Realignment of the Payette National Forest South Fork Salmon River Sediment Monitoring Program — Proposed Study Site Adjustments

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Introduction

Sediment monitoring in the South Fork Salmon River (SFSR) began in about 1966 following two extensive flooding events in the winter and spring of 1964-65. The first event occurred around Christmas in 1964 with warm rain on a relatively deep early snowpack that had formed at relatively low elevations and inundated important spawning areas in the upper SFSR. Later in the spring, during peak snowmelt in mid-April, intense thunderstorms passed over the lower Secesh River area that caused flooding and debris flows. These events are well described in the 1965 SFSR flood report (Jensen and Cole 1965). The SFSR watershed can be generally described as comprising narrow canyons, steep slopes, and shallow, unstable soils, so landsliding is relatively common, as are flood events; however, extensive logging and road development exacerbated the natural instability of the area and likely led to a large increase in the amount of fine sediment directly delivered to the river during these flood events.

Some of the early monitoring data in the mainstem upper SFSR are no longer readily available, but Platts (1974) summarizes core sample data collected from 1966 through 1973 and Platts and Megahan (1975a,b) update sediment trends through 1974. In 1975, the Boise National Forest (BNF) established permanent monitoring sites in the upper SFSR, from approximately Krassel Hole to Stolle Meadows (Corley 1975); these included core samples, photographs, direct observations of fish by snorkeling, and channel profiles. The core sampling was conducted in the same five traditional Chinook salmon (*Oncorhynchus tshawytscha*) spawning areas as the previous work, but sampling procedures were formalized and the BNF released annual or semi-annual reports for several years until about 1982. In 1989, Platts *et al.* (1989) summarized sediment trends in these spawning areas through 1985. Until recently, the BNF took responsibility for core sampling in the mainstem SFSR and produced some informal reports and also maintained the photographic monitoring. Beginning in 1996, the Payette National Forest (PNF) assumed the responsibility for producing core sampling reports as part of their overall sediment monitoring program, and, more recently, the PNF has also taken the lead in the mainstem core sampling with personnel and financial assistance from the BNF.

The PNF began sediment core sampling as early as 1976 (Chrostowski 1976) in the Secesh River watershed and expanded the program in 1981 (Lund 1982a) and has been continued more or less annually ever since; in addition, some sampling was started in the Chamberlain Basin for reference conditions in 1981 (Lund 1982b), but this area was not routinely sampled until 1989 (Ries *et al.* 1991). The PNF has continued this monitoring of intragravel sediment essentially unchanged to the present day and has presented the results with the SFSR sampling results since 1996 (Nelson *et al.* 1996).

In addition to core sampling, the PNF has a widespread interstitial sediment monitoring program. Dr. David Burns (Forest Fisheries Biologist, retired) adapted the cobble embeddedness sampling method of Kelley and Dettman (1980) for use on the PNF in 1984 (Burns 1984) and devised a modification that we call 30-Hoop Free Matrix (or

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simply free matrix counts) in 1988 (Ries and Burns 1989). The first PNF Land and Resource Management Plan (LRMP, USFS 1988) identified the SFSR as an area of special concern and effectively formalized the sediment monitoring program in the watershed, even to the point of identifying where monitoring should occur.

While the core sampling program has remained essentially the same since its inception, interstitial monitoring has varied somewhat over time in response to changes since publication of the LRMP. The first important change occurred with the decision to pave the SFSR Road (USFS 1990), which led to the establishment of several sites to monitor the effectiveness of paving. The next big change occurred after Chinook salmon were listed under the Endangered Species Act (ESA, Public Law 93-205, 16 USC 1531 *et seq.*) and we determined that livestock grazing was likely to adversely affect Chinook. This determination led to the establishment of several sites in the Secesh River watershed to assess effects of sheep grazing on salmonid habitat conditions in tributaries. At full expression, the PNF was measuring sediment conditions at approximately 115 sites (as cataloged now, some may be duplicates and not all were sampled in any given year).

In recent years, there has been some constriction in the number of sites monitored. This reflects a trend toward reduced budgets and competition among PNF programs for available funds. Sediment monitoring was, initially, a form of mitigation for the effects of roads, timber harvest, mining, and range management, but that focus has been lost. We have maintained the program as well as we could despite this, but it becomes increasingly difficult each year. In 2003, when the PNF published its revised LRMP (USFS 2003), the National Marine Fisheries Service (NMFS) applied several terms and conditions, one of which was to "[c]ontinue its current sampling, analysis, and reporting of sediment levels (core, free matrix/pebble counts, and cobble embeddedness) in the mainstem and tributaries for the duration of the revised LRMPs" (NMFS 2003). Since terms and conditions are non-discretionary, we are obligated to continue the program.

The purpose of this document is to determine whether we can effectively continue to extract the same amount of sediment information with a reduced, more readily funded monitoring effort. We see retaining similar information content as key to complying with the "current sampling" phrase if we reduce the effort. We believe that there are several sites than can be eliminated or made optional without sacrificing information, as the remainder of this document demonstrates. It focuses on the upper SFSR where the bulk of our sampling occurs, but some changes in the other analysis areas, particularly the lower SFSR, are proposed. No changes to interstitial monitoring sites in the Secesh River watershed are contemplated, but we propose making sampling at one core sampling site optional. We are also submitting this report to satisfy the SFSR interstitial sediment monitoring analysis and reporting requirement pursuant to the LRMP Bo for 2009 (2008 sampling season).

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Methods

Mapping

Analysis Areas and Watersheds

Sediment monitoring sites have been spatially organized by analysis areas as described in Faurot and Burns (2007) for consultation in the SFSR Section 7 Watershed. Analysis areas correspond approximately to 5th level hydrologic units (HUs), which comprise several individual 6th level HUs. We have elected to use the boundaries and coding for the new Watershed Boundary Delineation (WBD) layer for 6th level HUs, which will be called watersheds in this document. The WBD delineation is spatially identical to the older 6th level HU mapping used on the PNF, but the hydrologic unit codes (HUCs) differ. Analysis area and watershed polygons were assembled from the 6th-level WBD layer in ArcMap® as required for display.

Monitoring Site Mapping

Most of our primary and supplemental sites have been located by use of Geographic Positioning System (GPS) receivers. Coordinates were primarily North American Datum 1983 (NAD 83), zone T11, Universal Transverse Mercator (UTM) and had been recorded in our master monitoring sites catalog (part of our information system, PNFInfos, described in Nelson [2007]). We used Topo!® software to place waypoints using these coordinates when available or, when unavailable, used data sheet maps, field maps, and other documentary evidence that identified site locations to place the sites using Topo® and recorded the UTM coordinates. In some cases, North American Datum 1927 (NAD 27) coordinates had been recorded instead of NAD 83, but Topo® was able to make the conversion to NAD 83 directly. In other cases, the recorded UTM coordinates appeared to be incorrect, so the sites were manually placed using the other site location resources described above. These georeferenced waypoints were exported to a Garmin® eTrex GPS unit and downloaded to Garmin® MapSource® software and then exported in a format that could be read directly into ArcMap® for display. A very few sites were missed at this stage and were added manually in ArcMap® if necessary[1]. To insure proper alignment with streams, we used a stream layer constructed from National Hydrography Database (NHD) mapping that was processed using TauDEM, an ArcMap® plug-in that conforms stream layer arcs to drainage topography and snapped the sediment site point features to this hydrography layer; however, a small number required manual placement either due to limitations of the snapping plug-in (Hawths Tools) or snapping to the incorrect stream arc. Monitoring sites were then displayed to show their old or proposed monitoring program status.

Site Classification

Following the 2003 field season, we classified our sediment monitoring sites (excluding sites specifically designated for range monitoring and project-specific sites) into three main categories (Nelson and Burns 2004):

- **Primary (P)** — Sites that are expected to be sampled each year and had an established statistical comparison performed each year (includes SFSR Road Reconstruction monitoring sites).

[1] So far, this has only been needed for site E020 in Fitsum Creek.

- **Supplemental (S)** — Sites that were typically monitored each year but not used in established statistical comparisons.

- **Miscellaneous (M) —** for sites that were, for the most part, discontinued.

- **Range (R)** — In general, the annually monitored range compliance sites were not considered a regular part of the monitoring program unless they had previously been set up in response in the 1988 LRMP.

This scheme has been modified slightly since then as some comparisons were modified and preliminary discussion of reducing the scope of our sediment monitoring program was initiated (Nelson and Bonaminio 2008); we have finalized this site classification (including range sites [G, a subclass of primary sites], SFSR Road sites [R, a subclass of primary sites], and project-specific sites [N]) as a starting point for monitoring effort reduction in Table A1 (displayed in Figures 1-5). All of the existing sites have been mapped here to display the full suite of areas where we have collected sediment data. The sites will be reclassified pending the decision making rationale described below that will lead to a revised classification scheme:

- **Primary (P)** — Regular primary sites expected to be monitored annually as part of this program for general monitoring; these sites will be emphasized in annual reports.

- **Road (R)** — Primary sites expected to be monitored annually as part of this program for road reconstruction project monitoring

- **Grazing (G)** — Primary sites expected to be monitored annually for range monitoring needs.

- **Secondary (S) —** Sites that will be expected to be monitored each year but will not be emphasized in annual reports[2].

- **Optional (O)** — Regular Sites that have some value but can be excluded if needed (*i.e.*, insufficient time, fire, insufficient funding, bad weather, etc.). They should be re-visited periodically, however.

- **Discontinued (D)** — Regular sites that will no longer have any expectation of being monitored but may be need if an interest arises.

- **NEPA (N)** — Project-specific sites (mapped here as discontinued because they will not be used for routine sediment monitoring).

Note that the previous classification (Nelson and Bonaminio 2008) did not incorporate core sampling because we have traditionally had a core sampling program and an interstitial sampling program. This realignment attempts to meld these into a single monitoring program with the core sampling and interstitial as components of the program.

Evaluating Utility and Need of Individual Sites

[2] Annual reports typically perform multiple comparisons among primary sites by analysis area in the SFSR watershed. The secondary sites will not be part of these comparisons but will have their annual data tabulated. They may also be used in the annual regressions of 30-hoop free matrix on cobble embeddedness.

Subjective Initial Reduction

We decided that the first cut would be based on the interstitial monitoring site classification discussed above and reclassify most sites that had been discontinued (i.e., miscellaneous sites) as discontinued. There was one exception, Site E002 on South Fork Blackmare Creek was regularly monitored despite being classified as a miscellaneous site. This site has been reclassified as optional but we need to ensure that the data are correct because the mapping suggested that data may have recently been collected at Site E004 and entered as E002. There have always been problems with the sites on Blackmare Creek, but if we can get this properly resolved, there would be some utility in keeping a site on South Fork Blackmare Creek; most other sites were discontinued largely because of this difficulty with quality assurance related to confusion over site locations.

Another subjective method of eliminating sites involved apparent problems with a site. Two core sites were deemed to be optional using this criterion: E083 on the mainstem SFSR and E033 on upper Lake Creek in the Secesh River watershed. We do not advocate eliminating these entirely, but they are reasonable sites to miss if other constraints preclude sampling all sites. The SFSR site (E083) is at the Oxbow spawning area below Reed Ranch where the stream channel is actively downcutting because of the breach that formed in 1974 and cutoff the actual oxbow that provided most of the good spawning habitat. The other site (E033) is in upper Lake Creek just downstream of a geologic feature called the Threemile Placer that was heavily mined and has resisted effective stabilization of sandy spoils and tailings; consequently, the site always exhibits elevated intragravel fine sediments (Nelson *et al.* 2001 *et seq.*).

Another subjective change is incorporating the fact that we had previously decided to reduce the monitoring in the East Fork SFSR (EFSFSR) because mining at Stibnite had stopped (Nelson *et al.* 2006). We will not rigorously evaluate the information from these sites here and we will assume that the sites can be reclassified as discontinued or optional.

It is important to point out that we have made an effort not to further reduce the number of reference sites (that is, sites in relatively undeveloped watersheds) in this proposal beyond those that have already been abandoned. In some reference watersheds where reductions are proposed, some of the sites will be reclassified as optional sites to support the idea that they may still be important to evaluate at least periodically.

Statistical Analysis

In addition to subjective assessments, we did some objective evaluations of information content provided by individual sites using regression analysis with Microsoft® Excel®. These analyses consisted of regressing the data obtained from selected sites against other sites to determine the extent to which one site modeled the information presented by another site. We began by looking at the relationships of various sites within a catchment with the primary site in that catchment, but also included regressions among other selected pairs of sites. We selected a coefficient of determination (R^2) of 0.5 as an objective criterion for considering two sites to be providing essentially the same information because it would indicate that 50% of the variation in the response site was captured by the value obtained from the explanatory site, and we used the SAS® procedure PROC GLM to perform multiple comparisons of means ($\alpha = 0.10$) within tributary watersheds to see whether there were seemingly important differences in

sediment conditions among the sites; that statistical test used was Tukey's Honestly Significant Difference test. We did not intend to be completely rigorous in these analyses or in our reclassification of sites, however, and we elected to modify our interpretations in some cases using subjective criteria. Generally, these supplemental subjective criteria included safety issues, logistical issues with access (*i.e.*, was it more difficult to collect the data than it subjectively seemed to be worth), environmental issues that compromised the subjective value of a site, etc. How these were applied will be thoroughly disclosed where we discuss the modified monitoring program proposal.

At this time, we have done this only in the Upper and Lower SFSR analysis areas. Regressions and comparisons were primarily directed at primary and supplemental sites, but in some cases, particularly in the lower SFSR, miscellaneous sites were included to determine which combination of sites would be best sampled annually. This was only reasonable where miscellaneous sites had fairly complete data records; miscellaneous sites with short records were not considered and would be reclassified as discontinued.

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Results and Discussion

Upper SFSR

The following analysis is for the main tributary watersheds that contain multiple sites where we think there is opportunity to reduce monitoring effort. The treatment-control pair on Camp Creek is being retained as is the three site arrangement at Cabin Creek. These are for SFSR Road Reconstruction project monitoring and will continue to be evaluated as described in Nelson and Bonaminio (2008). In addition, the core sampling sites are being retained except that E083 (at the Oxbow) will be reclassified as optional as discussed above.

Blackmare Creek

The Blackmare Creek watershed is a true reference watershed with no history of development other than hiking and pack trails[3]; sheep grazing may have occurred historically but has not for at least 45 years. The Blackmare Creek watershed really only has one site that we are absolutely sure has been sampled in approximately the same location (*i.e.*, within about 100 meters) consistently. This site (E006), is near the mouth, has been previously selected as a primary site, and will be retained. Regressions were performed against this primary site with only two other sites, E002 and E006 because there have been longstanding problems with our confidence in the data collected at the other sites in this watershed; in fact, there is still some question about the integrity of the data from site E002 and it needs to be determined whether recent data have actually been collected at site E004 and assigned to E002 incorrectly. Regardless, the regression models both had R^2 values greater than 0.5 (Table 1).

Table 1.—Regression analysis of Blackmare Creek primary and supplemental[a] sediment monitoring sites (linear models of the form y = bx + a).

Monitoring Sites		Model Parameters		
Explanatory	Response	a	b	R^2
E006	E005	1.19	0.78	0.62
	E002	3.98	0.74	0.54

[a] E002 was classified as miscellaneous but has typically been monitored annually like a supplemental site.

For the most part, multiple comparison of mean free particle counts confirmed the similarity of the sites. There was no statistically detectable difference in means between sites E006 and either other site, but site E005 was significantly less than E002 (Table 2). This alone suggests that retaining site E005 as an optional site would be preferred over site E002, and the fact remains that the data record from E002 is both shorter and more likely corrupt than that from E005. This remains to be better resolved and there is opportunity for finer scale analysis in this watershed.

Table 2.—Annual 30-hoop free matrix means and multiple comparison[a] results from primary and supplemental sites in the Blackmare Creek watershed.

Year	Monitoring Site		
	E006	E005	E002
1988	9.5	.	.
1989	6.1	2.8	3.6
1990	9.1	15.6	11.1
1991	29.4	16.7	18.0
1992	16.9	10.1	23.4

[3] Note that we never use the term "unmanaged" for reference areas because the entire Forest is managed for some specific purpose, even if that management is for wilderness character.

Year	Monitoring Site		
	E006	E005	E002
1993	17.2	8.5	11.3
1994	1.3	3.7	8.4
1995	20.8	20.8	25.7
1996	14.5	8.2	4.5
1997	13.8	10.7	10.9
1998	3.9	3.2	.
1999	11.4	10.5	.
2000	8.9	4.0	12.7
2001	23.9	11.2	16.8
2002	8.8	10.2	11.1
2003	35.5	40.8	33.4
2004	6.5	12.9	13.6
2005	10.0	12.0	7.0
2006	16.7	15.0	.
2007	21.5	21.4	33.6
2008	17.9	.	.
Mean	**14.5AB**	**12.5B**	**15.3B**

[a] Means with different letters are significantly different ($P < 0.10$) by Tukey's HSD.

Fourmile Creek

We classify Fourmile Creek as a true reference because the watershed is undeveloped in the same way that Blackmare Creek is; however, the SFSR Road crosses Fourmile Creek a short distance upstream from its mouth and there is a campground there. Two of the Fourmile Creek monitoring sites (E067 and E068) comprise a treatment-control pair for monitoring effects of the SFSR Road reconstruction project (USFS 1990) and will be retained as primary sites. Thus we regressed the other two sites against these (Table 3, next page) and E128 (near the mouth) against E139 (well upstream, above the confluence of South Fork Fourmile Creek). Clearly, neither E128 nor E139 had coefficients of determinations greater than 0.5 when modeled against the primary sites, but the model that resulted from regressing E128 on E139 gave an R^2 of 0.78.

Table 3.—Regression analysis of Fourmile Creek sediment monitoring sites (linear models of the form y = bx + a).

Monitoring Sites		Model Parameters		
Explanatory	Response	a	b	R^2
E068	E128	4.95	1.08	0.31
	E139	4.78	0.74	0.17
E067	E128	6.31	0.90	0.29
	E139	-0.41	1.01	0.44
E139	E128	6.31	0.95	0.78

There were few significant differences in free particle counts among the Fourmile Creek sites, except that site E128 was significantly higher on average than the other three (Table 4). Despite this, we propose discontinuing monitoring at site E128 because we have an established treatment-control pair with E067 and E068 to monitor road effects, and we propose making E139 an optional site to retain a true reference site that could receive some periodic monitoring; because of the highly significant relationship between E128 and E139, we should be able to adequately estimate free matrix counts at the former from the latter if it was ever needed.

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Table 4.—Annual 30-hoop free matrix means and multiple comparison results from primary and supplemental sites in the Fourmile Creek watershed.

Year	Monitoring Site			
	E068	E067	E128	E139
1988	21.5	.	.	.
1989	33.1	.	23.7	.
1990	15.7	16.2	8.1	6.4
1991	17.8	34.4	34.1	32.3
1992	18.1	19.5	26.2	17.4
1993	12.0	15.2	19.5	12.7
1994	7.3	22.0	19.3	19.9
1995	28.3	24.2	56.8	50.2
1996	12.4	9.7	14.0	12.3
1997	17.4	7.7	23.0	8.4
1998	6.3	4.0	14.7	3.3
1999	9.7	15.7	10.8	12.7
2000	12.0	4.9	7.8	9.3
2001	12.9	16.5	35.6	25.6
2002	.	.	.	.
2003	22.5	21.0	25.5	16.6
2004	8.8	13.3	21.4	16.1
2005	19.6	17.6	12.3	9.8
2006	16.7	18.4	15.9	.
2007	.	17.3	12.5	16.0
2008	26.2	19.3	23.4	6.7
Mean	**16.7B**	**16.5B**	**21.3A**	**16.2B**

[a] Means with different letters are significantly different ($P < 0.10$) by Tukey's HSD.

Fitsum Creek

The Fitsum Creek watershed is primarily a reference watershed, though there was some timber harvest in the headwaters of North Fork Fitsum Creek sometime before 1965. The Cow Creek watershed in the Secesh River drainage was heavily logged at that time and provided access to North Fork Fitsum Creek, particularly in the Tie Creek drainage) and some of the mainstem Fitsum Creek upstream of the confluence of North Fork Fitsum Creek. The roads associated with that harvest in the Fitsum Creek watershed have been closed for a long time, mostly since the mid-1960s, and most are likely to be obliterated (except for some stretches that may be retained for trails) within the next five years. The large number of sites and the difficulty of accessing some of the sites make discontinuing sites in this watershed especially important.

We evaluated sites in the main Fitsum Creek and North Fork Fitsum Creek watersheds separately with the intention of retaining some sites as secondary sites in both watersheds and because these split the system into two relatively similar subwatersheds (the primary site, E023, of course, is downstream of the confluence of North Fork Fitsum Creek and integrates the two subwatersheds). In contrast, we made multiple comparisons across these subwatersheds to simplify the analysis. From the regression analysis, it appeared that E023 and E099 contained related information, as did E024 and E124; in North Fork Fitsum Creek, the strongest regression was E138 on E124, with the E138 on E021 model almost reaching our pre-selected R^2 indicator of 0.5.

Table 5.—Regression analysis of Fourmile Creek sediment monitoring sites (linear models of the form $y = bx + a$).

Monitoring Sites		Model Parameters		
Explanatory	Response	a	b	R^2
E023	E024	4.49	0.57	0.32
	E099	-0.36	1.41	0.48

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Monitoring Sites		Model Parameters		
Explanatory	Response	a	b	R^2
	E124	7.25	0.55	0.20
E024	E099	8.22	1.26	0.39
	E124	4.13	0.89	0.55
E022	E021	0.32	9.15	0.32
	E138	12.31	0.52	0.52
E021	E138	8.50	0.85	0.47

The multiple comparison analysis (Table 6) revealed some interesting relationships, most notably that E099 was much higher in free particles, on average, than the other sites and that E024 was significantly lower, on average, than site E023. This suggests that the sites highest in the tributaries above the old road system (Figure 6) are the cleanest, but below that, free particles increase moving downstream, but there are no obvious differences between subwatersheds. With the previously discontinued sites remaining that way, it seems reasonable to retain E023 as a primary site and to reclassify E024 and E022 as secondary sites. Somewhat more controversially, we suggest reclassifying E099 as optional despite its marginal relationship to either E023 or E024 and its clear value as a true reference site; however, it is now very difficult and possibly unsafe to access because of the fires that have burned in the watershed recently, and retaining it as optional gives some potential for repeat monitoring. We also suggest reclassifying E021 to optional and discontinuing E138 and E124. Site E124 is well correlated with E024 (an optional site), has been disrupted by a logjam that altered conditions in about 2001, and is difficult to access; E138 is well correlated with E022, a secondary site.

Table 6.—Annual 30-hoop free matrix means and multiple comparison results from primary and supplemental sites in the Fitsum Creek watershed.

Year	Monitoring Site						
	E023	E024	E099	E124	E022	E021	E138
1988	12.6	.	.	.	.	.	.
1989	16.1	16.6	.	.	4.7	9.3	.
1990	12.2	9.1	19.6	.	7.7	7.1	8.2
1991	35.6	18.4	43.0	5.4	24.2	22.9	28.8
1992	26.2	11.8	29.2	22.7	13.7	14.1	22.1
1993	24.3	22.1	26.4	9.0	17.4	13.0	15.0
1994	16.0	7.5	17.5	25.7	16.8	7.3	10.4
1995	25.1	17.5	56.5	17.9	23.5	26.0	28.9
1996	16.9	14.9	22.1	18.8	7.7	17.2	18.3
1997	16.3	6.9	14.9	20.9	9.6	8.8	18.7
1998	9.3	7.6	7.9	12.0	7.9	5.8	20.6
1999	15.6	12.3	9.8	4.0	12.6	10.2	12.7
2000	11.5	12.6	9.6	8.9	17.4	8.5	20.2
2001	24.9	22.1	26.9	10.5	22.7	23.0	23.9
2002	26.0	34.7	44.4	20.4	50.6	25.4	42.1
2003	9.5	13.1	27.7	40.5	48.5	17.4	31.7
2004	19.5	13.9	23.5	19.5	14.5	22.6	15.8
2005	14.1	6.2	23.5	19.7	14.3	15.3	26.7
2006	22.7	20.0	53.8	23.6	21.1	.	.
2007	13.7	20.7	.	14.8	16.9	.	35.2
2008	22.0	17.2	28.1	22.4	23.1	17.4	.
Mean	**18.7C**	**15.3D**	**27.0A**	**17.6CD**	**18.8C**	**15.1D**	**22.5B**

[a] Means with different letters are significantly different ($P < 0.10$) by Tukey's HSD.

Buckhorn Creek

Buckhorn Creek is a large watershed with numerous monitoring sites. The watershed has been harvested with attendant construction of many miles of logging roads. Recently, many roads, particularly those lower in the watershed have been obliterated or converted to trail. Sediment monitoring in this watershed is therefore useful for monitoring legacy effects of disturbance associated with timber harvest and road construction as well as the effectiveness of watershed rehabilitation actions.

We initially separated the West Fork Buckhorn Creek and its tributaries from the rest of the drainage of mainstem Buckhorn Creek for the regression analyses because this creates two relatively large subwatersheds and we do want to retain some annual sites in each (the primary site E016, of course, is downstream of the confluence of West Fork Buckhorn Creek and integrates both). On inspection, however, we noticed that regressions among sites within each subwatershed revealed poor relationships; consequently, we decided to expand the regressions to included some modeling across the two subwatersheds to enable better decisions about which sites were most important to retain for annual monitoring. In Table 7, these three categories of models are separated by a bold horizontal line.

Table 7.—Regression analysis of Buckhorn Creek primary and supplemental sediment monitoring sites (linear models of the form y = bx + a).

Monitoring Sites		Model Parameters		
Explanatory	**Response**	**a**	**b**	**R^2**
E016	**E015**	16.97	0.46	0.12
	E019	12.36	0.41	0.08
	E017	3.40	5.77	0.13
E015	**E019**	12.20	0.21	0.04
	E017	3.17	0.36	0.14
E017	**E019**	16.92	-0.00	0.00
E014	**E007**	22.38	0.21	0.01
	E008	13.14	0.26	0.04
	E098	14.96	0.78	0.17
E007	**E008**	9.66	0.26	0.17
	E098	15.62	0.38	0.19
E008	**E098**	14.42	0.68	0.24
E016	**E014**	6.16	0.67	0.39
	E098	9.8	1.38	0.48
E015	**E008**	-0.43	0.74	0.43
	E007	-1.79	1.25	0.57
	E098	4.15	0.97	0.42

As with Fitsum Creek, however, we also performed multiple comparisons among all sites across subwatersheds (Table 8). Typically, sites farthest upstream and above the legacy road system had the highest average free particle counts (Figure 7), but there were no clear differences between subwatersheds. We feel it would be reasonable to eliminate E098, which is difficult to access and is similar overall to E015 (both are upstream of the road system); E007 can be discontinued because it is well correlated with E015 and this one site in a relatively undeveloped portion of the watershed is sufficient. We also recommend discontinuing monitoring at sites E008 and E017 but retaining E019 as an optional site; E016 was not well correlated with E017 but being only a short distance downstream, it adequately integrates conditions in the Little Buckhorn Creek drainage. We suggest keeping E014 as a secondary site because it becomes the only site on West Fork Buckhorn Creek and is easy to access.

Table 8.—Annual 30-hoop free matrix means and multiple comparison results from primary and supplemental sites in the Buckhorn Creek watershed.

Year	Monitoring Site							
	E016	E015	E017	E019	E014	E007	E008	E098
1988	7.5	.	.	.	.	.	.	.
1989	12.6	13.5	2.9	36.4	6.1	20.8	24.4	.
1990	5.8	22.6	3.1	11.4	5.7	19.5	11.3	31.9
1991	16.3	36.8	16.0	21.8	14.1	57.4	30.3	42.5
1992	12.3	28.5	3.9	16.9	9.9	49.1	9.5	27.9
1993	9.7	29.5	5.4	18.3	24.3	28.1	28.7	19.3
1994	7.8	15.3	5.3	9.0	10.2	25.1	11.5	15.9
1995	12.5	37.1	21.9	27.2	17.8	28.8	32.4	49.0
1996	14.2	20.7	12.0	14.6	12.8	20.0	13.7	27.1
1997	7.4	17.1	6.5	9.2	13.8	23.5	8.4	18.3
1998	4.9	15.2	3.1	7.5	6.5	22.2	6.0	11.5
1999	5.5	13.9	4.4	16.7	10.0	11.1	15.0	23.6
2000	2.8	14.3	21.7	8.8	11.5	8.7	10.9	10.2
2001	14.0	20.7	21.1	.	16.3	28.4	11.8	25.0
2002	25.5	16.0	14.4	14.0	29.4	15.2	8.1	42.9
2003	17.9	29.3	19.1	20.6	13.5	41.1	24.4	34.1
2004	6.2	20.3	8.6	10.4	11.3	17.7	13.3	14.8
2005	8.1	20.8	11.0	14.0	13.9	23.7	20.2	15.1
2006	15.8	24.9	6.7	33.2	.	.	11.3	.
2007	15.1	24.1	17.7	13.6	.	21.7	10.3	20.5
2008	10.9	.	12.7	20.3	6.2	10.6	18.1	23.1
Mean	**11.1D**	**22.1B**	**10.9D**	**17.0C**	**13.0D**	**24.9AB**	**16.0C**	**25.0A**

[a] Means with different letters are significantly different (P < 0.10) by Tukey's HSD.

Lower SFSR

Porphyry Creek

We discontinued all monitoring in this reference watershed after 2007 because it is uncharacteristic of the SFSR and because access is difficult (Nelson and Bonaminio 2008). No changes are proposed for this watershed.

Sheep Creek

Nelson and Bonaminio (2008) reclassified the lower site on Sheep Creek (E039) as the primary reference site for the lower SFSR (it had been a supplemental site); the other Sheep creek sites had been discontinued and classified as miscellaneous sites previously (Nelson *et al.* 2006). No changes are proposed for this watershed.

Elk Creek

Elk Creek is a large, partially developed watershed in the lower SFSR. In fact, most of the watershed is in reference condition, except that the Warren-Profile Gap Road goes up the mainstem of the creek from the SFSR into the Big Creek watershed (Figure 8) and a service road accesses Pilot Peak Lookout. Several sites were classified as miscellaneous sites by Nelson *et al.* (2006) and are not being proposed for reintroducing into our monitoring program. We will retain the primary site (E030) and regression relationships among the primary and supplemental sites is shown in Table 9. None of the models produced an R2 of 0.5, but the relationship between site E029 and E031 was close.

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Table 9.—Regression analysis of Elk Creek primary and supplemental sediment monitoring sites (linear models of the form y = bx + a).

Monitoring Sites		Model Parameters		
Explanatory	Response	a	b	R^2
E030	E031	11.14	0.67	0.42
	E029	6.36	0.38	0.20
E029	E031	7.54	0.57	0.43

Multiple comparison showed that the integrator site at the mouth of the stream (E030) had the fewest free particles on average, while the other two sites, E031 farther up the mainstem and E029 at the mouth of West Fork Elk Creek, were similar. From this and the reasonably good model between E029 and E031, we conclude that we can discontinue E031 and retain the original primary site (E030) and site E029.

Table 10.—Annual 30-hoop free matrix means and multiple comparison results from primary and supplemental sites in the Elk Creek watershed.

Year	Monitoring Site		
	E030	E029	E031
1989	9.0	11.4	10.1
1990	.	14.0	11.9
1991	35.2	39.9	42.0
1992	2.7	21.7	26.1
1993	10.3	15.9	20.6
1994	11.9	11.5	30.1
1995	16.2	.	30.1
1996	12.9	17.1	13.7
1997	.	6.2	15.9
1998	11.4	4.1	14.3
1999	10.0	9.4	11.3
2000	3.9	19.3	7.4
2001	17.5	39.4	26.0
2002	10.4	20.7	16.6
2003	35.9	.	27.0
2004	12.4	22.9	9.6
2005	8.0	19.5	11.1
2006	27.7	36.1	32.6
2007	9.4	35.9	28.2
2008	16.1	24.0	19.4
Mean	**14.5A**	**20.5B**	**20.2B**

[a] Means with different letters are significantly different ($P < 0.10$) by Tukey's HSD.

Pony Creek

The Pony Creek watershed has only two sites and we typically monitor both of them. The regression relationship between the two provided an R2 of 0.40, a bit less than our desired value of 0.5, and the mean free particle counts were significantly less (18.2%) at E056 (the primary site) than E055 (22.4%). However, we believe that monitoring both sites annually is unnecessary and propose reclassifying E055 as optional. This would allow sampling when time and funding permits while providing an option of dropping this site if funding constrains, fires, etc. preclude full sampling.

Secesh River

No significant changes are proposed for the Secesh River monitoring sites. We propose to retain all of the sites currently incorporated in the range monitoring program as primary sites and not revisit the identified miscellaneous sites unless projects indicate a need for updated measurements. Those sites that were primary sites in Nelson and

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Bonaminio (2008) and are monitored as part of the range compliance monitoring are classed as primary rather than grazing, but it is understood that they are integral to both programs; if range compliance monitoring is discontinued at some point, these would remain primary sediment monitoring sites. We do propose reclassifying the core sampling site in Lake Creek at Threemile Creek (E033) to optional, however, because it is a troublesome site as mentioned previously and is one that we believe can safely be dropped if funding constraints, fire, etc. demand a reduced sampling effort.

East Fork SFSR

We are not proposing any significant changes in the EFSFSR either, except that the mainstem EFSFSR site just downstream of the mouth of Sugar Creek (E133) should be classified as optional. This will facilitate renewed monitoring in the event that mining operations resume at Stibnite.

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Conclusions

Proposed Reclassification of SFSR Monitoring Sites

The proposed reclassification based on the preceding discussion is summarized in Table 11 and displayed in Figures 9-16 (note that there are no changes to the sites we have on the BNF). This projects a potential 30% reduction in required sampling effort, although the realized reduction is likely to be less because the optional core sampling sites should be monitored annually if at all possible.

Table 11.—Proposed monitoring program site realignment summary.

Analysis Area	Watershed	Site Code	Program Status		Rationale
			Old	New	
Upper SFSR	Blackmare Creek	E006	P	P	Primary integrator site retained, an upper site retained as optional for periodic or opportunistic sampling, site with probable data integrity problems dropped.
		E005	S	O	
		E002	M	D	
	Fourmile Creek	E067	P	R	Road monitoring pair retained, E128 unnecessary due to relationship with E139 which was retained as optional for periodic or opportunistic sampling.
		E068	P	R	
		E128	S	D	
		E139	S	O	
	Fitsum Creek	E023	P	P	Retains 3 sites for annual monitoring and 2 for periodic or opportunistic sampling; sites with less information and/or access or reliability problems dropped.
		E024	S	S	
		E099	S	O	
		E124	S	D	
		E022	S	S	
		E021	S	O	
		E138	S	D	
	Buckhorn Creek	E016	P	P	Retains 3 sites for annual monitoring and 1 for periodic or opportunistic sampling; sites with less information and access problems dropped.
		E015	S	S	
		E019	S	O	
		E017	S	D	
		E014	S	S	
		E007	S	D	
		E008	S	D	
		E098	S	D	
	Camp Creek	E129	P	R	SFSR Road monitoring treatment-control pair.
		E130	P	R	
	Cabin Creek	B125	P	R	SFSR Road 3-way comparison as described in nelson and Bonaminio (2008).
		B126	P	R	
		B127	S	R	
	Mainstem SFSR	B081	P	P	These are all core sampling sites. Reclassifies E083 as optional because it is an uncharacteristic site and is one that can safely be excluded if logistical or funding constraints demand reduced sampling.
		B082	P	P	
		E083	P	O	
		E084	P	P	
		E085	P	P	
Lower SFSR	Sheep Creek	E039	P	P	No changes.
	Elk Creek	E030	P	P	Retains 2 sites for annual monitoring, drops one that provided little additional information.
		E029	S	S	
		E031	S	D	
	Pony Creek	E056	P	P	Retains the integrator site for annual monitoring and provides for periodic or opportunistic sampling at the other.
		E055	S	O	
Secesh River	Headwaters Lake Creek	E034	S	P	Reclassifies E033 as optional because it is an uncharacteristic site and is one that can safely be excluded if logistical or funding constraints demand reduced sampling.
		E048	P	P	
		E033	P	O	
		E035	S	P	Range monitoring program sites, now Grazing subset of primary. For some reason, E081 had been overlooked in previous classifications, should have been supplemental.
		E116	R	G	
		E117	R	G	
		E077	S	G	
		E081	S	G	
		E142	M	O	
	Summit Creek – Secesh River	E062	S	G	Reclassification only.
		E071	S	G	
	Victor Creek – Secesh River	E048	P	P	Core sampling sites.
		E096	P	P	
	Lick Creek	E057	S	G	Reclassification only.
East Fork SFSR	Profile Creek	E050	P	P	Retained paired primary sites, added option for Stibnite.
	Tamarack Creek	E076	P	P	
	Mainstem EFSFSR	E133	M	O	
Expected Annual Sample			**52**	**36**	**Potential 30% reduction in effort**

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Additional Scope for Effort Reduction

Further reductions in monitoring effort may also be reasonable. For example, we evaluate a few sites in the wilderness Chamberlain Creek watershed (not discussed here and not required by consultation) for reference conditions. This data set is now quite extensive and annual monitoring may not be needed. We could make these sites optional and establish a rotating schedule of monitoring optional sites in the SFSR one year and in Chamberlain the next. Alternatively, we could make it a three year cycle with no monitoring of optional sites in one year out of three. It seems highly likely that the reference sites in the SFSR that have been declared optional are as effective for monitoring reference conditions as wilderness streams. We expect to incorporate decisions along these lines in the very near future as funding recedes.

Sampling Proposal for 2009 and 2010

The following sampling scheme is proposed for the next two field seasons. Data analysis and reporting following the 2010 season can evaluate the effectiveness to this schedule and make recommendations as to whether adjustments are needed.

2009

- Sample all SFSR sites identified as primary or secondary.
- Sample SFSR sites identified as optional (if funding limits effort, the most difficult sites to access can be missed).
- Do not sample the Chamberlain Basin sites.

2010

- Sample all sites identified as primary or secondary.
- Sample the Chamberlain Basin sites.
- Do not sample the optional SFSR sites (except that the core sites should be done if possible).

If the rotational approach is determined to be is effective and is adopted, the sites should be reclassified so that the overlap between optional and required under the rotational schedule is clarified. In other words, sites like the core sample sites E084 and E033 and the range site E142 which was effectively discontinued but is quite reasonably an optional site be separated from the sites that are expected to be sampled under the rotational scheme.

Double Sampling

Note that no effort has been made in this analysis to ensure that double sampling is accommodated. Prior to the 2009 field season, it must be determined which sites that have been proposed for elimination or optional sampling were used in double sampling and substitutes must be established. It is essential that a minimum of about 15 sites have both cobble embeddedness and free matrix samples collected each year. Over the past few years, there has been an inadvertent decline in cobble embeddedness sampling that has not been beneficial for determining the relationship between the two sediment

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indices. The double sampling provides a method of assessing embeddedness data quality and, statistically speaking, the more doubling sampling the better; however, we still want to reduce overall sampling effort and about one-third of the overall sampling effort being directed at double sampling seems appropriate. These sites should be distributed, perhaps proportionally, in all of the analysis areas.

Final Notes

This proposal is preliminary. The assessment discussed above must be applied after no more than two field seasons to determine whether we are still obtaining the information needed to adequately monitor sediment conditions in the SFSR. Since one of the principal needs for sediment monitoring was revision of the LRMP-specified Watershed Conditions Indicators, however, it seems reasonable that phasing out of routine sediment monitoring in the SFSR generally can be considered. This should be approached very cautiously, however, because the effects on sediment conditions of extensive wildfire that occurred in 2006 and 2007 is still unknown; several years of varying flows are needed to determine whether sediment conditions will change as a result of this broad change in baseline conditions. In addition, SFSR road sites and range monitoring sites should be retained in the near term to comply with consultations relating to those programs at least until either grazing management changes or additional analyses devised to assess the utility of SFSR Road monitoring is completed.

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Appendix 1. Supplementary Tables

Table A1.—Sediment monitoring sites in the SFSR watershed by analysis area and watershed (WBD).

Analysis Area	Watershed	Stream	Site Code	Map Coordinates		Comments
				Easting	Northing	
Upper SFSR	Blackmare Creek	Blackmare Creek	E006	602381	4964048	Mapped according to GPS coordinates in PNFInfos; however, the apparent location of the site was adjusted manually for map display because the Blackmare 6th-level WBD watershed inexplicably excludes the mouth of Blackmare Creek.
			E005	599026	4962493	Mapped according to GPS coordinates in PNFInfos.
			E003*	598993	4962473	Mapped according to description in PNFInfos; seems equivalent to E001.
			E001	---	---	Not mapped; seems equivalent to E003.
		SF Blackmare Creek	E002*	598362	4961801	Mapped according to description in PNFInfos; GPS coordinates in database appear to be appropriate for E004.
			E004	598807	4962270	Mapped according to copies of topographic maps used to guide field crews.
			E027	---	---	Not mapped. Appears to be same site as E004B or E004 (E002 may have data from there as well).
	Buckhorn Creek	Buckhorn Creek	E015	591979	4971070	Mapped according to GPS coordinates in PNFInfos.
			E016	599643	4975082	Mapped according to GPS coordinates in PNFInfos.
			E019	596143	4972826	Mapped according to GPS coordinates in PNFInfos.
		WF Buckhorn Creek	E007	593954	4974216	Mapped according to GPS coordinates in PNFInfos.
			E014	599199	4974486	Mapped according to GPS coordinates in PNFInfos.
		NF Buckhorn Creek	E008	596648	4975765	Mapped according to GPS coordinates in PNFInfos.
			E098	596768	4979338	Mapped according to GPS coordinates in PNFInfos.
		SF Buckhorn Creek	E018*	592891	4970979	Mapped from description in PNFInfos.
		Little Buckhorn Creek	E017	598172	4972662	Mapped according to GPS coordinates in PNFInfos.
	Cabin Creek**	Cabin Creek	B125	603130	4946737	Mapped according to GPS coordinates in PNFInfos.
			B126	603184	4946787	Mapped according to GPS coordinates in PNFInfos.
			B127	604298	4946783	Mapped according to GPS coordinates in PNFInfos.
	Camp Creek	Camp Creek	E129	602037	4971524	Mapped according to GPS coordinates in PNFInfos.
			E130	602028	4971534	Mapped according to GPS coordinates in PNFInfos.
	Dollar Creek	Dollar Creek	B118*	603323	4952707	Mapped location estimated using information in PNFInfos (TRS) and assumed at road.
	Fourmile - SFSR	Fourmile Creek	E067	603286	4968503	Mapped according to GPS coordinates in PNFInfos.
			E068	603456	4968626	Mapped according to GPS coordinates in PNFInfos.
			E128	603306	4968589	Mapped according to GPS coordinates in PNFInfos.
			E139	605031	4967594	Mapped according to GPS coordinates in PNFInfos.
			E065*	604312	4968320	Mapped according to description in PNFInfos.
		SF Fourmile Creek	E066*	604323	4968276	Mapped according to rationale in PNFInfos (no good description).
	Fitsum Creek	Cougar Creek	E082*	600531	4970920	Mapped location estimated using information in PNFInfos (TRS) and assumed to be upstream of trail.
			E101*	601131	4971446	Mapped location estimated using information in PNFInfos (Description and TRS).
		Fitsum Creek	E023	600692	4983626	Mapped according to GPS coordinates in PNFInfos.
			E024	599271	4983320	Mapped according to GPS coordinates in PNFInfos.
			E099	593996	4982338	Mapped according to GPS coordinates in PNFInfos.
			E124	597641	4983661	Mapped according to GPS coordinates in PNFInfos.
			E070*	596208	4983459	Mapped from description in PNFInfos.
			E069*	595913	4983242	Mapped from description in PNFInfos.
		NF Fitsum Creek	E022	599048	4985703	GPS Coordinates in PNFInfos were clearly incorrect; mapped according to description in PNFInfos.
			E138	596810	4985622	Mapped according to GPS coordinates in PNFInfos.
			E021*	596908	4985549	Mapped from description in PNFInfos. Seems to be about the same as E138 (PNFInfos says that E138 may be a replacement for E020, but it seems more likely that this is the one it replaced).
			E020			Not mapped; seems to be equivalent to E022.
		SFSR	E084	602389	4964048	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).

Analysis Area	Watershed	Stream	Site Code	Map Coordinates		Comments
				Easting	Northing	
	Goat Creek		E131	604129	4956957	Mapped according to GPS coordinates in PNFInfos.
	SFSR	SFSR	B081	604287	4938304	Mapped according to GPS coordinates in Nelson *et al.* (2006) and added to PNFInfos.
			B082*	603408	4952855	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).
			E083	601210	4971767	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).
			E085	600504	4982390	Mapped according to GPS coordinates in PNFInfos.
EFSFSR	Caton Creek	Caton Creek	E112*	611422	4977965	Mapped location estimated using information in PNFInfos (TRS).
	Parks Creek	Parks Creek	E095	615570	4979152	Mapped according to GPS coordinates in PNFInfos.
	Profile Creek	Profile Creek	E050	624027	4979587	Mapped according to GPS coordinates in PNFInfos.
	Quartz Creek	Quartz Creek	E049*	620006	4980880	Mapped from description in PNFInfos.
	SFSR, East Fork	SFSR, East Fork	E132	631227	4977118	Mapped according to GPS coordinates in PNFInfos.
			E133	630927	4977332	Mapped according to GPS coordinates in PNFInfos.
			E025*	620635	4979821	Mapped from description in PNFInfos.
	Sugar Creek	Sugar Creek	E079	631430	4977120	Mapped according to GPS coordinates in PNFInfos.
			E080	632428	4977501	Mapped according to GPS coordinates in PNFInfos.
	Tamarack Creek		E076	627068	4979782	Mapped according to GPS coordinates in PNFInfos.
Secesh	Enos-Secesh	Secesh River	E115*	597710	4991318	Mapped from description in PNFInfos.
	Headwaters Secesh River	Lake Creek	E033	583499	5016988	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).
			E034*	582549	5021553	Mapped from description in PNFInfos and 1993 Range Report for site T2.
			E035	586125	5012345	Mapped according to GPS coordinates in PNFInfos.
		Nethker Creek	E048	585253	5013605	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).
			E116*	585789	5012912	Mapped according to copies of topographic maps used to guide field crews (GPS coordinates in PNFInfos put site about 0.17mi south in meadow).
		Threemile Creek	E117*	D	5011990	Mapped according to copies of topographic maps used to guide field crews (GPS coordinates in PNFInfos put site about 0.13mi south on hillside).
			E077	583940	5017595	Mapped according to GPS coordinates in PNFInfos; however, they were still in PNFInfos as E142, which I corrected (see EF.01.0009 and EF.01.0011).
			E078*	583847	5017399	Mapped according to copies of topographic maps used to guide field crews, description in PNFInfos, and in accordance with EF.01.0011).
			E142*	584090	5017886	Mapped according to copies of topographic maps used to guide field crews, description in PNFInfos, and in accordance with EF.01.0009 and EF.01.0011).
		Willow Creek	E081	582663	5020446	Mapped according to GPS coordinates in PNFInfos.
			E168*	582663	5020446	Mapped as described in PNFInfos; pure guesswork.
	Lick Creek	Lick Creek	E057	597070	4990895	Mapped according to GPS coordinates in PNFInfos.
			E058*	595477	4991556	Mapped from description in PNFInfos.
		NF Lick creek	E059*	595677	4991971	Mapped from description in PNFInfos.
		Split Creek	E060*	595652	4994008	Mapped from description in PNFInfos.
	Loon Creek	Loon Creek	E262†	588126	4998185	Mapped according to GPS coordinates in PNFInfos.
			E261*†	590273	5000495	Mapped from description in PNFInfos (reference map in EF.16.0014).
	Summit-Secesh	Grouse Creek	E062	591300	5013666	Mapped according to GPS coordinates in PNFInfos.
			E061*	591096	5015447	Mapped from description in PNFInfos.
			E063*	592116	5016178	Mapped from description in PNFInfos; very approximate.
		Josephine Creek	E265*†	581850	5009102	Mapped according to map in EF.16.004 (GPS coordinates in document and in PNFInfos put site about 0.25 mi south on hillside)
		Ruby Creek	E071*	587851	5012099	Mapped according to copies of topographic maps used to guide field crews (GPS coordinates in PNFInfos put site about 0.12mi south on hillside).
		Sand Creek	E064*	592346	5017849	Not sure whether this is on Grouse Creek or Sand Creek; mapped on Sand Creek, approximately same as temperature site E173.
		Secesh River	E046	593560	5007795	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).
			E096	593309	5009475	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).
		Summit Creek	E263†	584167	5009146	Mapped according to GPS coordinates in PNFInfos.
			E264†	582332	5003748	Mapped according to map in EF.16.010 (GPS coordinates in document and in PNFInfos put site about 0.2 mi north on hillside)
	Zena - Secesh	Cow Creek	E013	597531	4990497	Mapped according to NAD27 GPS coordinates in PNFInfos (NAD83 shown here).
			E011*	596479	4988817	Mapped from description in PNFInfos (the trail was visible as a road in Topo!® 4).

Analysis Area	Watershed	Stream	Site Code	Map Coordinates		Comments
				Easting	Northing	
			E012*	597078	4990418	Mapped from description in PNFInfos.
		Maverick Creek	E010*	596670	4990493	Mapped from description in PNFInfos.
		Secesh River	E114*	599577	4987480	Mapped from description in PNFInfos.
		Zena Creek	E072*	599169	4988484	Mapped from description in PNFInfos.
			E074*	599771	4990025	Mapped from description in PNFInfos; very approximate.
		WF Zena Creek	E075*	599904	4990250	Mapped from description in PNFInfos.
		EF Zena Creek	E073*	599981	4990186	Mapped from description in PNFInfos.
Lower SFSR	Bear Creek	Bear Creek	E026*	608643	4995699	Mapped as described in PNFInfos; placed near trail, upstream.
	Elk Creek	Elk Creek	E028	617536	5000919	Mapped according to GPS coordinates in PNFInfos.
			E030	611260	5000998	Mapped according to GPS coordinates in PNFInfos.
			E031	613489	5000704	Mapped according to GPS coordinates in PNFInfos.
			E102*	611333	5000883	Mapped as described in PNFInfos.
			E143*	612302	5000759	Mapped according to copies of topographic maps used to guide field crews (GPS coordinates in PNFInfos put site about 0.33mi north on hillside).
		WF Elk Creek	E029	617242	5000060	Mapped according to GPS coordinates in PNFInfos.
		MF Elk Creek*	E146	617724	5000412	Mapped as described in PNFInfos.
	Pony Creek	Pony Creek	E055	611847	5004888	Mapped according to GPS coordinates in PNFInfos.
			E056	612184	5004798	Mapped according to GPS coordinates in PNFInfos.
	Porphyry Creek	Porphyry Creek	E054	619936	5013188	Mapped according to GPS coordinates in PNFInfos (looks to be farther upstream than when first established).
			E052	621647	5010181	Mapped as described in PNFInfos.
			E053*	619625	5013451	Mapped as described in PNFInfos.
			E144*	620170	5013070	Mapped according to copies of topographic maps used to guide field crews.
			E145*	620570	5012589	Mapped according to copies of topographic maps used to guide field crews.
		NF Porphyry Creek	E051*	620288	5013137	Mapped from legal and description in PNFInfos; assumed to be near mouth.
	Grouse - SFSR	SFSR	E150*	617610	5012131	Mapped as described in PNFInfos.
	Sheep Creek	Sheep Creek	E039	607314	4989325	Mapped according to GPS coordinates in PNFInfos.
			E040*	608000	4988568	Mapped as described in PNFInfos.
			E041*	607547	4989060	Mapped as described in PNFInfos.
			E043*	608854	4987833	Mapped as described in PNFInfos.
			E044*	612155	4988466	Mapped as described in PNFInfos (at approximately 0.4mi from NF).
			E045*	608571	4987893	Mapped as described in PNFInfos.
		SF Sheep creek	E042*	608443	4987755	Mapped as described in PNFInfos.
	Rock - SFSR	Big Flat Creek†	E166	---	---	Not mapped; no good description readily available.
		Contux†	E164	---	---	Not mapped; no good description readily available.
		Deer Creek†	E165	---	---	Not mapped; no good description readily available.

* Coordinates from map in Topo!® 4.
** B125 and B126 may actually be on Warm Lake Creek (if cabin Creek is a tributary to warm Lake Creek and not *vice versa*).
† Project-specific site.

DRAFT

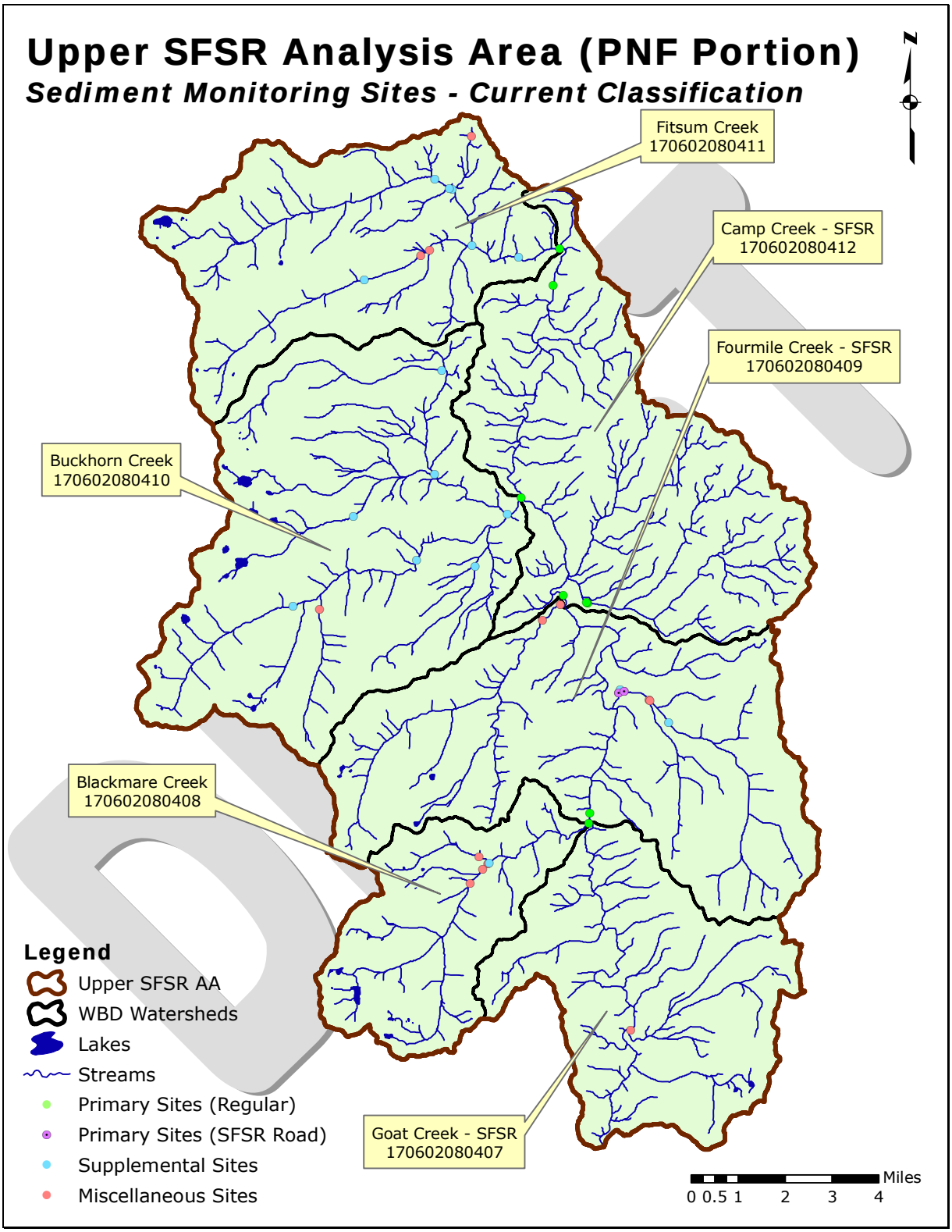

Figure 1.—Monitoring sites in the Upper SFSR analysis area, PNF portion.

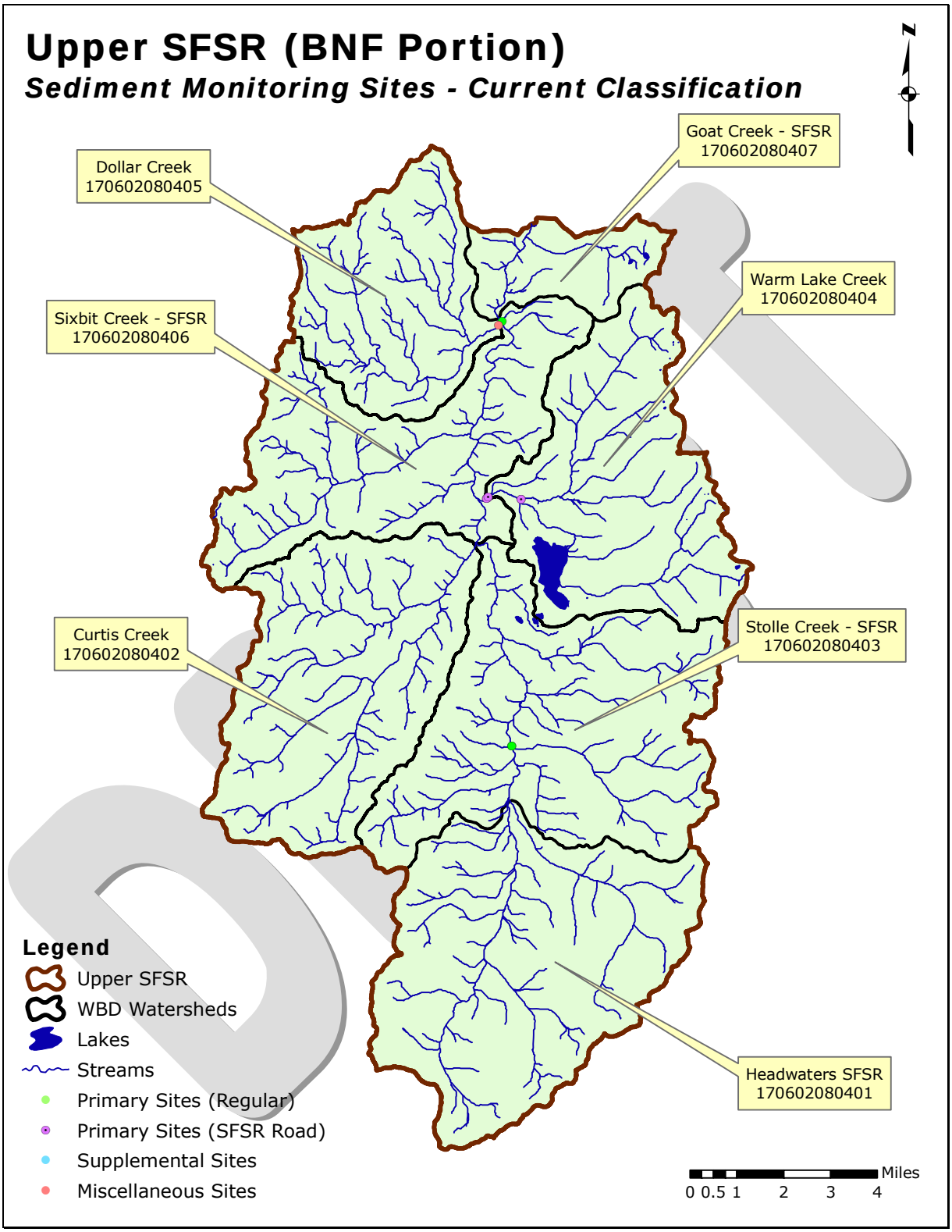

Figure 2.—Monitoring sites in the Upper SFSR watershed, BNF portion.

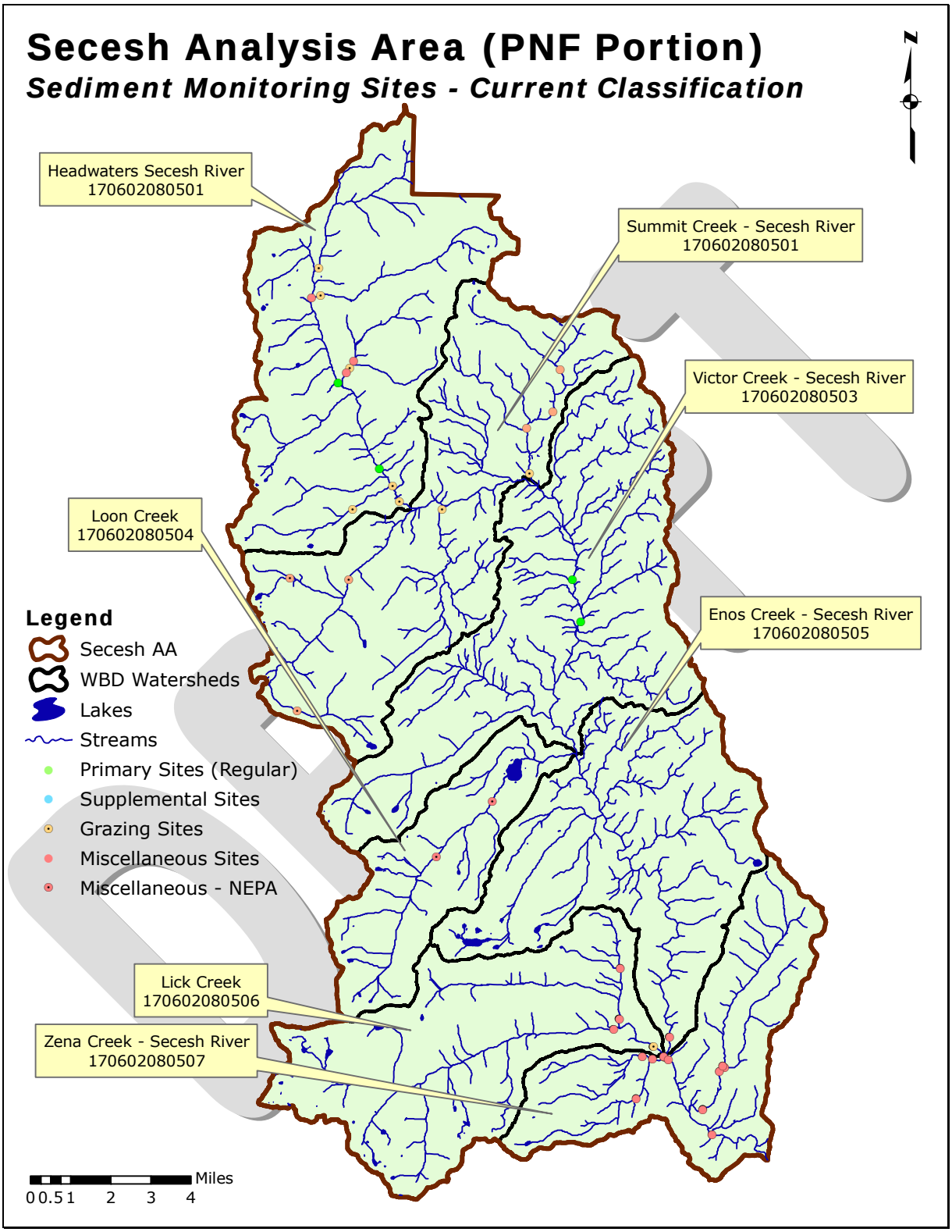

Figure 3.—Monitoring sites in the Secesh analysis area.

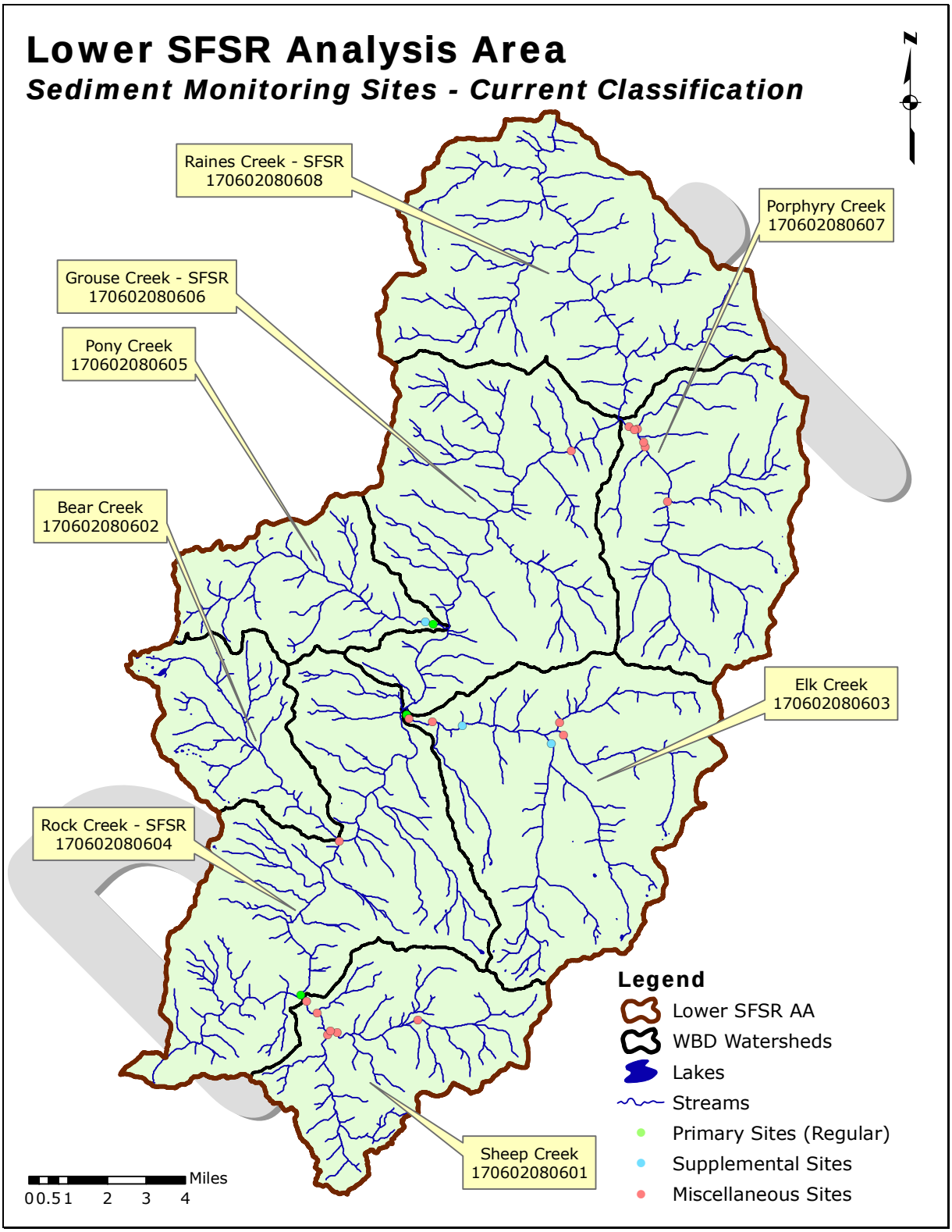

Figure 4.—Monitoring sites in the Lower SFSR analysis area.

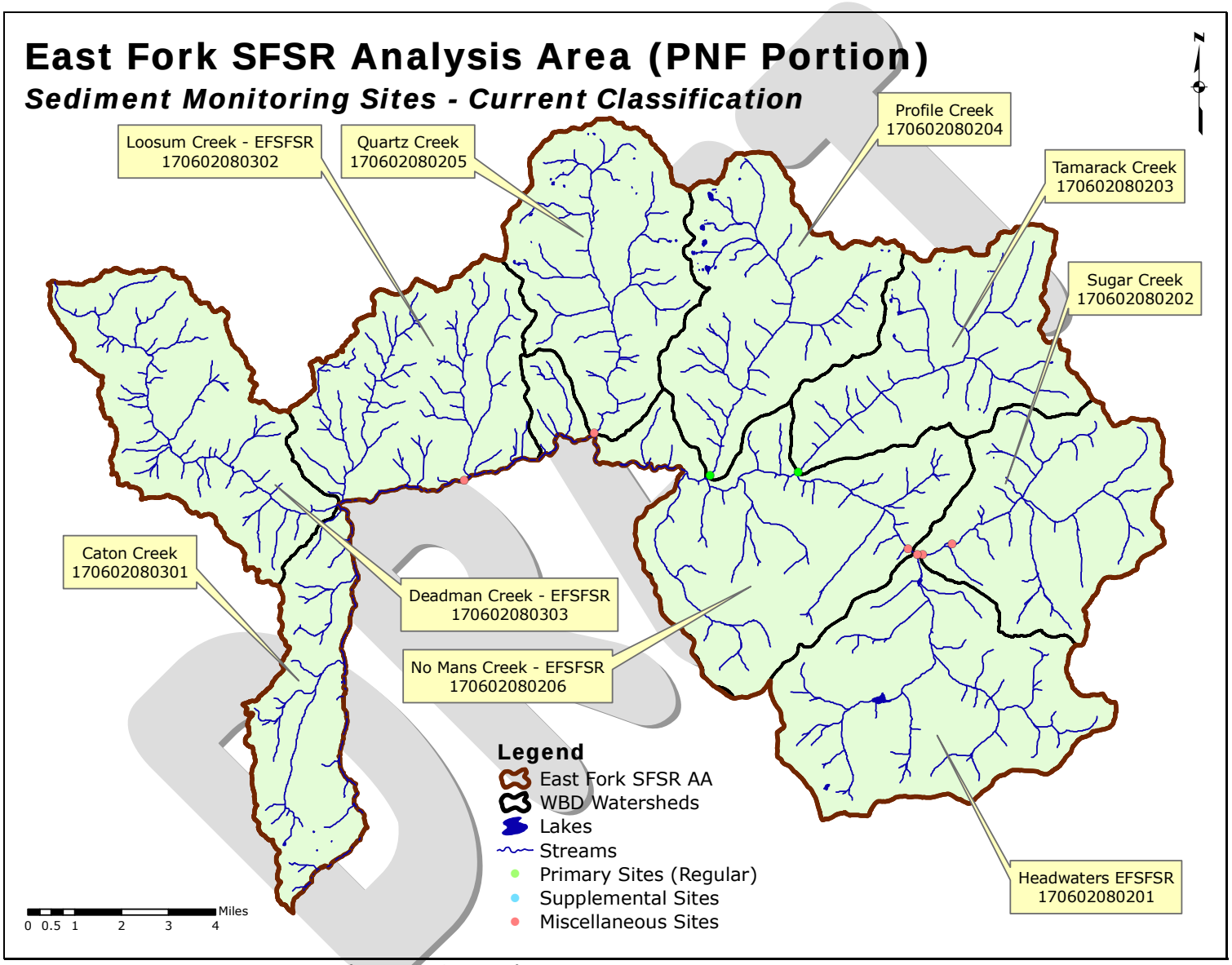

Figure 5.—Monitoring sites in the EFSFSR analysis area.

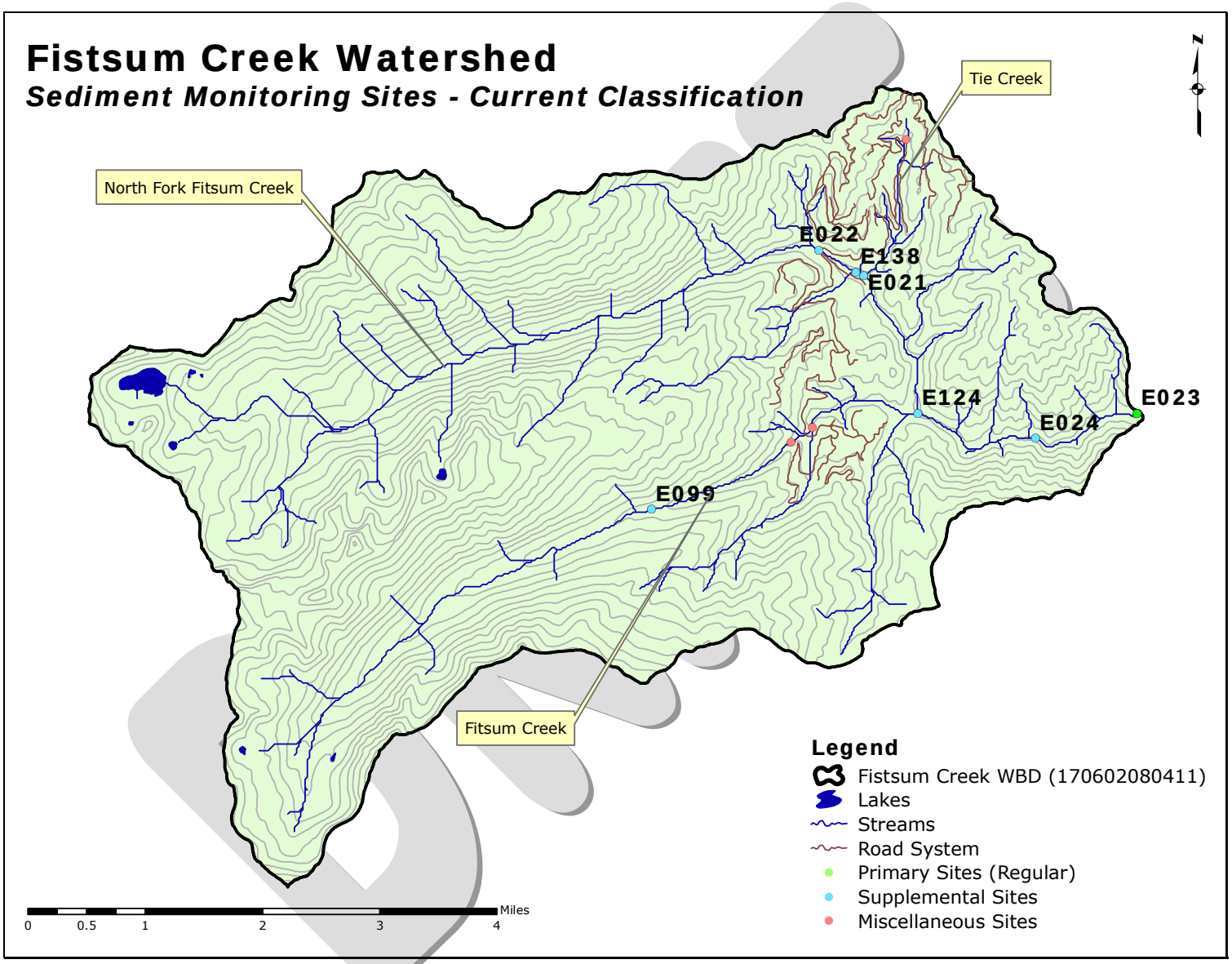

Figure 6.—Monitoring sites and road system in the Fitsum Creek watershed.

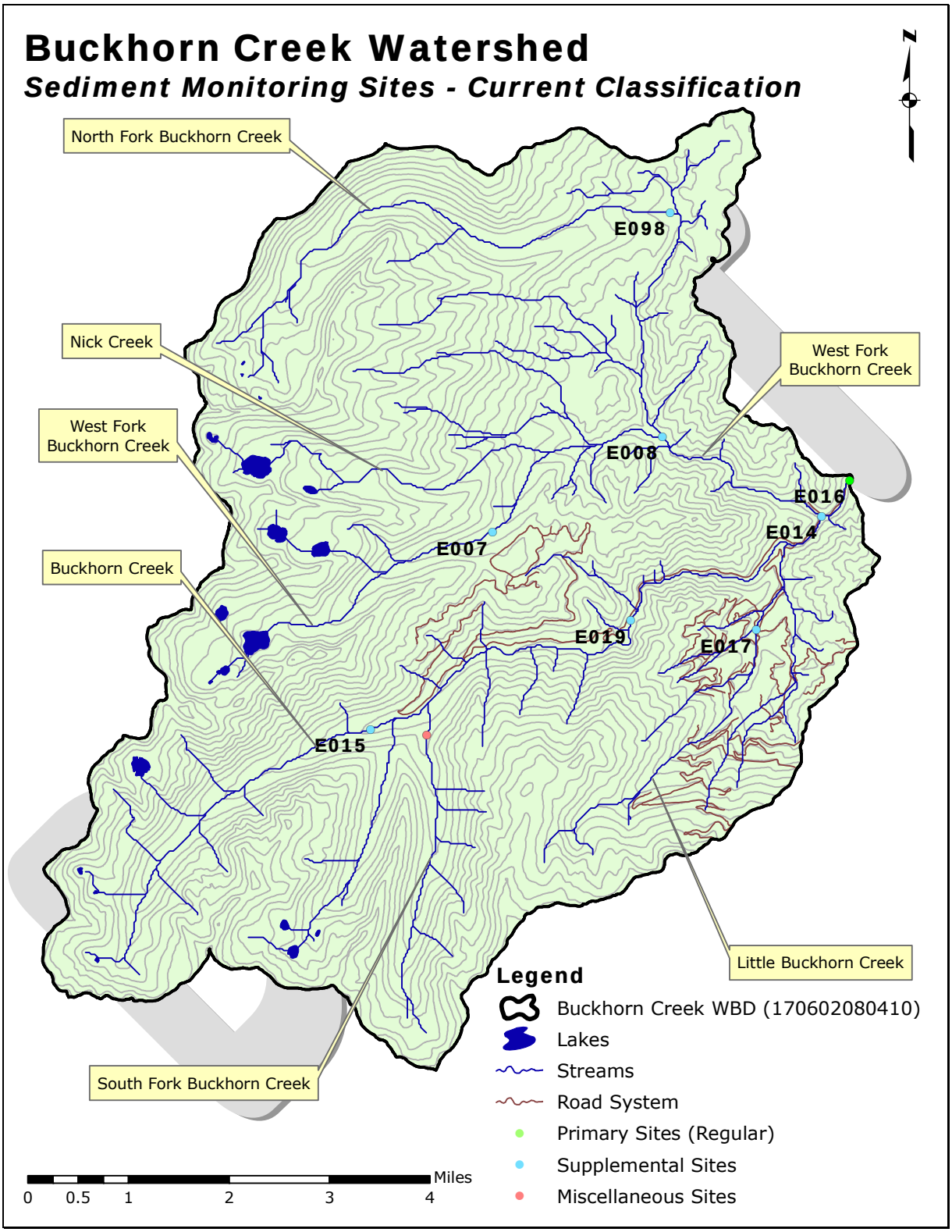

Figure 7.—Monitoring sites and road system in the Buckhorn Creek watershed.

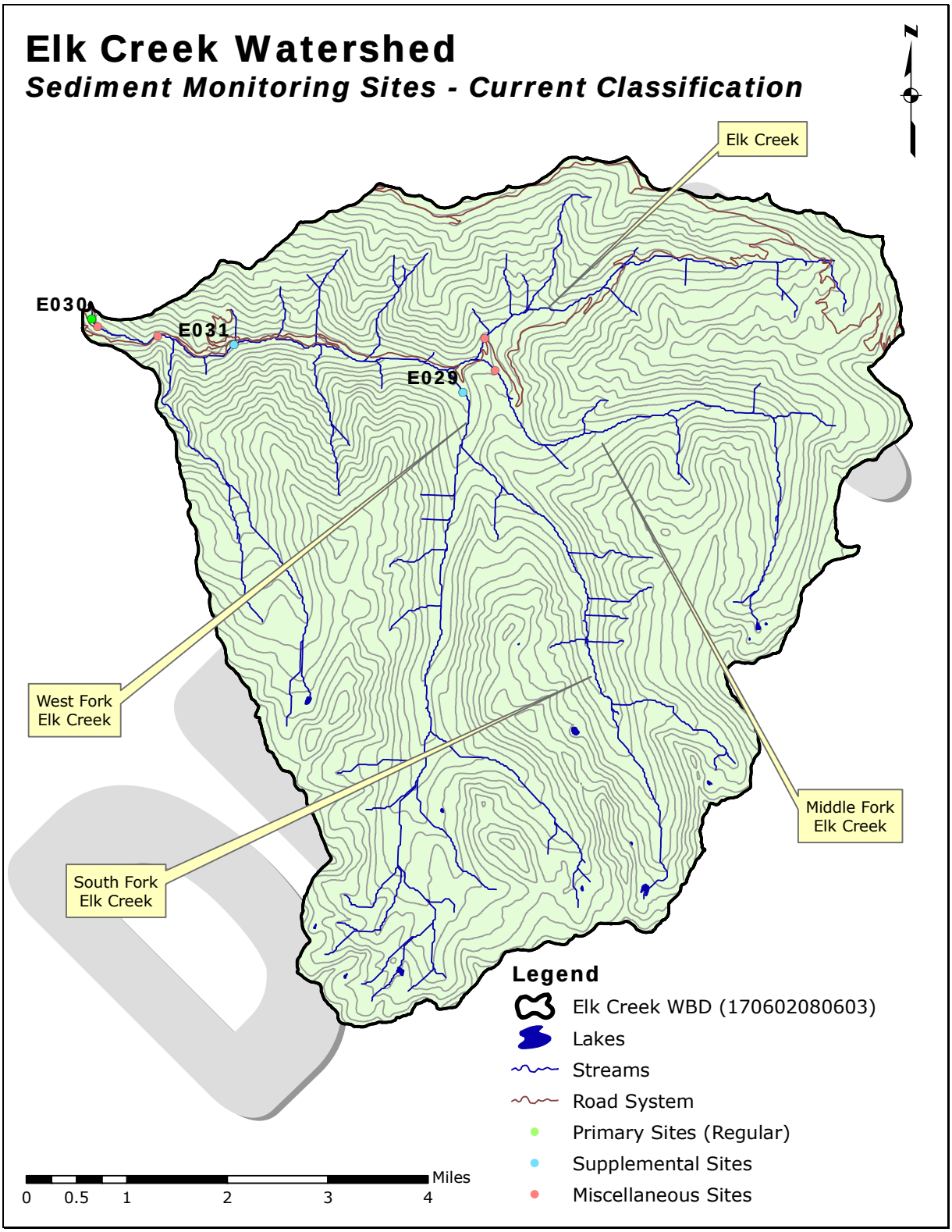

Figure 8.—Monitoring sites and road system in the Elk Creek watershed.

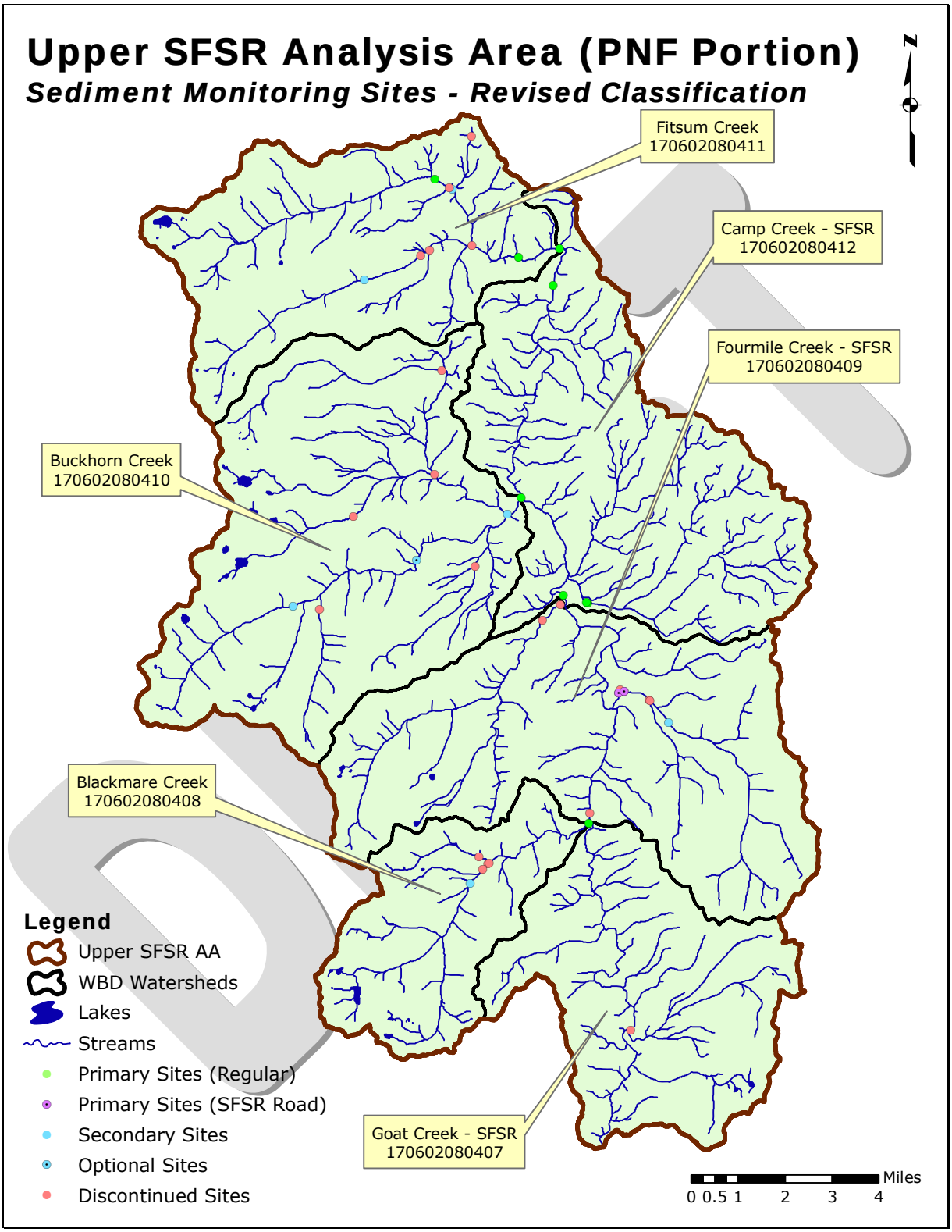

Figure 9.—Proposed site realignment in the upper SFSR analysis area, PNF portion.

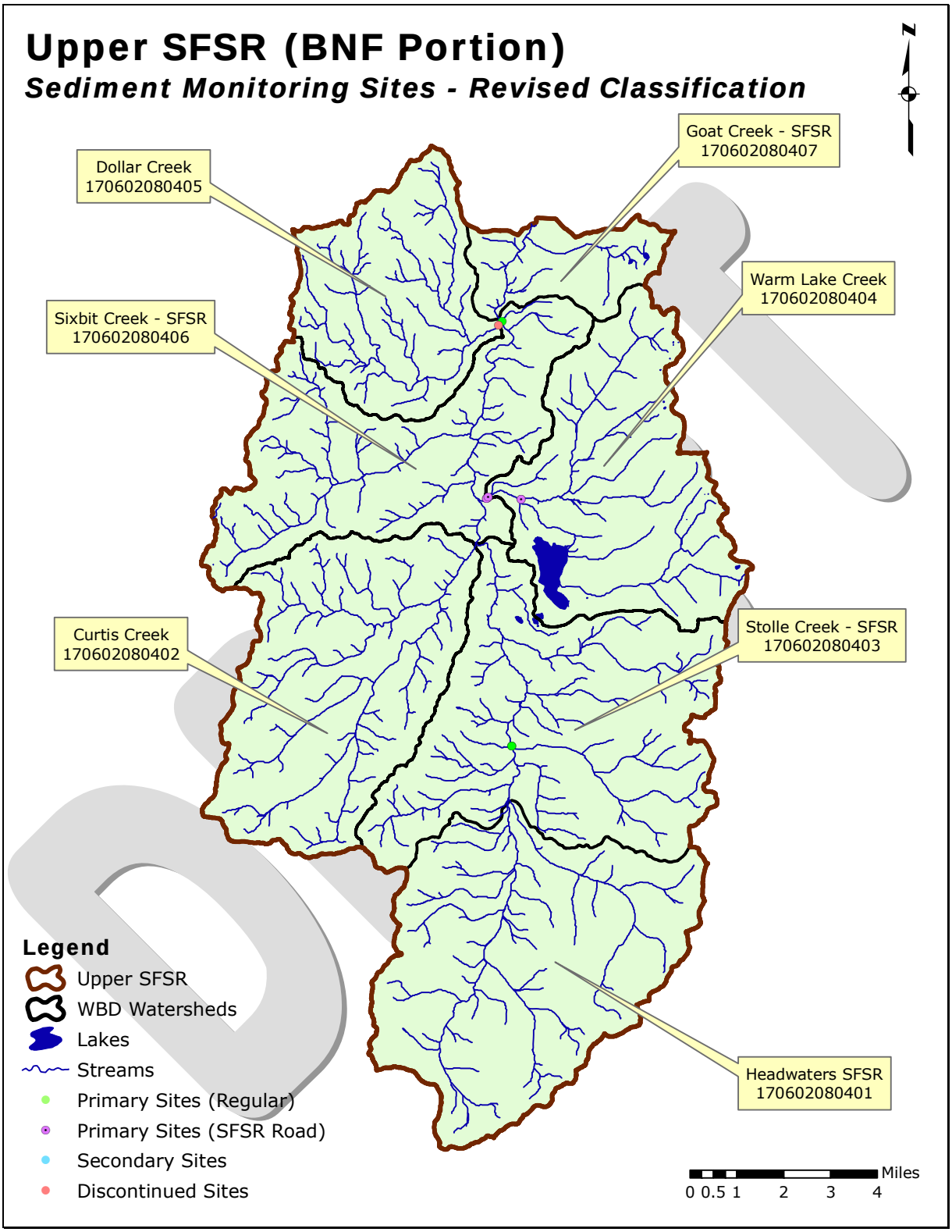

Figure 10.—Proposed site realignment in the Upper SFSR watershed, BNF portion.

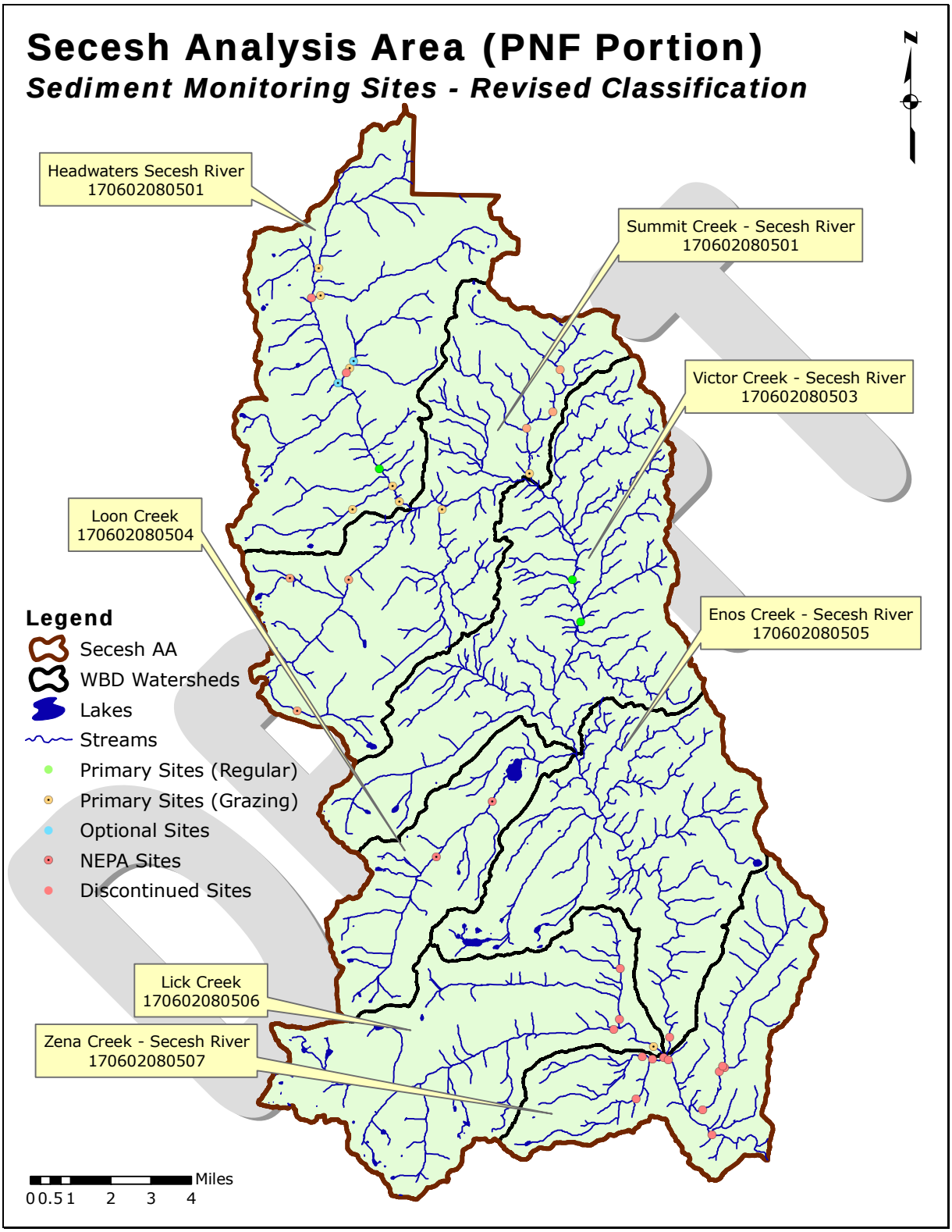

Figure 11.—Proposed site realignment in the Secesh analysis area

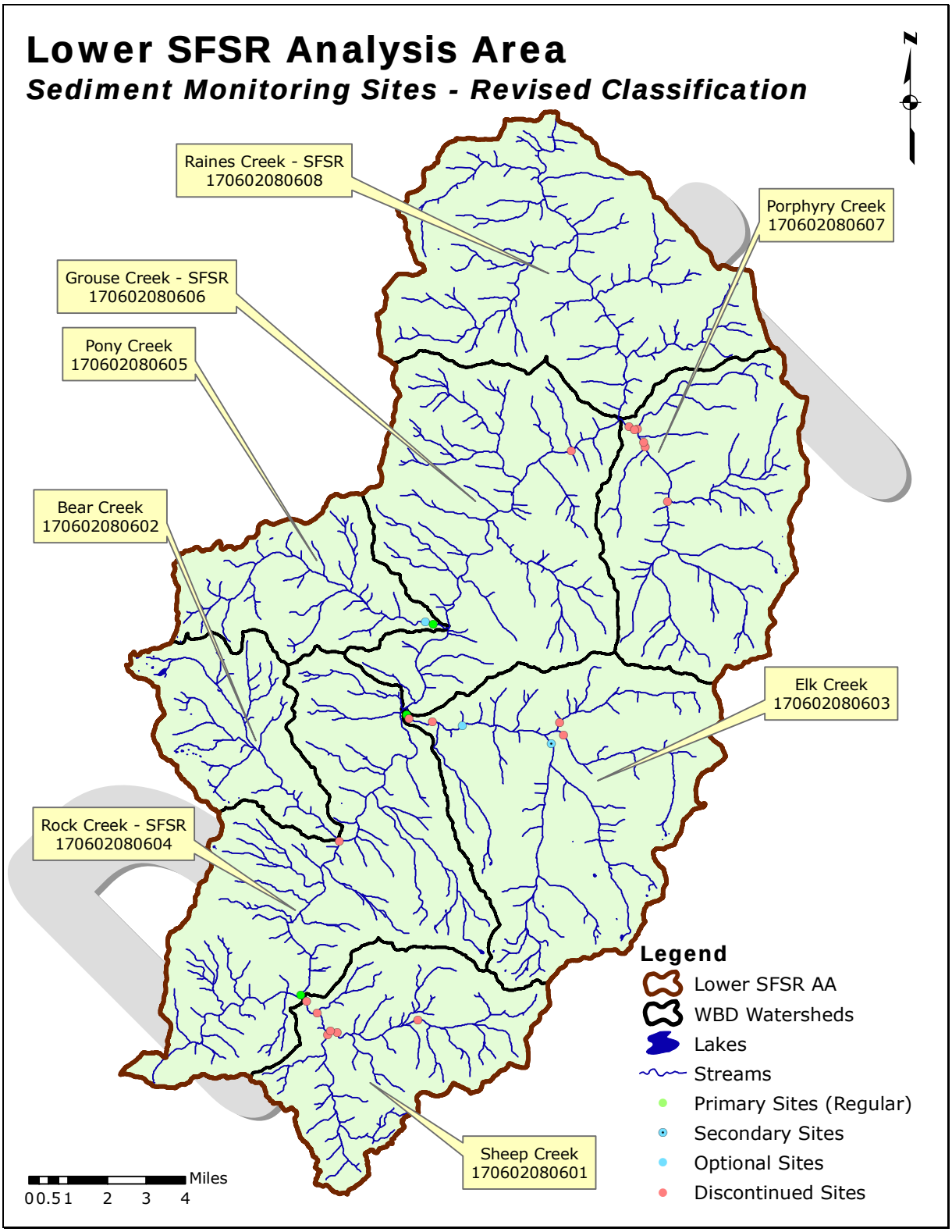

Figure 12.—Proposed site realignment in the Lower SFSR analysis area.

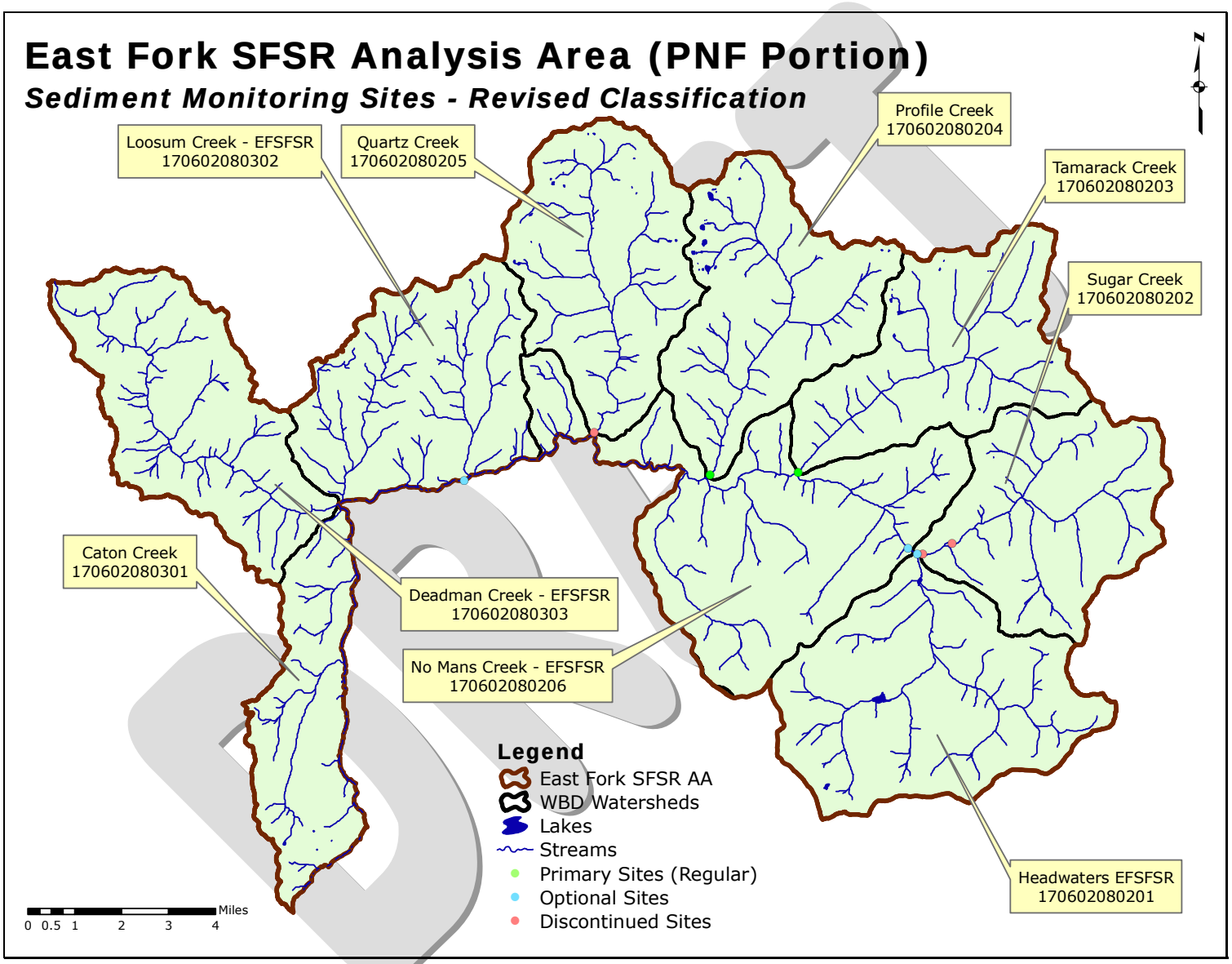

Figure 13.—Proposed site realignment in the East Fork SFSR analysis area.

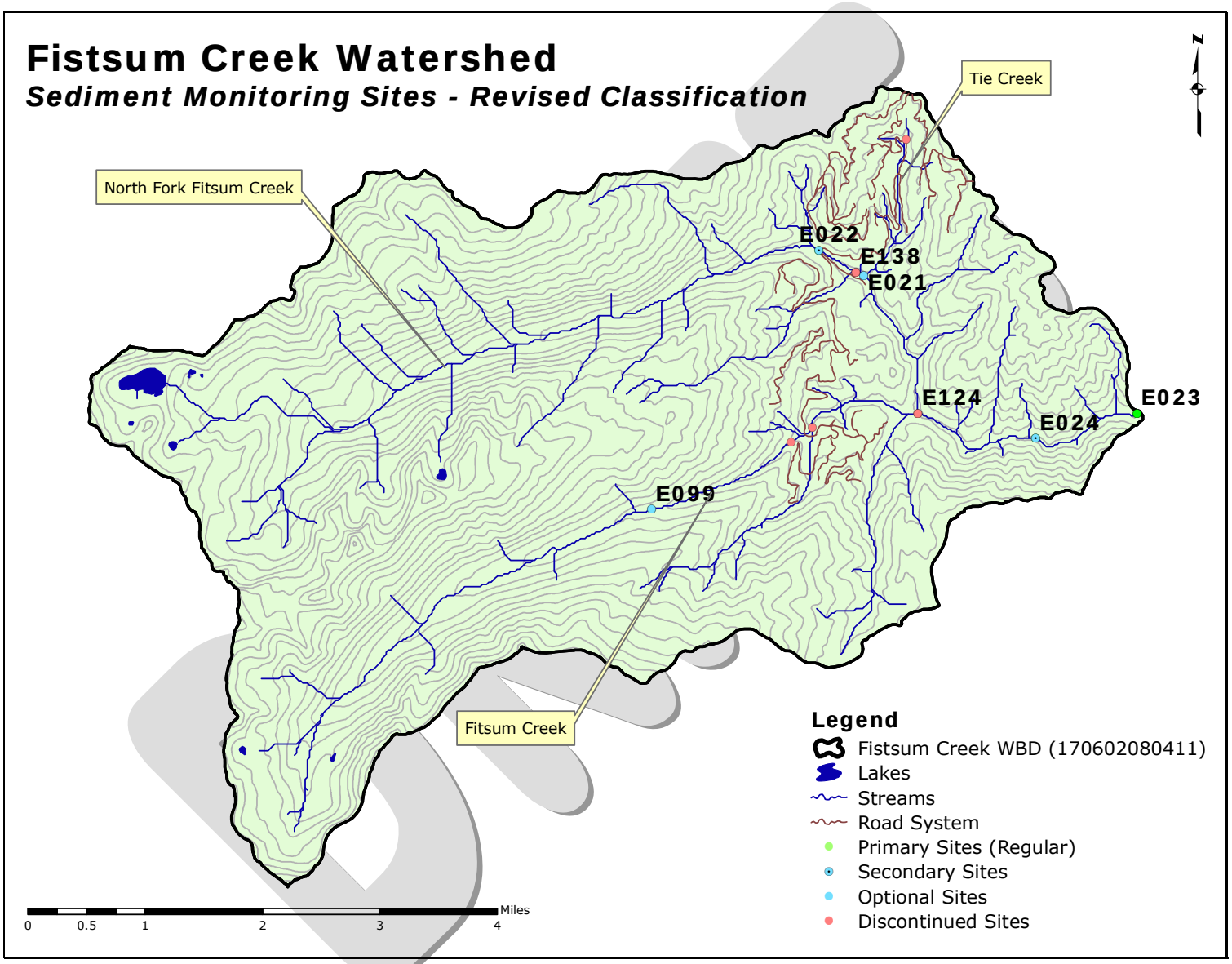

Figure 14.—Proposed monitoring site realignment and road system in the Fitsum Creek watershed.

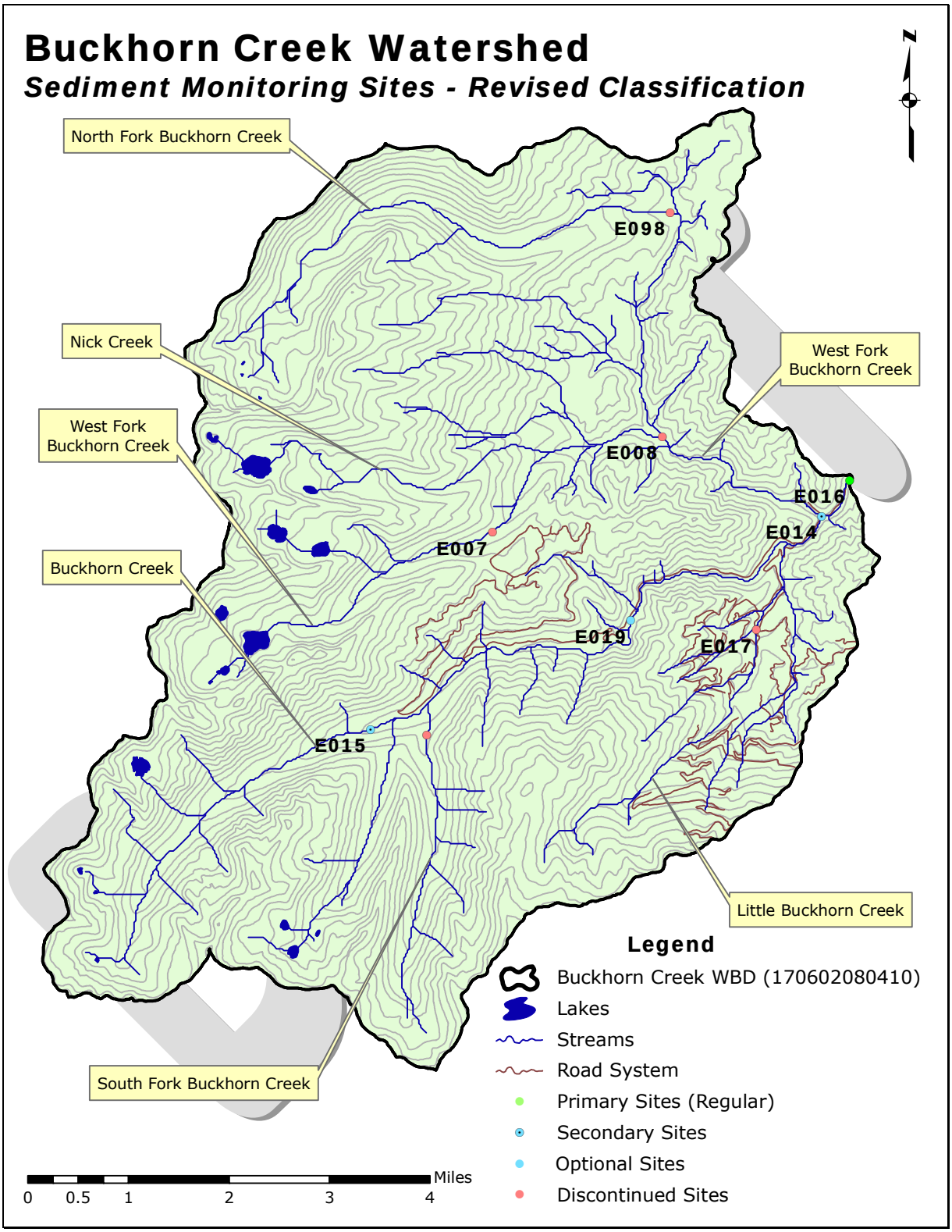

Figure 15.—Proposed monitoring site realignment and road system in the Buckhorn Creek watershed.

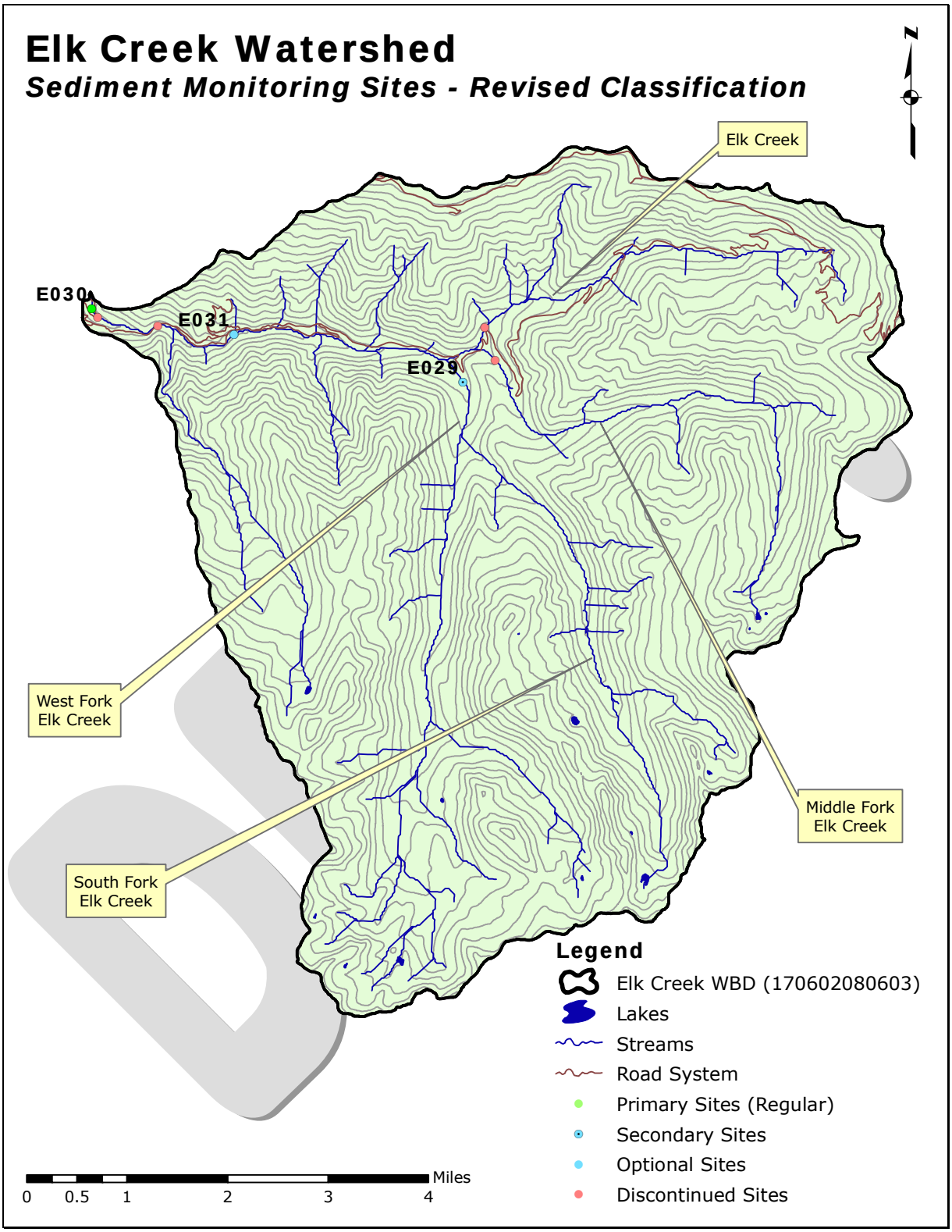

Figure 16.—Proposed monitoring site realignment and road system in the Elk Creek watershed.