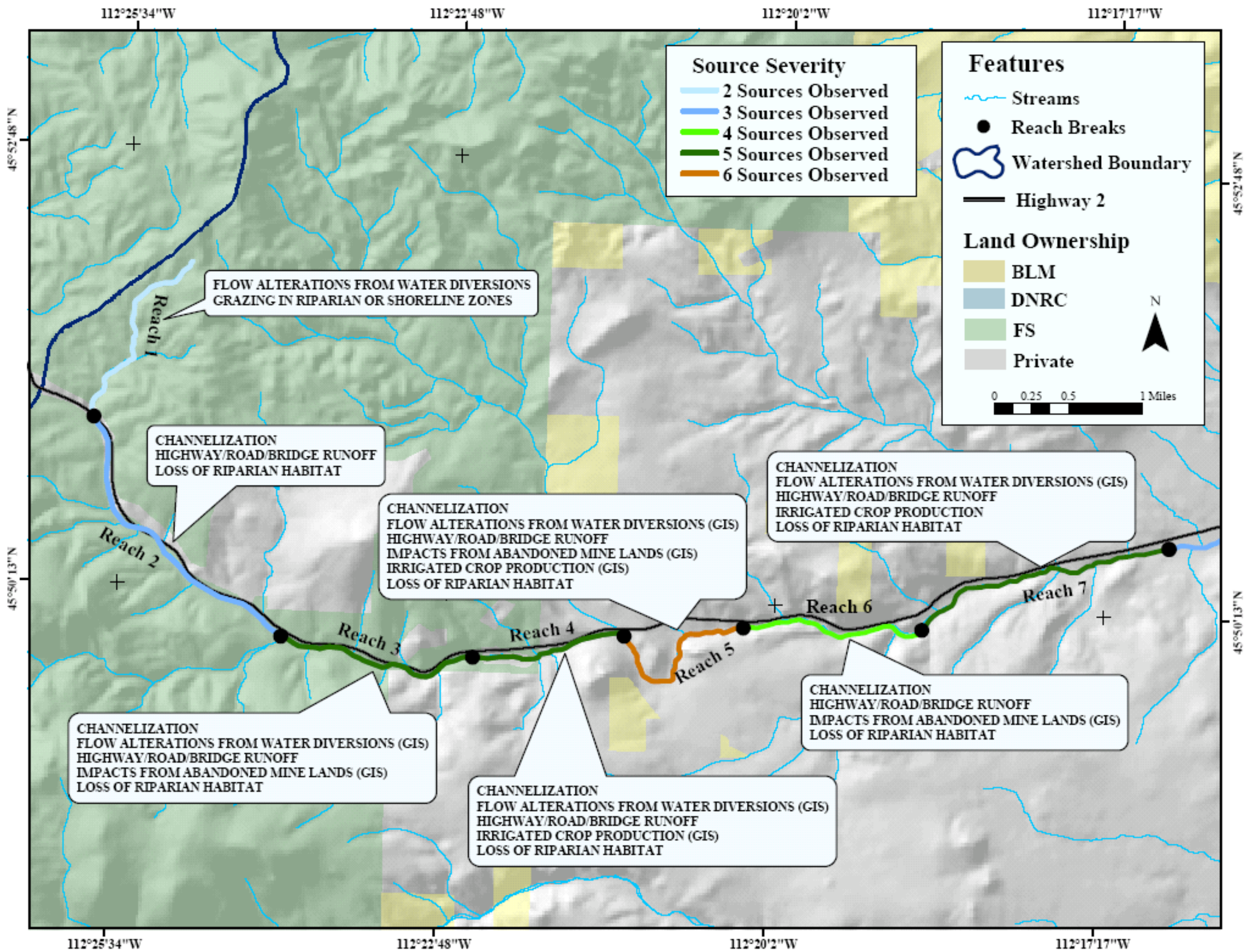

Figure 2-38. Upper Little Pipestone Creek Pollution Sources

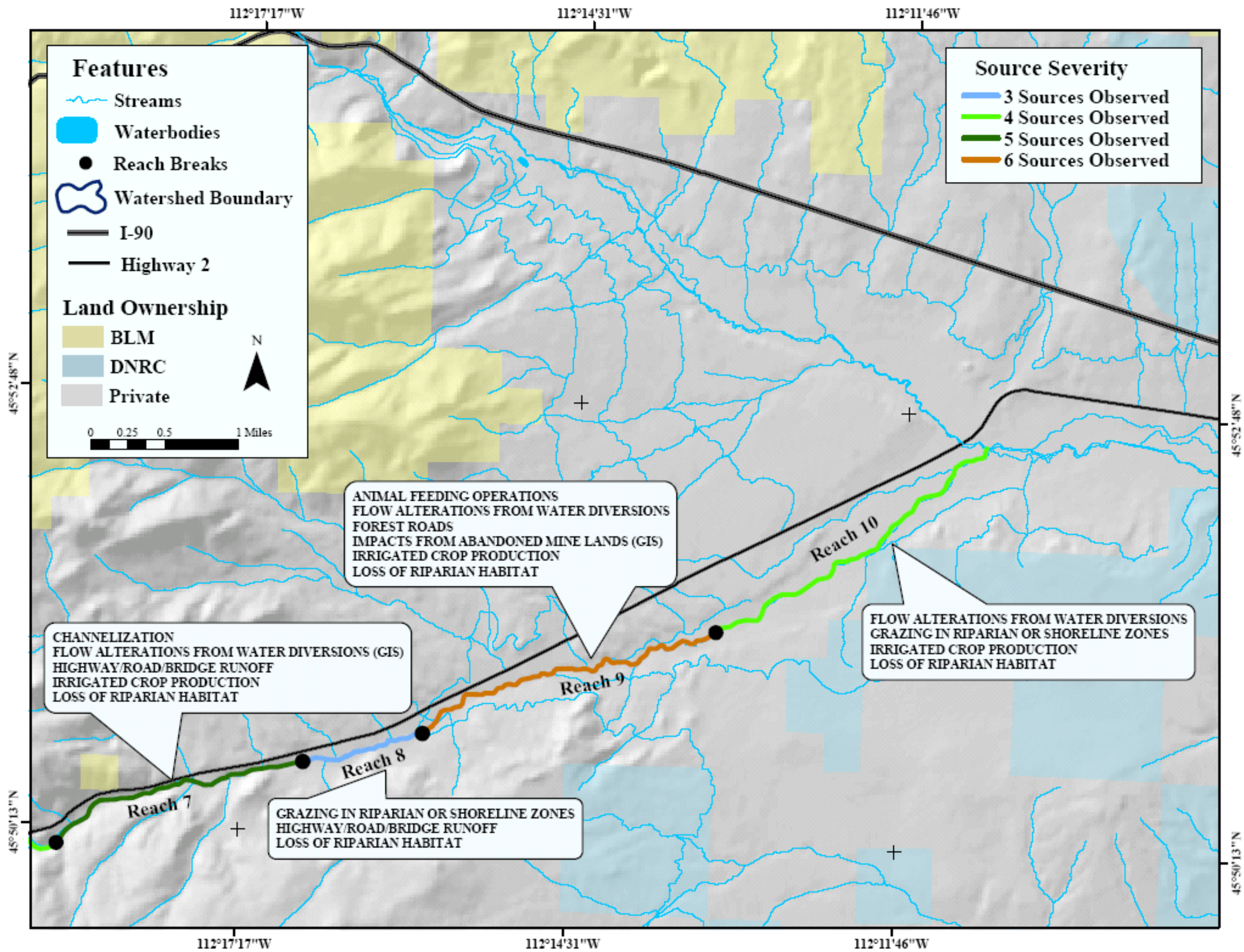

Figure 2-39. Lower Little Pipestone Creek Pollution Sources

2.2.9 Whitetail Creek

Whitetail Creek forms at the outlet of Whitetail Reservoir on the Beaverhead-Deerlodge National Forest. It flows for approximately 23 miles to where it meets the Jefferson Slough, a former channel of the Jefferson River. The suspected causes of impairment to Whitetail Creek are dewatering/flow alterations, habitat alterations, riparian degradation, and siltation. Suspected pollution sources to Whitetail Creek include agriculture, flow regulation/modification, grazing related sources, and hydromodification. According to the 2004 303(d) List, cold water fisheries and associated aquatic life, and primary contact recreation are partially supported water uses; while drinking water supply use has not been assessed.

For the purposes of the source assessment, Whitetail Creek was broken into 17 reaches (**Figures 2-40** to **2-45**). During the 2004 water quality monitoring project (May to September) and the October field source assessment, 8 of the 17 reaches were visited in the field (**Table 2-1**). Where available, field information was incorporated within the results of the source assessment.

Table 2-8. Field Assessment of Whitetail Creek Reaches

Whitetail Creek Reach Number	Visit Purpose	Percent of Reach Surveyed
Reach 5	Field Survey	25%
Reach 6	Field Survey	Less than 5%
Reach 12	Field Survey	30%
Reach 13	Field Survey	70%
Reach 14	Field Survey, Water Quality Monitoring	40%
Reach 15	Water Quality Monitoring	Less than 5%
Reach 16	Field Survey	40%
Reach 17	Water Quality Monitoring	Less than 10%

2.2.9.1 Whitetail Creek Rosgen Stream Types

The channel forms of Upper Whitetail Creek are predominantly controlled by landform structure, and flow releases from Whitetail Reservoir (**Figure 2-40**). The landform geology of Reaches 1 to 6 is the Boulder Batholith, while intrusive volcanic rocks are prominent in reaches 7 to 12. The stream headwaters in Whitetail Park at the outlet of Whitetail Reservoir (C-type) and then flows through a steep, narrow canyon (A-type). The canyon gradient lessens and valley bottom openings alternate between relatively confined (B-type reaches), and unconfined areas (C-type reaches). The area of Reach 5 viewed during the field survey exhibited a C-type channel with transformation to a B-type channel at the end of the reach. The beginning of Reach 6 was noted as a good potential for a reference B-type channel. Reach 12 was observed as a B-type channel trending to C-type in less confined areas, while Reach 13 had characteristics of a C-type channel. There were no significant changes in channel form between 1983 and 2001.

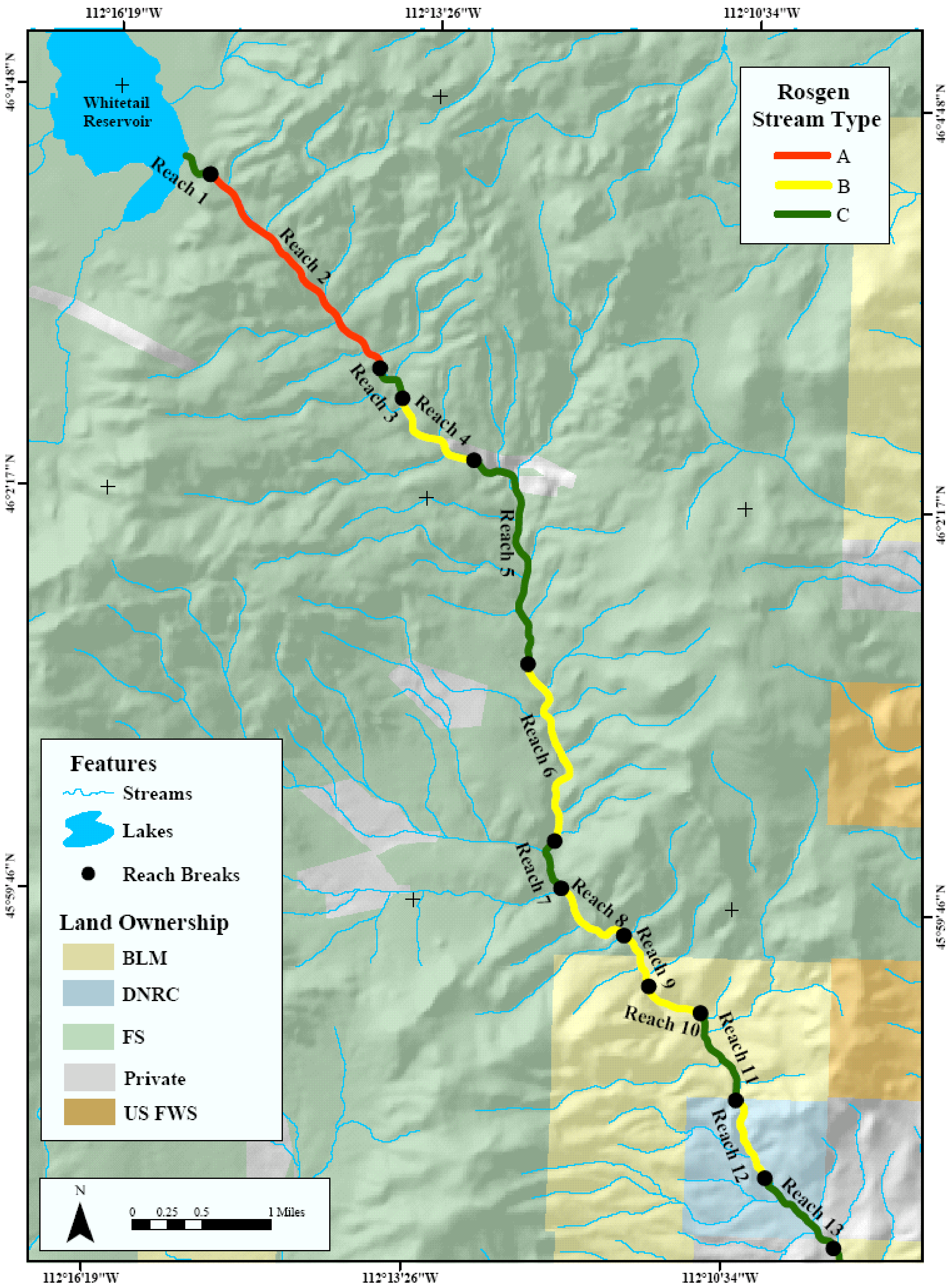

Figure 2-40. Upper Whitetail Creek Rosgen Stream Types

The channel forms of Lower Whitetail Creek are controlled by landform and historical and current landuse activities (**Figure 2-41**). The predominant valley type (VIII) would typically result in an unconfined stream type (C or E), yet alterations for flow diversions and possibly removal of beaver dams have resulted in sections of the stream with channel types out of balance with the valley type. The width to depth ratio in Reach 14 was lower than in reach 13 and was moderately entrenched in areas. This was thought to be related to a large diversion which diverts flow in the upper part of Reach 14. Channel form in Reach 14 exhibited C-type and Bc-type characteristics. After the confluence with Little Whitetail Creek, sinuosity greatly increases and the stream was thought to exhibit an E-type channel in Reaches 15 to 17. Most of the areas surveyed in Reach 16 exhibited E-type channel characteristics. Active beaver dams were observed in Reaches 16 and 17. There was also a notable difference in 'beaver management' along the stream depending on individual landowner, with beaver dams concentrated in some areas and totally absent in others. It is thought that active beaver dams in Reach 16, as well as beaver dam removal have resulted in diverse channel forms, such as braided sections and incised sections. For the lower portion of Whitetail Creek, only one time period was analyzed so significant changes in channel form since 1983 could not be determined.

2.2.9.2 Whitetail Creek Riparian Vegetation

The dominant riparian cover along Upper Whitetail Creek in Reaches 1 to 6 was mixed coniferous forest with upland shrubs (**Figure 2-42**). During the field review in Reach 5, sedges, alder, and willows were observed extending about 10 feet from the channel within the conifer forest. Riparian cover from Reaches 7 to 13 alternated between wetland (less confined valley bottom areas), mixed coniferous forest, and deciduous forest. Buffer widths were generally limited by valley bottom width and the availability of moisture. The relative health categories assigned to all of the upper reaches was either 'Excellent' or 'Fair', depending on whether disturbance was visible. Some areas of thistle infestation were observed in Reaches 5 and 13. Buffer widths were generally greater than 100 feet wide along both sides of the stream, and represented the distance of vegetation surrounding the stream before any disturbance was observed. There were no significant changes in riparian vegetation between 1983 and 2001.

Riparian cover along Lower Whitetail Creek transitioned from herbaceous, to wetland, to herbaceous (**Figure 2-43**). This is largely a reflection of landuse. It is suspected that a lowering of the water table in Reach 14 is one factor in the decrease of deciduous vegetation. During the field survey in Reach 14, decadent and dying cottonwood, intermixed with willow, alder, current, and red osier were confined to a narrow corridor along stream. Reaches 15 and 16 were dominated by willows. The riparian area appeared to be more intact in Reach 15 than in Reach 16, and may reflect the fact that land ownership was more subdivided in Reach 16 versus Reach 15. The herbaceous category for Reach 17 was due to development and farming in the riparian zone. The relative health category assigned to most of the lower reaches was: 'Poor'. For the lower portion of Whitetail Creek, only one time period was analyzed so significant changes in riparian vegetation since 1983 could not be determined.

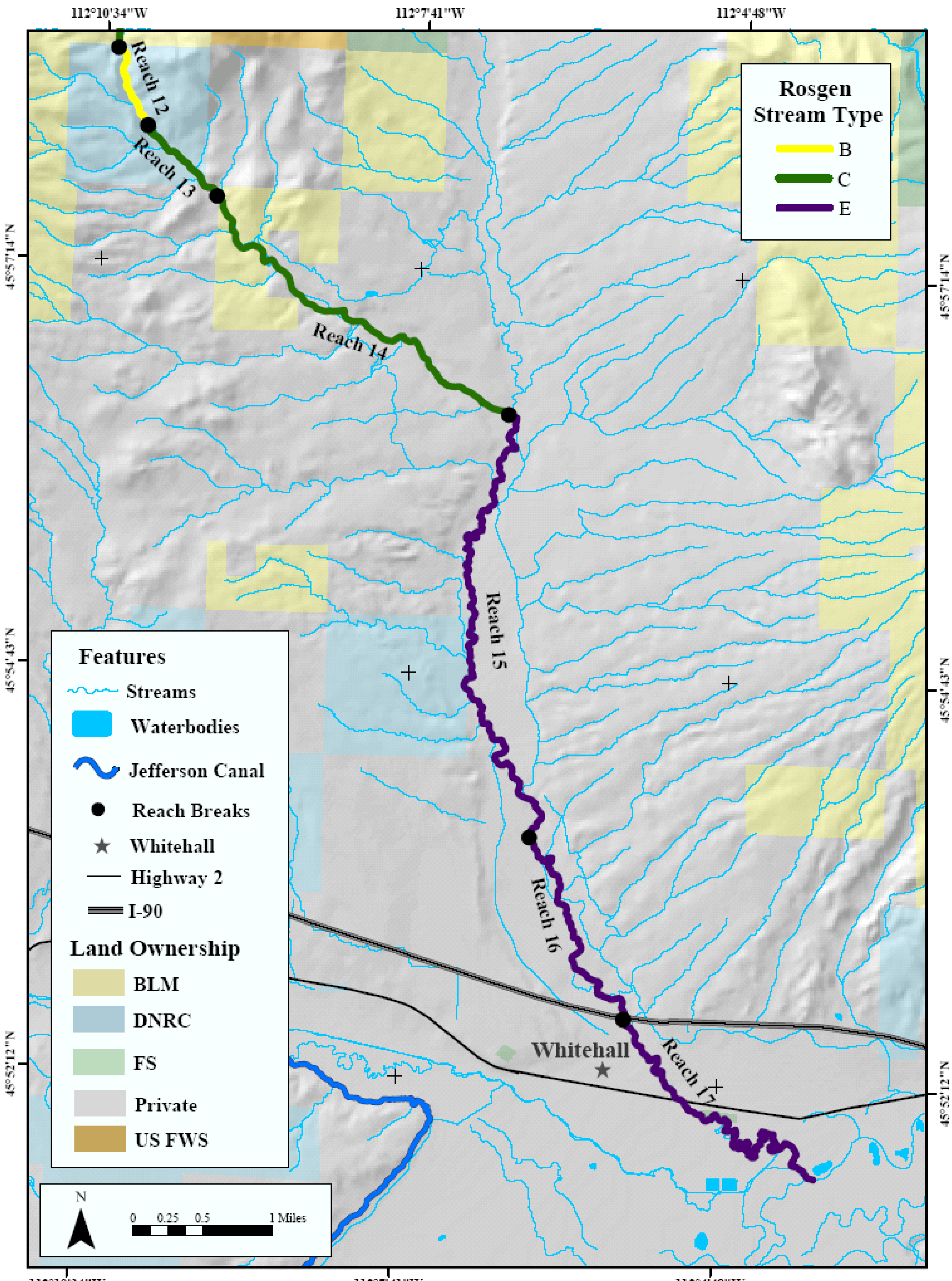

Figure 2-41. Lower Whitetail Creek Rosgen Stream Types

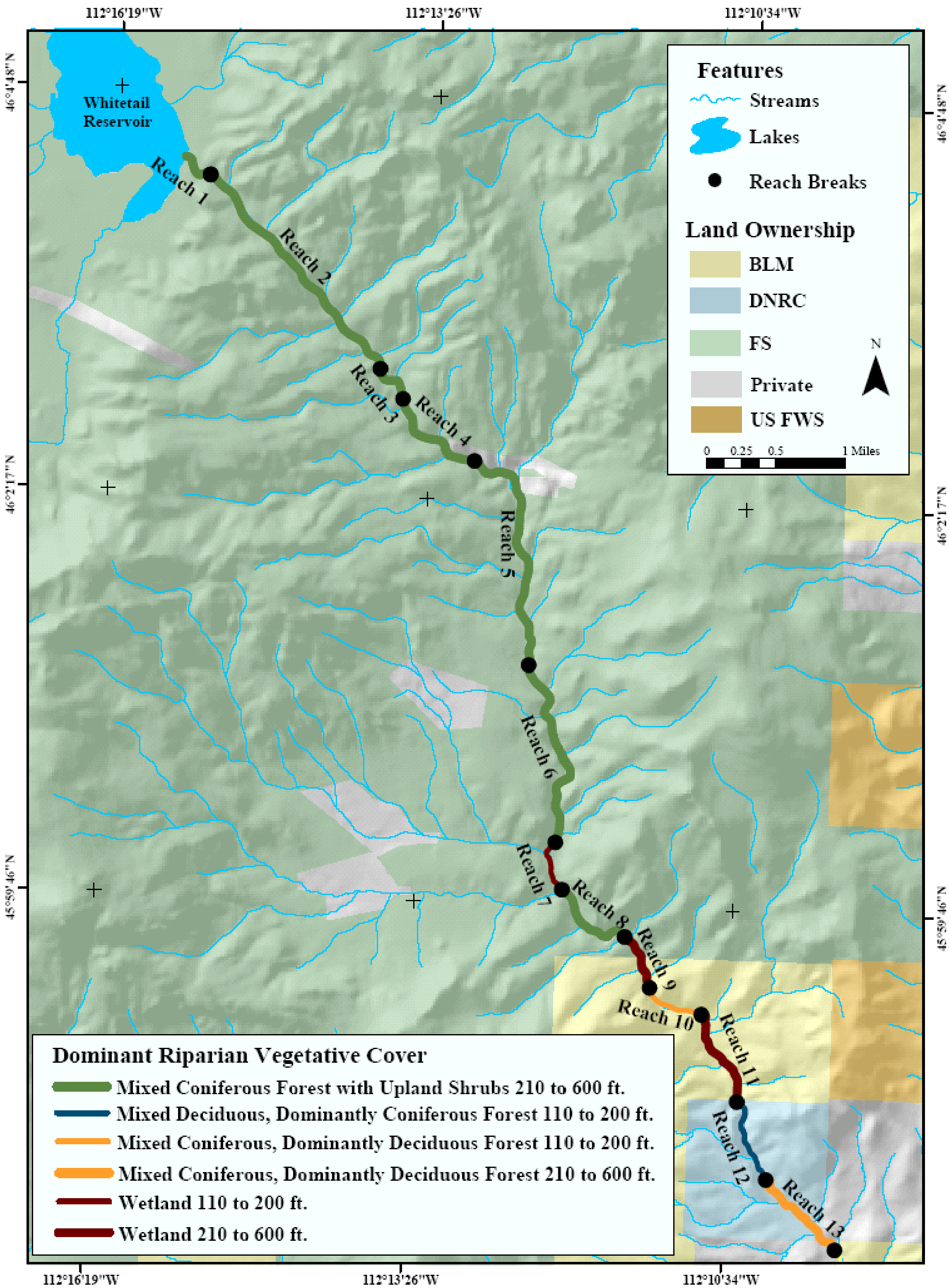

Figure 2-42. Upper Whitetail Creek Riparian Vegetation

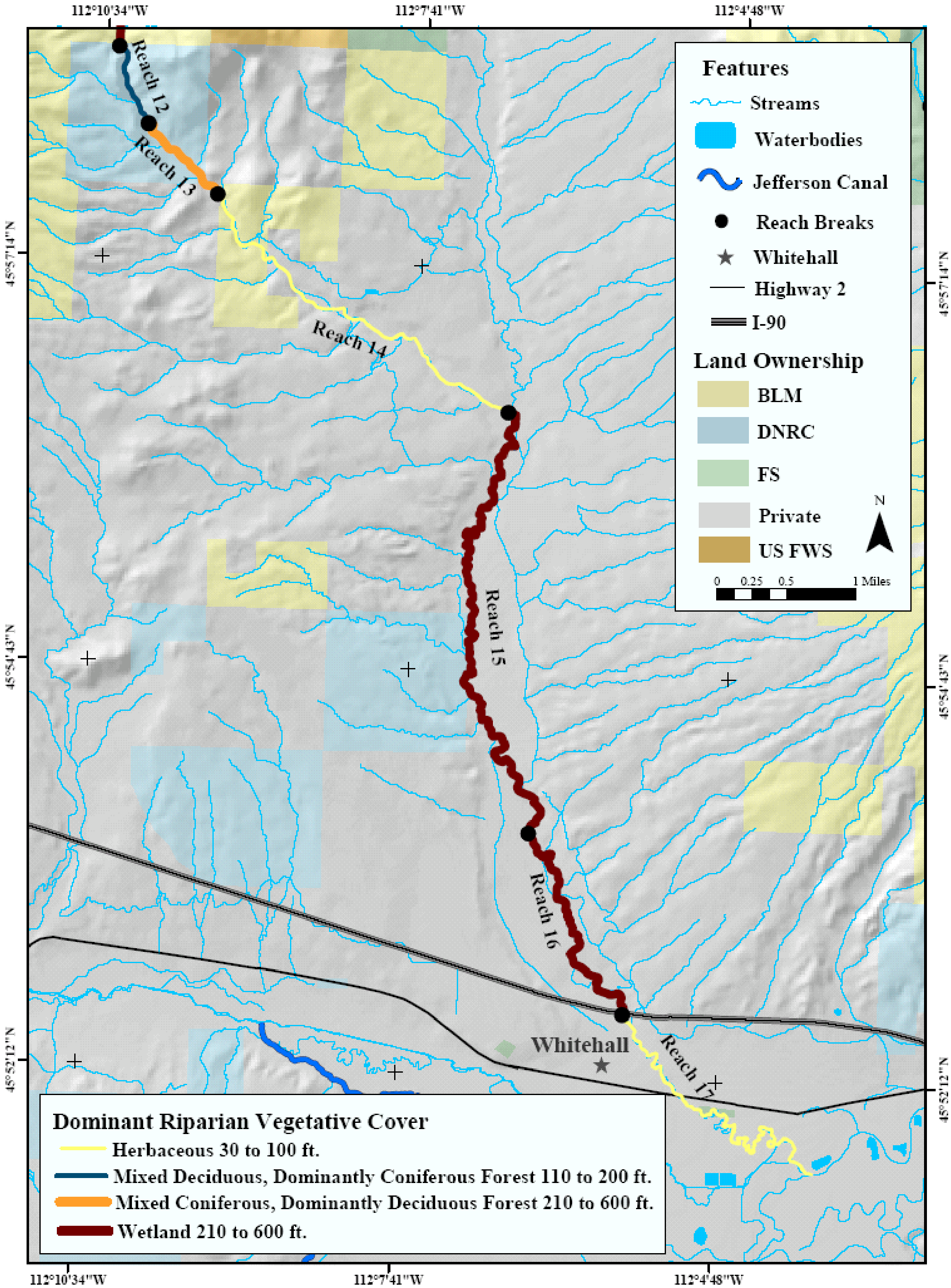

Figure 2-43. Lower Whitetail Creek Riparian Vegetation

2.2.9.3 Whitetail Creek Pollution Sources

Figure 2-44 displays the pollution sources assigned to the upper reaches of Whitetail Creek. In many instances, the sources of flow alterations from water diversions and impacts from abandoned mine lands were taken from GIS layers, and were not field verified. Most of the pollution sources observed in the field along Upper Whitetail Creek were related to the riparian grazing and unpaved roads (Reaches 5 and 13). Brown trout were observed in the upper reaches of Whitetail Creek during the October field assessment. During the aerial assessment of the 1983 photos, disturbance below a prospect area was visible in Reach 4, but was not visible in 2001. In 1983, beaver ponds were visible on two major tributaries to Whitetail Creek: Grouse Creek and Gillespie Creek (Reach 7), but were gone by 2001.

Figure 2-45 displays the pollution sources assigned to the lower reaches of Whitetail Creek. Many pollution sources observed along Lower Whitetail were related to agricultural operations. During the field source assessment, grazing impacts were observed in all of the field surveyed reaches. Alterations for irrigation diversions were observed in reaches 14, 16, and 17. The sources observed were localized by the property owner's land use, such as confined feedlots, removal of riparian vegetation, and small grazing pastures. For the valley portion of Whitetail Creek, only one time period was analyzed so significant changes in pollution sources since 1983 were not be determined.

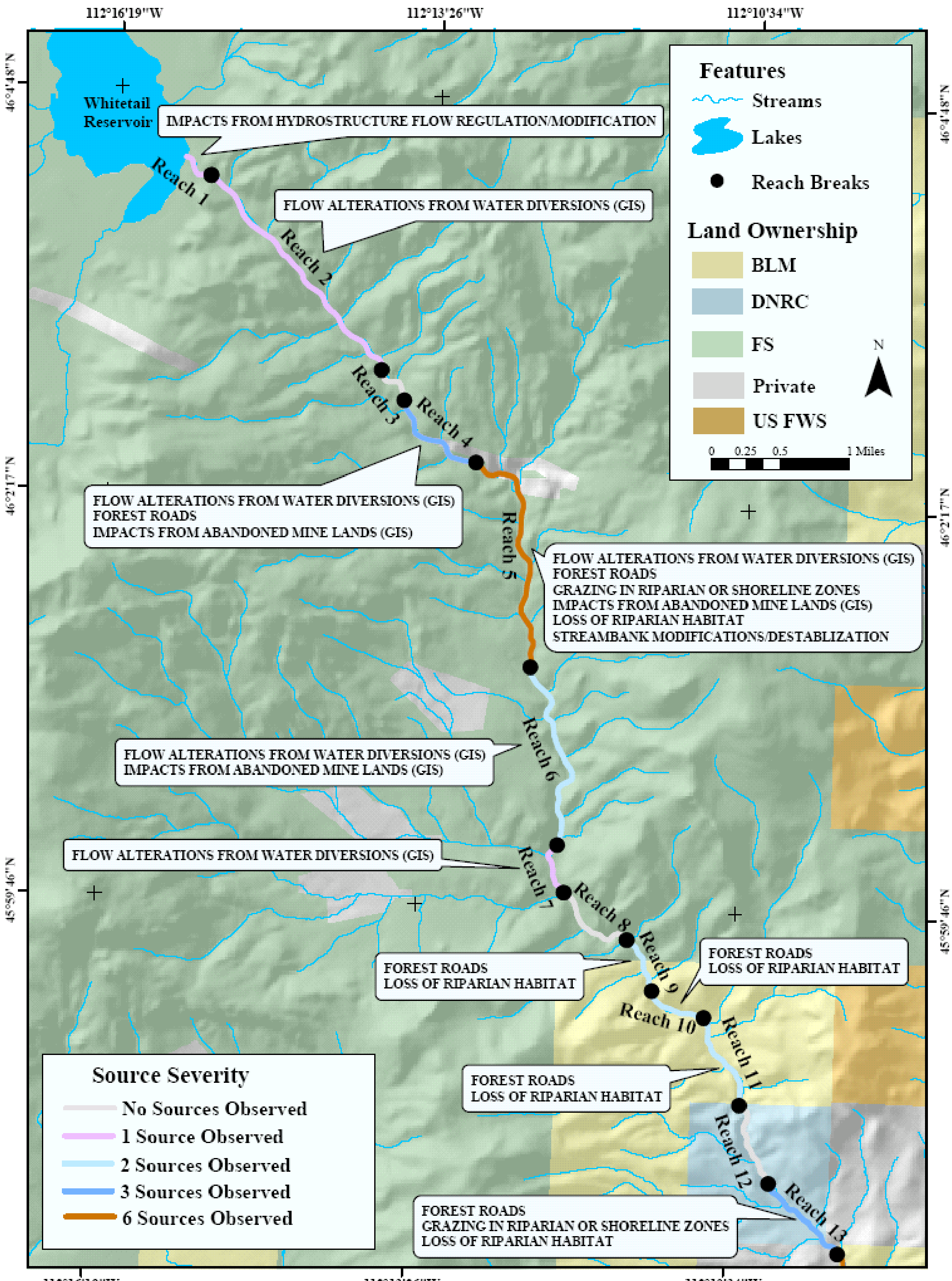

Figure 2-44. Upper Whitetail Creek Pollution Sources

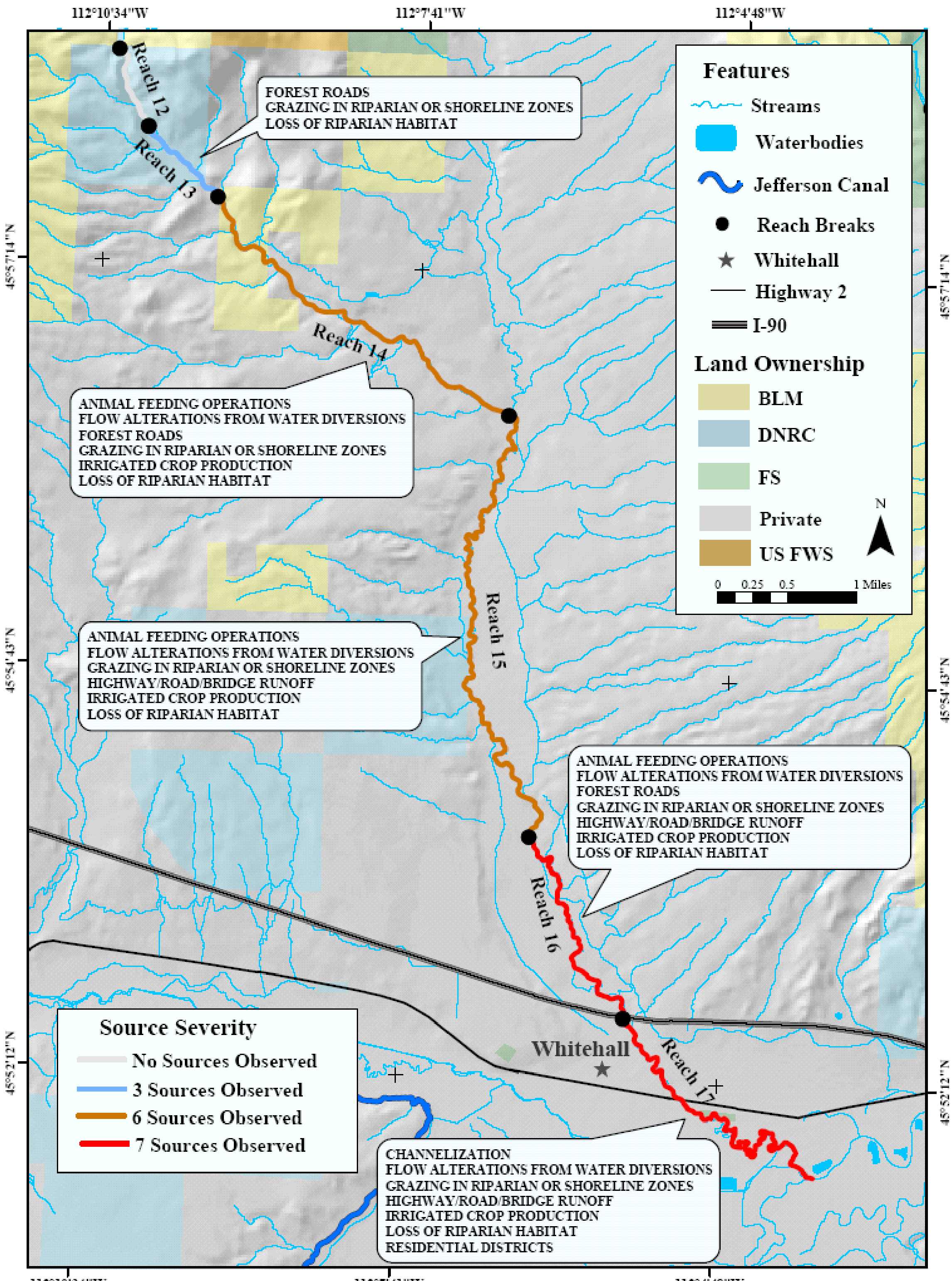

Figure 2-45. Lower Whitetail Creek Pollution Sources

2.2.10 Upper Jefferson River

The Jefferson River forms at the confluence of the Big Hole and Beaverhead Rivers in Madison County. It flows for approximately 84 miles to where it meets the Madison and Gallatin rivers at Three Forks, MT to form the Missouri River. The upper portion of the Jefferson River consists of the 42 mile section from the headwaters to the confluence with the Boulder River. The suspected causes of impairment to the Jefferson River are copper and lead, dewatering/flow alterations, habitat alterations, suspended sediment/siltation, and thermal modifications. Suspected pollution sources to the Jefferson River include abandoned mines, agriculture, bank modification/destabilization, flow regulation/modification, habitat modification, hydromodification (dams), removal of riparian vegetation, and resource extraction. According to the 2004 303(d) List, cold water fisheries and associated aquatic life, and drinking water supply uses are not supported; while industry and primary contact recreation are partially supported uses.

For the purposes of the source assessment, the Upper Jefferson was broken into 14 reaches (**Figures 2-46** to **2-49**). As mentioned earlier, no reaches were visited in the field during the October 2004 source assessment. During the 2004 water quality monitoring project (May to September), sections of Reach 2 and Reach 13 were visited in the field.

2.2.10.1 Upper Jefferson River Rosgen Stream Types

Reach designations for the Upper Jefferson River were made under the assumption that the river was predominantly a single channel. This decision was based on information collected during the 2003 Hoitsma Ecological riparian assessment, as well as Rosgen classification techniques based on valley type (VIII). Reach breaks were divided on the basis of meander wavelength, channel confinement, aspect, and adjacent landuses. After the analysis was conducted on the 2002 images, the channel was viewed with a more encompassing perspective on the 1983 aerial photographs (limited channel overview on a computer screen at 1:10,000, and 2002 images did not capture all of the channels). It was then determined that many of the reach designations do not fit wholly within one Rosgen channel type. It is the professional opinion of the analyst that the Upper Jefferson River is part of a 'multi-channel system', a term used by Dr. Steve Custer of Montana State University. The multi-channel system describes the concept of multiple channels with different channel patterns existing in a single system (Custer, 2001). This concept fits well for the Jefferson River due to the presence of gravels bars, large vegetated islands, and multiple channel threads.

An overall Rosgen stream type was assigned to the 14 designated reaches of the Upper Jefferson River (**Figures 2-46** and **2-47**). See **Table 2-9** for a review of the various channel patterns observed within the reaches. Overall Rosgen channel form changed for Reaches 4, 6, 11, 13, and 14 between 1983 and 1982. The changes were mostly due to the fact that drought impacts have reduced wetted channel width and exposured more gravel bars. Loss of wetted channel width has resulted in fewer channel anabraches in Reaches 6, 11 and 13; while exposure of gravel bars has increased channel braiding in Reaches 4 and 14. Subtle changes have occurred in Reaches 8, 10, and 12, but not enough to cause an overall change in the dominant channel type. It is the professional opinion of the surveyor that without alterations for flow diversions, most of the Upper Jefferson River would be an anabranched channel.

Table 2-9. Review of Channel Patterns Found Among the Upper Jefferson River Reaches

Reach ID	Overall Rosgen Channel Type	Comments
JEFF83-1	Da	None of measured reach is single thread. Anabranching channel with braided areas through non-vegetated bars.
JEFF02-1	Da	Anabranching channel with areas of braiding through non-vegetated bars.
JEFF83-2	D	Channel alternating between D and Da. A large Oxbow meander to the right bank before end of the reach is still connected to the channel (anabranch). Mostly D
JEFF02-2	D	Channel alternating between D and Da. A large Oxbow meander the right bank before the end of the reach is still connected to the channel (anabranch). Mostly D
JEFF83-3	D	Channel alternates between D, C, and Da, with an anabranch at the end of the reach. Anabranched areas appear to be influenced by irrigation diversion canals. Channel confinement evident along portions of the reach. Mostly D
JEFF02-3	D	Channel alternates between D, C, and Da, with an anabranch at the end of the reach. Anabranched areas appear to be influenced by irrigation diversion canals. Channel confinement evident along portions of the reach. Mostly D
JEFF83-4	Unclassified	Channel alternates between C, D and Da. Point bars are visible, with anabranching near the end of the reach.
JEFF02-4	D	Channel alternates between D and C. Possible anabranching in areas if water levels were higher. Mostly D.
JEFF83-5	Da	Main channel is mostly single thread with point bars and some braiding. A large side channel to the right bank that breaks off in Reach 4 gives the reach characteristics of Da channel. 2 Oxbows are located on the on the left bank near the end of the reach with connection to main channel.
JEFF02-5	Da	Main channel is mostly single thread with point bars and some braiding. A large side channel to the right bank that breaks off in Reach 4 gives the reach characteristics of Da channel. 2 Oxbows are located on the on the left bank near the end of the reach with connection to main channel.
JEFF83-6	Unclassified	Main channel is single thread channel (C) with braiding through detached point bars and near end of reach. Flow entering from a former channel in middle of the reach on the right bank (probably influenced by groundwater and irrigation return flow). The stream anabranches just downstream of the former channel.

Table 2-9. Review of Channel Patterns Found Among the Upper Jefferson River Reaches

Reach ID	Overall Rosgen Channel Type	Comments
JEFF02-6	C	Main channel is single thread channel (C) with braiding through detached point bars and near end of reach. Flow entering from a former channel in middle of the reach on the right bank (probably influenced by groundwater and irrigation return flow).
JEFF83-7	Da	Reach begins as a single thread channel and at about 1 meander wavelength anabranching begins. There is some braiding through gravel bars. Flow enters on the left bank before end of reach from a side channel that forms in the valley.
JEFF02-7	Da	Reach begins as a single thread channel and at about 1 meander wavelength anabranching begins. There is some braiding through gravel bars. Flow enters on the left bank before end of reach from a side channel that forms in the valley.
JEFF83-8	C	Mostly single thread channel. Beginning of reach is the end of an anabranch, and near the end of reach the channel is braided (not in 2001). Some shorter areas of braiding around detached vegetated point bars.
JEFF02-8	C	Mostly single thread channel. Beginning of reach is the end of an anabranch, with a few areas of braiding.
JEFF83-9	Da	Channel alternates between C, D, and Da. Begins as a single thread and about halfway becomes anabranched. Lots of water entering channel in at least 4 places from former channels and irrigation drains.
JEFF02-9	Da	Channel alternates between C, D, and Da. Begins as a single thread and about halfway becomes anabranched. The end of the reach would probably have more channels if the water level was higher.
JEFF83-10	D	Channel alternates between D and Da. Anabranched areas appear to be influenced by irrigation diversion canals.
JEFF02-10	D	Channel alternates between D and C, mostly D.
JEFF83-11	Da	Channel alternates between D and Da, mostly anabranching.
JEFF02-11	C	Channel alternates between C and D, mostly C. Channel would be anabranched in sections if water was higher.
JEFF83-12	Da	Most of reach is split into 2 main channels after intersecting a backwater channel. The island between the 2 main threads is well vegetated. There are more channels visible than are visible on the 1995 Orthos.

Table 2-9. Review of Channel Patterns Found Among the Upper Jefferson River Reaches

Reach ID	Overall Rosgen Channel Type	Comments
JEFF02-12	Da	Most of reach is split into 2 main channels after intersecting a backwater channel. The island between the 2 main threads is well vegetated. Lateral channel migration visible since 1995.
JEFF83-13	D	Channel alternates between D and Da, with water entering channel in at least 3 places from former channels and irrigation drains.
JEFF02-13	C	Mostly a single thread channel, with some braiding at gravel bars. Lots of side channels/canals entering stream.
JEFF83-14	D	Channel alternates between Da and D, mostly D.
JEFF02-14	Unclassified	Channel alternates between Da, D and C. First half anabranched and braided second half single thread.

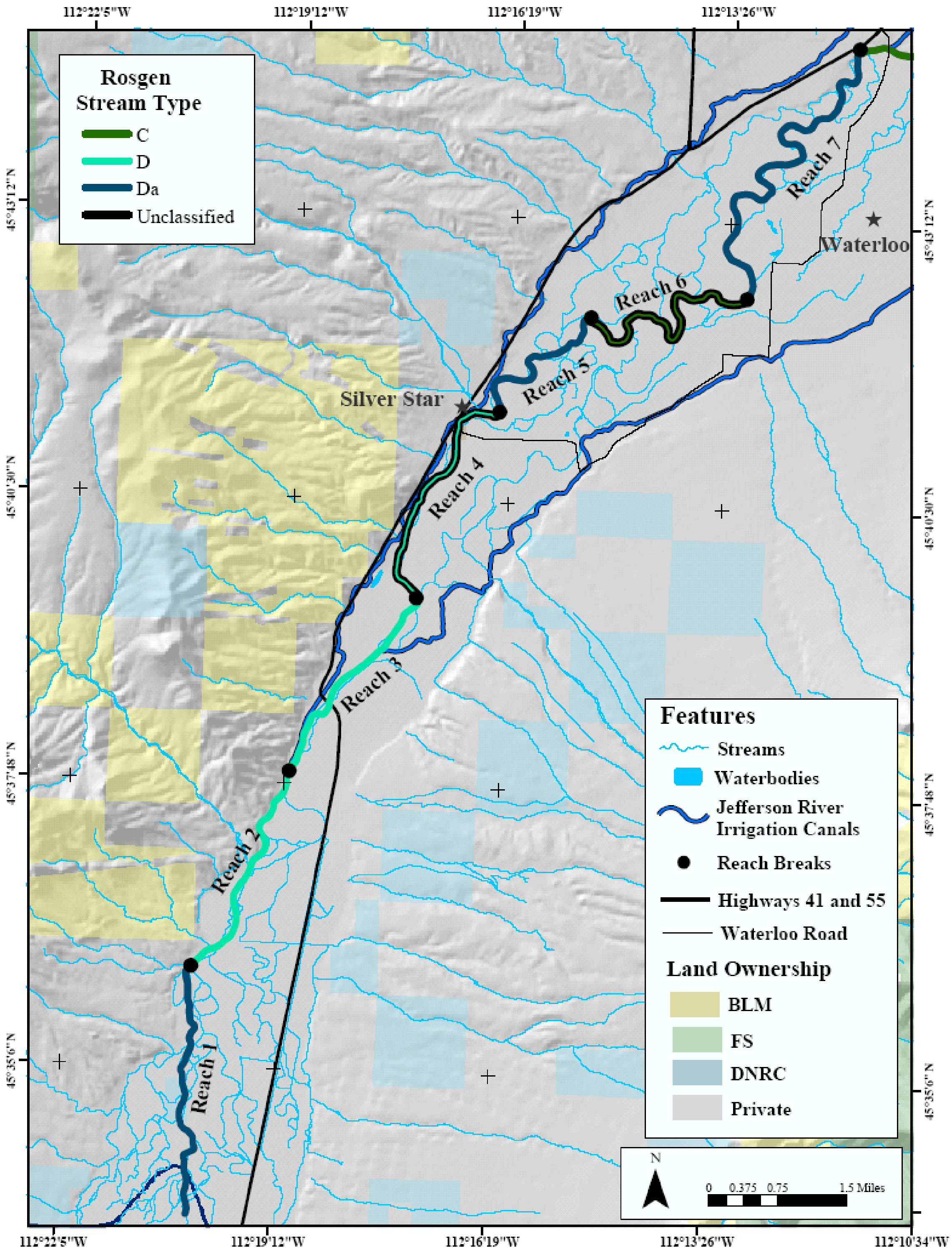

Figure 2-46. Upper Jefferson River Rosgen Stream Type, Reaches 1 to 7

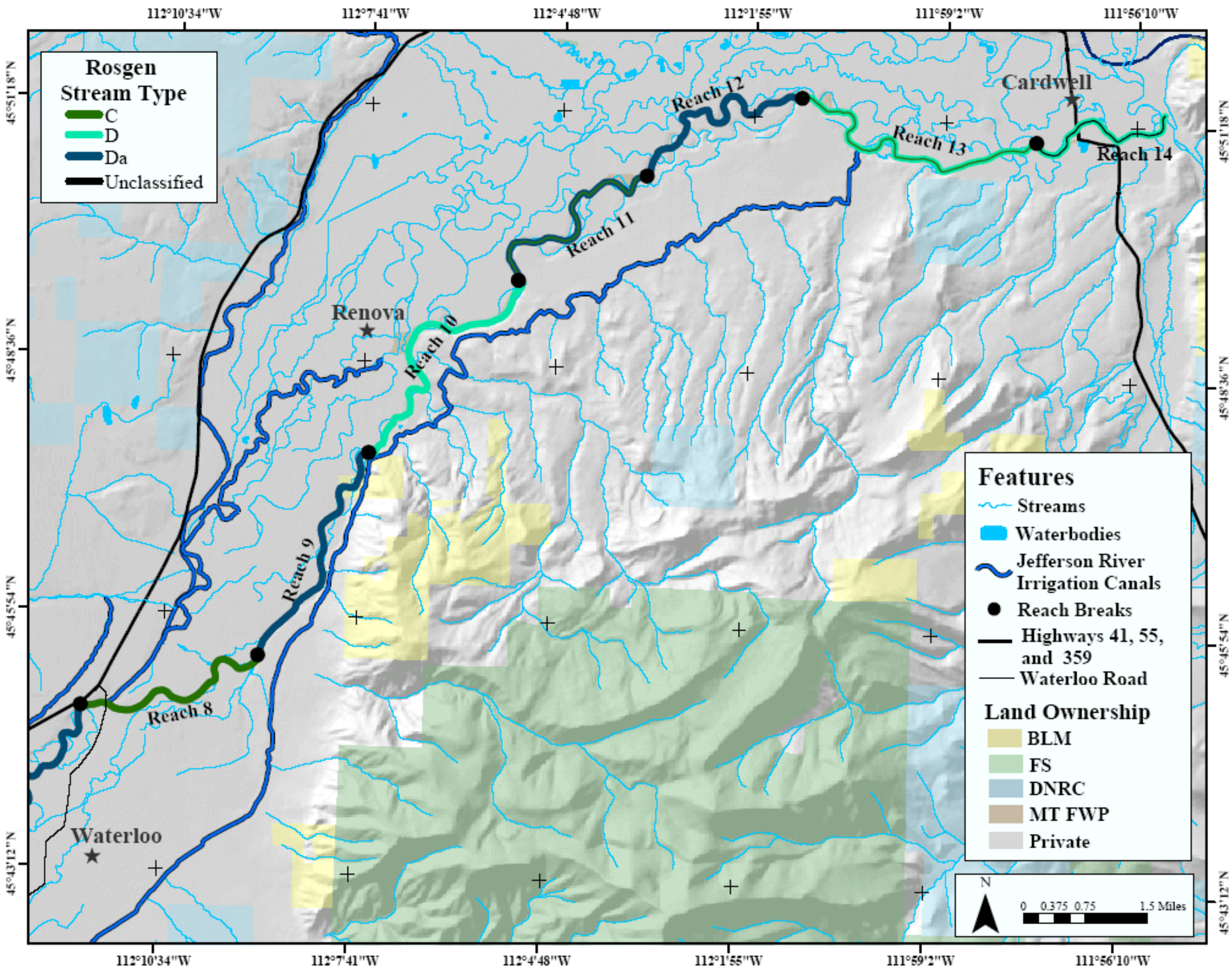

Figure 2-47. Upper Jefferson River Rosgen Stream Type, Reaches 8 to 14

2.2.10.2 Upper Jefferson River Riparian Vegetation

The dominant riparian cover along the Upper Jefferson River is wetland vegetation (**Figures 2-48 and 2-49**). Many types of cottonwoods, willows, shrubs and herbaceous plants were identified during the 2003 riparian inventory (Hoitsma Ecological, 2003). In general, wetland vegetation extended to 100 feet or more along both sides of the main river channel. Buffer widths for the 2002 photos were based on the GIS layer created by Hoistma Ecological, but were measured from the aerial photographs for the 1983 analysis. Differences in riparian buffer widths between 1983 and 2002 should be interpreted with this in mind. Between 1983 and 2001, the riparian buffer width in Reaches 2, 3, and 4 appeared to increase by an average of 12 percent, 28 percent, and 26 percent, respectively. During the same time period, buffer widths appeared to decrease in Reaches 6, 7, and 14 by 25 percent, 57 percent, and 42 percent, respectively.

2.2.10.3 Upper Jefferson River Pollution Sources

Figures 2-50 and **Figure 2-51** display the pollution sources assigned to the upper reaches of the Jefferson River. Aside from visible observations on the aerial photos and information from GIS layers, much of the pollution source information for the Upper Jefferson River for the 2002 analysis was taken from information collected during the 2003 riparian inventory (Hoitsma Ecological, 2003). The source of impacts from abandoned mine lands was taken from GIS layers which located abandoned mines up tributary drainages which eventually drain to reaches of the Upper Jefferson River.

This GIS identified source was not field verified, and results of the 2004 metals monitoring revealed no water quality violations for copper and lead in this section of the Jefferson River. Many pollution sources observed along the Upper Jefferson River were related to agricultural operations (irrigated agriculture, water diversions, loss of riparian habitat). All of the reaches assigned for the source of streambank modifications/destabilization were done so on the basis of information collected during the 2003 riparian inventory, and represent rip-rap, eroding banks, and impaired banks. The most notable difference in sources between 1983 and 2002 was the effect of drought.

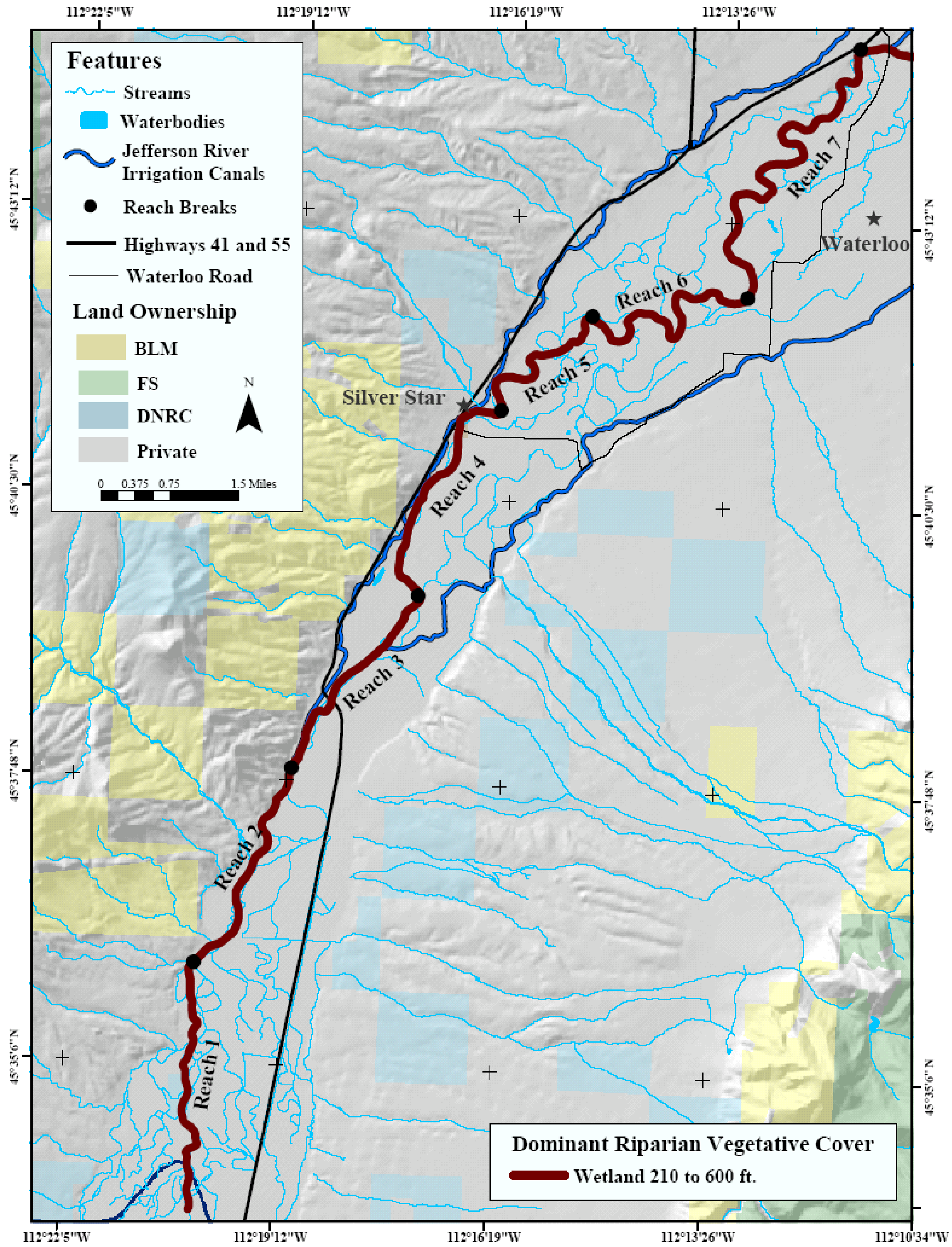

Figure 2-48. Upper Jefferson River Riparian Vegetation, Reaches 1 to 7

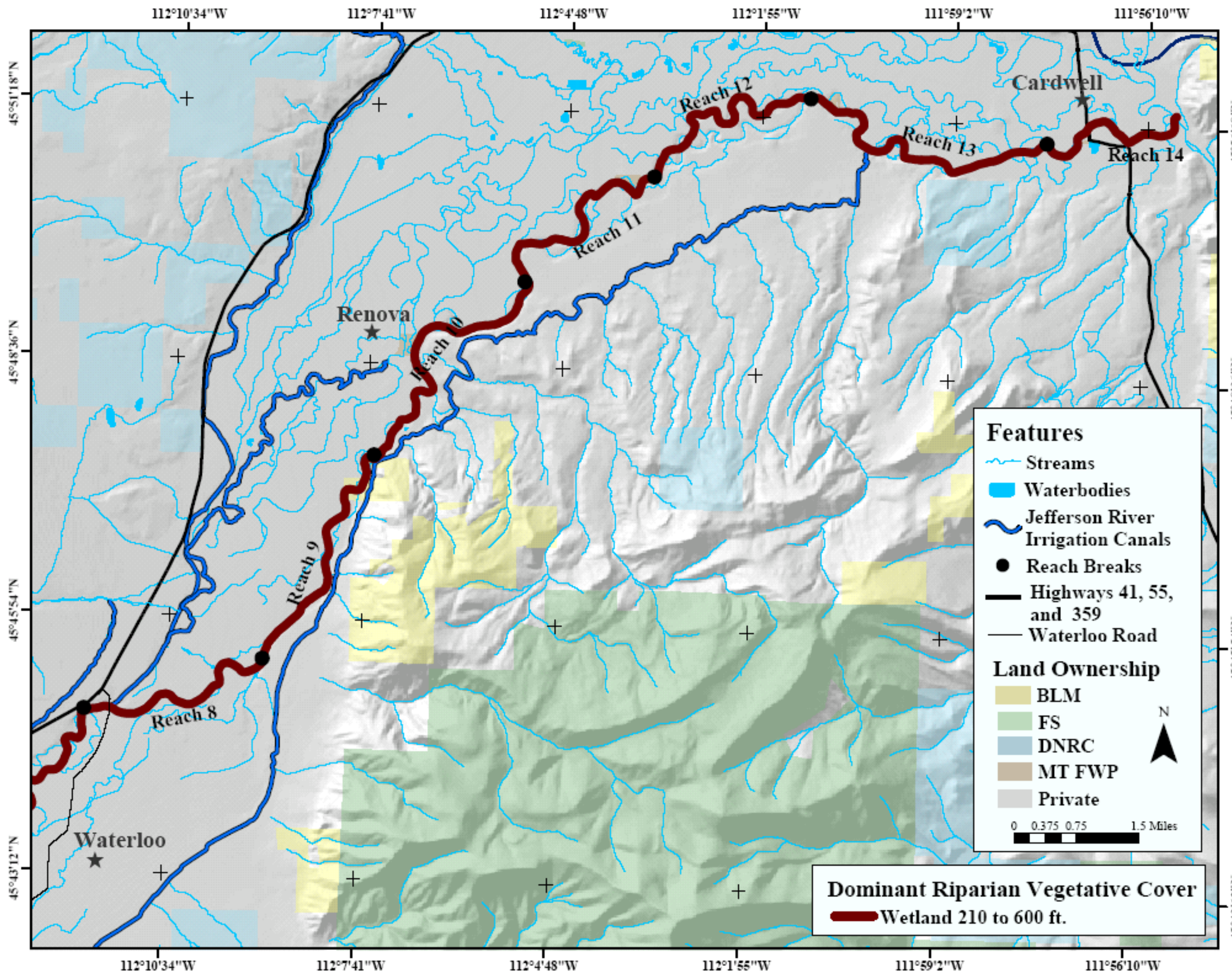

Figure 2-49. Upper Jefferson River Riparian Vegetation, Reaches 8 to 14

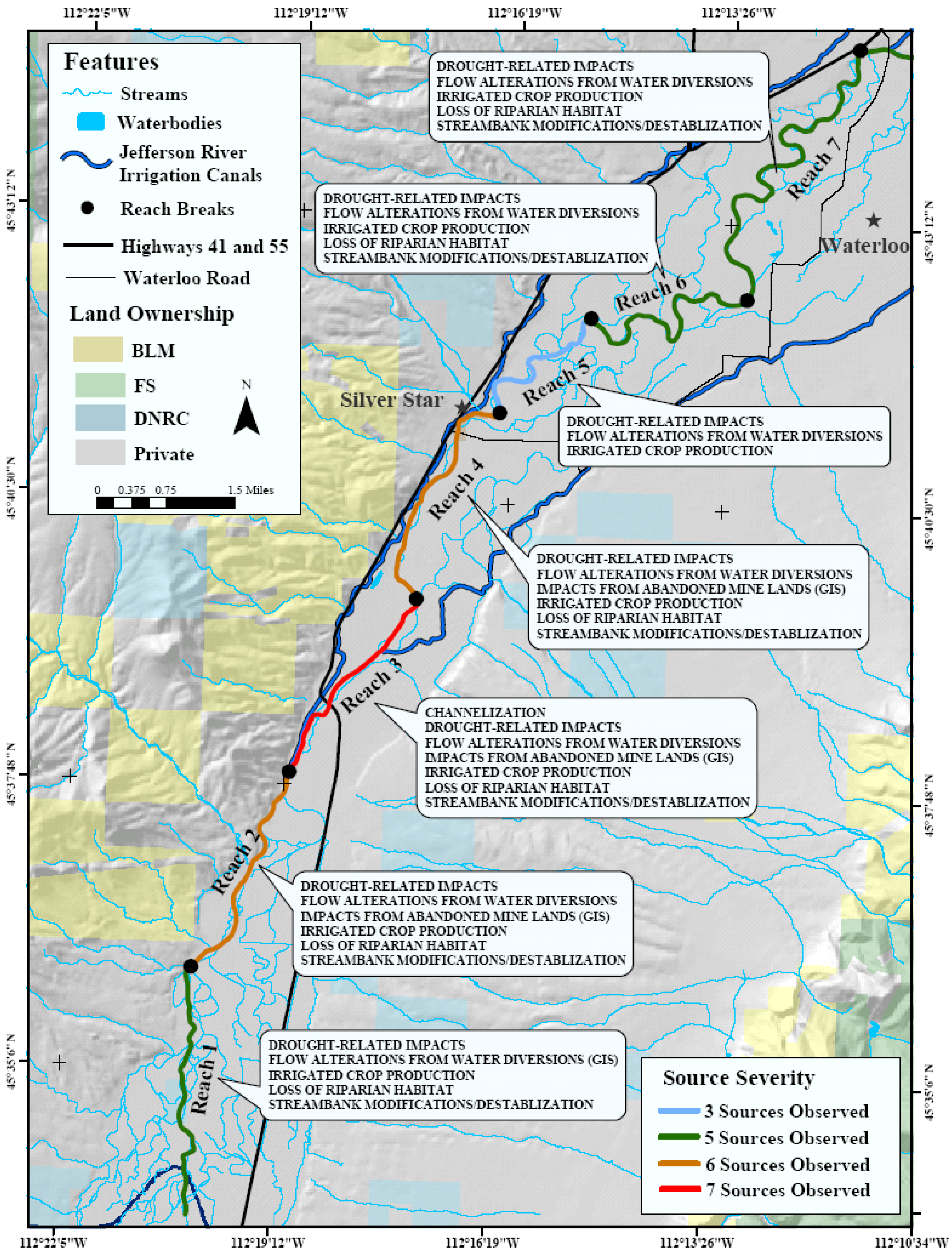

Figure 2-50. Upper Jefferson River Pollution Sources, Reaches 1 to 7

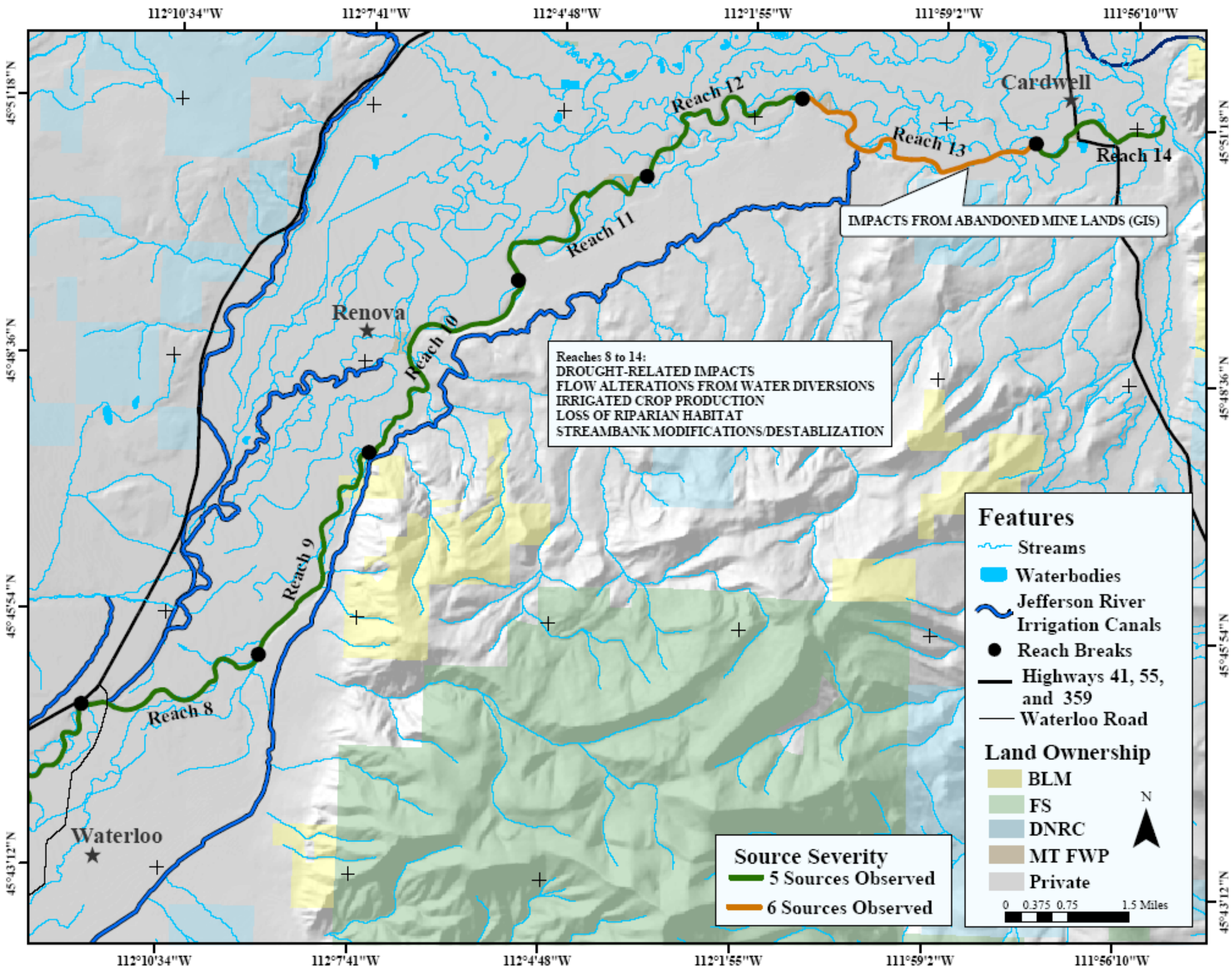

Figure 2-51. Upper Jefferson River Pollution Sources, Reaches 8 to 14

3.0 UPPER JEFFERSON SOURCE ASSESSMENT CONCLUSIONS

Overall, the most ubiquitous source affecting the 303(d) Listed tributary streams in the Upper Jefferson Watershed is riparian grazing. In many instances poor grazing practices have led to degraded riparian areas, unstable stream banks, and increased delivery rates of sediment, and possibly nutrients and pathogens to the listed streams. Roads would be the next most prevalent source to the tributary streams; delivering sediment, affecting buffer widths of riparian vegetation, and causing channel alterations. Natural sources of pollution in the Upper Jefferson Watershed can exacerbate problems stemming from anthropogenic sources. This is particularly true in the case of the highly erosive granitic geology, the Boulder Batholith (TKb), that is found along some portion of all of the 303(d) Listed tributary streams except for Fitz Creek and Dry Boulder Creek. The TKb formation is composed primarily of quartz monzonite and produces coarse sands that are easily transported during runoff events. The TKb formation appears to create a pattern of excessive coarse sediment deposition. In general, the listed streams found in this geology have high sediment loads, especially bed load.

Flow alterations from water diversions, and irrigated agriculture, are prominent in the Jefferson Valley, along the major tributary streams and the Upper Jefferson River. In some cases, water loss from a stream system is detrimental, and separating the effect of flow alterations from drought impacts may prove to be a difficult task, particularly in the case of the Jefferson River. In other cases, water additions may be damaging. For instance, although irrigation return flows add water back to stream systems, the water quality may be poor due to the addition of contaminants such as sediment, nutrients, heat, and possibly pesticides and herbicides.

3.1 Big Pipestone Creek

Data results from the 2004 source assessment have provided support for the following 303(d) Listed, suspected causes of impairment to Big Pipestone Creek: bank erosion, channel incisement, habitat degradation/alteration, riparian degradation, suspended sediment, and thermal modifications. Results from the 2004 water quality monitoring project provide support for impairment from nutrients. Spatially, the sources of hydromodification from Delmoe Lake releases (causing habitat alteration and probably disrupting suspended sediment loading) and unpaved road/trail sediment sources are particularly prominent in Reaches 1 to 8. At Reach 9, the first major irrigation diversions occur with hydromodification from irrigation diversions continuing virtually to the mouth of the stream. Bank erosion, channel incisement, riparian degradation, and grazing related sources were observed in almost all of the valley reaches surveyed in the field. Most likely, siltation is a cause of impairment for Reaches 10 to 16. Channelization is a particular problem for Reach 14, and the related headcutting effect may extend downstream of the reach. Municipal point source pollution most likely enters in Reach 16 from the Whitehall sewage lagoons. Sources associated with silviculture were not observed, although during the field source assessment a notice for a pending timber sale near the base of Delmoe Lake was posted. One source associated with thermal modifications was observed at the site of Pipestone Hot Springs (Reach 12), but this is most likely a natural thermal input. Source allocation work will need to be completed to quantify loadings from the pollutant source areas.

3.2 Cherry Creek

Data results from the 2004 source assessment did not provide direct support for the 1996 303(d) Listed suspected cause of impairment to Cherry Creek: flow alteration. Grazing related impacts were observed in Reaches 2 and 3, but do not necessarily represent impairment to beneficial uses. A report from a landowner at the base of the alluvial fan to Roxann Lincoln of the Jefferson River Watershed Council indicated that the stream usually goes dry there during the irrigation season. The stream appeared fairly healthy where surveyed in Reach 6, and was one of the few sites observed in the field with regenerating cottonwoods. Based on the visual results from the aerial assessment, possible negative impacts associated with flow alteration would most likely be located in Reaches 5 and 6, where irrigation diversions were observed.

3.3 Dry Boulder Creek

Data results from the 2004 source assessment did not provide direct support for the 1996 303(d) Listed suspected causes of impairment to Dry Boulder Creek: flow alteration and siltation. The stream was observed going dry in Reach 3, which corresponded with the reach where the Coal Creek diversion is, but the diversion site was not seen directly. With the name Dry Boulder Creek, and given the arid environment, it is very likely that this stream would naturally go dry on the alluvial fan. The change in lithology from crystalline rocks to porous carbonate rocks in Reach 3 may also contribute to natural stream dewatering. Siltation did not appear to be a problem where the creek was observed in Reaches 1 and 2. The Lower Boulder Lake water was crystal clear, and no excessive fines were observed in Reach 2. A stream ford observed in Reach 3, where there was still water in the stream, did not appear to contribute much silt. The only observed sediment source in need of correction was at the fist road crossing at the end of Reach 3. A large area of the unpaved public road is draining to the creek during wet events. The creek was dry at this point, and road fines were tracked at a few hundred feet downstream in the channel. Agriculture sources were not observed in the field or during the aerial assessment. During the aerial inventory, some stream modifications associated with past mining operations were observed in Reach 1, but the downstream impacts were not witnessed in the field.

3.4 Fish Creek

Data results from the 2004 source assessment may provide support for the following 303(d) Listed suspected causes of impairment to Fish Creek: habitat alterations, siltation, and flow alteration. Results from the 2004 water quality monitoring did not provide support for impairment from cadmium. Spatially, the sources of abandoned mines/resource extraction were observed in the field and aerially in Reaches 1 to 4. Channelization of a portion of Reach 3 was observed. The effects of placer mining and channelization in these reaches have caused modifications to channel form and alterations to riparian vegetation. Lack of cadmium water quality violations during the 2004 water sampling indicate that acid mine drainage is probably not occurring. Grazing sources were observed in Reaches 3 and 6 where destabilized stream banks have resulted in sediment delivery to the stream. Road sediment delivery sites were observed in Reaches 5, 7, 8, and 14. Sands were prominent in the streambed in Reaches 6, 14 and 15, but this is typical of streams in granitic geology. During the aerial inventory, agricultural operations were observed in Reaches 14 to 17. Discussions with a landowner in Reach 14 revealed that a water right held by the City of Butte diverts most of the creek's flow out of the watershed to the Basin Creek Reservoir. The diversion is located in the upper headwaters and was not located in the field. Butte's diversion diverts flow year round, and only needs to keep enough water in the stream for the senior water right holder located in Reach 16. The creek is usually dry below Reach 17. Reach 18 is channelized in areas and is part of the Jefferson Valley irrigation canal system. Due to the upstream water diversions and inflow from two different canals in Reach 17, it is likely that water in Reach 18 is Jefferson River water. As TMDLs are only required for pollutants, work is needed to quantify the effect of sediment on beneficial uses in Fish Creek. This effort should likely focus on reaches that support trout habitat.

3.5 Fitz Creek

Data results from the 2004 source assessment did not provide direct support for the 1996 303(d) Listed suspected cause of impairment to Fitz Creek: siltation. However, the stream was only observed in the field for a small section where it held water and for most of the alluvial fan where it was dry. Grazing was observed in Reaches 4 and 5, but appeared to have minimal impact due to lack of water in the stream. A stream ford was observed in Reach 4 which was a probably, overall, a minor sediment source to the stream. A small section of the road that follows the stream course was viewed in Reach 4. Although the road was within 100 feet of the stream, the riparian buffer and small active channel width appeared minimally affected by road sediment input. Depending on the results of the DEQ's reassessment monitoring, private property access may be needed to view the stream above the alluvial fan and quantify the effects of sediment on beneficial uses in Fitz Creek.

3.6 Halfway Creek

Data results from the 2004 source assessment may provide support for the following 303(d) Listed suspected causes of impairment to Halfway Creek: habitat alterations and siltation. Grazing sources were observed in Reaches 6 and 7 where destabilized stream banks have resulted in sediment delivery to the stream. Road sediment delivery sites and riparian disturbance were also observed in Reaches 6 and 7, but appeared to be more problematic in Reach 7. Sands were prominent in the streambed, as is typical of streams in granitic geology, but siltation was also evident, particularly in Reach 7. Although the upper reaches were not viewed in the field, it is thought that siltation impacts may not be problematic until Reaches 6 and 7 where roads and unpaved trails provide easy access to the stream and riparian area. As TMDLs are only required for pollutants, work is needed to quantify the effect of sediment on beneficial uses in Halfway Creek. This effort should likely focus on reaches that support trout habitat, and where road and grazing sources are present.

3.7 Hells Canyon Creek

Data results from the 2004 source assessment on Hells Canyon Creek may provide support for the 303(d) Listed suspected causes of impairments for habitat alterations and siltation, but did not provide direct support for dewatering/flow alteration. Grazing sources were observed in Reaches 4 and 6, where destabilized stream banks have resulted in sediment delivery to the stream. Part of Reach 4 is within the Hell's Canyon Creek Riparian Project area and is fenced off from grazing. There was a significant difference in vegetative health and stream bank condition outside of the riparian project area. Road sediment delivery sites and riparian disturbance were observed in Reaches 3, 4, 5 and 6. Road sediment delivery in Reach 5 is most problematic due to a catastrophic road failure that occurred sometime between 1983 and 2001. Although the area is closed to car traffic, ATV traffic is still allowed. Sands were prominent in the streambed, as is typical of streams in granitic geology, but siltation was also evident in Reaches 4, 5, 6, and 9. Sources associated with hydromodification were not visually observed in the field or on the aerial photos. Silviculture harvest was observed on the photos and was noted as occurring sometime before 1983. As TMDLs are only required for pollutants, work is needed to quantify the effect of sediment on beneficial uses in Halfway Creek. This effort should likely focus on reaches that support trout habitat, and where road and grazing sources are present.

3.8 Little Pipestone Creek

Data results from the 2004 source assessment have provided support for the following 303(d) Listed suspected causes of impairment to Little Pipestone Creek: bank erosion, habitat alteration, riparian degradation, and siltation. Channelization is particularly problematic for Reaches 2 and 3, and has resulted in alteration of channel form and infringement on the riparian area. Grazing impacts resulting in bank erosion and riparian degradation were observed in Reaches 1 and 10. Riparian buffer widths were minimal in Reaches 4, 5, 9, and 10. Agricultural operations were aerially observed in Reaches 4, 5, 8, 9, and 10. At Reach 9, the first major irrigation diversion was visually observed on the aerial photos. During the field source assessment of Reach 10, stream flow was less than a third of what it was observed at in Reach 8, and eventually went dry before the end of the reach area surveyed. Bank erosion, channel incisement, riparian degradation, and grazing related sources were observed in the valley reaches surveyed in the field. Sands were prominent in the streambed, as is typical of streams in granitic geology, but siltation was also evident in Reaches 8 and 10. Source allocation work will need to be completed to quantify loadings from the pollutant source areas.

3.9 Whitetail Creek

Data results from the 2004 source assessment have provided support for the following 303(d) Listed suspected causes of impairment to Whitetail Creek: dewatering/flow alterations, habitat alterations, riparian degradation, and siltation. Results from the 2004 water quality monitoring project may also provide support for impairment from nutrients. Dewatering appeared problematic during the 2004 water quality monitoring in Reach 17, as the stream went dry in August. The Whitetail Canal diversion diverts in Reach 16, so that dewatering probably begins here during the irrigation season. A large diversion was also observed in Reach 14, but some flow remained in the creek throughout the 2004 sampling in this reach. The effects of flow releases from Whitetail Reservoir are unknown, but likely disrupt suspended sediment transport and may have altered channel form in the upper reaches. Stream conditions were better on the surveyed portions of Upper Whitetail Creek below Whitetail Reservoir, in comparison to areas of Big Pipestone Creek surveyed below Delmoe Lake. Grazing related sources were observed in Reach 5, but may not necessarily represent impairment to beneficial uses. Stream condition takes a turn for the worse in Reach 13. Excess silt, areas of bank erosion, channel incisement, riparian degradation, and grazing related sources were field observed in portions of Reaches 13, 14, 16, and 17. Source allocation work will need to be completed to quantify loadings from the pollutant source areas. Source allocation efforts should probably focus on Reaches 13 to 17.

3.10 Upper Jefferson River

Data results from the 2004 source assessment of the Upper Jefferson River may provide support for the 303(d) Listed suspected causes of impairments for dewatering/flow alterations, habitat alterations, suspended sediment/siltation, and thermal modifications. Results of the 2004 water quality monitoring appeared to challenge the 303(d) Listing for impairment from copper and lead. However, extremely low field measurements of dissolved oxygen during the 2004 monitoring raised questions about nutrient impairments to the river. Irrigated agriculture and associated flow diversions and return flow canals were observed along most of the Upper Jefferson River. It is likely that any impairment from dewatering/flow alterations, habitat alterations, and thermal modifications are associated with water withdrawals, water returns, and possibly field conversion of riparian area. Channel braiding was common along the river, and appeared to increase in areas between 1983 and 2002. The increase in the appearance of gravel bars is thought to be related to drought versus an increase in sediment supply; yet this aerial observation should be quantified in the field. Visual observations from the 2003 riparian inventory indicated that “limited fine sediment” was present in areas of low velocity, and that “the channel bed was consistently comprised of cobble and gravel” (Hoistma, Inc., p. 18). As TMDLs are only required for pollutants, work is needed to quantify the effects on beneficial uses and potentially allocate loads for sediment, nutrients, and temperature in the Upper Jefferson River.

4.0 WORKS CITED

ARM (Administrative Rules of Montana). 2002. *Surface Water Quality Standards and Procedures*. Administrative Rules of Montana 17.30.601–646, Helena, MT.

Custer, S. 2001. *The Purpose of Classification*. Montana State University- Bozeman, MT. October 2001 – Draft.

Hoistma Ecoligical, Inc. 2003. *Final Report Jefferson River Riparian Inventory*. Bozeman, MT. December 2003.

Land & Water Consulting, Inc. 2003a. *Jefferson River Water Quality Restoration Planning Areas, Watershed Characterization*. Helena, MT. June 2003.

Land & Water Consulting, Inc. 2003b. *Jefferson River Water Quality Restoration Planning Areas, Water Quality Status Report*. Helena, MT. July 2003.

Land & Water Consulting, Inc. 2004. *Upper Jefferson River Preliminary Source Assessment Quality Assurance Project Plan*. Helena, MT. June 2004.

Montana Fish Wildlife and Parks. 2004. *FWP GIS layers available for download*. MFWP website at http://fwp.state.mt.us/insidefwp/fwplibrary/gis/gisdownloads.asp. April 2004.

Montana Natural Resource Information System. 2004. *Montana State Library Geographic Information (GIS data)*. NRIS website at http://nris.state.mt.us/gis/default.htm. April 2004.

Rosgen. D., Silvey, H.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.