CENTRAL VALLEY REGIONAL
WATER QUALITY CONTROL BOARD

BEAR CREEK
MERCURY INVENTORY

Staff Report

June 2009

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CENTRAL VALLEY REGION

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and
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EXECUTIVE SUMMARY

A Basin Plan amendment to control mercury in the Cache Creek watershed (Cache Creek Watershed Mercury Program) was adopted by the Central Valley Regional Water Quality Control Board as required by the State of California Porter-Cologne Water Quality Control Act (Cooke and Morris, 2005). This mercury inventory is in response to the Basin Plan which commits Regional Board staff to complete "*assessments…to determine whether responsible parties should be required to conduct feasibility studies to evaluate methods to control sources of mercury…Assessments are needed of stream beds and banks in…Bear Creek south of the Bear Valley Road crossing...".* The two objectives of this report were to provide an initial survey of the major tributaries to Bear Creek to identify if any of these tributaries are mercury sources, and to estimate the amount of mercury stored in the depositional areas, stream beds, and banks of Bear Creek available for downstream transport.

During the fall of 2006 Regional Board staff collected sediment samples from point bars, depositional areas, instream sediments and from the mouth of major tributary creeks. Depositional areas and tributaries were identified from aerial photographs of Bear Creek provided by the National Agriculture Imagery Program (USDA, 2005) and field verified. The samples were sieved into three grain-size fractions and analyzed for mercury by Moss Landing Marine Laboratories.

Of the ten tributaries to Bear Creek that were sampled, Sulphur Creek had the highest sediment mercury concentrations with 91.8 ppm, 212 ppm and 21.9 ppm in the <63 µm, 63-1000 µm and 1000-3800 µm size fractions, respectively. These high concentrations were not surprising since the Sulphur Creek watershed has geothermal springs with high mercury concentrations, naturally mercury-enriched soils, and experienced much mercury mining activity. Another survey of mainstem Sulphur Creek found mercury concentrations that ranged from 0.9 to 141 ppm in fine grain sediment (Cooke and Stanish, 2007).

Excluding Sulphur Creek, sediment mercury concentrations of the other nine tributaries sampled ranged from 0.04-0.53 ppm, 0.03-0.13 ppm and 0.04-0.15 ppm in the <63 µm, 63-1000 µm and 1000-3800 µm size fractions, respectively. Of these tributaries, only Tributary 2 had a mercury concentration greater than 0.40 ppm in one of its three size fractions (0.53 ppm in the <63 µm fraction). The Basin Plan's Cache Creek Watershed Mercury Program defines enriched sediment as having an average mercury concentration of 0.4 ppm, dry weight in the <63 µm fraction (Cooke and Morris, 2005). The tributaries that drain the Rathburn-Petray mercury mine complex were not sampled during this survey; however, a study done by U.S. Geological Survey indicated that mercury concentrations of water and sediment from some of the tributaries and springs downstream of these mines were high (tributary sediment 0.16-360 ppm;

tributary water 12.4-855 ng/l; spring water 6.9-690 ng/l; Slowey and Rytuba, 2008).
Regional Board staff identified 40 depositional areas along Bear Creek south of the Bear Valley Road crossing which contain approximately 114 million kg of sediment. The study estimates that 91 kg of mercury are present in these deposits within this 16 mile stretch of Bear Creek. This is about 24 times less than the 2,200 kg present in the 15-mile Cache Creek canyon from Harley Gulch to Bear Creek (Foe and Bosworth, 2008). Uncertainty about the estimate for Bear Creek may range between 46 to 182 kg. The lower value is estimated from observations that up to half the sediment in depositional areas may be cobble and larger sized material and has little or no associated mercury. The upper value results from the fact that nine of the identified depositional zones were not included in this estimate, and almost none of the smaller depositional piles were assessed.

Sulphur Creek is a major mercury source to Bear Creek as mercury concentrations in depositional areas and instream sediments downstream of its confluence were higher than upstream concentrations for all three size fractions. Average downstream concentrations increased by 9-, 4- and 5-fold in the <63 µm, 63-1000 µm and 1000-3800 µm size fractions, respectively. About 78% of the total mass of sediment deposited along Bear Creek is above Sulphur Creek, but this material only accounts for 15% of the estimated total mercury mass. In contrast, depositional areas below Sulphur Creek only contain 22% of the total mass of sediment inventoried, but account for 85% of the mercury mass due to their higher mercury concentrations.

INTRODUCTION

A Basin Plan Amendment to control mercury in the Cache Creek watershed (Cache Creek Watershed Mercury Program) was adopted by the Central Valley Regional Water Quality Control Board as required by the State of California Porter-Cologne Water Quality Control Act (Cooke and Morris, 2005). The Basin Plan committed Regional Board staff to complete "*assessments…to determine whether responsible parties should be required to conduct feasibility studies to evaluate methods to control sources of mercury…Assessments are needed of stream beds and banks in…Bear Creek south of the Bear Valley Road crossing...".* Mercury in the sediments of creek deposits and tributaries of Cache Creek from Harley Gulch to Bear Creek was assessed in the first of a series of reports in fulfillment of the Basin Plan requirements (Foe and Bosworth, 2008). This report, which is an initial assessment of mercury in sediments in Bear Creek downstream of the Bear Valley Road crossing, is the second of the series. The third report in the series will describe mercury inventories in Cache Creek between the confluence of Bear Creek and the town of Rumsey.

Bear Creek is a relatively large tributary of Cache Creek with no dams and a perennial flow. The Bear Creek watershed includes the majority of the mercury mines in the Sulphur Creek mercury mining district. These include Wide Awake, Manzanita, Empire, Central, Elgin and Clyde mercury and gold mines, which drain to Sulphur Creek, a tributary to Bear Creek. The Rathburn-Petray mercury mine complex discharges to several small tributaries of Bear Creek located within the southern Bear Valley. Overall, the mines within the Bear Creek watershed produced about 200,000 kg of mercury (Churchill and Clinkenbeard, 2003).

This study has two objectives:

1. Survey the mouths of tributaries to Bear Creek to determine mercury concentrations in sediment, and use this information, if possible, to identify tributaries that may be mercury sources to Bear Creek.
2. Estimate the amount of mercury stored in the depositional areas, stream beds and banks of Bear Creek available for downstream transport.

METHODS AND MATERIALS

Mercury Sediment Sampling

During the fall of 2006, Regional Board staff collected sediment samples from large point bars, depositional areas, instream sediments and from the mouth of major tributary creeks to ascertain the distribution and mass of mercury in Bear Creek. For this report, depositional areas are defined as areas where sediments were identified and subject to erosion and redeposition. Sampling locations along the mainstem of Bear Creek and its tributaries are illustrated in Figures 1 and 2, respectively. Samples collected from depositional areas along Bear

Creek were taken from ponded areas within the perennial creek channel and from deposits within the floodplain. Instream sediments were also sampled to characterize mercury concentrations in the perennial channel away from depositional zones. Smaller depositional areas were not assessed. The instream samples were not used in the mercury mass inventory calculations and are noted in Table 1.

One composite sample was collected at each depositional area or tributary. Each composite was composed of approximately 10 random sub-samples of about equal volume. Sub-samples were collected with a trowel from the surface to a depth of about four inches over a 25 m^2 area. Sediment samples from the tributaries were collected upstream of the high water mark from Bear Creek.

Depositional areas and tributaries were identified from aerial photographs of Bear Creek provided by the National Agriculture Imagery Program (USDA, 2005). While in the field, Regional Board staff confirmed the existence of the major deposits identified from photographs. Figure 3 shows the identified depositional areas that were evaluated. Not every creek deposit and tributary was sampled.

Mercury Analysis

The composite samples were dried, homogenized, and sieved into three size fractions (<63 µm, 63-1000 µm and 1000-3800 µm) by Moss Landing Marine Laboratories (MLML)[1]. Samples were sieved by passing a known weight of material sequentially through 3800, 1,000, and 63 micron mesh screens. Each size fraction was weighed and the percentage of the total weight of the sample was estimated. A sub-sample from each fraction was analyzed for total mercury at MLML using a flow injection mercury system (CALFED, 2000). Standard reference material and laboratory duplicates were analyzed to estimate accuracy and precision. Laboratory contamination was assessed using method blanks. All results are reported as milligrams mercury per kilogram dry weight sediment or parts per million (ppm). Mercury concentrations along the mainstem of Bear Creek are reported in Table 1 and the tributaries in Table 2.

Mercury Inventory

Regional Board staff identified 40 depositional areas along Bear Creek. The mass of sediment in each deposit in kilograms was estimated from equation 1:

(1) Total Weight (kg) = Height (m) x Surface Area (m^2) x 1530 (kg/m^3)

The average height of each deposit above water level was estimated during the field surveys, and the surface area was computed from the aerial photographs using ArcGIS software. A conversion factor of 1530 kg/m^3 was used to translate

[1] Moss Landing Marine Laboratories, 7544 Sandholdt Road, Moss Landing, CA 95039

volumes of loosely mixed sand to weight (Dunn et al., 1981). The dimensions, volume, and mass of sediment in each depositional pile are provided in Table 3.

The mercury mass of each depositional pile was determined by summing the mercury mass of each size fraction using equation 2:

(2) $\sum$ (Total Weight (kg) x %Weight of Fraction$_i$ x Mercury Concentration of fraction$_i$ (mg/kg))
i=3 size fractions

Total Weight is the estimated weight of the flood plain deposit from equation 1. The %Weight of Fraction$_i$ and Mercury concentration of Fraction$_i$ are the proportion of the total weight and the mercury concentration of each size fraction, respectively.

Sediment samples were collected in 5 of the 40 identified depositional areas. These were used to characterize mercury concentrations and grain-size distributions of their associated deposit in equation 2. To determine the mercury content of the unsampled depositional areas, the mercury concentrations and grain-size distributions of the nearest upstream and downstream samples were averaged. The only exception was when a major tributary entered between an upstream or downstream sample and the depositional area, whereupon this sample was not used to characterize the mercury content of the pile. The total mercury mass was not estimated for 8 of the 40 identified depositional zones due to limited mercury samples and the presence of another tributary input downstream of the Rathburn and Petray mines. The inventory of mercury in each depositional pile is summarized in Table 4.

RESULTS AND DISCUSSION

Quality Assurance/Quality Control Program

Accuracy and precision were measured by analyses of standard reference material (1944 NIST - 3.4 ppm mercury) and laboratory duplicates. Relative percent differences[2] for the three laboratory duplicates were 8.7%, 9.5%, and 27.6%. Percent recoveries for the laboratory standard reference material were 99.4%, 101.3%, and 107.6%. The estimates of accuracy and precision were deemed satisfactory for estimating mercury concentrations and loads in Bear Creek.

[2] Relative Percent Difference (RPD) = |(Duplicate 1 - Duplicate 2)| / ((Duplicate 1 + Duplicate 2)/2) x 100

Tributary Mercury Concentrations

The mouths of ten tributaries of Bear Creek, including Sulphur Creek, were surveyed during October 2006 (Table 2). Sulphur Creek had the highest sediment mercury concentrations with 91.8 ppm, 212 ppm and 21.9 ppm in the <63 µm, 63-1000 µm and 1000-3800 µm size fractions, respectively. Cooke and Stanish (2007) reported that fine grain (<63 µm) sediment mercury concentrations of instream samples collected from mainstem Sulphur Creek were 4.6 ppm upstream of West End Mine, 0.9 ppm near Manzanita Mine, 141 ppm near Wilbur Springs, and 21 and 25 ppm at the mouth of Sulphur Creek. The Sulphur Creek watershed has geothermal springs with high mercury concentrations, naturally mercury-enriched soils, and experienced much mercury mining activity. Churchill and Clinkenbeard (2003) estimate that the average annual mercury loads exported from mines within the Sulphur Creek watershed are between 1.2 and 11 kg/yr. Furthermore, the authors estimate that 3,200 to 4,200 kg of mercury remain in calcine piles in the Sulphur Creek watershed with the potential for erosion to Bear and Cache Creeks.

Excluding Sulphur Creek, sediment mercury concentrations in the tributaries ranged from 0.04-0.53 ppm, 0.03-0.13 ppm and 0.04-0.15 ppm in the <63 µm, 63-1000 µm and 1000-3800 µm size fractions, respectively (Table 2). With the exception of Sulphur Creek, only Tributary 2 had a mercury concentration greater than 0.40 ppm in one of its three size fractions (0.53 ppm in the <63 µm fraction). All other tributary samples had mercury concentrations of 0.15 ppm or less in all three fractions. Tributary 2 drains the area to the west of Bear Creek at the southern end of Bear Valley (Figure 2). Its watershed boundary is approximately one mile south of the Rathburn mercury mine. It is not known whether the drainage contains mercury from the Rathburn mine or active geothermal springs, or a combination of both. The Basin Plan's Cache Creek Watershed Mercury Program defines enriched sediment as having an average mercury concentration of 0.4 ppm or greater, dry weight in the <63 µm fraction (Cooke and Morris, 2005). Staff recommends further mercury analysis to be done in Tributary 2 since the sample collected at its mouth indicates that it contains mercury-enriched sediment.

The tributaries that drain the Rathburn-Petray mercury mine complex, which enter Bear Creek upstream of Tributary 2, were not sampled. Churchill and Clinkenbeard (2003) estimate that 29,400 to 30,400 kg of mercury remain in the waste piles of this mine complex, which could potentially be transported downstream. The United States Geological Survey collected water and sediment samples from these tributaries and nearby saline springs during 2004-2006 (Slowey and Rytuba, 2008). Some of the water and sediment samples from tributaries and springs downstream of the mines had high mercury concentrations (tributary sediment 0.16-360 ppm; tributary water 12.4-855 ng/l; spring water 6.9-690 ng/l). However, it is uncertain how much of the mercury-contaminated sediment reaches Bear Creek since the tributary sediment samples were collected a few miles upstream of the confluence. A total (unfiltered) mercury water sample collected at the mouth of one of these tributaries by Regional Board staff in October 2004 had a concentration of 8,638 ng/l. This sample was taken from the subsurface flow that filled up a hole dug with a shovel; therefore, it is unknown how much of this associated mercury is actually entering Bear Creek through groundwater. Further investigation is warranted to quantify the amount of mercury entering Bear Creek from these tributaries.

Mercury Inventory

The weight of sediment present in all 40 identified depositional piles along Bear Creek from the Bear Valley Road crossing to its confluence with Cache Creek is estimated to be 114 million kilograms or 75,000 m^3. For comparison, depositional zones in the Cache Creek Canyon from Harley Gulch to Bear Creek contained an estimated 2.4 billion kilograms of sediment (Foe and Bosworth, 2008). When standardized for the distance of creek surveyed, deposits in this section of Bear Creek have about 23 times less sediment mass than in Cache Creek. In 2000 and 2001, an average of 1.8 million kg of sediment/yr was exported from Bear Creek between Bear Valley Road and Cache Creek (Cooke *et al.*, 2004).

The study estimates that 91 kg of mercury are present in this 16 mile stretch of Bear Creek (Table 4). This is about 24 times less than the 2,200 kg present in the 15-mile Cache Creek canyon from Harley Gulch to Bear Creek. Uncertainty about the estimate for Bear Creek may range between 46 to 182 kg. The lower value is estimated from observations that up to half the sediment in depositional areas may be cobble and larger sized material and has little or no associated mercury. The upper value results from the fact that eight of the identified depositional zones were not included in this estimate, and almost none of the smaller depositional piles were assessed. The eight piles not included in the total mercury mass account for 63% of the total mass of sediment deposited along Bear Creek. All but one of these deposits (DC-01 through DC-08) are above the tributaries that drain the Rathburn-Petray complex and are expected to have lower mercury concentrations. The concentrations of the one sample (BC-01) collected above the mine tributaries were 0.54, 0.06 and 0.06 ppm in the <63 µm, 63-1000 µm and 1000-3800 µm size fractions, respectively (Table 1). This sample was not used to characterize depositional areas DC-01 through DC-08 because a major tributary enters Bear Creek between the sample location and these piles (this tributary was not sampled). If BC-01 were used to characterize sediment concentrations for these eight depositional piles, the mercury mass estimate would increase by 7% to about 98 kg.

Sulphur Creek is a major mercury source in Bear Creek as mercury concentrations in depositional areas and instream sediments downstream of its confluence were higher than upstream concentrations for all three size fractions

(Table 5). Average downstream concentrations increased by 9-, 4- and 5-fold in the <63 µm, 63-1000 µm and 1000-3800 µm size fractions, respectively. The increase in the <63 µm size fraction is statistically significant ($p<0.05$, t-test). About 78% of the total mass of sediment deposited along Bear Creek is above Sulphur Creek, but this material only accounts for 15% of the estimated total mercury mass. In contrast, depositional areas below Sulphur Creek only contain 22% of the total mass of sediment inventoried, but account for 85% of the mercury mass due to their higher mercury concentrations. The topography along Bear Creek is more steep and canyon-like downstream of Sulphur Creek particularly along Highway 16, indicating that this stretch of Bear Creek has a higher-energy flow. This possibly explains why Regional Board staff identified fewer and smaller sediment deposits in this section and suggests that mercury eroding from Sulphur Creek is readily transported downstream to Cache Creek. These observations emphasize the importance of mercury mine cleanups in the Sulphur Creek watershed for protection of the downstream Cache Creek watershed.

The Basin Plan's Cache Creek Watershed Mercury Program required Board staff to do assessments to determine whether landowners and other responsible parties should be required to conduct feasibility studies to evaluate methods to control and remediate mercury sources in the watershed (Cooke and Morris, 2005). The Executive Officer of the Regional Board will prioritize the need for feasibility studies and subsequent remediation actions based on mercury concentrations and masses, erosion potential, and accessibility.

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Table 1: Mercury concentration and grain-size proportion data for the mainstem depositional area samples.

Station Code	Location	Latitude	Longitude	Sample Date	Percentage of total sample weight [1]			Mercury concentration (ppm)		
					<63 µm	63-1000 µm	1000-3800 µm	<63 µm	63-1000 µm	1000-3800 µm
BC01	Depositional Area upstream of Bear Valley Road Bridge	39.099060	-122.412490	10/16/2006	7.0%	53.0%	33.4%	0.54	0.06	0.06
BC03	Depositional Area	39.069120	-122.410450	10/16/2006	14.0%	32.2%	27.6%	2.30	1.15	0.10
BC04	Instream Sediment	39.070810	-122.410850	10/16/2006	8.7%	24.2%	26.5%	1.29	2.01	0.56
BC06	Depositional Area	39.080030	-122.413020	10/16/2006	13.5%	46.5%	18.2%	2.00	0.59	0.13
BC08	Depositional Area	39.056650	-122.411690	10/16/2006	6.3%	37.1%	36.2%	3.11	4.51	0.12
BC11	Instream Sediment	39.042260	-122.409490	10/16/2006	8.2%	55.4%	22.5%	2.30	0.08	0.05
BC13	Depositional Area	39.038660	-122.407050	10/16/2006	7.1%	25.0%	34.5%	51.20	24.70	0.66
BC14	Depositional Area	39.021100	-122.391150	10/16/2006	21.9%	50.7%	16.3%	15.60	12.20	0.40
BC16	Depositional Area	39.011780	-122.361210	10/16/2006	22.0%	34.1%	29.0%	7.88	1.49	1.76
BC17	Depositional Area	39.011780	-122.361210	10/16/2006	3.4%	6.8%	37.3%	12.10	5.77	0.43
BC20	Depositional Area	38.995080	-122.355170	10/17/2006	4.2%	29.0%	27.1%	1.70	1.86	0.32
BC23	Depositional Area	38.974950	-122.339290	10/17/2006	14.8%	48.5%	33.5%	28.20	1.65	2.74
BC24	Instream Sediment	38.966380	-122.340480	10/17/2006	16.5%	27.4%	42.3%	14.00	1.13	0.14
BC26	Depositional Area	38.929720	-122.333880	10/17/2006	17.0%	33.7%	44.0%	2.67	0.59	0.15

[1] Note: Percentages do not add up to 100% because percent grain size greater than 3800µm is not included in summation. Size fractions greater than 3800µm were not analyzed for mercury; therefore, total mercury estimate for each location may be underestimated.

Table 2: Mercury concentration and grain-size proportion data for the tributary samples.

Station Code	Name	Latitude	Longitude	Sample Date	Percentage of total sample weight[1]			Mercury concentration (ppm)		
					<63 µm	63-1000 µm	1000-3800 µm	<63 µm	63-1000 µm	1000-3800 µm
T1	Tributary 1	39.076680	-122.415110	10/16/2006	36.6%	24.5%	35.8%	0.14	0.05	0.09
T2	Tributary 2	39.071980	-122.411870	10/16/2006	15.8%	30.6%	36.4%	0.53	0.11	0.15
T3	Tributary 3	39.057250	-122.412330	10/16/2006	10.4%	6.5%	36.3%	0.20	0.13	0.10
T4	Tributary 4	39.041510	-122.409840	10/16/2006	14.6%	18.3%	21.0%	0.07	0.10	0.10
SC	Sulphur Creek	39.039290	-122.408640	10/16/2006	24.2%	50.6%	19.1%	91.80	212.00	21.90
T5	Tributary 5	39.011960	-122.364460	10/16/2006	23.0%	37.5%	28.3%	0.20	0.06	0.06
T6	Tributary 6	39.012410	-122.358880	10/17/2006	9.9%	16.2%	46.4%	0.14	0.04	0.05
T7	Craig Canyon	38.982550	-122.352260	10/17/2006	13.5%	17.4%	43.1%	0.13	0.07	0.05
T8	Thompson Canyon	38.972610	-122.341680	10/17/2006	15.9%	51.3%	23.1%	0.07	0.06	0.08
T9	Brophy Canyon	38.947010	-122.348950	10/17/2006	56.3%	40.7%	1.6%	0.04	0.03	0.04

[1] Note: Percentages do not add up to 100% because percent grain size greater than 3800µm is not included in summation. Size fractions greater than 3800µm were not analyzed for mercury; therefore, total mercury estimate for each location may be underestimated.

Table 3: Dimensions, Volume, and Weight of sediment in each identified Depositional Zone.

Depositional Zone ID	Latitude	Longitude	Surface Area (m^2)	Depth (m)	Volume (m^3)	Weight (10^6 kg)
D-01	39.096785	-122.412909	1,220	0.61	744	1.14
D-02	39.095977	-122.412406	1,783	0.76	1,359	2.08
D-03	39.094962	-122.412467	2,246	1.07	2,396	3.67
D-04	39.093107	-122.411858	919	0.61	560	0.86
D-05	39.091818	-122.411396	15,314	1.22	18,675	28.57
D-06	39.090465	-122.410990	1,360	1.07	1,451	2.22
D-07	39.088812	-122.413058	2,735	0.76	2,085	3.19
D-08	39.087467	-122.414120	11,478	1.52	17,497	26.77
D-09	39.083782	-122.413142	1,722	0.76	1,313	2.01
D-10	39.083571	-122.413683	4,855	0.76	3,701	5.66
D-11	39.079832	-122.412826	5,000	0.76	3,811	5.83
D-12	39.076873	-122.414356	1,035	0.76	789	1.21
D-13	39.075475	-122.414035	856	0.30	261	0.40
D-14	39.073839	-122.413469	2,021	0.76	1,540	2.36
D-15	39.072599	-122.412051	903	0.76	688	1.05
D-16	39.068891	-122.410506	1,938	0.30	591	0.90
D-17	39.067970	-122.410755	384	0.30	117	0.18
D-18	39.056506	-122.411463	1,145	0.61	698	1.07
D-19	39.039932	-122.408071	640	0.76	488	0.75
D-20	39.038737	-122.406952	217	0.30	66	0.10
D-21	39.037324	-122.406194	404	0.30	123	0.19
D-22	39.030361	-122.404962	672	0.76	512	0.78
D-23	39.029416	-122.403621	592	0.76	451	0.69
D-24	39.021133	-122.391219	189	0.91	173	0.26
D-25	39.015033	-122.379404	1,633	0.91	1,494	2.29
D-26	39.012545	-122.374043	299	0.76	228	0.35
D-27	39.012047	-122.369220	858	0.76	654	1.00
D-28	39.012289	-122.365932	1,427	0.76	1,087	1.66
D-29	39.011706	-122.361704	466	0.76	355	0.54
D-30	39.010928	-122.360285	1,646	0.76	1,255	1.92
D-31	39.001518	-122.354932	100	0.46	46	0.07
D-32	38.995196	-122.355894	168	0.91	153	0.23
D-33	38.994270	-122.353775	489	0.30	149	0.23
D-34	38.984608	-122.351468	1,819	0.76	1,386	2.12
D-35	38.977752	-122.339571	2,323	0.91	2,125	3.25
D-36	38.974983	-122.339306	443	0.61	270	0.41
D-37	38.951584	-122.348617	2,220	1.07	2,369	3.62
D-38	38.938130	-122.342017	1,278	0.76	974	1.49
D-39	38.937445	-122.338021	1,860	1.07	1,985	3.04
D-40	38.930853	-122.334186	347	0.30	106	0.16
TOTAL:						**114.33**

Table 4: Inventory of Mercury Mass in each Depositional Zone.

Depositional Zone ID	Sample(s) used to represent deposit	Estimated Mercury Mass (kg)			Total Mercury Mass (kg)
		<63 µm fraction	63-1000 µm fraction	1000-3800 µm fraction	
D-01	none	--	--	--	--
D-02	none	--	--	--	--
D-03	none	--	--	--	--
D-04	none	--	--	--	--
D-05	none	--	--	--	--
D-06	none	--	--	--	--
D-07	none	--	--	--	--
D-08	none	--	--	--	--
D-09	BC-6	0.54	0.55	0.05	1.14
D-10	BC-6	1.53	1.55	0.14	3.22
D-11	BC-6	1.58	1.60	0.14	3.31
D-12	BC-6	0.33	0.33	0.03	0.69
D-13	BC-6	0.11	0.11	0.01	0.23
D-14	BC-6	0.64	0.64	0.06	1.34
D-15	BC-6	0.29	0.29	0.03	0.60
D-16	BC-3	0.29	0.33	0.03	0.65
D-17	BC-3	0.06	0.07	0.01	0.13
D-18	BC-8	0.21	1.79	0.05	2.05
D-19	BC-13 & 14	3.62	5.21	0.10	8.93
D-20	BC-13 & 14	0.49	0.71	0.01	1.21
D-21	BC-13 & 14	0.91	1.31	0.03	2.25
D-22	BC-13 & 14	3.80	5.47	0.11	9.37
D-23	BC-13 & 14	3.35	4.82	0.09	8.27
D-24	BC-14	0.90	1.63	0.02	2.56
D-25	BC-16 & 17	2.91	1.69	0.83	5.43
D-26	BC-16 & 17	0.44	0.26	0.13	0.83
D-27	BC-16 & 17	1.27	0.74	0.36	2.38
D-28	BC-16 & 17	2.12	1.23	0.60	3.95
D-29	BC-16 & 17	0.69	0.40	0.20	1.29
D-30	BC-16 & 17	2.44	1.42	0.69	4.56
D-31	BC-20	0.01	0.04	0.01	0.05
D-32	BC-20	0.02	0.13	0.02	0.16
D-33	BC-20	0.02	0.12	0.02	0.16
D-34	BC-20	0.15	1.14	0.18	1.48
D-35	BC-23	13.59	2.60	2.99	19.18
D-36	BC-23	1.73	0.33	0.38	2.44
D-37	none	--	--	--	--
D-38	BC-26	0.68	0.30	0.10	1.07
D-39	BC-26	1.38	0.61	0.20	2.18
D-40	BC-26	0.07	0.03	0.01	0.12
TOTAL:		46.17	37.46	7.59	**91.22**

Table 5: Average sediment mercury concentrations of depositional areas and instream sediments in each size fraction upstream and downstream of Sulphur Creek.

Location	Average Mercury Concentration (ppm)		
	<63 µm	63-1000 µm	1000-3800 µm
Bear Creek upstream Sulphur Creek	1.92	1.40	0.17
Bear Creek downstream Sulphur Creek	16.67	6.17	0.82

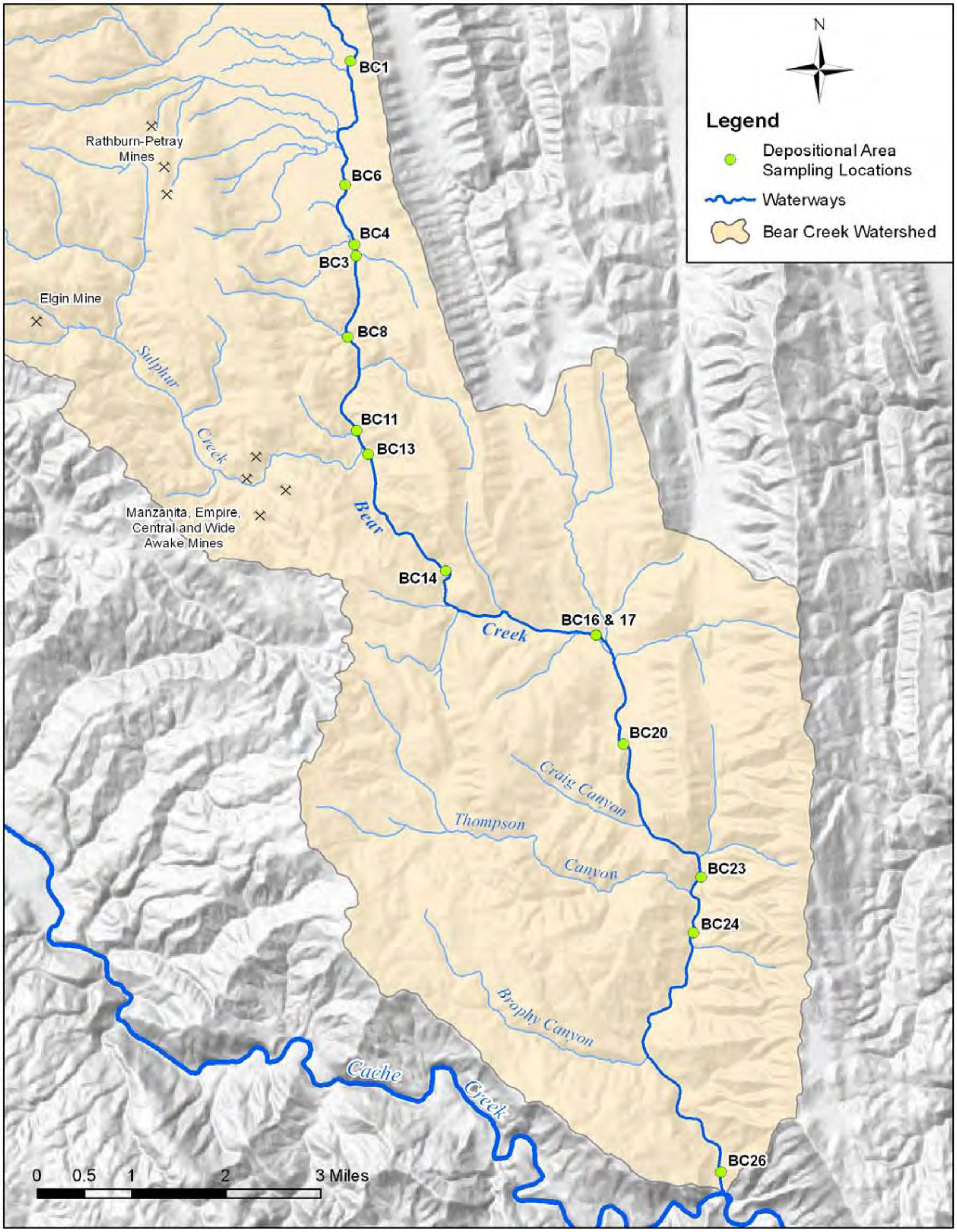

Figure 1: Depositional Area Sampling Locations along Mainstem Bear Creek.

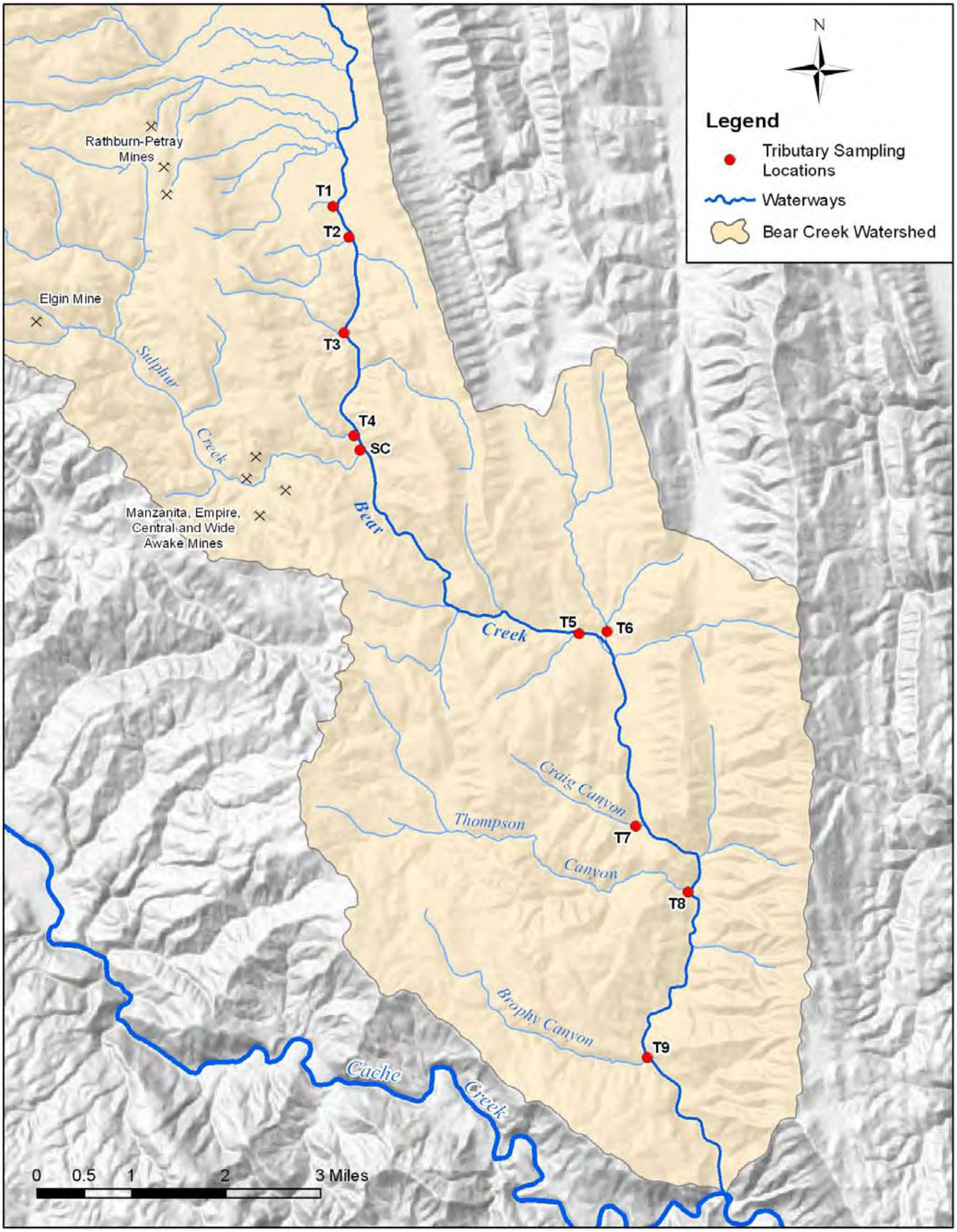

Figure 2: Tributary Sampling Locations.

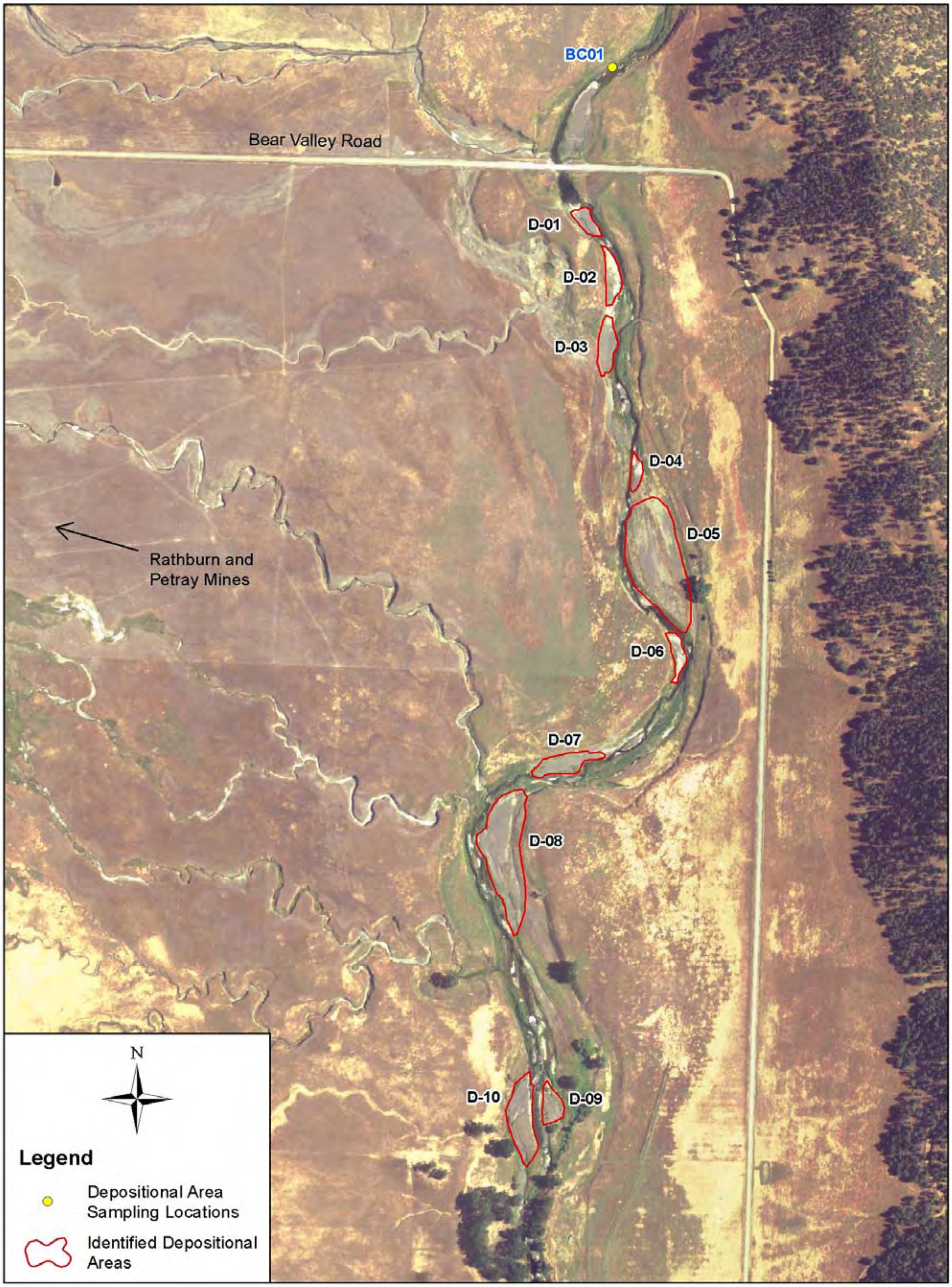

Figure 3a: Identified Depositional Areas along Bear Creek from Bear Valley Road crossing to Cache Creek.

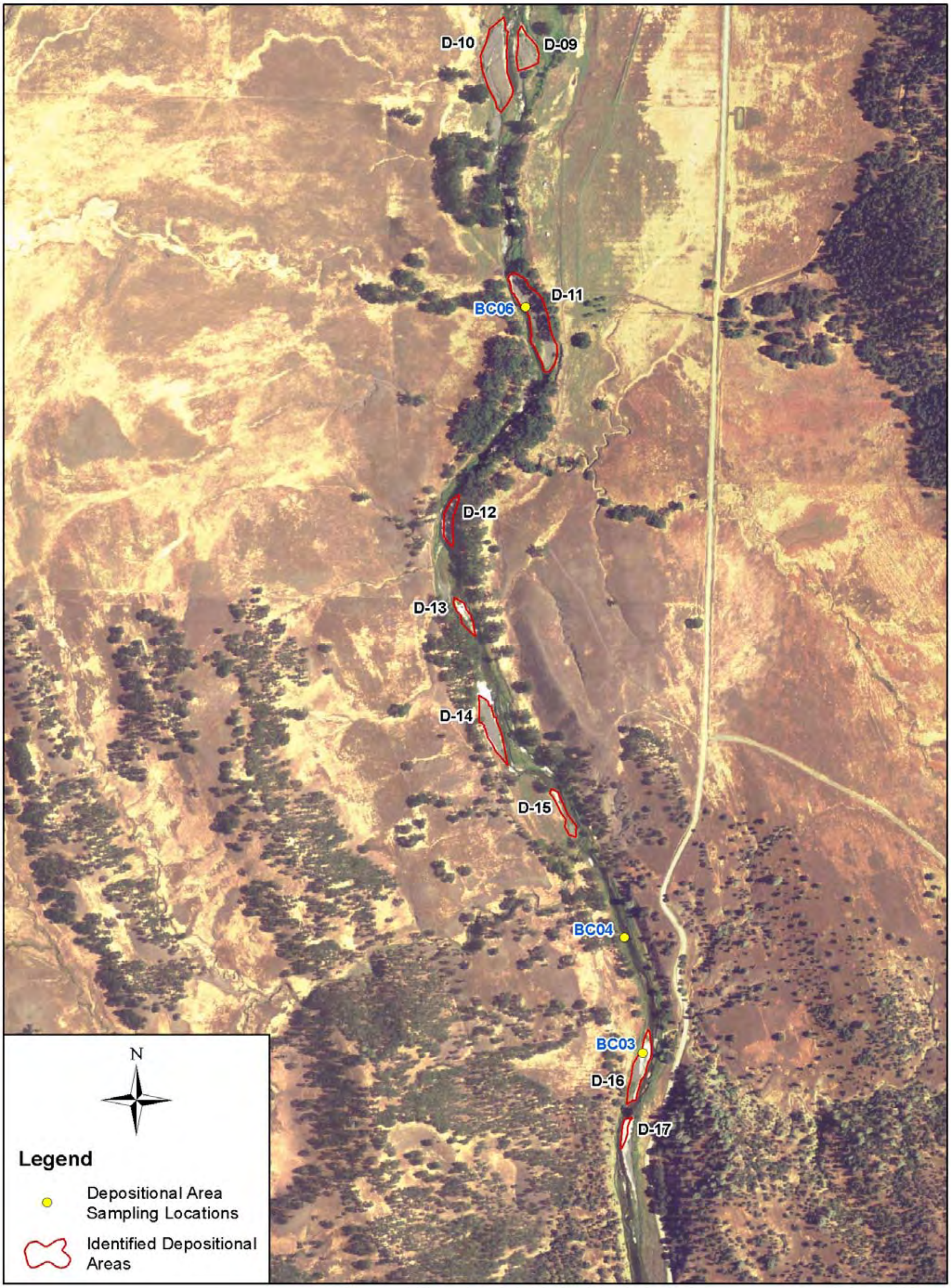

Figure 3b (continued).

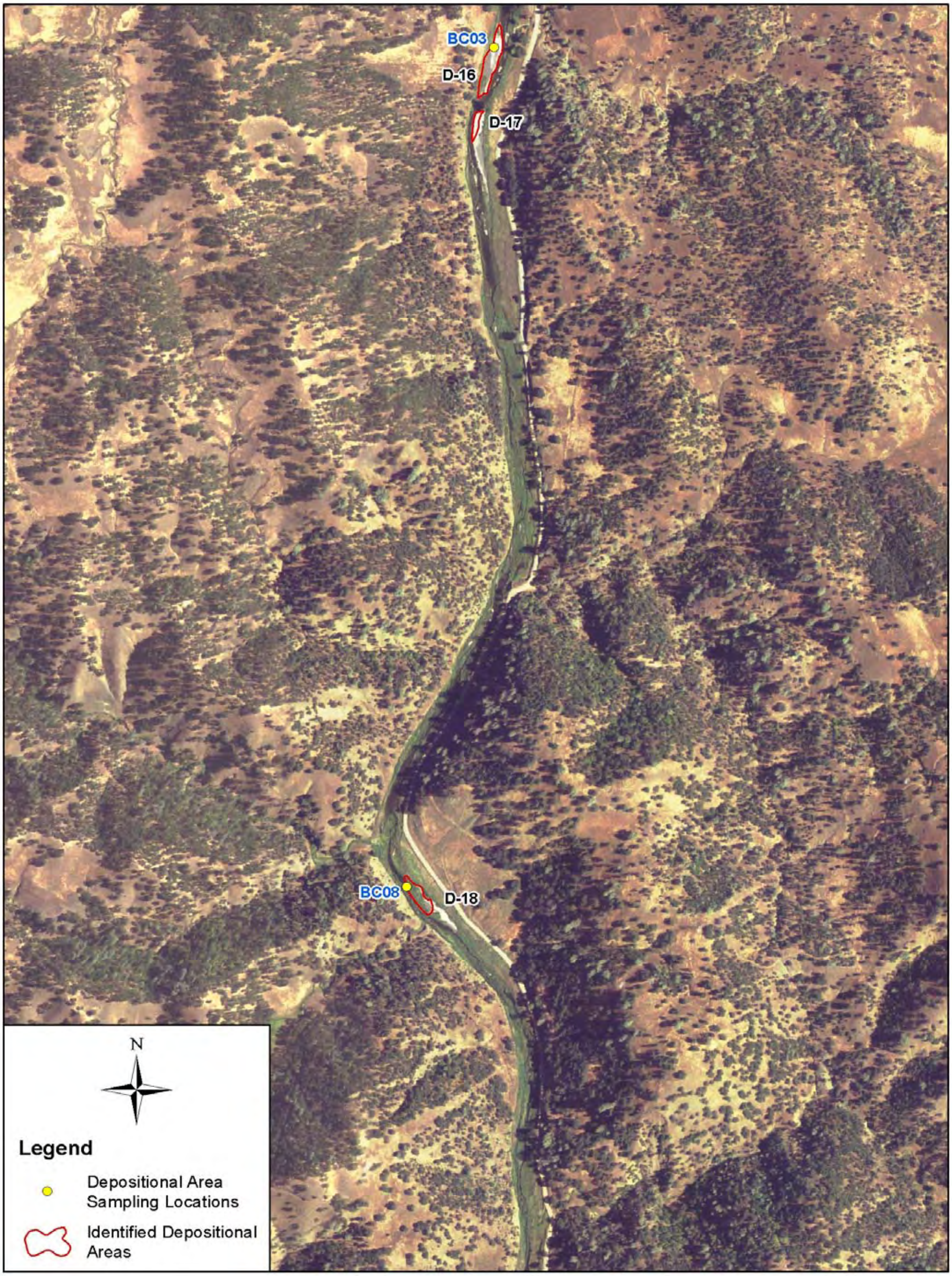

Figure 3c (continued).

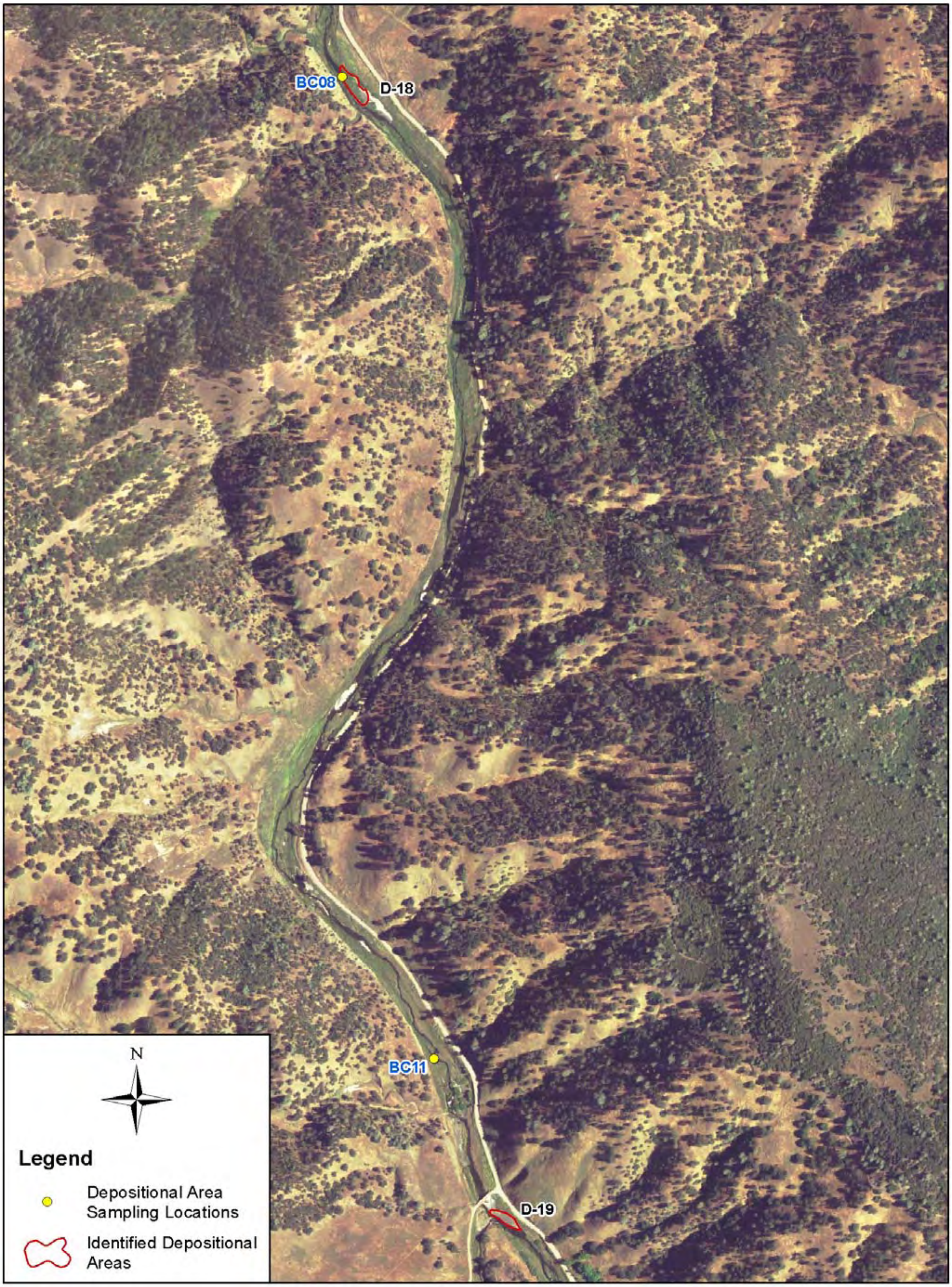

Figure 3d (continued).

Figure 33e (continued).

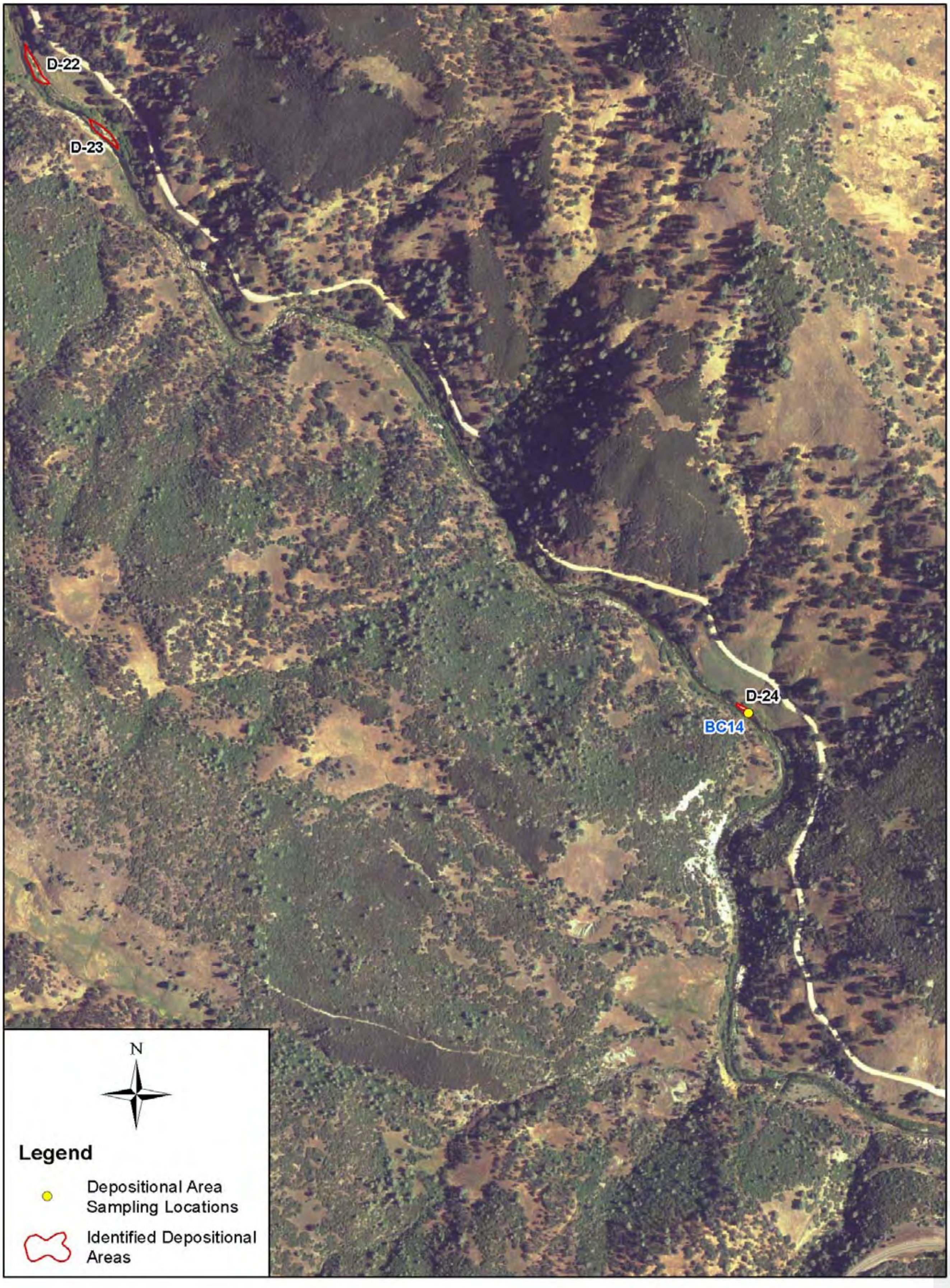

Figure 3f (continued).

Figure 3g (continued).

Figure 3h (continued).

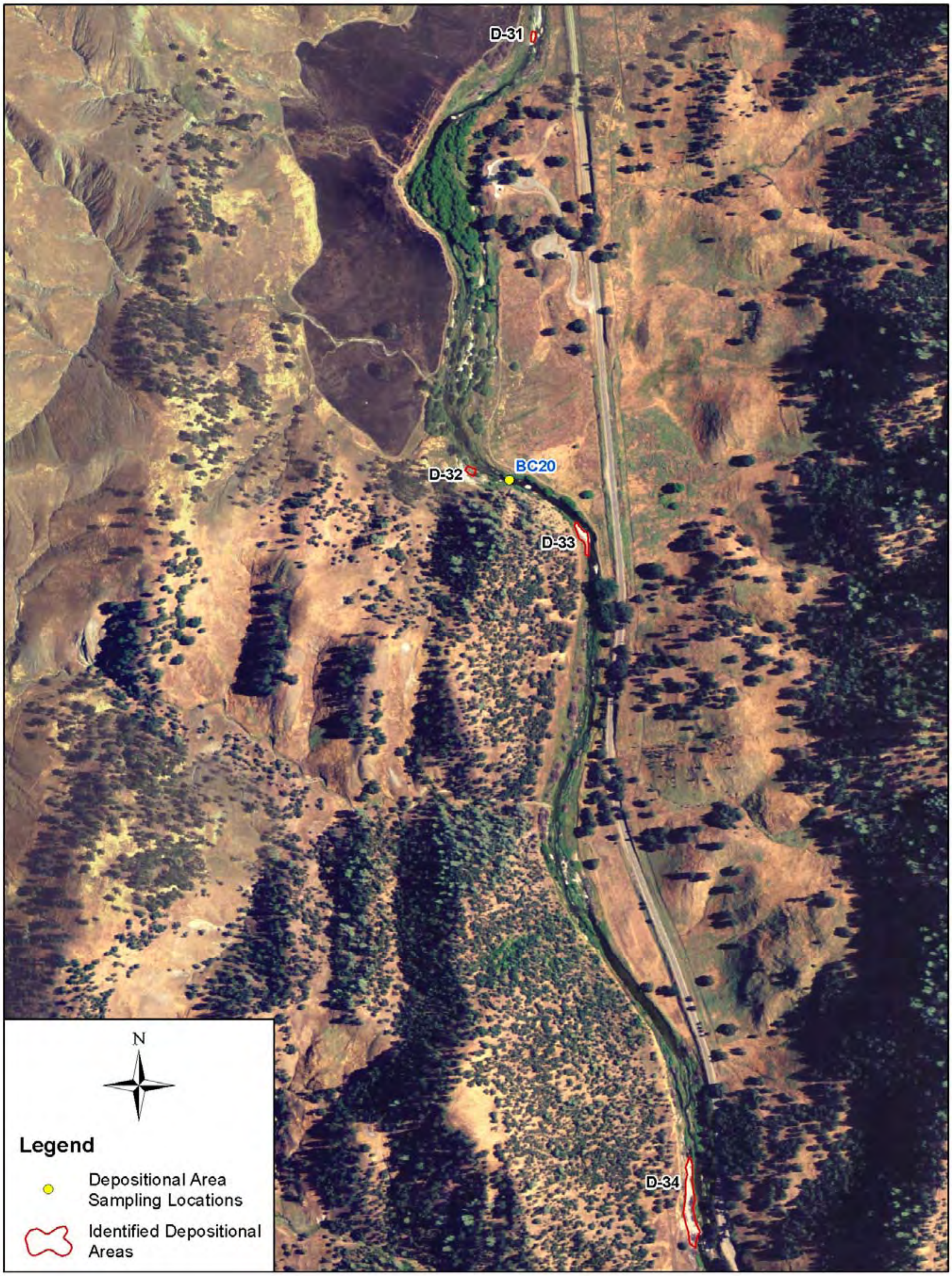

Figure 3i (continued).

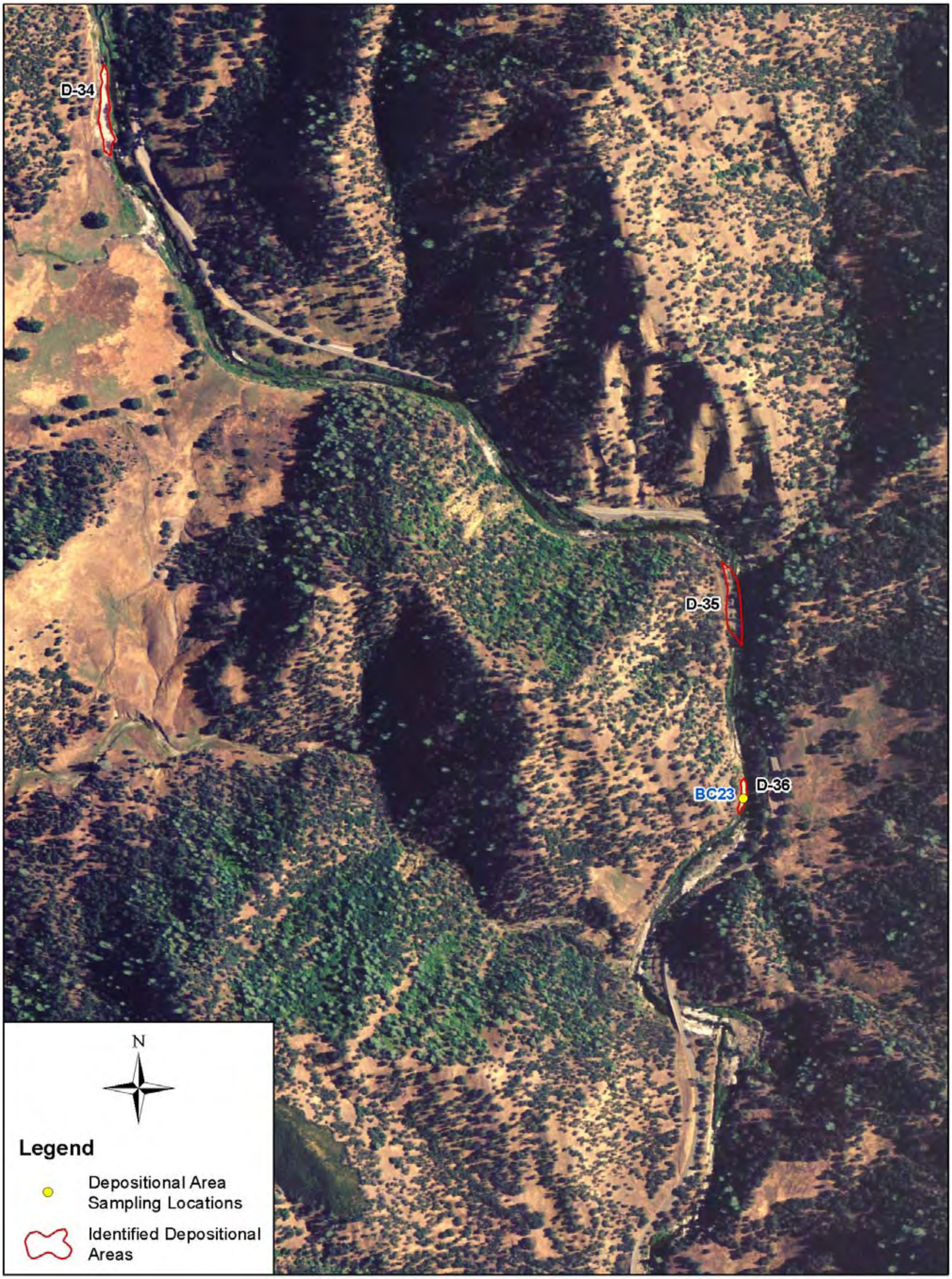

Figure 3j (continued).

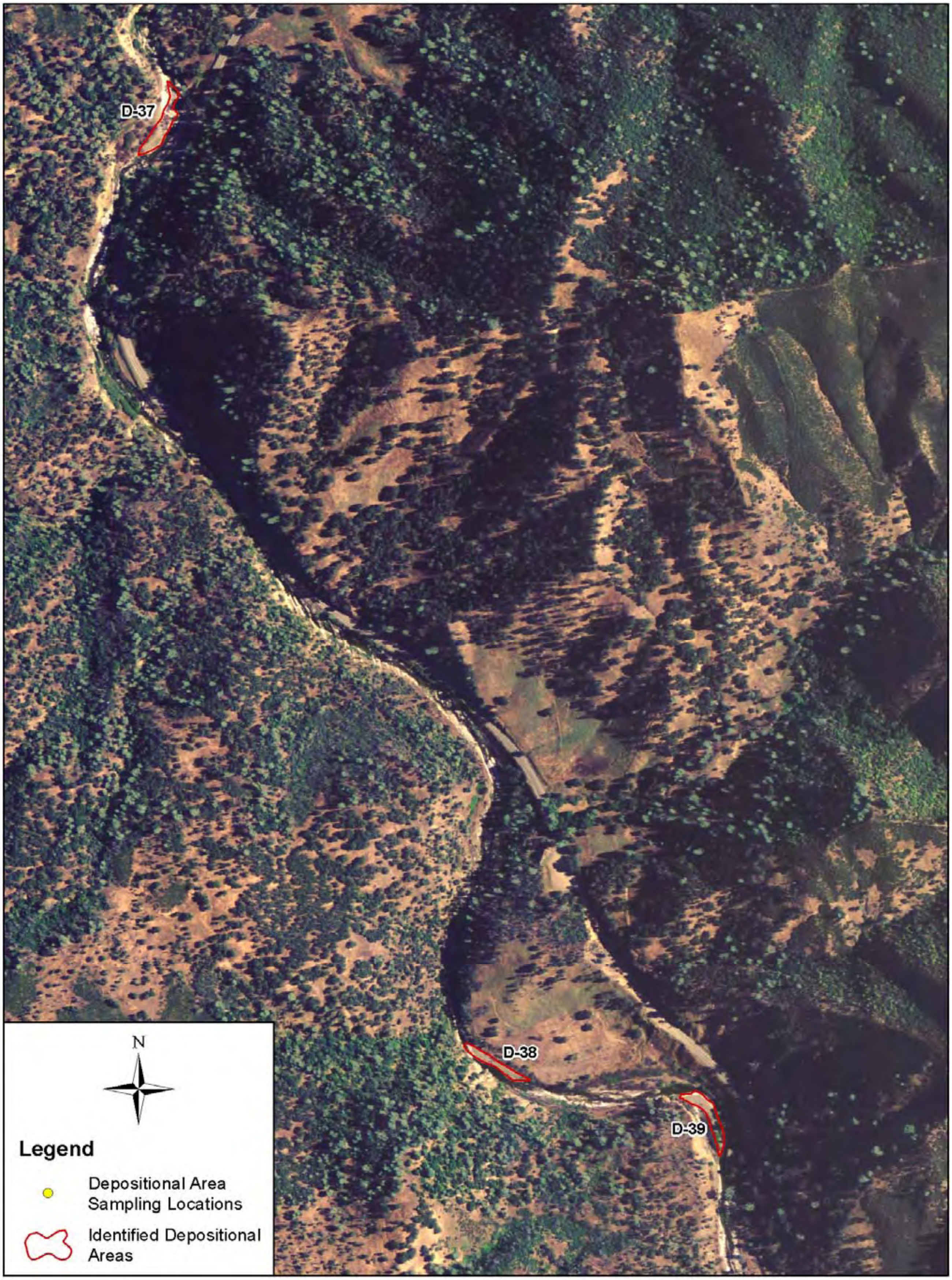

Figure 3k (continued).

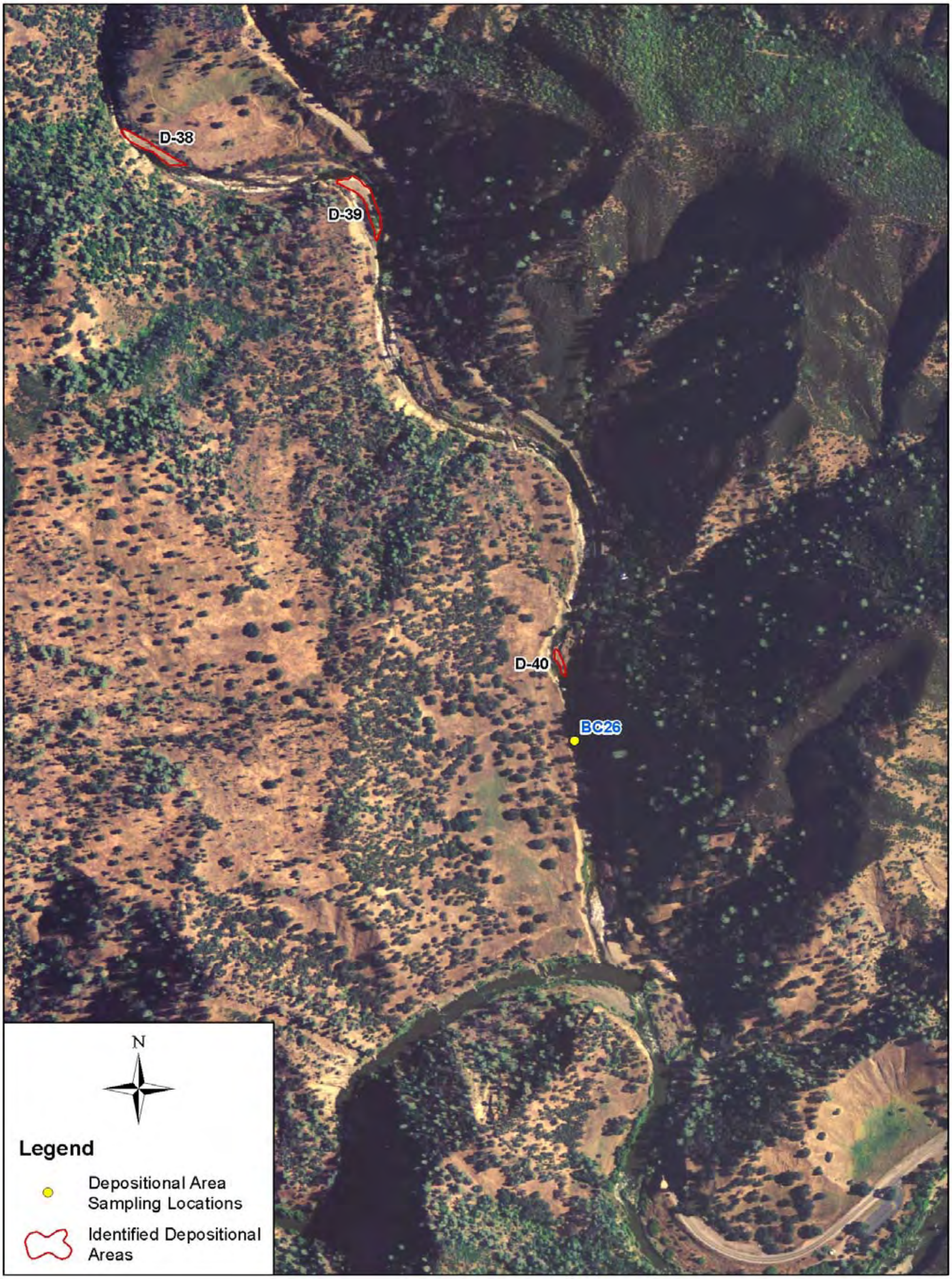

Figure 3l (continued).