Digital database of mining-related features at selected historic and active phosphate mines, Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho

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Western U.S. Phosphate Project[2]

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ABSTRACT

This report provides a description of data and processes used to produce a spatial database that delineates mining-related features in areas of historic and active phosphate mining in the core of the southeastern Idaho phosphate resource area. The data have varying degrees of accuracy and attribution detail. Classification of areas by type of mining-related activity at active mines is generally detailed; however, the spatial coverage does not differentiate mining-related surface disturbance features at many of the closed or inactive mines.

Nineteen phosphate mine sites are included in the study. A total of 5,728 hc (14,154 ac), or more than 57 km^2 (22 mi^2), of phosphate mining-related surface disturbance are documented in the spatial coverage of the core of the southeast Idaho phosphate resource area. The study includes 4 active phosphate mines - Dry Valley, Enoch Valley, Rasmussen Ridge, and Smoky Canyon - and 15 historic phosphate mines - Ballard, Champ, Conda, Diamond Gulch, Gay, Georgetown Canyon, Henry, Home Canyon, Lanes Creek, Maybe Canyon, Mountain Fuel, Trail Canyon, Rattlesnake Canyon, Waterloo, and Wooley Valley. Spatial data on the inactive historic mines is relatively up-to-date; however, spatially described areas for active mines are based on digital maps prepared in early 1999. The inactive Gay mine has the largest total area of disturbance, 1,917 hc (4,736 ac) or about 19 km^2 (7.4 mi^2). It encompasses over three times the disturbance area of the next largest mine, the Conda mine with 607 hc (1,504 ac), and it is nearly four times the area of the Smoky Canyon mine, the largest of the active mines with 497 hc (1,228 ac).

The wide range of phosphate mining-related surface disturbance features (approximately 80) were reduced to 13 types or features used in this study– adit and pit, backfilled mine pit, facilities, mine pit, ore stockpile, railroad, road, sediment catchment, tailings or tailings pond, topsoil stockpile, water reservoir, and disturbed land (undifferentiated). In summary, the spatial coverage includes polygons totaling 1,114 hc (2,753 ac) of mine pits, 272 hc (671 ac) of backfilled mine pits, 1,570 hc (3,880 ac) of waste dumps, 26 hc (64 ac) of ore stockpiles, and 44 hc (110 ac) of tailings or tailings ponds. Areas of undifferentiated phosphate mining-related land disturbances, called “disturbed land,” total 2,176 (5,377 ac) or nearly 21.8 km^2 (8.4 mi^2). No determination has been made as to status of reclamation on these lands. Subsequent site-specific studies to delineate distinct mine features will allow modification of this preliminary spatial database.

INTRODUCTION

Location, Background, and Purpose

The U.S. Geological Survey (USGS) has been studying the Permian Phosphoria Formation and related rock units in southeastern Idaho and the Western Phosphate Field throughout much of the twentieth century. In response to a request by the Bureau of Land Management (BLM), a new series of resource, geological, and geoenvironmental studies was undertaken by the USGS in 1998. Present studies, conducted under the Western U.S. Phosphate Project, consist of integrated, multidisciplinary research directed toward (1) resource and reserve estimation of phosphate in selected 7.5-minute quadrangles; (2) element residence, mineralogical, and petrochemical characteristics; (3) mobilization and reaction pathways, transport, and fate of potentially toxic elements associated with the occurrence, development, and societal use of phosphate; (4) geophysical signatures; and (5) improving understanding of depositional environment. To carry out these studies, the USGS has formed collaborative research with the BLM and the U.S. Forest Service (FS), which are responsible for land management and resource conservation on public lands, and with five companies currently leasing or developing phosphate resources in southeast Idaho: Agrium U.S. Inc. (Rasmussen Ridge mine), Astaris LLC (formerly FMC Corporation) (Dry Valley mine), J.R. Simplot Company (Smoky Canyon mine), Rhodia Inc. (Wooley Valley mine – inactive), and Monsanto (formerly Solutia Inc.) (Enoch Valley mine). Because raw data acquired during the project require time to interpret, the data are released in open-file reports for prompt availability to other scientists. Open-file reports associated with this series of resource and geoenvironmental studies are submitted to the Federal and industry collaborators for comment; however, the USGS is solely responsible for the contents of the reports.

One of the purposes of the Western U.S. Phosphate Project is to identify lands in southeastern Idaho affected by phosphate mining-related activities, and delineate mining-related features at the mines utilizing a geographic information system (GIS). A geospatial database of phosphate-mining related features provides a digital foundation for resource studies and monitoring the progress of regional geoenvironmental studies as well as analysis and interpretation of the results. Although the digital data are dated, particularly in areas of active mining and reclamation, the database can be periodically updated as needed.

Previous Studies

A spatially registered description of the phosphate mines in southeastern Idaho has not been published or released previous to this work. Several Mineral Investigation Resource Maps published in the early 1980s show mine pit boundaries (Derkey and others, 1983-1985; Palmer and others, 1985); however, these maps only show the boundaries as of the time the maps were created. Considerable mining has occurred since that time, some within the area covered by previously published maps.

Although none of the historic literature applies directly to work reported here, mention of selected references is essential. Pioneering workers such as Mansfield (1918, 1920, 1927, 1933), McKelvey and others (1953a, 1953b, 1959, 1967), Sheldon (1963, 1989), Service and Popoff

(1964), Service (1966, 1967), and Gulbrandsen and Krier (1980), concentrated predominantly on delineation and evaluation of phosphate resources and on deposit origin. Research in recent decades has produced significant literature by Gulbrandsen (1966), Piper (1974), Desborough (1977), Altschuler (1980) and others on the unusual chemistry of the Meade Peak Phosphatic Shale Member, the primary source of phosphate ore. Phosphate deposit origin, demand, and commodity studies are reported in Herring (1995), Herring and Fantel (1993), and Herring and Stowasser (1991).

METHODOLOGY

Spatial Database

Three primary types of spatial data were collected and utilized to verify the location of selected mine boundaries and features: Computer-Aided Drawing (CAD) files provided by phosphate mining companies; hard copy maps provided by a variety of agencies and companies; and USGS Digital Orthophoto Quarter Quadrangles (DOQQs). Other types of information used include color aerial photographs and the locations of control points identified using a field-portable Rockwell PLGR (Precision Lightweight GPS Receiver) Geographic Positioning System (GPS) unit during field visits. Spatial data were compiled using ArcView and ArcInfo software.

J.R. Simplot, Monsanto, Astaris LLC, and Agrium provided CAD files showing the status of mining at the end of 1998 for the four active mines in southeast Idaho, respectively, the Smoky Canyon, Enoch Valley, Dry Valley, and Rasmussen Ridge mines. In addition, J.R. Simplot provided a CAD drawing of the Conda/Woodall Mountain mine, Agrium provided hard copy mine maps for the Mountain Fuel, Champ, and Maybe Canyon mines, and Monsanto staff at the Enoch Valley mine provided hard copy maps of the Ballard mine. In order to identify and delineate older mined lands, DOQQ coverage was obtained for southeast Idaho. The DOQQs were created from black and white aerial photography flown in 1992 and 1993. Since DOQQs are georegistered, they were used to map mined areas for which no other digital data were available. Additionally, color and color infrared aerial photographs flown in the 1970s, 1980s and 1990s were used to identify and delineate mining-related features. Mapping of mine boundaries and features was accomplished with a mouse employing on-screen digitizing in ArcView 3.2 and ArcInfo. Where available, color stereo photo pairs were used to interpret information that could not be clearly distinguished on the DOQQs.

Despite the fact that DOQQs are spatially registered, additional processing was necessary to transform other data into spatially registered digital format. CAD files were obtained both in Drawing Interchange Format (DXF) and as AutoCad drawing (.dwg) files. Company surveying for the CAD files was based on local mine grids. Idaho Stateplane East projection was used for most of the drawings. ArcInfo was used to convert the CAD files to Arc format using DXFARC command. Control points used to transform the files varied with the data supplied. For CAD files that had latitude/longitude locations, those points were used to transform the CAD drawings to ArcInfo spatial databases. Most of the files and hard copy maps had only a Public Land Survey (PLS) grid for spatial control. The PLS grid was used to transform the data to a spatially registered coverage. For this process, a PLS ArcInfo coverage of Idaho, obtained from Idaho

Department of Water Resources, was used to create a tic file. Section corners were converted to tics and used for the transforms. Coverages were then attributed with information supplied by the mining companies. The resolution of the PLS coverage is 1:100,000.

Mine features on paper copies of maps obtained from Agrium and the Bureau of Indian Affairs (BIA) were digitized using ArcInfo. Latitude-longitude control points were not present on the maps, so section corners were used to transform the data, similar to the method used for the CAD drawings.

Individual mine coverages were combined into a single coverage for the region. Since the mining companies used a variety of names for similar mine features, revised feature names were assigned to groups or classes of mine features in order to apply a simple common terminology to all disturbed land. Thus, in addition to area (m^2) and perimeter (m), seven items have been added to the polygon feature attribute table: source, mine name, original feature, date, feature (assigned classification), hectares (hc), and acres (ac). Items reported in the feature attribute table, as well as a list of original mine features shown on the phosphate company maps, are described in Appendix A.

Data Problems

Several data problems were encountered. Most of the CAD files did not have a perfect correspondence to the disturbed area visible on the DOQQs. Minor changes were made in some areas to correct specific deficiencies, but no major revisions of the polygons were made. A problem encountered in digitizing from black and white DOQQs was the difficulty of distinguishing areas of re-vegetated mine waste from undisturbed land. This was overcome for many of the mine sites by using stereo pairs of color aerial photographs, since recent reclamation commonly applied standard vegetative mixes that exhibit a color response that contrasts with the surrounding natural vegetation. In areas that predate modern reclamation efforts, waste disposal areas may not be obvious, even on color photographs, due to sloughing and natural re-vegetation. In this and similar cases, the overall mining disturbed area, or polygon, is undifferentiated and is assigned as “disturbed land” (see Appendix A). The authors attempted to develop a data set of “reclaimed lands” in the database of mine features; however, several problems preclude inclusion of such data at this time (see “Reclamation” below).

Reclamation

Reclamation of mined lands has been a standard practice for companies operating phosphate mines in Idaho since the 1970’s. In fact, phosphate mining and processing companies operating in southeastern Idaho have received numerous awards for their reclamation efforts over the last 25 years.

Reclamation standards developed by the land managing agencies and the companies have changed over time in response both to regulatory development and as knowledge and experience have been gained. Consequently, reclamation procedures are in a constant state of flux. Because our understanding of the ecosystem is evolving, even the application of state-of-the-art mining and reclamation standards have resulted in unexpected impacts. Much of this is due to an incomplete understanding of the geologic characteristics of the rock and how rocks are affected

by ground and surface waters as well as plant nutrition needs. In response to the lack of understanding of the interaction of phosphatic rock and shale with water and biota, other scientists involved in the Western U.S. Phosphate project are studying these relationships in order to provide better guidance for disposal of waste rock from phosphate production.

Several difficulties culminated in the decision not to include a reclamation data set in this first-generation GIS coverage. First, there is the question of "what constitutes reclamation?" As noted above, standards changed over time. Companies operating before1970 were commonly released from lease liability with little or no requirements for re-grading, reseeding, or backfilling pits; however, these lands may be considered as reclaimed. As various laws and regulations developed, mining and reclamation practices were modified to address such conditions resulting in much higher standards for today's operators. The issue of land ownership also affects reclamation. Phosphate resources occur on Federal, State, and private lands, and reclamation standards of the various land administrators and owners may not be consistent. There is also a problem with reliability and consistency of available data. Digital and hard-copy maps acquired from different sources varied considerably in reclamation classifications. Furthermore, active mining post-dated aerial photo coverage. Even at older mines (e.g. Lanes Creek), some reclamation activity has occurred in the nine years since regional aerial photo coverage was taken.

Reclamation also crosscuts mining features. To capture reclamation status would entail delineation of features that do not necessarily coincide with mining features and are best captured in a different GIS product.

MINE SPECIFIC DESCRIPTIONS

Specific mines included in the ArcInfo coverage provided with this report are discussed below in alphabetical order. Data attribute quality varies considerably, as only limited time was available for field checking. Information on time intervals of mine operations was obtained from Lee (2000). A detailed description of the mining history of the phosphate mines listed below can be found in Lee's report.

Ballard Mine

The Ballard mine opened in 1952 and ceased operation in 1969 (Lee, 2000). Two mylar copies of mine maps were obtained from Enoch Valley mine staff, Monsanto Company. The maps contained an outline of the mine area disturbed by mining; however, the boundaries on the two maps did not agree. For this reason, it was decided to digitize the disturbance from DOQQs created using 1992 photography. Digitizing was conducted on screen in ArcView 3.2. Color aerial photographs and information collected during a 1999 site visit were used to adjust the boundaries and to delineate specific mine features.

Champ Mine/Champ Mine Extension

Mining at the Champ mine and Champ mine extension began in 1982 and was completed in 1985 (Lee, 2000). Mine boundaries and features were digitized from a 1994 reclamation map for the Champ/Champ mine extension provided by Agrium U.S. Inc. Adjustments to boundaries and features were accomplished using color aerial photographs and information collected during a 1999 site visit.

Conda/Woodall Mountain/Trail Canyon Mines

Mining at the Conda mine, including Woodall Mountain, occurred between 1920 and 1984 (Lee, 2000). Underground methods were used until 1956, and surface stripping was phased in beginning in 1952 (Lee, 2000). J.R. Simplot Company provided a DXF file that detailed most activity in this area through 1998. Not included in the file was the make-up water pond at the Conda mine and the Trail Canyon mine. These features were digitized in ArcView 3.2 from DOQQs. Delineation of some mine features was supplemented by using color aerial photography.

Kerr McGee's adjoining limestone mine was also digitized and included in the current coverage; however, the open pit disturbance area is not included in the summary statistics. The mine was included because limestone from this mine was used in vanadium recovery from ferrophosphorous slag (highly reduced iron-phosphorous waste).

Diamond Gulch Mine

Diamond Gulch was mined in 1960 (Lee, 2000). The outline of the mined area was digitized from DOQQs using ArcView 3.2 supplemented by a site visit in 1999. Due to the complex nature of strip mining, waste disposal, and reclamation at this site, no attempt was made to delineate individual features.

Dry Valley Mine

Minor production from the Dry Valley Mine reportedly occurred in 1971 for testing purposes. Full production began in 1992, and the mine is presently in operation (Lee, 2000). Astaris LLC provided a DXF file and a hard copy map outlining mining areas and specific features as of the end of 1998.

Enoch Valley Mine

The Enoch Valley mine began production in 1989, and it remains in operation (Lee, 2000). Monsanto provided a DXF file and a hard copy map outlining mining areas and specific features as of the end of 1998. Map boundaries between the Enoch Valley mine DXF map and the adjacent Rasmussen Ridge mine DXF map did not match. Modifications were made to the road that connects the two mines.

Gay Mine

The Gay mine, located on the Fort Hall Reservation of the Shoshone-Bannock Tribes, operated from 1946 to 1993 (Lee, 2000). The BIA provided hard copy maps; a mine panel map as of December 1990 and a reclamation map as of 1989. The mine panel map was digitized, and additional land affected by the mining operation was digitized from DOQQs created from aerial photographs taken in July 1992. The hard copy map of mining panels did not correspond well to mined areas visible on the DOQQS; therefore, most of the mine pits and backfilled mine pits are included in the category of disturbed lands. Also included in the disturbed lands category are more than 50 mill shale piles stockpiled by the mine operators. Mill shales are composed of subgrade phosphatic shales that generally range in grade from 14 to 18 percent P_2O_5. These materials were stockpiled in anticipation of their potential use in direct fertilizer applications. Since mining was not completed until 1993, it is possible that some of the areas impacted by mining are not delineated in this coverage.

Georgetown Canyon Mine

Georgetown Canyon was mined between 1958 and 1964 (Lee, 2000). Disturbed areas were mapped from DOQQs using ArcView 3.2 supplemented by color and color infrared aerial photography, and information collected during site visits in 1999 and 2000. In addition to alluvium, disturbed lands in the valley bottom may also be underlain by both mine and processing wastes, including slag.

Henry Mine

The Henry mine operated between 1969 and 1989 (Lee, 2000). Disturbed areas were mapped from DOQQs using ArcView 3.2 with supplemental information from color aerial photography and a site visit in 1999. Much of the historic mine area has been reclaimed; therefore, in some areas, disturbed lands are difficult to delineate on the DOQQs.

Home Canyon Mine

Mining at the Home Canyon mine, entirely by underground methods, occurred from 1920 to 1924 (Lee, 2000). The area encompassed by the main adit and dump was digitized from a DOQQ using ArcView v. 3.2 supplemented by information gathered during site visits in 1999 and 2000.

Lanes Creek Mine

Mining began at the Lanes Creek mine in1978 and continued until at least 1988 (Lee, 2000). Disturbed areas were mapped from DOQQs using ArcView 3.2 with modifications based on a site visit in 1999. The mine is presently (2000) undergoing reclamation.

Maybe Canyon Mine (North Maybe Canyon, South Maybe Canyon, North Maybe Canyon Extension)

Maybe Canyon mine operated between 1965 and 1993 (Lee, 2000). Features in the mined area were digitized from two 1995 reclamation maps of the North Maybe and South Maybe mines provided by Agrium U.S. Inc. Adjustments to the delineated features were accomplished by using DOQQs in ArcView 3.2 with supplemental information collected during a site visit in 1999. An adit and dump located between the North and South Maybe Canyon mines, along with a settling pond at the mouth of Maybe Canyon, were digitized from DOQQs.

Mountain Fuel Mine

Mountain Fuel mine operated briefly in 1966-1967; however no ore was produced at that time. Operations began again in 1985, and phosphate was produced until 1993 when the mine closed (Lee, 2000). Features in the mined area were digitized from a 1995 reclamation map of the Mountain Fuel mine created by Nu-West Mining, Inc. and provided by Agrium U.S. Inc. Adjustments to the delineated features were accomplished by using DOQQs in ArcView 3.2 with supplemental information collected during a site visit in 1999.

Rasmussen Ridge Mine

Mining at the Rasmussen Ridge mine began in 1991, and it remains in operation (Lee, 2000). Agrium U.S. Inc. provided a DXF file that detailed mining-related features in this area through 1998. Map boundaries between the DXF maps of the Rasmussen Ridge mine and the adjacent Enoch Valley mine did not match and were modified. Some polygons were modified to match the disturbed area visible on the DOQQs made from 1992 aerial photography.

Rattlesnake Mine

Limited mining was conducted at the Rattlesnake mine, entirely by underground methods, in early 1920 (Lee, 2000). The area encompassed by the main adit and dump was digitized from a DOQQ using ArcView v. 3.2 supplemented by information gathered during brief site visits in 2000. The workings were mostly hidden under a canopy of trees, and GPS measurements were used to help define the polygon made for this property.

Smoky Canyon Mine

The Smoky Canyon mine began production in 1984, and it is still in operation (Lee, 2000). The J.R. Simplot Company provided a DXF file that detailed mining-related features in this area through 1998. The polygon shapes were modified only slightly.

Waterloo Mine

Phosphate was mined by underground methods at the Waterloo mine between 1907 and the late 1920's and by open-pit methods between 1945 and 1960 (Lee, 2000). The disturbed area was mapped from DOQQs using ArcView 3.2 with supplemental information collected during a site visit in 1999. Due to the size and complexity of the site and the lack of a mine map, no attempt

was made to delineate individual mine features. The mined area is now a landfill operated and owned by Bear Lake County and is undergoing additional changes.

Wooley Valley Mine [Mill Canyon (Unit # 4), Little Long Valley (Unit # 3), and Blackfoot Narrows (Unit #1)]

The Wooley Valley mine operated between 1955 and 1989 (Lee, 2000). Disturbed areas were mapped and delineated from DOQQs using ArcView 3.2 with supplemental input from color aerial photographs and information collected during site visits in 1999 and 2000. Due to reclamation efforts on selected parts of the historic mine, disturbed lands features are difficult to delineate on the DOQQs.

SUMMARY OF SPATIAL COVERAGE

Seventeen of the nineteen sites included in this spatial database of phosphate mines in the core of the southeastern Idaho phosphate resource area were mined predominantly by open pit methods, the standard phosphate mining practice since the 1940s. Open pit phosphate mines that operated over the last 50 years in southeastern Idaho are typically characterized by large open pits, up to 90 to 120 m (300 to 400 ft) deep, voluminous waste dumps that may contain as much as 23 million m^3 (30 million yd^3) or more, and major support facilities and transportation systems (see Appendix A). Such a mine complex may occupy an area ranging from a few hectares to several square kilometers. Land disturbances associated with underground mines typically cover a few hectares or less. Three small underground mine sites are included in the spatial database. One of these is part of the Maybe Canyon mine complex, lying in Maybe Canyon between the North and South Maybe pits. The Rattlesnake and Home Canyon mines were underground operations. A major part of the Waterloo mine, and the Conda mine prior to 1956, was underground as well (Lee, 2000).

Figure 1 is a generalized map of the southeast Idaho phosphate resource area showing the 19 mine sites included in the spatial database, and Table 1 summarizes the acreage of the various mine features at each of the sites. The spatial coverage of phosphate mining-related surface disturbance in southeastern Idaho covers an area from the Gay mine northeast of Pocatello to the Waterloo mine near Montpelier and from the Conda mine near Soda Springs east to the Smoky Canyon mine. Several predominantly underground mine sites located to the south, between Montpelier and the Utah border, and north to the Montana border, are not included in this coverage. The 19 mines in the area studied include a total of 5,728 hc (14,154 ac) or more than 57 km^2 (22 mi^2). Figure 2 charts the relative size of land disturbance of the 19 mine sites. The Gay mine (figure 3) has by far the largest total area of disturbance, 1,917 hc (4,736 ac) or about 19 km^2 (7.4 mi^2). It encompasses over three times the disturbance area of the next largest mine, the Conda mine (figure 4) with 607 hc (1,504 ac), and it is nearly four times the area of the Smoky Canyon mine (figure 5), the largest of the active mines with 497 hc (1228 ac). Figure 6 shows a cluster of mines in the core of the Blackfoot River watershed, and Figure 7 is a map of the Wooley Valley mine and Angus Creek drainage, the location of on-going site-specific studies by USGS scientists also participating in the Western U.S. Phosphate project.

The spatial coverage includes mine feature polygons totaling 1,114 hc (2,753 ac) of mine pits, 272 hc (671 ac) of backfilled mine pits, 1,570 hc (3,880 ac) of waste dumps, 26 hc (64 ac) of ore stockpiles, and 44 hc (110 ac) of tailings or tailings ponds (table 1). The cumulative area of lands classed as “disturbed land” (undifferentiated), 2,176 hc (5,377 ac), may include any or all of the full range of mine features, especially mine pits, backfilled mine pits, waste dumps, and facilities. “Disturbed land” accounts for the largest area of phosphate mining-related disturbance, followed by waste dumps and mine pits. Subsequent site-specific studies to delineate distinct mine features will allow modification of this preliminary spatial database.

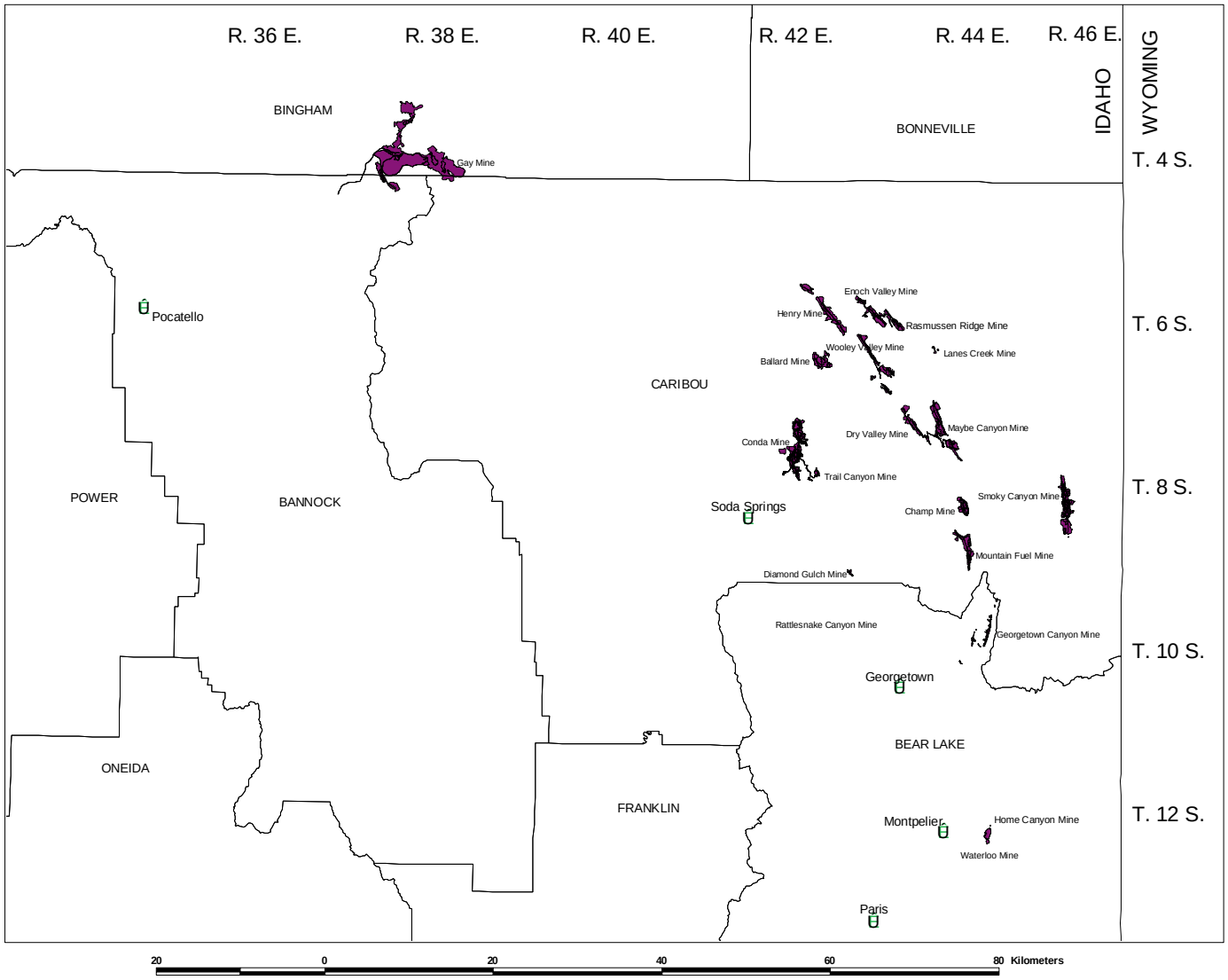
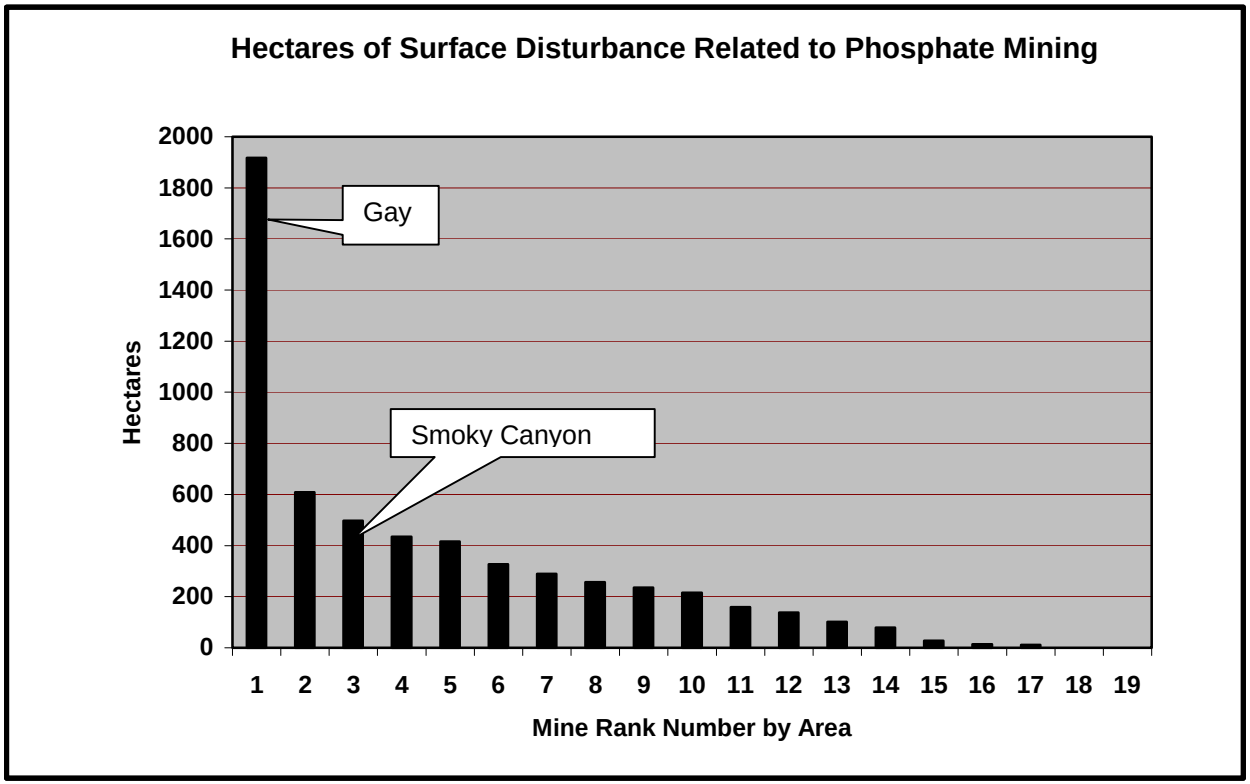


Figure 1. Generalized map of the southeast Idaho phosphate resource area showing the 19 mine sites included in the spatial database.

Table 1. Mine feature acreage for 19 mines and total for southeastern Idaho phosphate resource area.

Rank by Area	Mine Name	No. of Polygons	Adit and Pit	Mine Pit	Backfilled Mine Pit	Waste Dump	Ore Stockpile	Tailings or Tailings Pond	Disturbed Land	Sediment Catchment & Water Reservoir	Roads, Railroads, & Facilities	Topsoil Stockpile	Net Disturbed			
			(hc)	(hc)	(hc)	(hc)	(hc)	(hc)	(hc)	(hc)	(hc)	(hc)	(hc)	(km2)	(acres)	(mi2)
1	Gay Mine	42		46.0					1808.4	0.6	61.6		1916.7	19.2	4736	7.4
2	Conda Mine	177		166.6		239.0		35.8	24.2	40.2	103.0		608.6	6.1	1504	2.3
3	Smoky Canyon Mine	183		265.5		156.3			11.5		63.8		497.1	5.0	1228	1.9
4	Maybe Canyon Mine	47	0.1	133.7		222.5	3.1		9.6	0.4	46.7		416.0	4.2	1028	1.6
5	Henry Mine	18		62.1	97.8	221.9		5.3	41.0	0.2	6.4		434.7	4.3	1074	1.7
6	Wooley Valley Mine	37		54.8	61.3	146.0	7.3		2.6	13.1	42.0		327.2	3.3	808	1.3
7	Mountain Fuel Mine	22		48.8	49.5	163.4			12.3		15.8		289.8	2.9	716	1.1
8	Ballard Mine	24		86.5		40.3			129.9		0.2		256.9	2.6	635	1.0
9	Enoch Valley Mine	40		41.7		143.7				4.3	45.6		235.2	2.4	581	0.9
10	Dry Valley Mine	33		77.7		86.9	7.0			4.9	39.2		215.8	2.2	533	0.8
11	Champ Mine	17		22.2	24.8	82.0	5.8		24.0				158.8	1.6	392	0.6
12	Rasmussen Ridge Mine	24		51.0	38.9	27.3			0.4	0.7	15.1	4.0	137.2	1.4	339	0.5
13	Georgetown Canyon Mine	41		25.5		34.0	2.4	3.4	20.3	0.4	15.7		101.7	1.0	251	0.4
14	Waterloo Mine	1							79.4				79.4	0.8	196	0.3
15	Trail Canyon Mine	4		26.9						0.7			27.6	0.3	68	0.1
16	Diamond Gulch Mine	3		0.6					12.6				13.2	0.1	32	0.05
17	Lanes Creek Mine	8		3.6		7.2	0.2			0.1		0.7	11.7	0.1	29	0.05
18	Home Canyon Mine	1	0.3										0.3	0.003	0.8	0.001
19	Rattlesnake Canyon Mine	1	0.2										0.2	0.002	0.4	0.0007
	= active mine	723	0.6	1114	272	1570	26	44	2176	65	455	5	5728	57.3	14154	22.1



Rank by Area	Mine Name
1	Gay Mine
2	Conda Mine
3*	Smoky Canyon Mine
4	Henry Mine
5	Maybe Canyon Mine
6	Wooley Valley Mine
7	Mountain Fuel Mine
8	Ballard Mine
9*	Enoch Valley Mine
10*	Dry Valley Mine
11	Champ Mine
12*	Rasmussen Ridge Mine
13	Georgetown Canyon Mine
14	Waterloo Mine
15	Trail Canyon Mine
16	Diamond Gulch Mine
17	Lanes Creek Mine
18	Home Canyon Mine
19	Rattlesnake Canyon Mine
*	= active mine

Figure 2. Chart of phosphate mining-related disturbed lands, ranked by total area of surface disturbance, in southeastern Idaho.

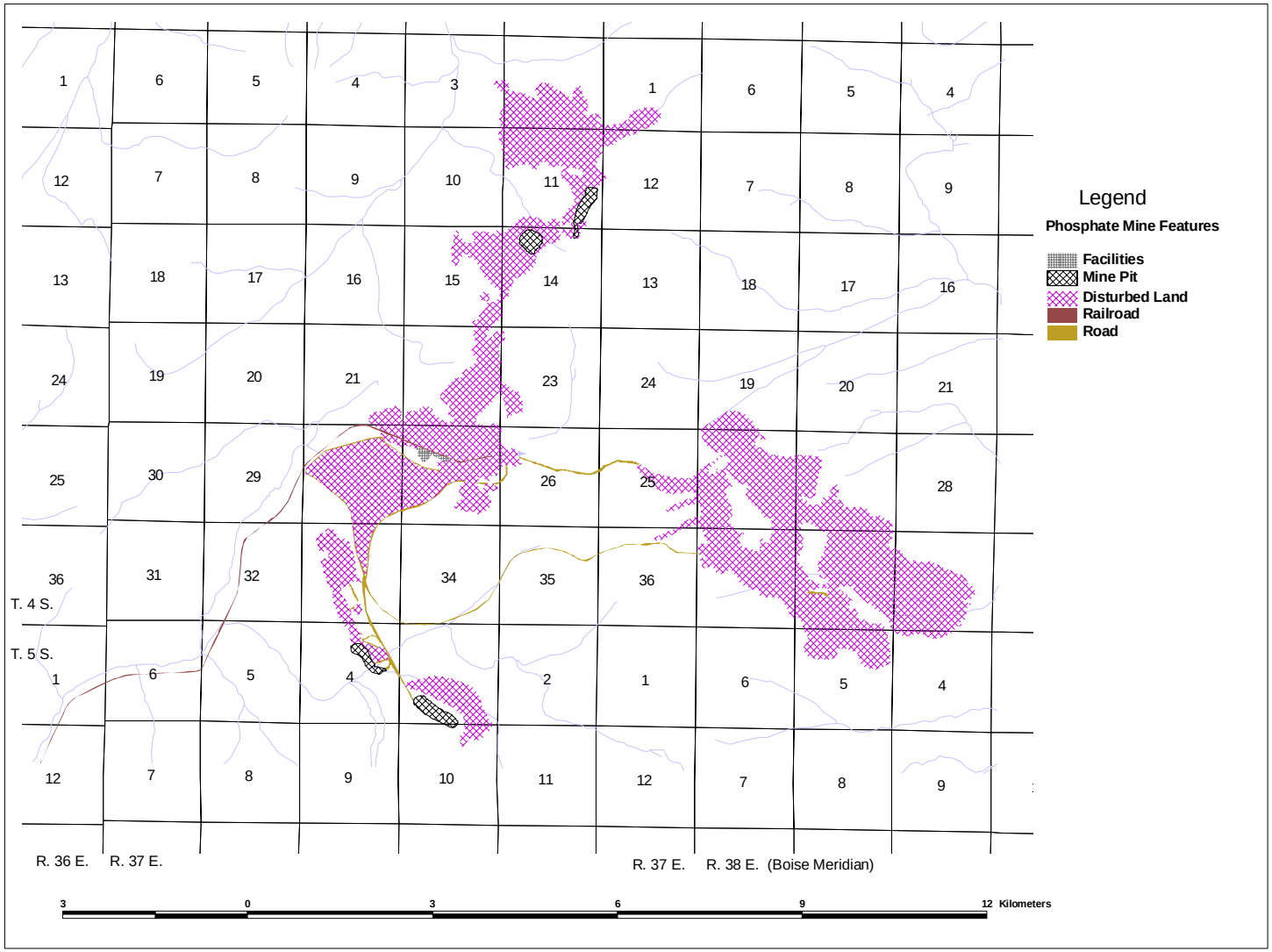


Figure 3. Map of phosphate mining-related surface disturbance at the Gay mine, Bingham, Bannock, and Caribou Counties, Idaho.

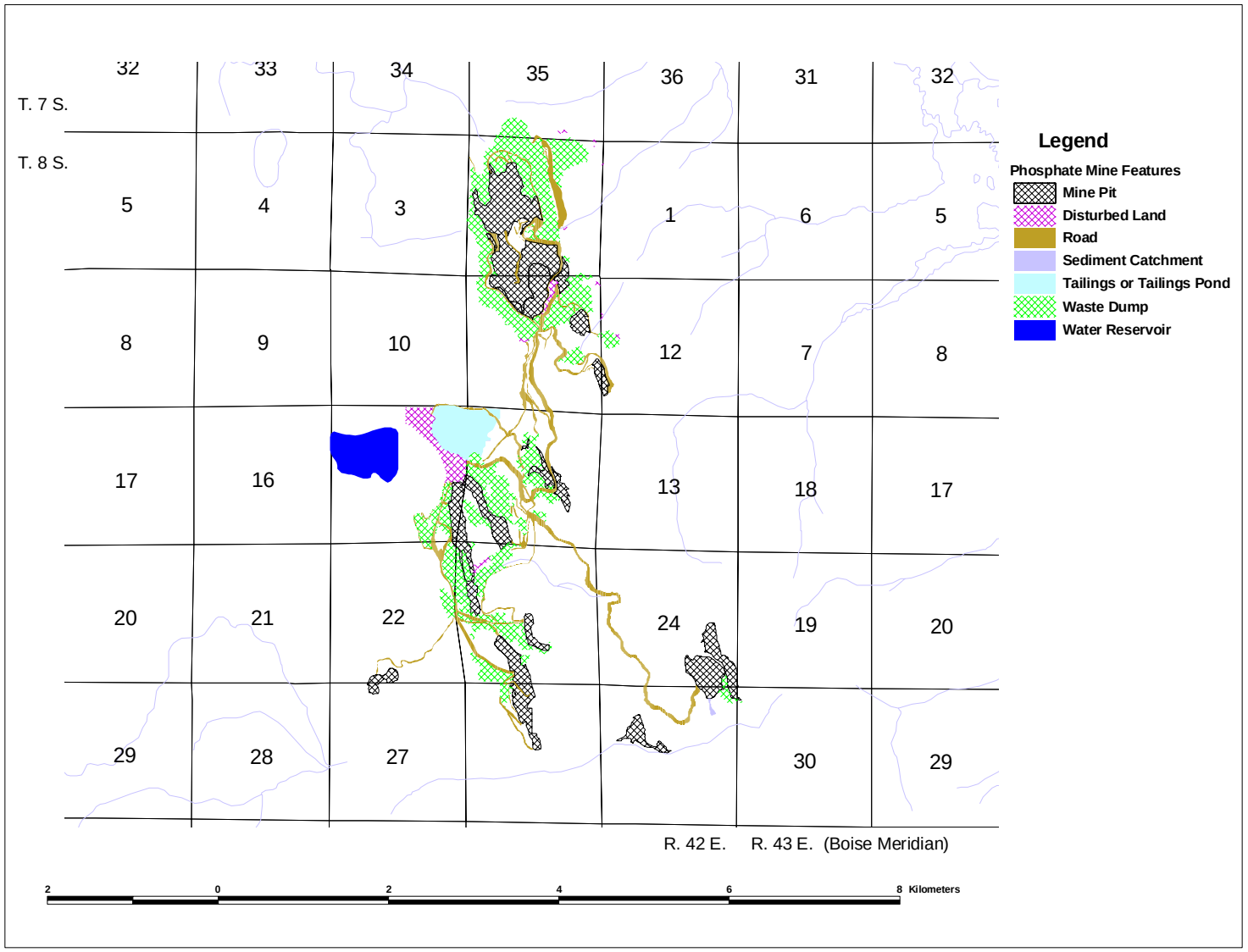


Figure 4. Map of phosphate mining-related surface disturbance at the Conda and Trail Canyon mines, Caribou County, Idaho.

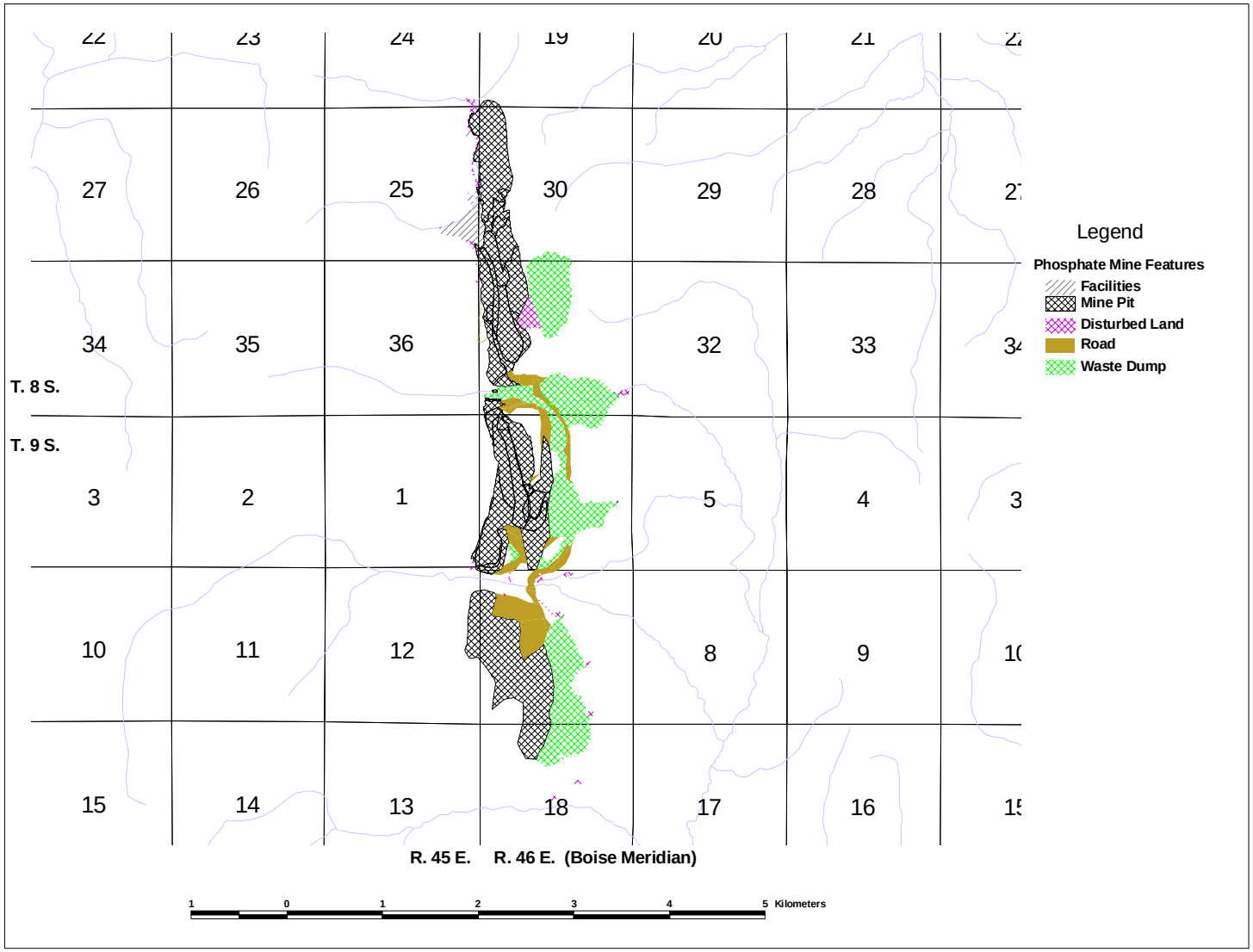


Figure 5. Map of phosphate mining-related surface disturbance at the Smoky Canyon mine, Caribou County, Idaho.

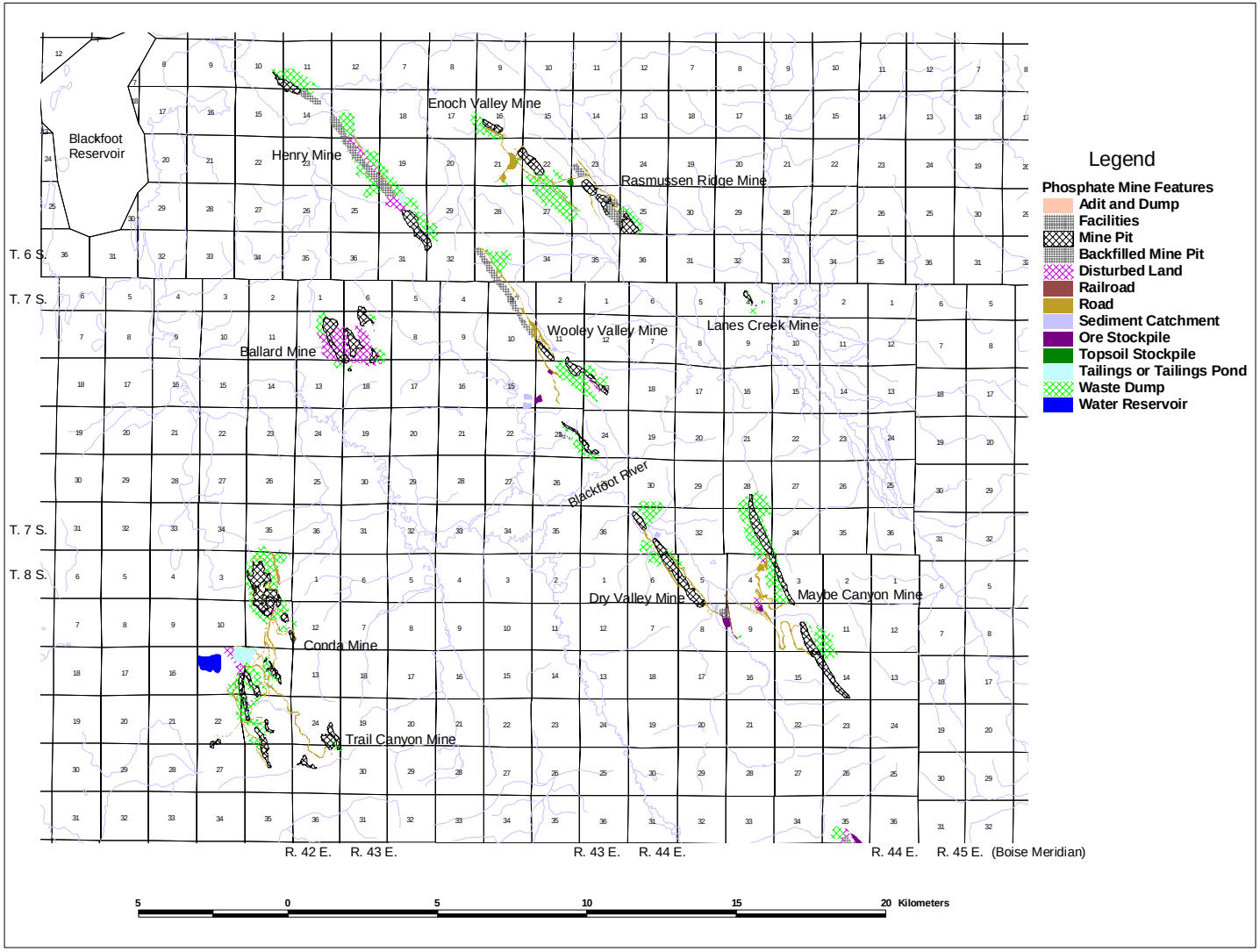


Figure 6. Map of phosphate mining-related surface disturbance at selected mines in the Blackfoot River watershed, Idaho.

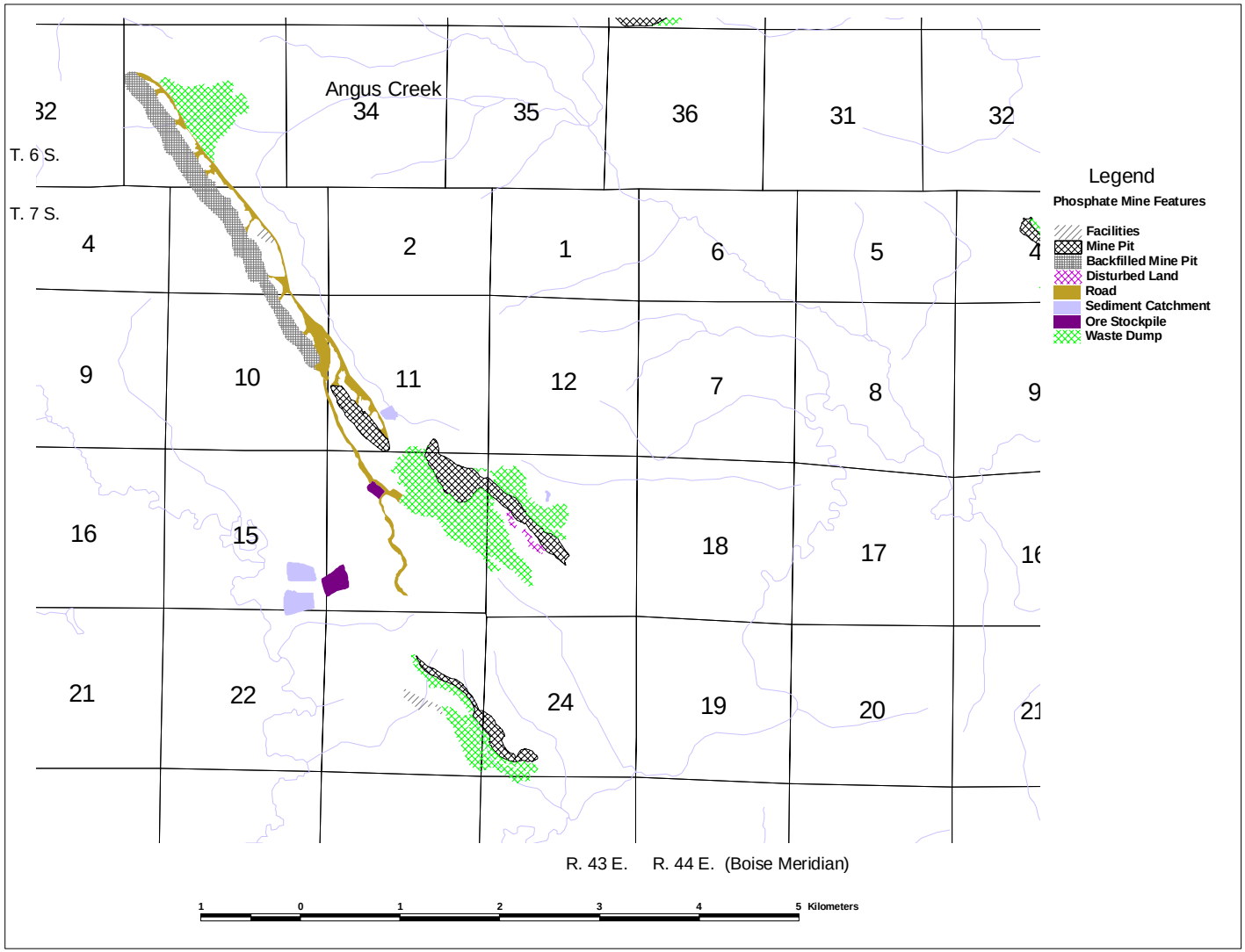


Figure 7. Map of phosphate mining-related surface disturbance at the Wooley Valley mine and Angus Creek watershed, Caribou County, Idaho.

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APPENDIX A – DIGITAL DOCUMENTATION

Introduction

As discussed in the 'methodology' section of this report, the digital map of the core of the southeastern Idaho phosphate resource area includes input on many different mines from a variety of sources: digital maps, hard copy maps, and reports from mining companies and land management agencies; DOQQs; color and infrared aerial photos; and others. Sources of data varied not only by type, but also date. For instance, digital data provided by the companies was current as of late 1998 or early 1999, whereas, DOQQs were made from aerial photographs taken in 1992 and 1993. Data input included many different terms for similar mine-related disturbances, or features, shown on the map as polygons. Some data delineated land by reclamation status while others described mine status. In order to reduce the number of polygon or feature types, the authors developed a simplified terminology scheme based on mining related features. For instance, the terms *ore stockpile*, *ore stockpile residue*, and *stockpile area*, used variably by different companies, are combined into one term, ***ore stockpile***. The original list of 80 polygons, or mine features, are presented in table A-1, and the 13 revised polygon classes, or mine features, are presented in table A-2. Both the original and revised lists include a polygon labeled as "undisturbed" to represent polygons enclosed or surrounded by mine disturbance features.

GIS Documentation

The digital map of mining-related features includes both a polygon attribute table (*phosmine.pat*) and an arc attribute table (*phosmine.aat*) that are related to a table of source information (*phosmine.ref*) by the SOURCE item (Table A-1).

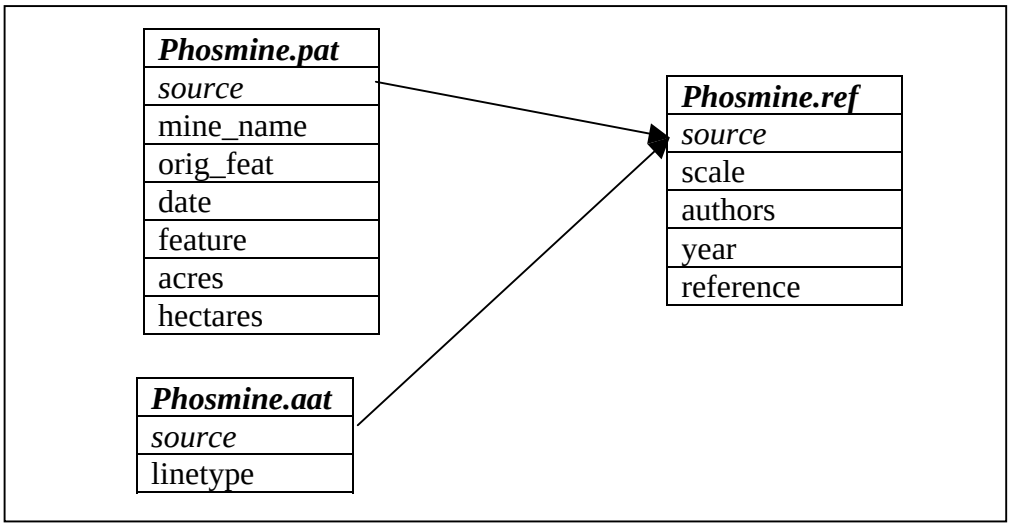

Table A-1. Relationships between feature attribute tables and lookup table, for the **PHOSMINE** dataset.

Areal Features

Descriptions of user defined items added in the polygon attribute table, *PHOSMINE.PAT*, are:

PHOSMINE.PAT			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
source	integer	4	Numeric code or abbreviation of the source information. (This item and related information occur in the PHOSMINE.REF file.)
mine_name	character	50	Name of mines
orig_feat	character	50	Original name given to polygon feature
date	character	50	Date of information
feature	character	50	Name assigned to feature for this report
acres	number	16.2	Acreage determined by multiplying the area item by 0.0002471
hectares	number	16.2	Hectares determined by multiplying the area item by 0.0001

Polygon Feature Attribute Table Definitions

The feature attribute table includes seven user defined items: source, mine_name, orig_feat, date, feature, acres, and hectares. Attributes are described below:

- **Source**: The attribute in the source item is a code number that relates to a record in the *phosmine.ref* look up table. Many of the sources are mining company files and maps that are not published and were loaned to the authors for this compilation.
- **Mine_Name**: Names of operating mines are assigned based on that used by the phosphate company; names of historic mines are taken primarily from Lee (2000).
- **Orig_feat**: Original name of feature. This is either the name supplied by the mining company or the name used during digitization of the feature.
- **Date**: Generally the most recent date of the information source is assigned. In some cases, linework supplied by the mining companies was modified to match features visible on DOQQ's, but the earlier date was not used.
- **Feature**: Revised feature names are assigned to areas, or polygons, that reflect major groups or classes of mine disturbance. The authors exercised some latitude in the interpretation of particular terms used on mining company maps after selected mine visits and careful examination of color aerial photographs. In general, mine pits indicate where phosphate resources have been removed, whereas waste dumps, ore stockpiles, tailings and tailings ponds, and backfilled pits constitute impoundments of mining or processing wastes. Original and revised mine feature terms are listed in tables A-2 and A-3, and definitions and examples of revised mine features are presented below.
- **Acres**: The area of the polygons in acres calculated by multiplying the area item (square meters) by 0.0002471.
- **Hectares**: The area of the polygons in hectares calculated by multiplying the area item (square meters) by 0.0001.

Table A-2. Index of original mine features from all data sources and revised mine features.

NO.	ORIGINAL MINE FEATURE	REVISED MINE FEATURE
1	Adit and Dump	Adit and Dump
2	1998 Reclamation	Disturbed Land
3	Miscellaneous	Disturbed Land
4	Pit and Dump	Disturbed Land
5	Proposed N.M.M.E. Pit	Disturbed Land
6	Unnamed Disturbance	Disturbed Land
7	Agrium Shop and Offices	Facilities
8	Bone Yard	Facilities
9	Building Foundation	Facilities
10	Buildings	Facilities
11	Facilities	Facilities
12	Maintenance Shop	Facilities
13	Office	Facilities
14	Parking Area	Facilities
15	Plant	Facilities
16	Prill Silo	Facilities
17	Spare Equipment Storage Area	Facilities
18	85 Pit	Mine Pit
19	BHA-Pit	Mine Pit
20	Central Rasmussen South Pit	Mine Pit
21	CME	Mine Pit
22	North Maybe Pit	Mine Pit
23	North Pit	Mine Pit
24	Pit	Mine Pit
25	Pit #1	Mine Pit
26	Pit #2	Mine Pit
27	South Maybe Pit	Mine Pit
28	South Pit	Mine Pit
29	South Rasmussen Open Pit Area	Mine Pit
30	West Limb Pit	Mine Pit
31	A-Pit	Backfilled Mine Pit
32	Backfill	Backfilled Mine Pit
33	Backfill Dump	Backfilled Mine Pit
34	B-Pit	Backfilled Mine Pit
35	Central Rasmussen North Pit Backfill Area	Backfilled Mine Pit
36	Lower South Rasmussen Pit Active Backfill Area	Backfilled Mine Pit
37	North Pit Backfill	Backfilled Mine Pit
38	South Rasmussen Active Pit Backfill Area	Backfilled Mine Pit
39	Railroad	Railroad
40	Backside Haulage Road	Road
41	Haul Road	Road
42	Road	Road

43	Road and Surface Area	Road
44	Sediment Basin	Sediment Catchment
45	Sediment Catchment Basin/Pond	Sediment Catchment
46	Settling Pond	Sediment Catchment
47	Silt Retention Pond	Sediment Catchment
48	Ore Stockpile	Ore Stockpile
49	Ore Stockpile Residue	Ore Stockpile
50	Stockpile Area	Ore Stockpile
51	Growth Media Storage Area	Topsoil Stockpile
52	Topsoil Stockpile	Topsoil Stockpile
53	Tailings Pile	Tailings or Tailings Pond
54	Tailings Pond	Tailings or Tailings Pond
55	Delineated Wetlands	Undisturbed
56	Undisturbed	Undisturbed
57	1998 North Dump	Waste Dump
58	A Dumps	Waste Dump
59	Active Dump	Waste Dump
60	Center Dump	Waste Dump
61	CME North Dump	Waste Dump
62	Dump and Catchment Basin/Pond	Waste Dump
63	Dump Area 5	Waste Dump
64	Dump Area F	Waste Dump
65	East B Dump	Waste Dump
66	East Dump	Waste Dump
67	East Limb Dumps	Waste Dump
68	East Mill Dump	Waste Dump
69	El Paso Dump	Waste Dump
70	N.W. Waste Dump	Waste Dump
71	North B Dump	Waste Dump
72	Overburden	Waste Dump
73	RR Dump	Waste Dump
74	Saddle Dump	Waste Dump
75	South B Dump	Waste Dump
76	South Maybe Dump	Waste Dump
77	Valley Dump	Waste Dump
78	Waste Dump	Waste Dump
79	West Dump	Waste Dump
80	West Mill Dump	Waste Dump

Table A-3. List of revised mine features.

NO.	REVISED MINE FEATURE
1	Mine Pit
2	Backfilled Mine Pit
3	Waste Dump
4	Adit and Dump
5	Ore Stockpile
6	Topsoil Stockpile
7	Tailings or Tailings Pond
8	Sediment Catchment
9	Facilities
10	Road
11	Railroad
12	Water Reservoir
13	Disturbed Land
14	Undisturbed

Descriptions of Revised Mine Features

- Mine Pit: Open pit or strip mine is an excavation that may include overburden, phosphate ore, and low-grade waste. The typical modern phosphate mine pit is a hundred meters or more wide, hundreds to thousands of meters long, and up to 120 m deep. Some of the thirteen original feature terms used on digital or hard copy mine maps include pit, pit # 1, pit # 2, north pit, south pit, and BHA-pit. Mine operators often assign site-specific names to mine pits for management purposes. Note that the "disturbed land" classification may include additional mine pits that were not evident to the authors.

- Backfilled Mine Pit: An open pit or strip mine that is partially or completely back filled with waste rock. Typically, this waste material consists of overburden, such as Rex Chert, or low-grade material from the Meade Peak member, such as center shale waste. Some of the eight original feature terms used on digital or hard copy mine maps include backfill, backfill dump, and north pit backfill. Note that the "disturbed land" classification may include additional backfilled pits that were not evident to the authors.

- Waste Dump: Pile or body of mine waste or spoil materials. Typically, this material consists of a range of materials including overburden, such as Rex Chert, low-grade material from the Meade Peak member, such as center waste shale, or any other materials removed in order to expose, excavate, and ship ore. Some of the twenty-four original feature terms used on digital or hard copy mine maps include: A dumps, active dump, center dump, east dump, and valley dump. Mine operators also commonly assign site-specific names to waste dumps for management purposes. Note that the "disturbed land" classification may include additional waste dumps that were not evident to the authors.

- Adit and Dump: An adit is a horizontal or nearly horizontal passage driven (excavated) from the surface for the working of an underground mine. An accompanying dump contains the excavated waste material (see Waste Dump above). An adit may be driven for exploration or for production.

- Ore Stockpile: Phosphatic ore stored on the surface before shipping. This feature is also referred to as ore stockpile residue or stockpile area. Note that the "disturbed land" classification may include additional ore stockpiles that were not evident to the authors.

- Topsoil Stockpile: A pile of topsoil typically reserved for mine reclamation. This feature is also referred to as a growth media storage area.

- Tailings or Tailings Pond: Waste material or slurry from processing of phosphate ore usually stored in an impoundment; typically fine grained. Note that the "disturbed land" classification may include additional tailings features that were not evident to the authors.

- Sediment Catchment: A surface structure, such as a reservoir, constructed to hold runoff or discharge waters. This feature is also referred to as a sediment basin, settling pond, or silt retention pond.

- Facilities: Any buildings, related structures, or areas constructed and maintained to support the phosphate mining and processing operation. Examples of original feature terms include buildings, building foundation, maintenance shop, office, parking area, plant, prill silo, and spare equipment storage area. Note that the "disturbed land" classification may include additional facilities that were not evident to the authors.

- Road: A roadway or pathway for wheeled vehicles in support of mining. Examples of original feature terms include haul road, backside haulage road, and road and surface area. Roads may have been constructed by cut, cut and fill, or fill methods. Cut or cut and fill methods will generally result in a road composed of rock through which the road is cut. However, roads constructed using fill materials may be composed of any rock wasted from the mining operation or surrounding area including overburden or waste rock bounding the ore zones.

- Railroad: Rail transport system used to haul phosphate ore from the mine loading facility, typically referred to as a tipple, to the storage area at a processing plant.

- Water Reservoir: A fresh water reservoir at Conda provides make-up water for a phosphate slurry pipeline, operated by J.R. Simplot Company, that transports phosphate produced at the Smoky Canyon mine to the processing plant in Pocatello.

- Disturbed Land: An undifferentiated disturbance, including any of the above described features, related to phosphate mining, transport, or processing. This classification was assigned to many areas, or polygons, that could not otherwise be identified due to lack of hard copy or digital maps of mine features, inadequate resolution on DOQQs or aerial photos, or insufficient time for field reconnaissance. For instance, lacking both maps of mine

features and a thorough field reconnaissance, the entire area affected by the Waterloo mine is classified as disturbed land. Certainly, subsequent studies to delineate distinct mine features will allow modification of the spatial database.

- Undisturbed: Areas of undisturbed land that are included with or are enclosed by polygons of phosphate mining-related surface disturbance.

Linear Features

Descriptions of user defined items added to the arc attribute table, *PHOSMINE.AAT*, are:

PHOSMINE.AAT			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
source	integer	4	Numeric code or abbreviation of the source information. (This item and related information occur in the *PHOSMINE.REF* file.)
linetype	character	50	Description of the line type

Linetype has two sources. Data converted from CAD or DXF files and lines that were digitized from DOQQ's or paper maps. Most of the lines that were digitized or converted from CAD were coded line type 1. These are generally contacts of features specifically related to extraction and deposition of rock material. Lines digitized from DOQQ's mostly fall in that category also. The remaining line types are infrastructure, geographic features, and potential mining areas. Table A-4 lists the line types used and their description.

Table A-4. Descriptions of linetype used in the phosmine.aat.

Linetype	**Description**
1	Lines delineating mining features from CAD files or digitized from paper maps.
Building	Building outline, digitized from DOQQ's
Creek	CAD lines of unnamed creek cutting through Smoky Canyon Mine
Digitized from DOQQ	Interpreted mine features digitized from Digital Orthophoto Quarter Quarter quadrangle maps
Mine Extension	Lines digitized from paper map that delineate lands not disturbed in 2000, but may be mined at a future date.
Ore Tram	Digitized lines of location of an ore tram at Wooley Valley Mine that is no longer in existence
Power line	Power lines
Railroad	Railroad tracks digitized from paper maps
Road	Roads
Sage Creek	CAD lines of Sage Creek, Idaho cutting through Smoky Canyon Mine
Stream	CAD lines of unnamed stream cutting through Smoky Canyon Mine
U of I Selenium Test Site	CAD lines of University of Idaho selenium test site at Smoky Canyon Mine

Source Attributes

Descriptive source or reference information for the **PHOSMINE** ArcInfo coverage files is stored in the PHOSMINE.REF file. Attribute descriptions for items in the PHOSMINE.REF data source file is as follows:

PHOSMINE.REF			
ITEM NAME	ITEM TYPE	ITEM LENGTH	ATTRIBUTE DESCRIPTION
source	integer	4	Numeric code used to identify the data source. (This item also occurs in the *PHOSMINE.PAT* AND *PHOSMINE.AAT* files.)
scale	integer	8	Scale of source map. (This value is the denominator of the proportional fraction that identifies the scale of the map that was digitized or scanned to produce the digital map.)
authors	character	200	Author(s) or compiler(s) of source map entered as last name, first name or initial, and middle initial.
year	integer	4	Source (map) publication date
reference	character	250	Remainder of reference in USGS reference format.

Obtaining Digital Data

The digital version of this coverage is available in ArcInfo interchange- format with associated data files. These data and map images are maintained in a Universal Transverse Mercator (UTM) map projection:

Projection:	UTM
Zone:	12
Units:	meters
Datum:	NAD83

Note that this projection can also be described in the following manner:

Transverse Mercator:
Scale Factor at Central Meridian: 0.999600
Longitude of Central Meridian: -111.000000
False Easting: 500000.000000
False Northing: 0.000000
Units: meters
HorizontalDatumName: North American Datum of 1983
Ellipsoid Name: Geodetic Reference System 80

To obtain copies of the digital data, do one of the following:

1. Download the digital files from the USGS public access World Wide Web site on the Internet: **URL =** http://geopubs.wr.usgs.gov/open-file/of01-142/
or

2. Anonymous FTP from **geopubs.wr.usgs.gov,** in the directory
pub/ open-file/of01-142/

The Internet sites contain the digital coverage of disturbed areas at selected phosphate mines in southeastern Idaho in ArcInfo interchange-format files (phosmine.e00).

To manipulate these data in a geographic information system (GIS), you must have a GIS that is capable of reading ArcInfo interchange-format files and can perform relational linking.

APPENDIX B – LIST OF DIGITAL FILES

There are three files associated with this report. They are:

Phosmine.e00 – Arc Export format spatial database of mining-related features
Phosmine.met – Metadata for phosmine spatial data
OF_01142.pdf – This report in Adobe Portable Document Format (PDF)

APPENDIX C - METADATA

```
Identification_Information:
  Citation:
    Citation_Information:
      Originator: J. Douglas Causey and Phillip R. Moyle
      Publication_Date: 2001
      Title: Digital database of mining-related features at selected historic
and active phosphate mines, Bannock, Bear Lake, Bingham, and Caribou
Counties, Idaho
      Edition: 1
      Geospatial_Data_Presentation_Form: vector digital data
      Series_Information:
        Series_Name: Open File Report
        Issue_Identification: OF 01-142
      Publication_Information:
        Publication_Place: Menlo Park, CA
        Publisher: U.S. Geological Survey
  Description:
    Abstract: This is a spatial database that delineates mining-related
features in areas of historic and active phosphate mining in the core of the
southeastern Idaho phosphate resource area.  The data has varying degrees of
accuracy and attribution detail. The breakdown of areas by type of activity at
active mines is detailed; however, the disturbed areas at many of the closed
or inactive mines are not subdivided into specific categories detailing the
type of activity that occurred.
    Purpose: It is used to identify lands in southeastern Idaho affected by
phosphate mining, and delineate mining-related features at the mines.
  Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 1998
    Currentness_Reference: ground condition
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: None planned
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -112.178715
      East_Bounding_Coordinate: -111.114629
      North_Bounding_Coordinate: 43.107205
      South_Bounding_Coordinate: 42.305389
  Keywords:
    Theme:
      Theme_Keyword_Thesaurus: None
      Theme_Keyword: phosphate
      Theme_Keyword: mining
      Theme_Keyword: mine land
      Theme_Keyword: disturbed land
    Place:
      Place_Keyword_Thesaurus: None
      Place_Keyword: Idaho
      Place_Keyword: Soda Springs
      Place_Keyword: Caribou County
      Place_Keyword: Bear Lake County
      Place_Keyword: Blackfoot Reservoir
```

```
      Place_Keyword: Bannock County
      Place_Keyword: Bingham County
      Place_Keyword: Gay mine
      Place_Keyword: Fort Hall
      Place_Keyword: Smoky Canyon Mine
      Place_Keyword: Enoch Valley Mine
      Place_Keyword: Rassmussen Ridge Mine
      Place_Keyword: Conda Mine
      Place_Keyword: Trail Canyon Mine
      Place_Keyword: Mountain Fuel Mine
      Place_Keyword: Ballard Mine
      Place_Keyword: Champ Mine
      Place_Keyword: Henry Mine
      Place_Keyword: Georgetown Canyon Mine
      Place_Keyword: Waterloo Mine
      Place_Keyword: Lanes Creek Mine
      Place_Keyword: Rattlesnake Canyon Mine
      Place_Keyword: Kerr McGee limestone mine
      Place_Keyword: Wooley Valley Mine
      Place_Keyword: Maybe Canyon Mine
      Place_Keyword: Dry Valley Mine
      Place_Keyword: Diamond Gulch Mine
  Access_Constraints: None
  Use_Constraints:
    This digital database is not meant to be used or displayed at any scale
    larger than 1:24,000 (e.g. 1:12,500).
    Any hardcopies utilizing these data sets shall clearly indicate
    their source. If the user has modified the data in any way
    they are obligated to describe the types of modifications they
    have performed on the hardcopy map. User specifically agrees
    not to misrepresent these data sets, nor to imply that changes they
    made were approved by the US Geological Survey.
  Point_of_Contact:
    Contact_Information:
      Contact_Person_Primary:
        Contact_Person: J. Douglas Causey
        Contact_Organization: U.S. Geological Survey
      Contact_Position: Geologist
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 904 W. Riverside Ave., Rm 202
        City: Spokane
        State_or_Province: WA
        Postal_Code: 99201-1087
        Country: USA
      Contact_Voice_Telephone: 509.368.3116
      Contact_Facsimile_Telephone: 509.368.3199
      Contact_Electronic_Mail_Address: dcausey@usgs.gov
      Hours_of_Service: 8 AM - 4 PM PST
  Native_Data_Set_Environment: Windows NT Version 4.0 (Build 1381) Service
Pack 6; ESRI ArcInfo 8.1.0.415
Data_Quality_Information:
  Attribute_Accuracy:
    Attribute_Accuracy_Report:
      Attribute accuracy was verified by manual comparison of the source with
      hard copy printouts, plots, and on-screen evaluation.
  Logical_Consistency_Report:
```

```
    Polygon and chain-node topology present.
    Segments making up the boundaries of a polygon
    tie end-to-end to completely enclose the area. No duplicate
    features exist. Intersecting
    lines are separated into individual line segments at the point of
    intersection.  All nodes are
    represented by a single coordinate pair which indicates the beginning
    or end of a line segment.
  Completeness_Report: All polygons were derived from company or government
maps, or digitized using aerial photo interpretation.
  Positional_Accuracy:
    Horizontal_Positional_Accuracy:
      Horizontal_Positional_Accuracy_Report: Accuracy is variable.  Most lines
are probably within 10 meters.
  Lineage:
    Source_Information:
      Source_Citation:
        Citation_Information:
          Originator: J. Douglas Causey and Phillip R. Moyle
          Publication_Date: 2001
          Title: Digital database of mining-related features at selected
historic and active phosphate mines, Bannock, Bear Lake, Bingham, and Caribou
Counties, Idaho
          Edition: 1
          Geospatial_Data_Presentation_Form: map
          Series_Information:
            Series_Name: Open file report
            Issue_Identification: OF 01-142
          Publication_Information:
            Publication_Place: Menlo Park, California
            Publisher: U.S. Geological Survey
          Online_Linkage: http://geopubs.wr.usgs.gov/open-file/of01-142
      Source_Scale_Denominator: 24000
      Type_of_Source_Media: online
      Source_Time_Period_of_Content:
        Time_Period_Information:
          Single_Date/Time:
            Calendar_Date: 1998
        Source_Currentness_Reference: ground condition
      Source_Citation_Abbreviation: Causey and Moyle, 2001
      Source_Contribution: Combined, attributed, and defined all digital work
into one report
    Process_Step:
      Process_Description: Hard copy maps were digitized, see report
      Source_Used_Citation_Abbreviation: See phosmine.ref table
      Process_Date: January, 2001
      Source_Produced_Citation_Abbreviation: Causey and Moyle, 2001
      Process_Contact:
        Contact_Information:
          Contact_Person_Primary:
            Contact_Person: J. Douglas Causey
            Contact_Organization: U.S. Geological Survey
          Contact_Position: Geologist
          Contact_Address:
            Address_Type: mailing and physical address
            Address: 904 W. Riverside Ave., Rm 202
            City: Spokane
```

```
            State_or_Province: WA
            Postal_Code: 99201-1087
            Country: USA
          Contact_Voice_Telephone: 509.368.3116
          Contact_Facsimile_Telephone: 509.368.3199
          Contact_Electronic_Mail_Address: dcausey@usgs.gov
          Hours_of_Service: 8 AM - 4 PM PST
    Process_Step:
      Process_Description: CAD files were converted to Arc files
      Source_Used_Citation_Abbreviation: CAD files
      Process_Date: January, 2001
      Source_Produced_Citation_Abbreviation: Causey and Moyle, 2001
      Process_Contact:
        Contact_Information:
          Contact_Person_Primary:
            Contact_Person: J. Douglas Causey
            Contact_Organization: U.S. Geological Survey
          Contact_Position: Geologist
          Contact_Address:
            Address_Type: mailing and physical address
            Address: 904 W. Riverside Ave., Rm 202
            City: Spokane
            State_or_Province: WA
            Postal_Code: 99201-1087
            Country: USA
          Contact_Voice_Telephone: 509.368.3116
          Contact_Facsimile_Telephone: 509.368.3199
          Contact_Electronic_Mail_Address: dcausey@usgs.gov
          Hours_of_Service: 8 AM - 4 PM PST
    Process_Step:
      Process_Description: Data digitized from DOQQ's
      Source_Used_Citation_Abbreviation: DOQQ
      Process_Date: February, 2001
      Source_Produced_Citation_Abbreviation: Causey and Moyle, 2001
      Process_Contact:
        Contact_Information:
          Contact_Person_Primary:
            Contact_Person: J. Douglas Causey
            Contact_Organization: U.S. Geological Survey
          Contact_Position: Geologist
          Contact_Address:
            Address_Type: mailing and physical address
            Address: 904 W. Riverside Ave., Rm 202
            City: Spokane
            State_or_Province: WA
            Postal_Code: 99201-1087
            Country: UAS
          Contact_Voice_Telephone: 509.368.3116
          Contact_Facsimile_Telephone: 509.368.3199
          Contact_Electronic_Mail_Address: dcausey@usgs.gov
          Hours_of_Service: 8 AM - 4 PM PST
    Process_Step:
      Process_Description: Data from previous 3 process steps were projected
to common projection (UTM Zone 12, NAD 83, units meters) and combined.
Mismatches were corrected based on DOQQ's.  Attributes were defined.
      Source_Used_Citation_Abbreviation: DOQQ
      Process_Date: March, 2001
```

```
      Source_Produced_Citation_Abbreviation: Causey and Moyle, 2001
      Process_Contact:
        Contact_Information:
          Contact_Person_Primary:
            Contact_Person: J. Douglas Causey
            Contact_Organization: U.S. Geological Survey
          Contact_Position: Geologist
          Contact_Address:
            Address_Type: mailing and physical address
            Address: 904 W. Riverside Ave., Rm 202
            City: Spokane
            State_or_Province: WA
            Postal_Code: 99201-1087
            Country: USA
          Contact_Voice_Telephone: 509.368.3116
          Contact_Facsimile_Telephone: 509.368.3199
          Contact_Electronic_Mail_Address: dcausey@usgs.gov
          Hours_of_Service: 8 AM - 4PM PST
  Cloud_Cover: 0
Spatial_Data_Organization_Information:
  Direct_Spatial_Reference_Method: Vector
  Point_and_Vector_Object_Information:
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Complete chain
      Point_and_Vector_Object_Count: 3833
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Entity point
      Point_and_Vector_Object_Count: 724
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
      Point_and_Vector_Object_Count: 724
    SDTS_Terms_Description:
      SDTS_Point_and_Vector_Object_Type: Point
      Point_and_Vector_Object_Count: 242
Spatial_Reference_Information:
  Horizontal_Coordinate_System_Definition:
    Planar:
      Map_Projection:
        Map_Projection_Name: Transverse Mercator
        Transverse_Mercator:
          Scale_Factor_at_Central_Meridian: 0.999600
          Longitude_of_Central_Meridian: -111.000000
          False_Easting: 500000.000000
          False_Northing: 0.000000
      Planar_Coordinate_Information:
        Planar_Coordinate_Encoding_Method: coordinate pair
        Coordinate_Representation:
          Abscissa_Resolution: 0.000128
          Ordinate_Resolution: 0.000128
        Planar_Distance_Units: meters
    Geodetic_Model:
      Horizontal_Datum_Name: North American Datum of 1983
      Ellipsoid_Name: Geodetic Reference System 80
      Semi-major_Axis: 6378137.000000
      Denominator_of_Flattening_Ratio: 298.257222
Entity_and_Attribute_Information:
  Detailed_Description:
```

```
Entity_Type:
  Entity_Type_Label: phosmine.aat
  Entity_Type_Definition: Boundary lines on disturbed land polygons
  Entity_Type_Definition_Source: This report
Attribute:
  Attribute_Label: FID
  Attribute_Definition: Software coding
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: SHAPE
  Attribute_Definition: Software coding
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: FNODE#
  Attribute_Definition: From node
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: TNODE#
  Attribute_Definition: To node
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: LPOLY#
  Attribute_Definition: Left polygon
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: RPOLY#
  Attribute_Definition: Right polygon
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: LENGTH
  Attribute_Definition: Length of line
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: PHOSMINE#
  Attribute_Definition: Internal number
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: PHOSMINE-ID
  Attribute_Definition: User identification number
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: LINETYPE
  Attribute_Definition: Line type
  Attribute_Definition_Source: This report
Attribute:
  Attribute_Label: $ID
  Attribute_Definition: Software coding
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: $FROMNODE
  Attribute_Definition: Sotware coding
  Attribute_Definition_Source: ESRI
Attribute:
  Attribute_Label: $TONODE
  Attribute_Definition: Software coding
  Attribute_Definition_Source: ESRI
Attribute:
```

```
      Attribute_Label: $LEFTPOLYGON
      Attribute_Definition: Software coding
      Attribute_Definition_Source: ESRI
    Attribute:
      Attribute_Label: $RIGHTPOLYGON
      Attribute_Definition: Software coding
      Attribute_Definition_Source: ESRI
  Detailed_Description:
    Entity_Type:
      Entity_Type_Label: phosmine.pat
      Entity_Type_Definition: Polygons delineating features at mines sites
      Entity_Type_Definition_Source: This report
    Attribute:
      Attribute_Label: FID
      Attribute_Definition: Software coding
      Attribute_Definition_Source: ESRI
    Attribute:
      Attribute_Label: SHAPE
      Attribute_Definition: Software coding
      Attribute_Definition_Source: ESRI
    Attribute:
      Attribute_Label: AREA
      Attribute_Definition: Area of polygon in square meters
      Attribute_Definition_Source: ESRI
    Attribute:
      Attribute_Label: PERIMETER
      Attribute_Definition: Perimeter of polygon in meters
      Attribute_Definition_Source: ESRI
    Attribute:
      Attribute_Label: PHOSMINE#
      Attribute_Definition: Internal number
      Attribute_Definition_Source: ESRI
    Attribute:
      Attribute_Label: PHOSMINE-ID
      Attribute_Definition: User defined id number = phosmine# - 1
      Attribute_Definition_Source: ESRI
      Beginning_Date_of_Attribute_Values: 2001
      Ending_Date_of_Attribute_Values: 2001
    Attribute:
      Attribute_Label: SOURCE
      Attribute_Definition: Code for source reference of these polygons
      Attribute_Definition_Source: phosmine.ref
    Attribute:
      Attribute_Label: MINE_NAME
      Attribute_Definition: Name of mine
      Attribute_Definition_Source: This report
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: Ballard Mine, Champ Mine, Conda Mine, Trail
Canyon Mine, Diamond Gulch Mine, Dry Valley Mine, Enoch Valley Mine, Gay Mine,
Georgetown Canyon Mine, Henry Mine, Home Canyon Mine, Lanes Creek Mine, Maybe
Canyon Mine, Mountain Fuel Mine, Rasmussen Ridge Mine, Rattlesnake Mine, Smoky
Canyon Mine, Waterloo Mine, Wooley Valley Mine
          Enumerated_Domain_Value_Definition: Names of Mines that were
included in this coverage
          Enumerated_Domain_Value_Definition_Source: This report
    Attribute:
```

```
      Attribute_Label: ORIG_FEAT
      Attribute_Definition: Name originally ascribed to feature when it was
digitally captured
      Attribute_Definition_Source: This report
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: Any description of type of disturbance
          Enumerated_Domain_Value_Definition: Term describing disturbance of
land surface by mining and related activities
          Enumerated_Domain_Value_Definition_Source: Original sources and this
report
    Attribute:
      Attribute_Label: DATE
      Attribute_Definition: Date of information related to this polygon
      Attribute_Definition_Source: This report
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: Any 4 digit date
          Enumerated_Domain_Value_Definition: Date of information about
disturbance of land surface
          Enumerated_Domain_Value_Definition_Source: This report
    Attribute:
      Attribute_Label: FEATURE
      Attribute_Definition: Standardized name given to feature
      Attribute_Definition_Source: This report
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: Adit and Dump, backfilled mine pit,
disturbed land, facilities, mine pit, ore stockpile, railroad, road, sediment
catchment, tailings, tailings pond, topsoil stockpile, undisturbed, waste
dump, water reservoir
          Enumerated_Domain_Value_Definition: Terms that describe the type of
land disturbance
          Enumerated_Domain_Value_Definition_Source: This report
    Attribute:
      Attribute_Label: ACRES
      Attribute_Definition: Area of polygon in acres
      Attribute_Definition_Source: Derived by multiplying Area item by
0.0002471
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: Any numeric
          Enumerated_Domain_Value_Definition: Number of acres in polygon
          Enumerated_Domain_Value_Definition_Source: This report
    Attribute:
      Attribute_Label: HECTARES
      Attribute_Definition: Area of polygon in hectares
      Attribute_Definition_Source: Derived by multiplying Area item by 0.0001
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: Any numeric
          Enumerated_Domain_Value_Definition: Number of hectares in the
polygon
          Enumerated_Domain_Value_Definition_Source: This report
Distribution_Information:
  Distributor:
    Contact_Information:
```

```
      Contact_Organization_Primary:
        Contact_Organization: U.S. Geological Survey
      Contact_Address:
        Address_Type: mailing address
        Address: Open-File Reports, Box 25286
        City: Denver
        State_or_Province: CO
        Postal_Code: 80225
        Country: USA
      Contact_Voice_Telephone: 1-303-202-4200

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    out of the delivery, installation, operation, or support by USGS.

    This data is not to be used at any scale greater than 1:24,000 (e.g.
1:12,500)
  Standard_Order_Process:
    Digital_Form:
      Digital_Transfer_Information:
        Format_Name: ARC
        Format_Version_Number: 8.0.2
        File_Decompression_Technique: No compression applied
        Transfer_Size: 1.941
      Digital_Transfer_Option:
        Online_Option:
          Computer_Contact_Information:
            Network_Address:
              Network_Resource_Name: http://geopubs.wr.usgs.gov/open-
file/of01-142
          Access_Instructions: World Wide Web (WWW)
Metadata_Reference_Information:
  Metadata_Date: 20010313
  Metadata_Future_Review_Date: None planned
  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: U.S. Geological Survey
        Contact_Person: J. Douglas Causey
      Contact_Position: Geologist
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 904 W. Riverside Ave., Rm 202
        City: Spokane
```

```
        State_or_Province: WA
        Postal_Code: 99201-1087
        Country: USA
      Contact_Voice_Telephone: 509.368.3116.
      Contact_Facsimile_Telephone: 509.368.3199
      Contact_Electronic_Mail_Address: dcausey@usgs.gov
      Hours_of_Service: 8 AM - 4 PM PST
  Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial
Metadata
  Metadata_Standard_Version: FGDC-STD-001-1998
  Metadata_Time_Convention: local time
  Metadata_Access_Constraints: None
  Metadata_Use_Constraints: None
  Metadata_Extensions:
    Online_Linkage: http://www.esri.com/metadata/esriprof80.html
    Profile_Name: ESRI Metadata Profile
```