Spatial Database of Mining-Related Features in 2001 at Selected Phosphate Mines, Bannock, Bear Lake, Bingham, and Caribou Counties, Idaho

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2006

Data Series 223

U.S. Department of the Interior
U.S. Geological Survey

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ABSTRACT

This report describes the spatial database, PHOSMINE01, and the processes used to delineate mining-related features (active and inactive/historical) in the core of the southeastern Idaho phosphate resource area. The spatial 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, for many of the closed or inactive mines the spatial coverage does not differentiate mining-related surface disturbance features.

Nineteen phosphate mine sites are included in the study, three active phosphate mines - Enoch Valley (nearing closure), Rasmussen Ridge, and Smoky Canyon - and 16 inactive (or historical) phosphate mines - Ballard, Champ, Conda, Diamond Gulch, Dry Valley, Gay, Georgetown Canyon, Henry, Home Canyon, Lanes Creek, Maybe Canyon, Mountain Fuel, Trail Canyon, Rattlesnake, Waterloo, and Wooley Valley. Approximately 6,000 hc (15,000 ac), or 60 km^2 (23 mi^2) of phosphate mining-related surface disturbance are documented in the spatial coverage. Spatial data for the inactive mines is current because no major changes have occurred; however, the spatial data for active mines were derived from digital maps prepared in early 2001 and therefore recent activity is not included. The inactive Gay Mine has the largest total area of disturbance, 1,900 hc (4,700 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 610 hc (1,500 ac), and it is nearly four times the area of the Smoky Canyon Mine, the largest of the active mines with about 550 hc (1,400 ac).

The wide range of phosphate mining-related surface disturbance features (141) from various industry maps were reduced to 15 types or features based on a generic classification system used for this study: mine pit; backfilled mine pit; waste rock dump; adit and waste rock dump; ore stockpile; topsoil stockpile; tailings or tailings pond; sediment catchment; facilities; road; railroad; water reservoir; disturbed land, undifferentiated; and undisturbed land. In summary, the spatial coverage includes polygons totaling about 1,100 hc (2,800 ac) of mine pits, 440 hc (1100 ac) of backfilled mine pits, 1,600 hc (3,800 ac) of waste rock dumps, 31 hc (75 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, undifferentiated,” total about 2,200 hc (5,500 ac) or nearly 22 km^2 (8.6 mi^2). No determination has been made as to status of reclamation on any of the lands. Subsequent site-specific studies to delineate distinct mine features will allow additional revisions to this spatial database.

INTRODUCTION

Purpose, Location, and Background

The U.S. Geological Survey (USGS) studied 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 geo-environmental studies was undertaken by the USGS in 1998. Project work formally ended in 2003, and results of most of the research are presented in Hein (2004).

This report updates and replaces spatial data contained in Causey and Moyle (2001), an initial attempt by Western U.S. Phosphate Project staff to identify lands in southeastern Idaho (fig. 1 and pl. 1) affected by phosphate mining. By delineating phosphate and related resource mine features utilizing a geographic information system (GIS), a geospatial database of phosphate-mine 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. Because mining and reclamation activities are on going at some mines, the database is dated (circa 2001); however, inactive mines are generally not subject to major changes, and the spatial data can be periodically updated as needed.

Previous Studies

The first spatial database (PHOSMINE) of the phosphate mines in southeastern Idaho was produced by Causey and Moyle (2001). The boundaries of several phosphate mines were shown on Mineral Investigation Resource Maps published in the early 1980s (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.

Although none of the historical literature applies directly to work reported in this update, 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 in this locality. Phosphate deposit origin, demand, and commodity studies are reported in Herring (1995), Herring and Fantel (1993), and Herring and Stowasser (1991). Detailed geochemical analyses of samples collected from many of the waste rock dumps included in this spatial database are in Moyle and Causey (2001). More than 75 additional publications on subjects ranging from geology, geochemistry, environmental, mineral resources, and history were produced by scientists working on the 1997-2003 Western U.S. Phosphate Project; many are included or cited in Hein (2004).

METHODOLOGY

Spatial Database

In addition to data included in the previous spatial database of phosphate mines in southeastern Idaho (Causey and Moyle, 2001), PHOSMINE01 includes three primary types of spatial data that were collected and utilized to verify the location of selected mine boundaries and features: (1) Computer-Aided Design (CAD) data and GIS files provided by phosphate mining companies; (2) hard copy maps provided by a variety of agencies and companies; and (3) USGS Digital Orthophoto Quarter Quadrangle (DOQQ) images. The authors' knowledge of specific mine sites was also used to modify feature boundaries and assign feature classes. Additional information used in Causey and Moyle (2001) included color aerial photographs and control point locations identified during field studies utilizing a field-portable Geographic Positioning System (GPS) instrument, a Rockwell Precision Lightweight GPS Receiver (PLGR). Spatial data were compiled using Environmental Systems Research Institute, Inc. (ESRI) ArcInfo platforms, including ArcView and ArcMap software.

J.R. Simplot, Solutia (associated with Monsanto), Astaris LLC (associated with FMC), and Agrium provided digital (CAD or ESRI) data files showing the status of mining at the end of 2001 for the then four active mines in southeast Idaho, respectively, the Smoky Canyon, Enoch Valley, Dry Valley (now inactive), and Rasmussen Ridge Mines. In addition, J.R. Simplot provided CAD data for a drawing of the Conda (Woodall Mountain) Mine. For a list of specific file names, please refer to the section "Overview of data files" and the internal metadata.

In order to identify and delineate older mined lands, DOQQ images were obtained for southeast Idaho. The DOQQ images were created from black and white aerial photography flown in 1992 and 1993. Because DOQQ images are geo-registered, they were also used to map mined areas for which no other digital data were available.

Spatial data produced by Causey and Moyle (2001) for most inactive (historical) mines is reproduced in the current database because the affected areas have not changed. Hard copy maps provided by Agrium (Mountain Fuel, Champ, and Maybe Canyon Mines) and Monsanto (Ballard Mine) and color/color infrared aerial photographs flown in the 1970s, 1980s, and 1990s were used to identify and delineate mining-related features. Mine boundaries and features in Causey and Moyle (2001) were digitized on-screen using ArcView 3.2 and ArcInfo. Where available, color stereo photo pairs were used to interpret information that could not be clearly distinguished on the DOQQ images.

Additional processing was necessary to transform some of the company mine files into spatially registered digital format. CAD data files were obtained in both Drawing Interchange Format file (DXF) format and AutoCAD drawing file (DWG) format. 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 data to ArcInfo spatial databases. Most of the files and hard copy maps had only a Public Land Survey (PLSS) grid for spatial control. The PLSS grid was used to transform the data to a spatially registered coverage. For this process, three 1:100,000-scale ArcInfo coverages of Geographic Coordinate Database (GCDB) spatial data, containing PLSS information, were used to create a tic file. The Palisades, Preston, and Soda Springs GCDB coverages were obtained from the BLM. Section corners were converted to tics and used for the transforms. Coverages were then attributed with information supplied by the mining companies. ESRI data, obtained in shape file (SHP) format, did not require transformation.

Mine features on hard copies of maps obtained from Agrium and the Bureau of Indian Affairs (BIA) were digitized by Causey and Moyle (2001) using ArcInfo.

Because latitude-longitude control points were not present on the maps, section corners were used to transform the data, similar to the method used for the CAD data.

Classification of Mining-Related Features

Maps provided by mining companies used a variety of names to identify similar elements or features of a mine (for example, dump, dump A, rock dump, waste dump). Consequently, there were 141 unique mine feature polygon names after combining coverages of the individual mines into a single regional coverage. To simplify identification of features on the coverage, a common classification system was developed and applied. Generalized mine feature names were assigned to groups or classes (for example, waste rock dump) of features produced by or associated with mining. A comparative matrix that lists the mine feature classifications used in the spatial database, and descriptions of the features, is presented in table 1. Note that the authors of the current database made minor changes to the original classification system of Causey and Moyle (2001). The original mine feature polygon names from all data sources and the associated revised mine feature name classification assigned by the authors are listed in table 2. Note that some questions arise when one mine feature is subsequent to another, such as a road over a waste rock dump or a backfilled pit. These were reclassified on a case-by-case basis. The polygon feature attribute table in the spatial database includes fields for *source*, *mine name*, *original feature*, *original feature date*, *date*, *hectares* (hc), and *acres* (ac), as well as current *status* (active or inactive), in addition to the assigned "*feature*" classification and the default attributes of *area* (m^2) and *perimeter* (m).

Data Input and Interpretation Issues

Several data problems were encountered in the conversion process. Individually and cumulatively, the variety of map media used and the range of spatial controls contributed to uncertainty in the final geospatial database. Significant problems areas included:

- *Multiple file types* - The mine information was delivered in a variety of different source media types, and the geospatial data were delivered in different file formats as well. Data files were delivered in DXF, DWG, and SHP file formats. Each file had to be converted to ARCGIS coverage format to be integrated into the final composite PHOSMINE01 coverage product.

- *Inadequate number of control points* - Many of the mine maps lacked section corners and other survey control points. These points are needed to provide commonality from which to create 'displacement links' to align the individual mine map coverages to the composite coverage during the spatial adjustment process.
- *Topology errors* - Polygon boundaries on many digital maps were not closed and/or the line segments were not snapped (connected) to each other. The spatial database model cannot be attached and attributed until the polygons are created, and closing the gaps to form proper polygons requires considerable editing time.
- *Map warp, skew, or rotational problems* - Many polygon boundaries did not correspond directly to the extent of the mine features visible on the DOQQ images or the original PHOSMINE coverage because warp, skew, and rotational issues were present in the mine map coverages. Hard copy map warpage, a lack of identifiable control points, and a range of other data collection issues can cause these problems. Minor changes were made to the mine feature polygon extents to accommodate these problems.
- *Mine feature classification* - Many of the mine boundaries and related features on the company CAD-file maps did not have precise correspondence to the disturbed areas visible on the DOQQ images. Minor changes were made to the coverage to adjust for some of these specific differences. Since roads placed around mines or reclaimed areas are temporary in nature, the authors attempted to classify some road areas/polygons on the mines with the feature underlying the road, such as back-filled pit or waste rock dump. Another problem encountered in comparing the mine map data to the black and white DOQQ images was the difficulty of distinguishing areas of revegetated mine waste rock from undisturbed land. This was overcome for many of the mine sites by using stereo pairs of color aerial photographs, because recent reclamation efforts commonly used special vegetative mixes that exhibit a color response that contrasts with the surrounding natural vegetation. In areas that predate modern reclamation efforts, waste-rock disposal areas may not be obvious, even on color photographs, due to sloughing and natural revegetation. In some cases, the nature of the mining-related area, or polygon, could not be determined and was assigned as "disturbed land,

undifferentiated" (appendix). The authors attempted to develop a data set of "reclaimed lands" in the original database of mine features (Causey and Moyle, 2001); however, several problems preclude inclusion of such data at this time (see "Reclamation" below).

Significant Figures, Rounding, and Conversions

The spatial database that accompanies this report contains a polygon feature attribute table listing the area, in square meters (m^2), of each of the mine feature polygons. These raw data are automatically reported to the fifth decimal place by ESRI's ArcMap program for each project. Although the digital file is projected to Universal Transverse Mercator (UTM) projection, the polygon area data that are listed in the tables found in this report were determined from an Albers Equal Area (Albers) projection. In the Albers projection, the area of displayed features is preserved; however; the other properties - shape, angle, and scale - are distorted. The authors estimate that the mine feature area data are, in fact, accurate only to two significant figures. Consequently, all of the spatial data relating to polygon areas cited later in this report are rounded to two significant figures based on guidelines discussed in Hansen (1991). For instance, the mine-pit area of the Ballard Mine is reported in the spatial database polygon feature attribute table as 865,697.14275 m^2, but rounding to two significant figures modifies the number to 870,000 m^2. Although the accuracy of polygon areas may vary between different mines and types of features, depending on the quality of data input, processing, and interpretation, the two-significant-number limit was applied systematically to all spatial data reported here. Only the raw data listed in the spatial database polygon feature attribute table remains unchanged.

It may be valuable to users if the mine feature polygon data, reported in metric units (square meters, m^2) by ESRI's ArcMap program, are also converted to and reported in other metric units, such as hectares, or in inch/pound units, such as acres. Therefore, spatial data discussed in this report are presented in four units of measure in addition to square meters: hectares (hc), square kilometers (km^2), acres (ac), and square miles (mi^2). Conversion factors - hc = m^2/10,000, km^2 = m^2/1,000,000, ac = m^2/4,047, and mi^2 = m^2/2,590,000 (Hansen, 1991) - were applied to the spatial data in square meters after rounding to two significant figures; therefore, all of the data discussed in the body of the report are rounded.

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. The latest included three awards presented by Idaho's Department of Lands in 2004: Agrium received the "Excellence in Ongoing Operations" at its Rasmussen Ridge Mine; J.R. Simplot was honored for its "Excellence in Exploration Reclamation" for work in Manning Creek, Deer Creek, and Wells Canyon; and Monsanto received the "Special Project Award" for its reclamation efforts (Idaho State Journal, 2004; National Mining Association, 2004).

Reclamation standards developed by the land-managing agencies and the companies have changed over time in response both to regulatory development and to experience and technological improvements. Consequently, reclamation procedures and standards 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 has 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 order to improve our understanding of the interaction of phosphatic rock and shale with water and biota, scientists involved in the Western U.S. Phosphate project conducted research on some these relationships in order to provide better guidance for disposal of waste rock from phosphate production (Hein, 2004).

Although one of the goals in developing the original spatial database of mining-related features (Causey and Moyle, 2001) was to include a reclamation status data set, several difficulties culminated in the decision not to include such data. First, there is the question of "what constitutes reclamation?" As noted above, standards have changed over time. Companies operating before1970 were commonly released from lease liability with minimal requirements for re-contouring, reseeding, or backfilling pits; however, from a legal point of view, these lands may be considered as reclaimed. As various laws and regulations developed, mining and reclamation practices were modified resulting in much higher standards for today's operators. The issue of land ownership may also affect reclamation. Phosphate resources occur on Federal, State, and private lands, and reclamation standards of the various land administrators and owners may not be consistent. Reclamation also crosscuts mining features. To capture reclamation status would entail delineation of features that do not necessarily coincide with mining features.

MINE-SPECIFIC DESCRIPTIONS

The nineteen mines included in the spatial database provided with this report are shown on figure 1, a generalized map of the southeast Idaho phosphate resource area, and discussed below in alphabetical order. Data attribute quality varies considerably, as only limited time was available for field checking of historical information for the Causey and Moyle (2001) study, and no additional fieldwork has been conducted to supplement the revised spatial database. Information on time intervals of mine operations was obtained primarily from Lee (2000). A detailed description of the mining history of the phosphate mines listed below can be found in Lee's report.

Active Phosphate Mines

Enoch Valley Mine

The Enoch Valley Mine (fig. 2) began production in 1989 (Lee, 2000) and operated continuously until production was reduced in 2003-04 due to dwindling reserves. The mine provided feed for Monsanto's elemental phosphorus plant in Soda Springs. Enoch Valley Mine production is being replaced by Solutia's new South Rasmussen Ridge Mine (not included in this spatial database), which lies south of Agrium's Rasmussen Ridge Mine and began operation in 2001. Solutia, Inc., staff provided an ESRI shape file that detailed mining areas and specific mining features for the Enoch Valley Mine as of the end of 2001. As occurred with the 1998 data reported in Causey and Moyle (2001), boundaries between the Enoch Valley Mine map and the adjacent Rasmussen Ridge Mine map did not match. Modifications were made to the road that connects the two mine sites and other features adjacent to the road.

Rasmussen Ridge Mine

Rhone-Poulenc began mining at the Rasmussen Ridge mine (fig. 2) in 1991 (Lee, 2000), and in late 1998 it was sold to Agrium U.S., Inc., who currently operates the property. The mine provides feed to the phosphoric acid plant in Conda, primarily for use as fertilizer. Mining of the phosphate deposit has progressed in three stages from south to north and is now concentrated at the north end of the lease property. Rhone-Poulenc, and later Agrium, referred to the three pit/panel stages as South, Central, and North Rasmussen Ridge Mines (Wendell Johnson, personal communication, July 29, 2004). Agrium provided a DXF file that detailed mining-related features in this area through 2001. Map boundaries between the DXF data 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 DOQQ images made from 1992 aerial photography.

Smoky Canyon Mine

The Smoky Canyon Mine (fig. 3) operated by J.R. Simplot Company began production in early 1984 and still continues on the west limb of the Boulder Creek anticline (Lee, 2000). Phosphate rock mined at Smoky Canyon, primarily used as fertilizer, is crushed and pulverized at an on-site mill and transported by slurry pipeline to their phosphoric acid processing plant in Pocatello, Idaho. The J.R. Simplot Company provided three DXF files that detailed mining-related features in this area through 2001. The polygon shapes were modified only slightly.

Inactive Phosphate Mines

Ballard Mine

The Ballard Mine (fig. 4) opened in early 1952 and ceased operation in late 1969 when the reserves were depleted. Reclamation of the mine site extended into 1970 (Lee, 2000). Two mylar copies of mine maps were obtained from Enoch Valley Mine staff. The maps contained an outline of the mine area disturbed by mining; however, the boundaries on the two maps did not agree. Causey and Moyle (2001) digitized the mining-related disturbance area from DOQQ images 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 (Causey and Moyle, 2001).

Champ Mine/Champ Mine Extension

Phosphate mining at the Champ Mine (fig. 5) 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 (Causey and Moyle, 2001).

Conda/Woodall Mountain/Trail Canyon Mines

Mining at the Conda Mine complex (fig. 6), including Woodall Mountain (north lobe) and Trail Canyon (S.E. area), occurred between 1920 and 1984. Underground methods were used until 1956, and surface stripping, occurred in phases beginning in 1952 (Lee, 2000). J.R. Simplot Company provided a DWG data file that detailed most activity in this area through 2001. Not included in the file was the make-up water pond at the Conda Mine and the Trail Canyon Mine, the last of the mine complex to be mined. These features were digitized in ArcView 3.2 from DOQQ images. Delineation of some mine features was supplemented by using color aerial photography.

Diamond Gulch Mine

Diamond Gulch (fig. 7) was mined only in the year 1960 due to economic and geological conditions, and reclamation was conducted on the mine site during 1961 and 1962 (Lee, 2000). The outline of the mined area was digitized from DOQQ images using ArcView 3.2 supplemented by a site visit in 1999. Due to the complex nature and co-mingling of strip mining, waste disposal, and reclamation at this site, no attempt was made to delineate individual mine-related features (Causey and Moyle, 2001).

Dry Valley Mine

Minor production from the Dry Valley Mine (fig. 8) reportedly occurred in 1971 for testing purposes; full production did not begin until 1992. The mine was operating in 2001; however, it is currently inactive. Astaris LLC provided a DXF file and a hard copy map outlining mining areas and specific features as of the end of 2001. This file, once converted, showed considerable skew when compared to the original PHOSMINE coverage. Extensive work was done to the polygon boundaries to create alignment with the DOQQ images and original PHOSMINE coverage.

Gay Mine

The Gay Mine (fig. 9), located on the Fort Hall Reservation of the Shoshone-Bannock Tribes, operated from 1946 to 1993 (Lee, 2000). The BIA provided two 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 DOQQ images created from aerial photographs taken in July 1992 (Causey and Moyle, 2001). The hard copy map of mining panels did not correspond well to the previously mined areas visible on the DOQQ images; therefore, most of the mine pits and backfilled mine pits are included in the category of *disturbed lands, undifferentiated*. Also included in the *disturbed lands, undifferentiated* 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 Mine (fig. 10) operated between 1958 and 1964 (Lee, 2000). Mining was conducted on outcrops on the upper slopes of Snowdrift Mountain, and ore was transported to a plant at the base of the slope in Georgetown Canyon. Mine features and the plant site were mapped from DOQQ images using ArcView 3.2 supplemented by color and color infrared aerial photography and information collected during site visits in 1999 and 2000 (Causey and Moyle, 2001). In addition to alluvium, disturbed lands in portions of Georgetown Canyon may also be underlain by both mine waste rock and processing wastes, including slag. Tailings from the Georgetown Canyon plant were also impounded in a small canyon about one mile downstream. Reclamation of the plant site was underway in 2001-2002.

Henry Mine

The Henry Mine (fig. 11) operated between 1969 and 1989 (Lee, 2000). As with the Rasmussen Ridge Mine, the Henry was mined in a sequence of pits, the North, Central, and South Henry. Mine features were mapped from DOQQ images using ArcView 3.2 with supplemental information from color aerial photography and a site visit in 1999 (Causey and Moyle, 2001). Much of the mine area has been reclaimed; therefore, in some areas disturbed lands are difficult to delineate on the DOQQ images.

Home Canyon Mine

Mining at the Home Canyon Mine (fig. 12), 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 (Causey and Moyle, 2001).

Lanes Creek Mine

Mining began at the Lanes Creek Mine (fig. 13), in 1978 and continued until at least 1988 (Lee, 2000). Mine features were mapped from DOQQ images using ArcView 3.2 with modifications based on a post-reclamation site visit in 1999 (Causey and Moyle, 2001).

Maybe Canyon Mine

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

Maybe Canyon Mine (fig. 8) 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 DOQQ images 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 DOQQ images (Causey and Moyle, 2001).

Mountain Fuel Mine

Mountain Fuel Mine (fig. 5) operated briefly in 1966-67; 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 DOQQ images in ArcView 3.2 with supplemental information collected during a site visit in 1999 (Causey and Moyle, 2001).

Rattlesnake Mine

Limited mining was conducted at the Rattlesnake Mine (fig. 14), 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 (Causey and Moyle, 2001).

Waterloo Mine

The Waterloo Mine, the oldest Phosphate mine in Idaho, was mined by underground methods (fig. 12) between 1907 and the late 1920’s and by open-pit methods between 1945 and 1960 (Lee, 2000). The mined area was mapped from DOQQ images 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 (Causey and Moyle, 2001). To further complicate the surface features, the mined area is now a landfill operated and owned by Bear Lake County.

Wooley Valley Mine

[Mill Canyon (Unit no. 4), Little Long Valley (Unit no. 3), and Blackfoot Narrows (Unit no. 1)]

The Wooley Valley Mine complex (fig. 15) consists of a cluster of open pits mined sequentially between 1955 and 1989 (Lee, 2000). Mine features were mapped and delineated from DOQQ images using ArcView 3.2 with supplemental input from color aerial photographs and information collected during site visits in 1999 and 2000. Mine features in some of the disturbed areas are difficult to delineate on the DOQQ images due to reclamation efforts on selected parts of the mine (Causey and Moyle, 2001).

Other Mining

Although phosphate resources are abundant in southeastern Idaho, there is a continuing need for new mining of known sources of phosphate and related resources as existing mines are depleted. For instance, reserves at the Enoch Valley Mine (fig. 2) are dwindling, and the feed for Monsanto's elemental phosphorus plant in Soda Springs is being replaced by Solutia's new South Rasmussen Ridge Mine, which is not included in this spatial database. Additional areas of intense exploration and near-future mine development include J.R Simplot's Manning Creek and Sulfur Canyon leases near Smoky Canyon, as well as the Trail Creek and Dairy Syncline lease areas, none of which are included in the current spatial database. In another example of change, Agrium U.S., Inc., may reopen the Dry Valley Mine (formerly operated by Astaris LLC and inactive when this database was collected) in order to replace feed for its Conda fertilizer plant currently provided by the Rasmussen Ridge Mine. Other types of mining related to the phosphate industry also occur in the area. For instance, Kerr McGee's limestone mine (now inactive) was also included in the spatial database because limestone from this site was used in vanadium recovery from ferrophosphorous slag (highly reduced iron-phosphorous waste) produced by Monsanto's elemental phosphorus plant in Soda Springs.

SUMMARY OF SPATIAL COVERAGE

The spatial coverage of phosphate mining-related surface disturbance in southeastern Idaho includes an area from the Gay Mine northeast of Pocatello south to the Waterloo Mine near Montpelier and from the Conda Mine near Soda Springs east to the Smoky Canyon Mine near the Wyoming border (pl. 1). 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. Eighteen of the 19 phosphate mines included were operated predominantly by open-pit methods, the standard phosphate mining practice since the 1940s to 1950s. Open pit phosphate mines that have operated in southeastern Idaho over the past 50 years were typically characterized by large open pits, up to 90 to 120 m (300 to 400 ft) deep, voluminous waste rock dumps that may contain as much as 23 million m^3 (30 million yd^3) or more, and include major support facilities as well as transportation systems. Such a mine complex may occupy an area ranging from a few hectares to several square kilometers.

Land-surface disturbances associated with underground mines typically cover a much smaller area, perhaps only 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 Mine and Home Canyon Mine were underground operations, and a major part of the Waterloo Mine, and the Conda Mine prior to 1956, were underground as well (Lee, 2000). Mine portals and underground workings at some of the mines are obscured or were removed by subsequent open-pit mining.

The various mine features effected by each of the nineteen phosphate mines included in the spatial database total about 6,000 hc (15,000 ac), or 60 km^2 (23 mi^2) (table 3; plate 1). Figure 16 charts the relative size of land disturbance of the 19 phosphate mine sites. The inactive Gay Mine (fig. 9) has by far the largest total area of disturbance, 1,900 hc (4,700 ac) or about 19.2 km^2 (7.4 mi^2), which is more than three times the disturbance area of the next largest mine, the Conda Mine (fig. 6) (also inactive) with about 610 hc (1,500 ac), and it is nearly four times the area of the Smoky Canyon Mine (fig. 3), the largest of the active mines with about 550 hc (1,400 ac). The core of the Blackfoot River watershed includes a cluster of mines - Enoch Valley and Rasmussen Ridge (fig. 2), and Henry (fig. 11), and to the south, the Ballard (fig. 4) and Wooley Valley Mines (fig. 15). Proceeding south are the Dry Valley and Maybe Canyon Mines (fig. 8), the Champ and Mountain Fuel Mines (fig. 5), the Diamond Gulch Mine (fig. 7), and the Rattlesnake Mine (fig. 14), all in Caribou County, and the Georgetown Canyon (fig. 10), Waterloo, and Home Canyon Mines (fig. 12) in Bear Lake County.

The spatial coverage includes mine feature polygons totaling about 1,100 hc (2,800 ac) of mine pits, 440 hc (1100 ac) of backfilled mine pits, 1,600 hc (3,800 ac) of waste rock dumps, 31 hc (75 ac) of ore stockpiles, and 44 hc (110 ac) of tailings or tailings ponds (table 3). The cumulative area of lands classed as “disturbed land, undifferentiated,” about 2,200 hc (5,500 ac), may include any or all of the full range of mine features, especially mine pits, backfilled mine pits, waste rock dumps, and facilities. Disturbed land, undifferentiated, accounts for the largest area of phosphate mining-related features, followed by waste rock dumps and mine pits. Subsequent site-specific studies to delineate distinct mine features will allow additional revisions of this spatial database.

OVERVIEW OF DATA FILES

The data for the regional mine features map are provided in several files that are listed and briefly described in table 4. FGDC-compliant[3] metadata files (Phosmine01_meta.xml and Phosmine01_meta.txt) provide information about the map data and include information about data sources, data quality, map projection, and how to obtain the data on the World Wide Web, in addition to providing a data dictionary for the row and column data in the database tables. The database contains internal metadata that can be read in ESRI's ArcCatalog module[4] and exported to a variety of file formats. Metadata was exported to both XML-format (eXtensible Markup Language) and TXT-format (TeXT) files. The spatial database (PHOSMINE01.E00) provides map data in a vector format that can be used in a geographic information system (GIS). The symbolization files (*.lyr) provide a suite of colors and line patterns for displaying or plotting a map using ESRI's ArcMap.

SPATIAL DATABASE FOR THE MINE FEATURES MAP

The Phosmine01.e00 file contains vector information for the lines (arcs) and map units (polygons) of the mine features map in two feature attribute tables, PHOSMINE01.AAT (arcs) and PHOSMINE01.PAT (polygons). The data in the feature attribute tables are coded and can be deciphered by looking up the codes in the associated look-up tables. One can join the feature attribute tables to the look-up tables in a GIS to obtain a variety of different mine features maps. A simplified mine features map created from the Phosmine01.e00 spatial database is shown in figure 1, and the fully detailed map is shown in plate 1. Although plate 1 is presented at a scale of 1:150,000, the mine feature polygon boundaries are considered to be accurately useable at a scale of 1:24,000. A schematic of the relationships between the database tables is given in figure 17. Each of the files in the Phosmine01.e00 database is described in further detail in the Phosmine01_meta.xml or the Phosmine01_meta.txt metadata file.

ESRI COVERAGE-FORMAT TABLES

The PHOSMINE01.E00 file can be imported into a PHOSMINE01[5] coverage with two feature attribute tables, PHOSMINE01.AAT and PHOSMINE01.PAT, that are topologically

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[3] Federal Geographic Data Committee (http://www.fgdc.gov).
[4] ArcGIS, version 8 (http://www.esri.com).
[5] Small caps are used to denote ArcInfo coverage and table names.

related to each other (that is, line segments generally form polygon boundaries and have directionality, and polygons are designated as occurring on either the left side of a line segment or the right side). The PHOSMINE01 coverage consists of both feature attribute tables and look-up tables. For the sake of providing a compact and efficient database, the two feature attribute tables contain several fields that are coded. These codes are defined in a set of look-up tables. The arc attribute table of mine features lines, PHOSMINE01.AAT, relates (and can be digitally joined) to the PHOSMINE01.LCD look-up table of line code descriptions (MINE FEATURE CONTACTS, ROADS, RAILROADS, POWER LINES, OR BUILDING FOOTPRINTS) and the PHOSMINE01.REF look-up table of references for sources of map unit data (fig. 17). The polygon attribute table of mine features units, PHOSMINE01.PAT, relates (and can be digitally joined) to the PHOSMINE01.REF look-up table of references for sources of map unit data.

RECOMMENDATIONS FOR UPDATING THE MINE FEATURE SPATIAL DATABASE

Maps of the mine areas were provided in a variety of paper and(or) digital formats, they often utilized a local mine area coordinate system, and a variety of terminology was used to identify mine features. This created a tremendous workload in compiling the spatial database, because all the digital maps needed to be standardized. Following these recommendations to improve process steps will enable users to develop a highly accurate, minimally distorted, informational, and timely product that could then be used to update or prepare a new compilation (fig. 18).

(1) Create/digitize mine feature data in actual real-world/ground coordinates. Apply a coordinate system if possible. This will eliminate the need for a coordinate transformation of the CAD layer/drawing.

- Do not digitize/create mine feature data in page units such as inches. This creates inconsistent data offset, scale, and rotation when combined with past data or data from other mines.
- Transform current mine plan grids to or prepare new mine plans in real-world coordinates where possible.
- Utilize a common projection that can be agreed upon by private, state, and Federal entities involved with phosphate mine planning, monitoring, and reclamation in southeastern Idaho. The PHOSMINE01 projected coordinate

system is: North American Datum of 1983 (NAD83), Universal Transverse Mercator (UTM), Zone 12

(2) Integrate known control points onto/into the mine drawing/data file.

- Permanent location control points are necessary to translate local grid databases into real-world coordinates because most of the ground features traditionally used as control points at mines, such as road intersections or drainage corridors, are transient due to the changing landscape. The exception to this would be permanent building corners.
- Use four to ten evenly dispersed GPS control points for registration purposes. Section corners and benchmarks are excellent choices for GPS control points.

(3) Utilize the USGS mine feature classification system.

- A set of USGS approved mine feature definitions would be made available to the mining companies. New feature names would be added as necessary.

(4) Complete ESRI/CAD data topology.

- Snap lines.
- Close all polygons.
- Eliminated duplicate line features.

(5) Deliver data in one of three media types to the BLM:

- ESRI ArcInfo, version 8.x or higher, export file (E00).
- ESRI ArcGIS, version 8.x or higher, shapefiles (SHP).
- AutoCAD version 2004 (not DXF or AutoCAD v14).
- Scale-stable hardcopy, such as mylar. Paper maps should be rolled, not folded.

ACKNOWLEDGMENTS

The authors appreciate the assistance of the numerous phosphate-mining industry and land-management agency staff that provided input to this product. Susan Nash, J.R. Simplot Company, Steve Smith, Monsanto, Alan Haslam and Dan Kline, Agrium U.S., Inc., and Jim Williams, Astaris LLC, contributed time or supplied digital and hard copy maps that were used to create the ArcInfo coverage included in this report. Sam

Hernandez, BIA, Fort Hall, ID, provided copies of mine maps, aerial photographs and a tour of the Gay Mine. Bill Lee (retired), Peter Oberlindacher (retired), Jeff Cundick, and Wendell Johnson, BLM, and Jeff Jones, USFS, provided information and maps of phosphate mining activity in southeastern Idaho.

Thanks also to several USGS staff that provided timely and diligent technical reviews of and input on this report: Karen Bolm, Tucson, AZ; Lorrie Moyer, Reno, NV; Dave Frank, Spokane, WA; and especially Pam Derkey, Spokane, WA.

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APPENDIX: Map Symbolization (ArcGIS layer files)

Introduction

ArcGIS layer files (*.lyr) were developed to easily display pre-defined views of the spatial data. In ArcGIS, a layer file may store symbology, symbology classifications, labeling properties, scale dependency, and definitions. A layer file does not contain the spatial data, but it acts as a pointer to a dataset's physical location. A layer file can be transferred from one system to another, so that the user does not have to re-create the map appearance.

Overview of layer files

Three layer files were created to symbolize polygon features in the ArcInfo coverage and derivative shapefiles provided in this publication: one for the coverage PHOSMINE01, one for the derivative shapefile PHOSMINE01, and one for a second derivative shapefile MINE_FEATURES. Each of the layer files symbolizes the various values in the FEATURE field (item) to approximate the colors used in Plate 1. Table A-1 provides an explanation of each layer file and the coverage or shapefile used to create it.

Table A-1. Explanation of each layer file and the coverage or shapefiles used to create it.

Layer file	Symbolizes	COVERAGE or SHAPEFILE (feature class)	Value Field
phosmine01_poly_feature.lyr	Mining features	PHOSMINE01 coverage (polygon)	*FEATURE*
phosmine01_shp_feature.lyr	Mining features	PHOSMINE01 shapefile (polygon)	*FEATURE*
mine_features.lyr	Mining features	MINE_FEATURES shapefile (polygon)	*FEATURE*

Using a layer file

The layer files can be added to an ArcMap 9.1 session by clicking the Add Data button and browsing to the location where the layer files are stored, or by dragging a layer file from ArcCatalog into an open ArcMap session. The symbolized map can be printed, but the symbology classification cannot be changed. Remember that a layer file stores how a map is classified and points to the data: it is <u>not</u> the spatial dataset.

Troubleshooting

The layer files will work properly if stored in the same location as the coverage or shapefile from which they were created and if the data path has not been broken. The "import geometry type does not match destination geometry type" is a common error that occurs when importing symbology into a coverage. The ESRI website lists the following "cause" and "solution" for an error of this type. To view the on-line article, visit http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=22484 .

Solution or Workaround for a Broken Data Path

1. Open ArcCatalog and browse to the location of the LYR file.
2. Double-click on the .lyr file to open the Layer Properties dialog box.
3. Select the Source tab.
4. Click Set Data Source and browse to the correct data source, click Add.
5. Click OK to close the Layer Properties dialog box.
6. Open ArcMap.

You will now be able to import symbology from the LYR file.

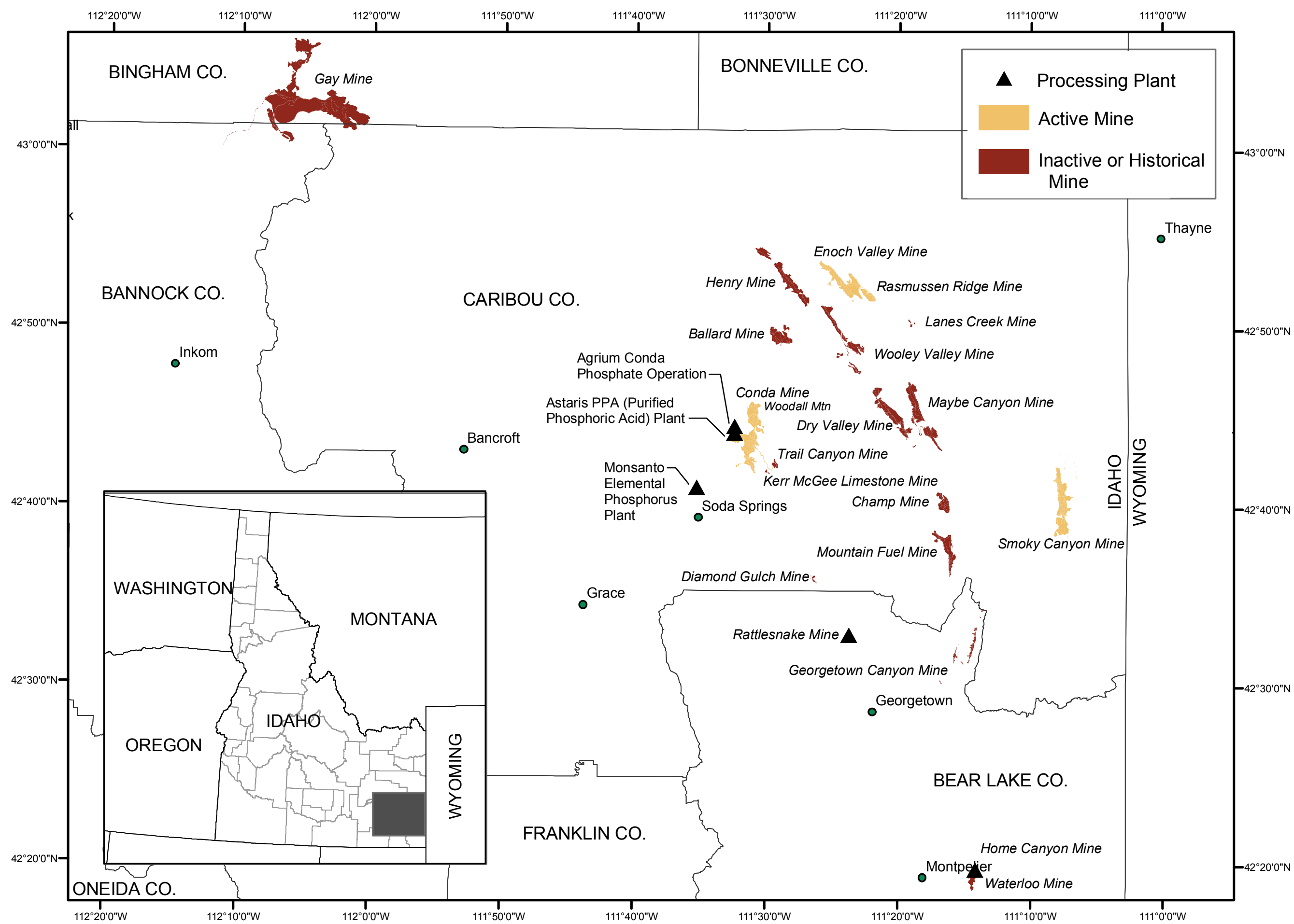

Figure 1. Generalized map of the southeast Idaho phosphate resource area showing the 19 phosphate mines and related sites included in the spatial database.

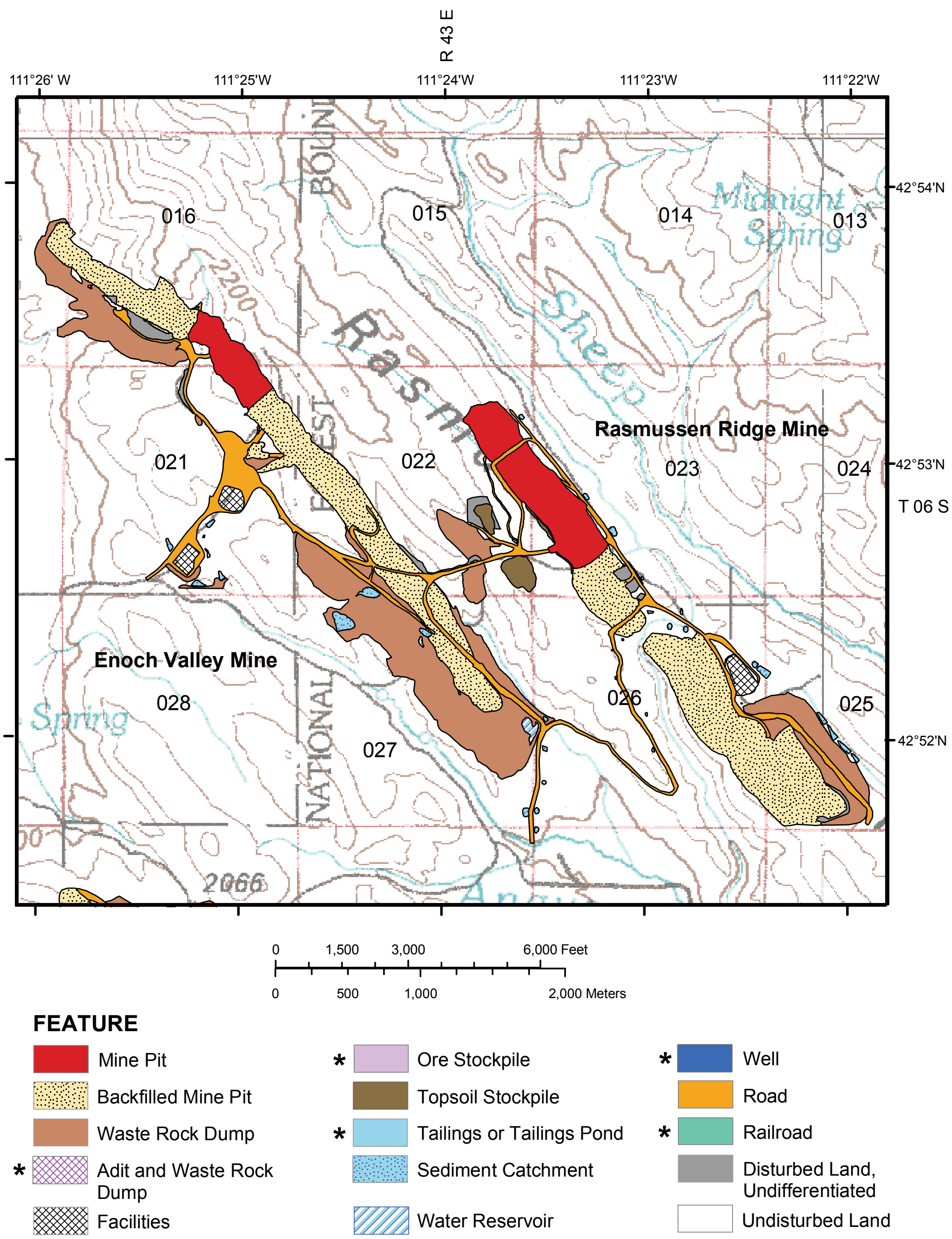

Figure 2. Map of phosphate mining-related features at the Enoch Valley and Rasmussen Ridge Mines, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

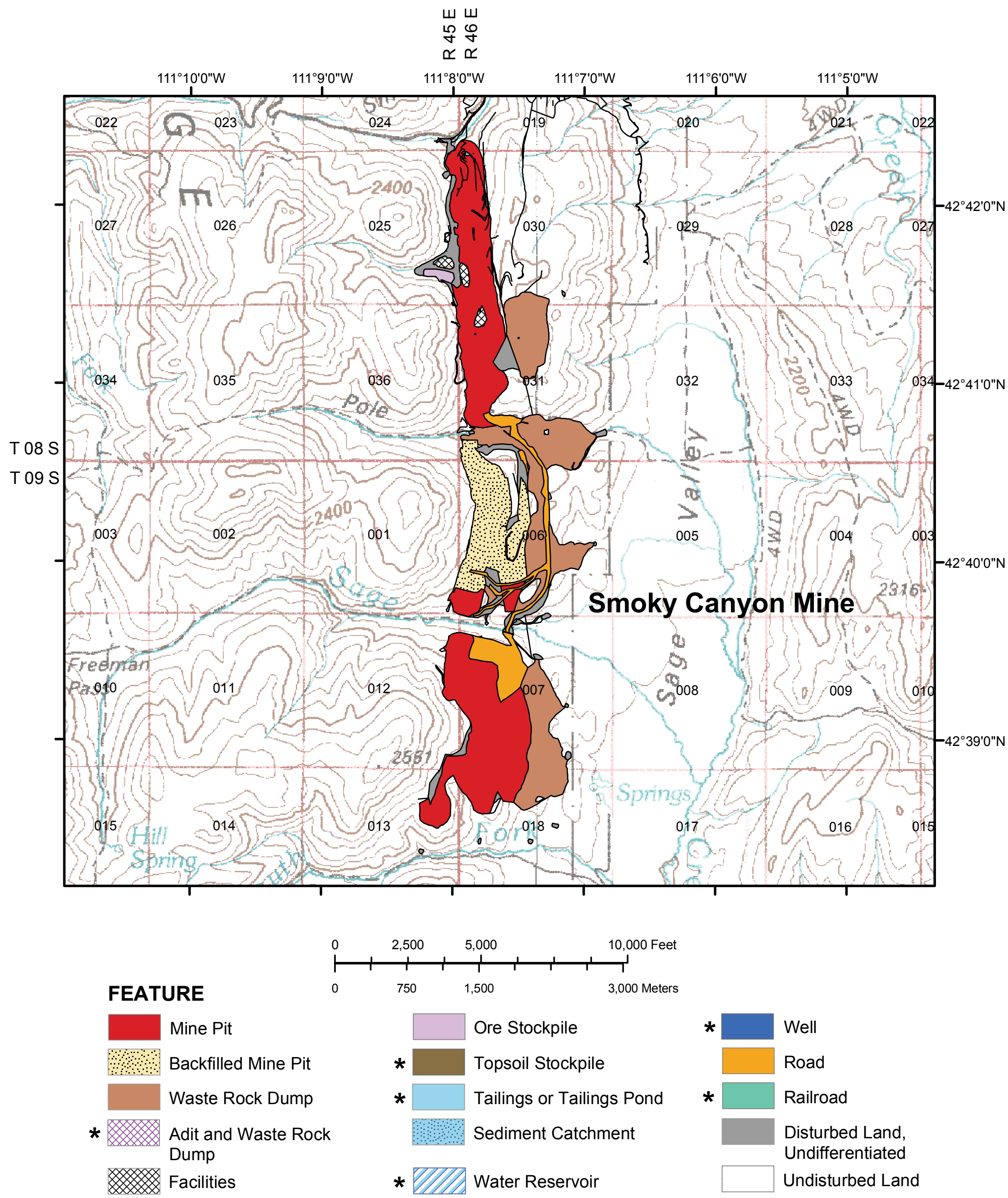

Figure 3. Map of phosphate mining-related features at the Smoky Canyon Mine, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

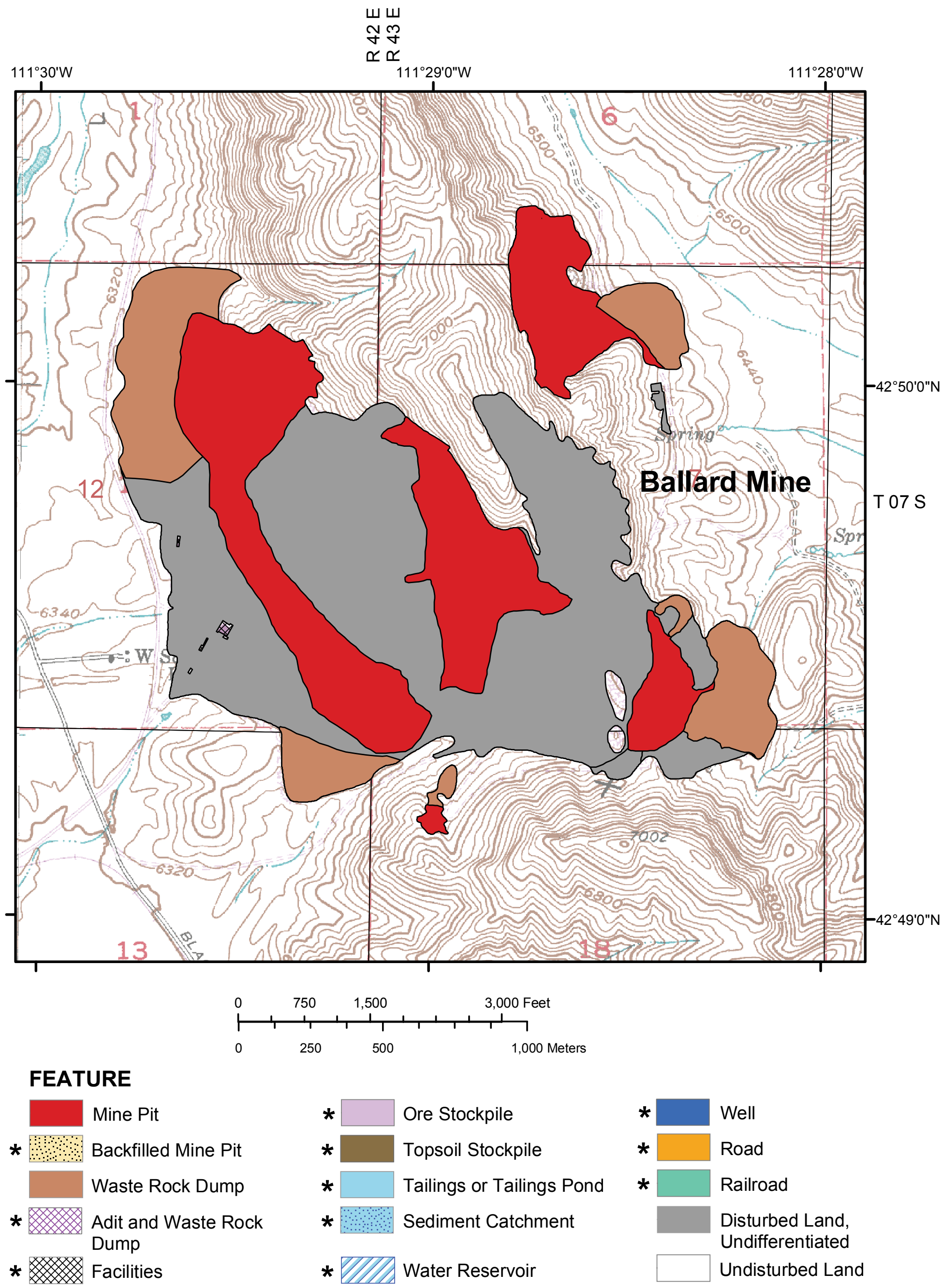

Figure 4. Map of phosphate mining-related features at the Ballard Mine, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

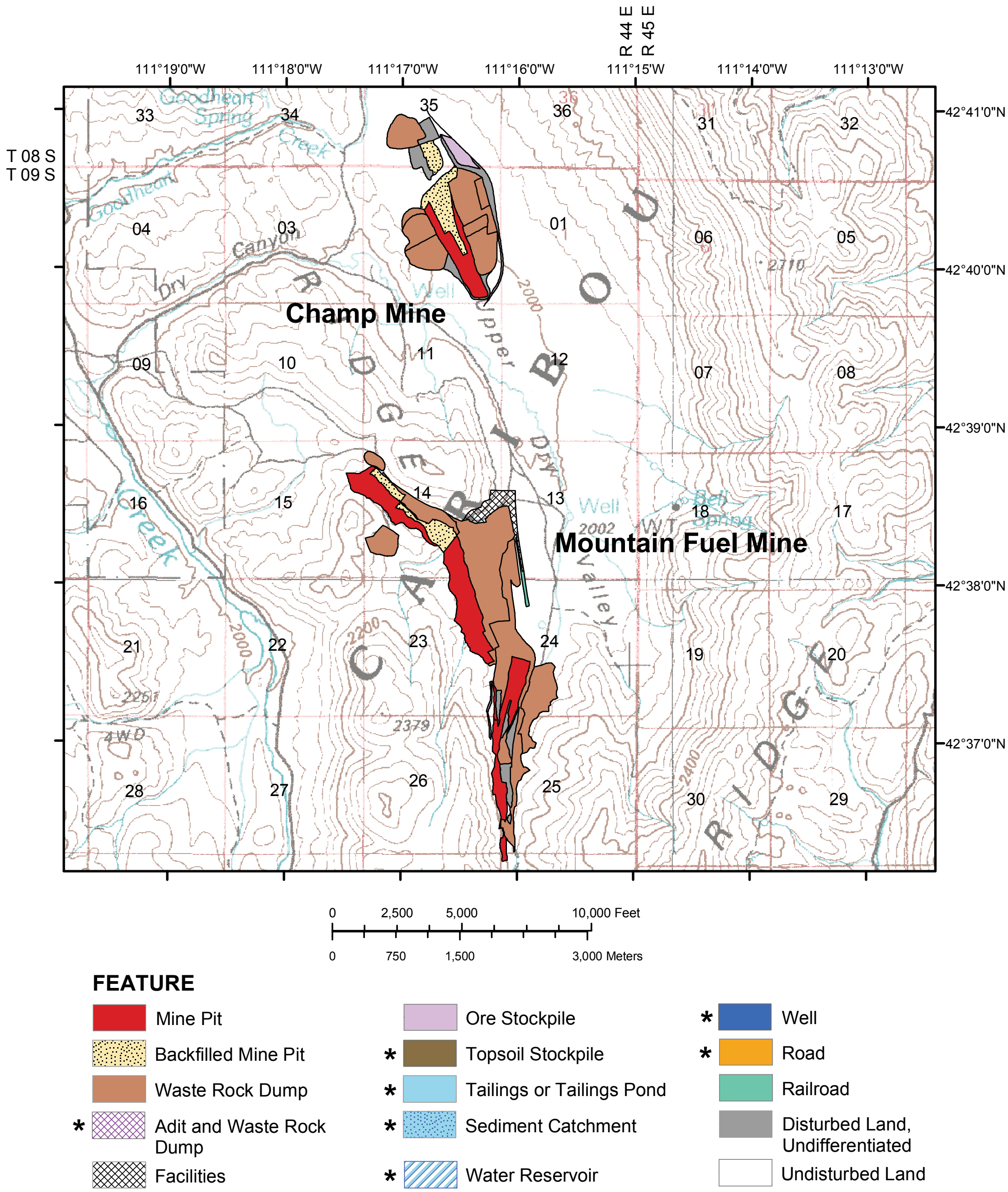

Figure 5. Map of phosphate mining-related features at the Champ and Mountain Fuel Mines, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

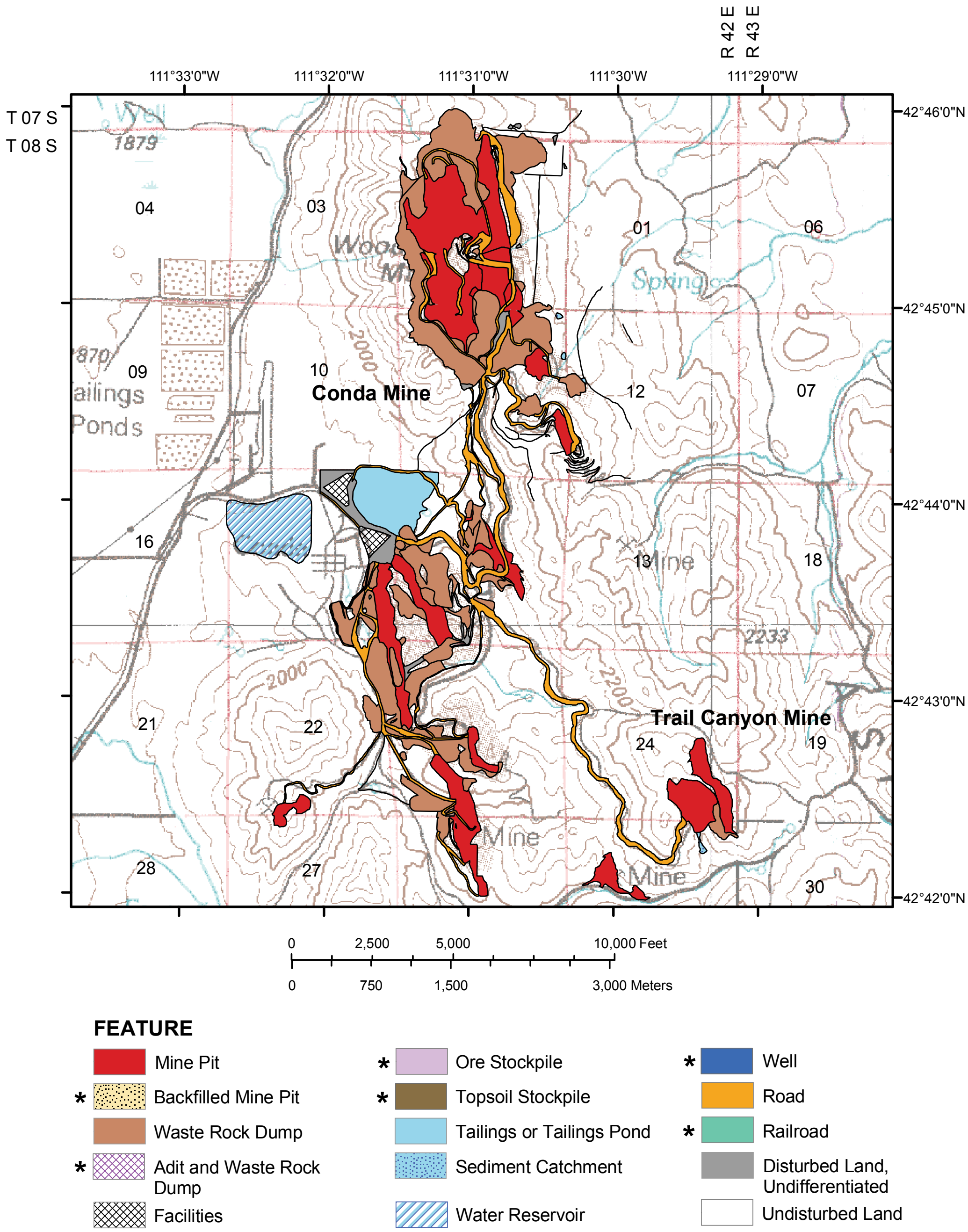

Figure 6. Map of phosphate mining-related features at the Conda and Trail Canyon Mines, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

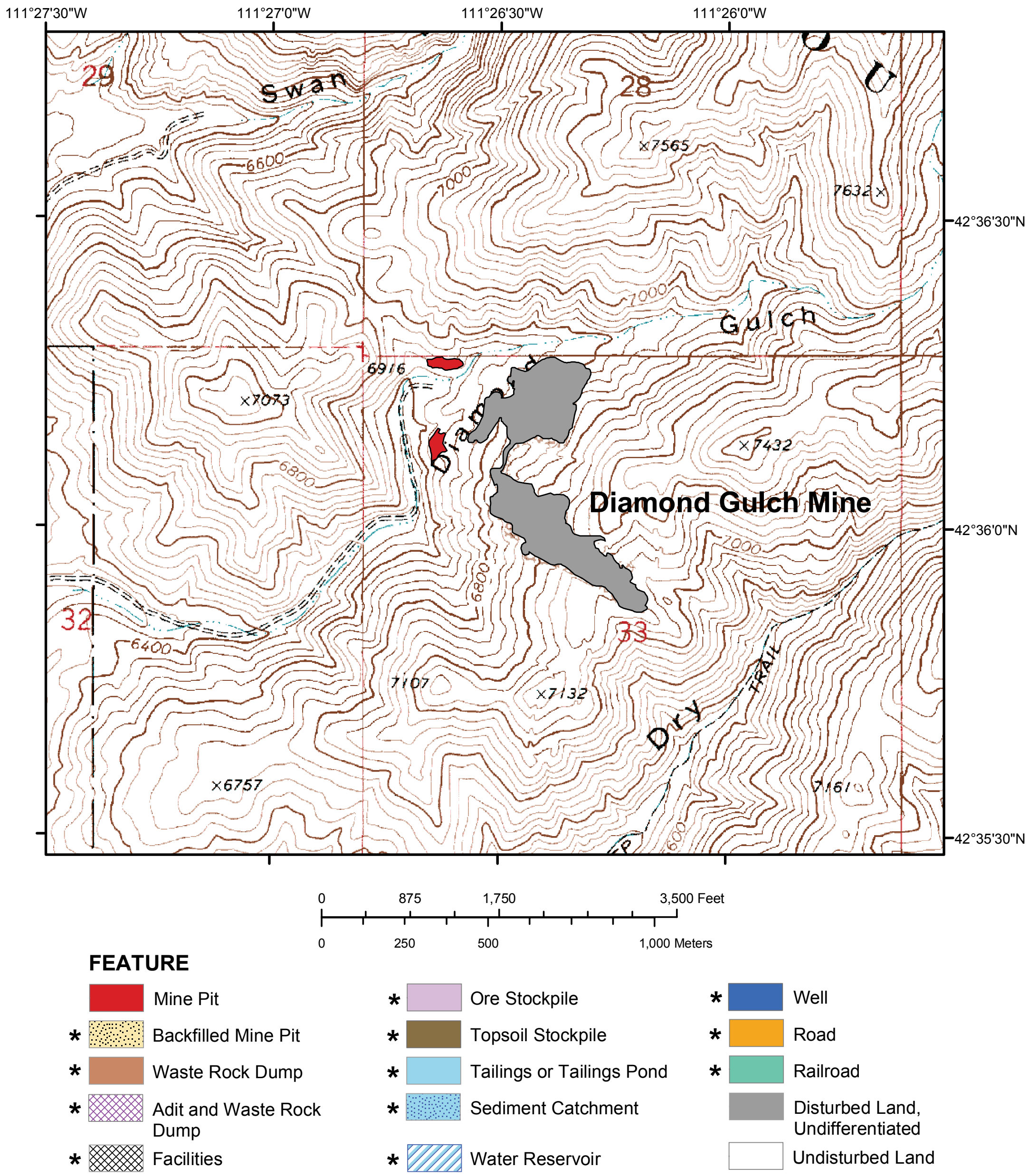

Figure 7. Map of phosphate mining-related features at the Diamond Gulch Mine, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

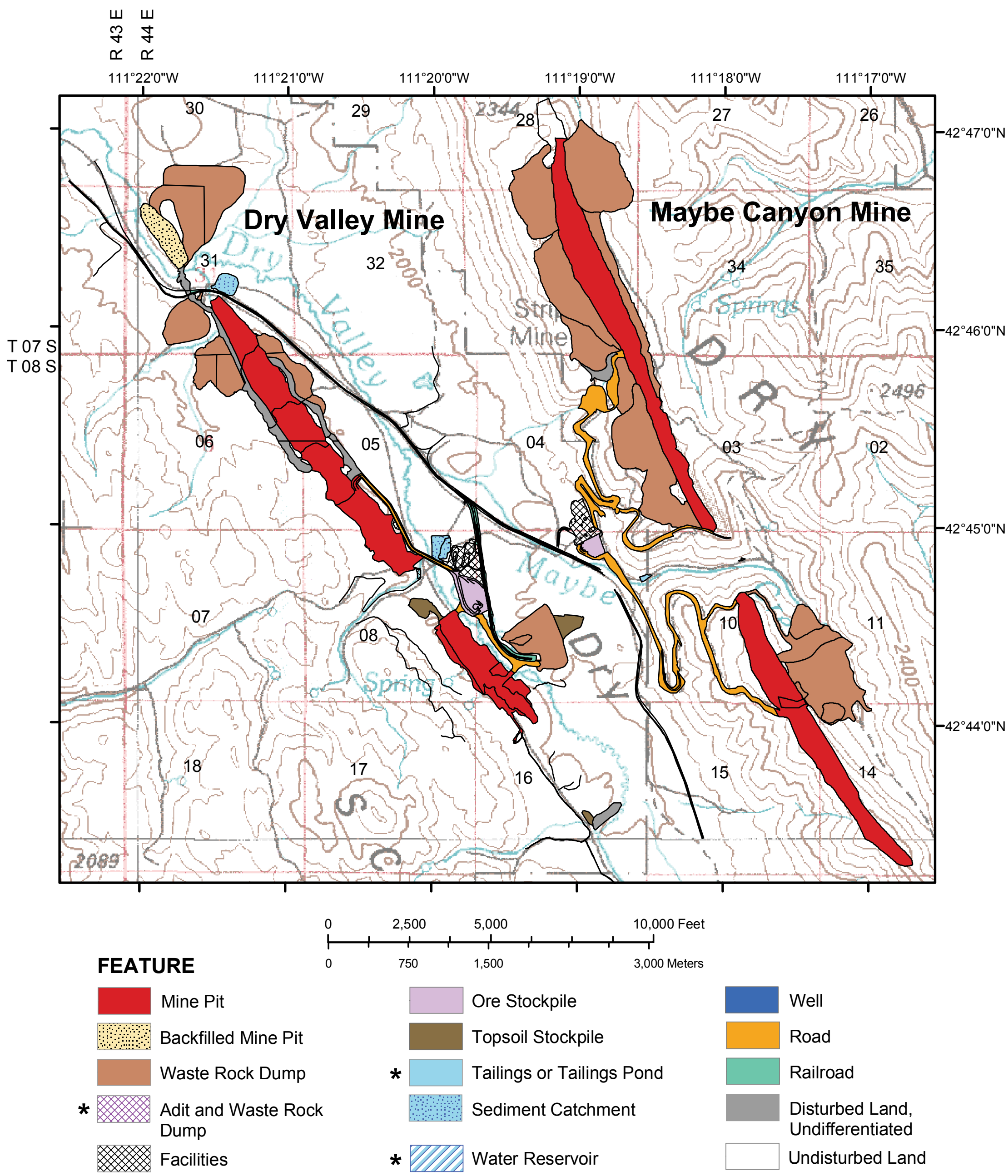

Figure 8. Map of phosphate mining-related features at the Dry Valley and Maybe Canyon Mines, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

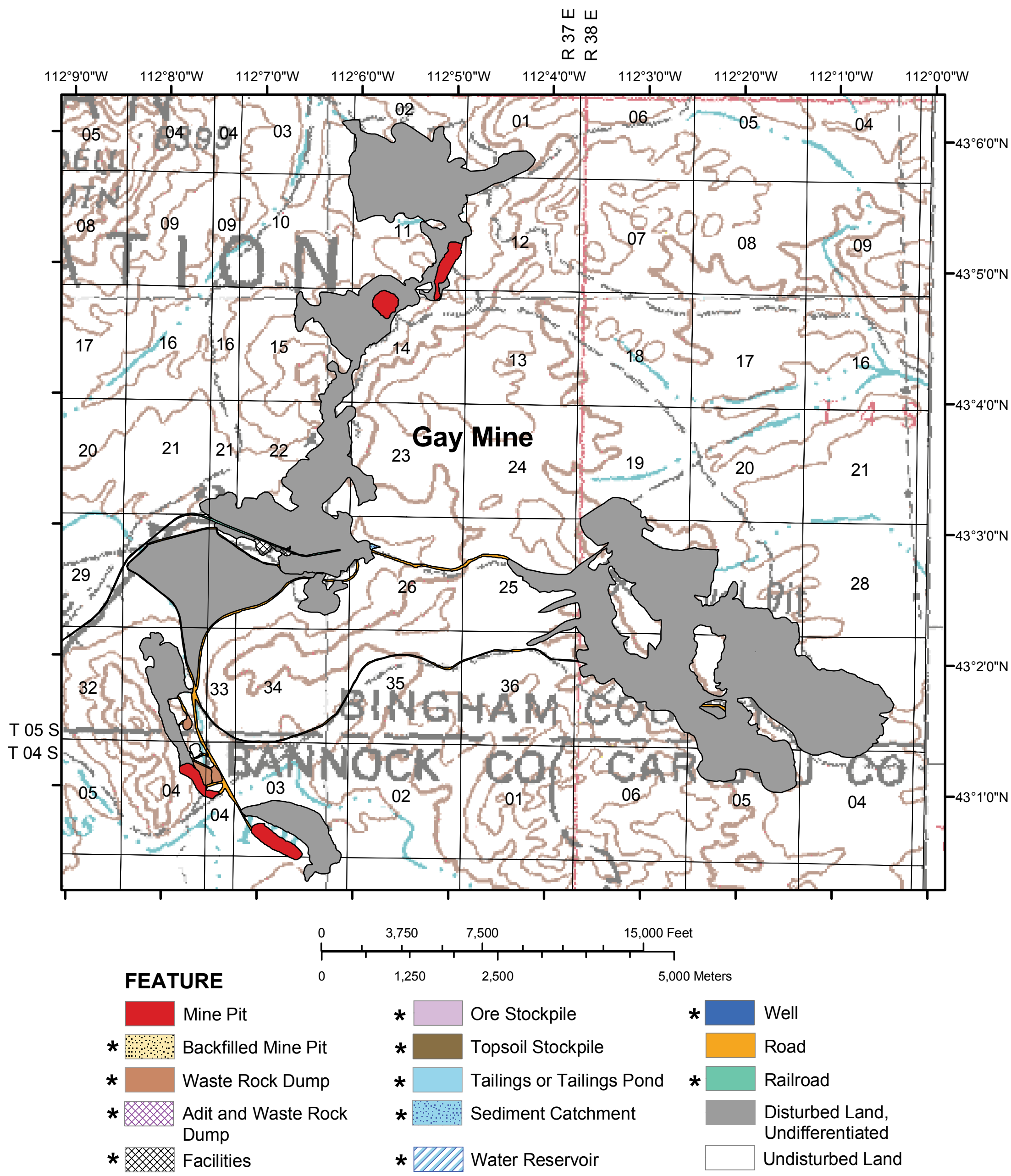

Figure 9. Map of phosphate mining-related features at the Gay Mine, Fort Hall Indian Reservation, Bingham, Bannock, and Caribou Counties, Idaho. (Features shown with an asterisk are not on this figure.)

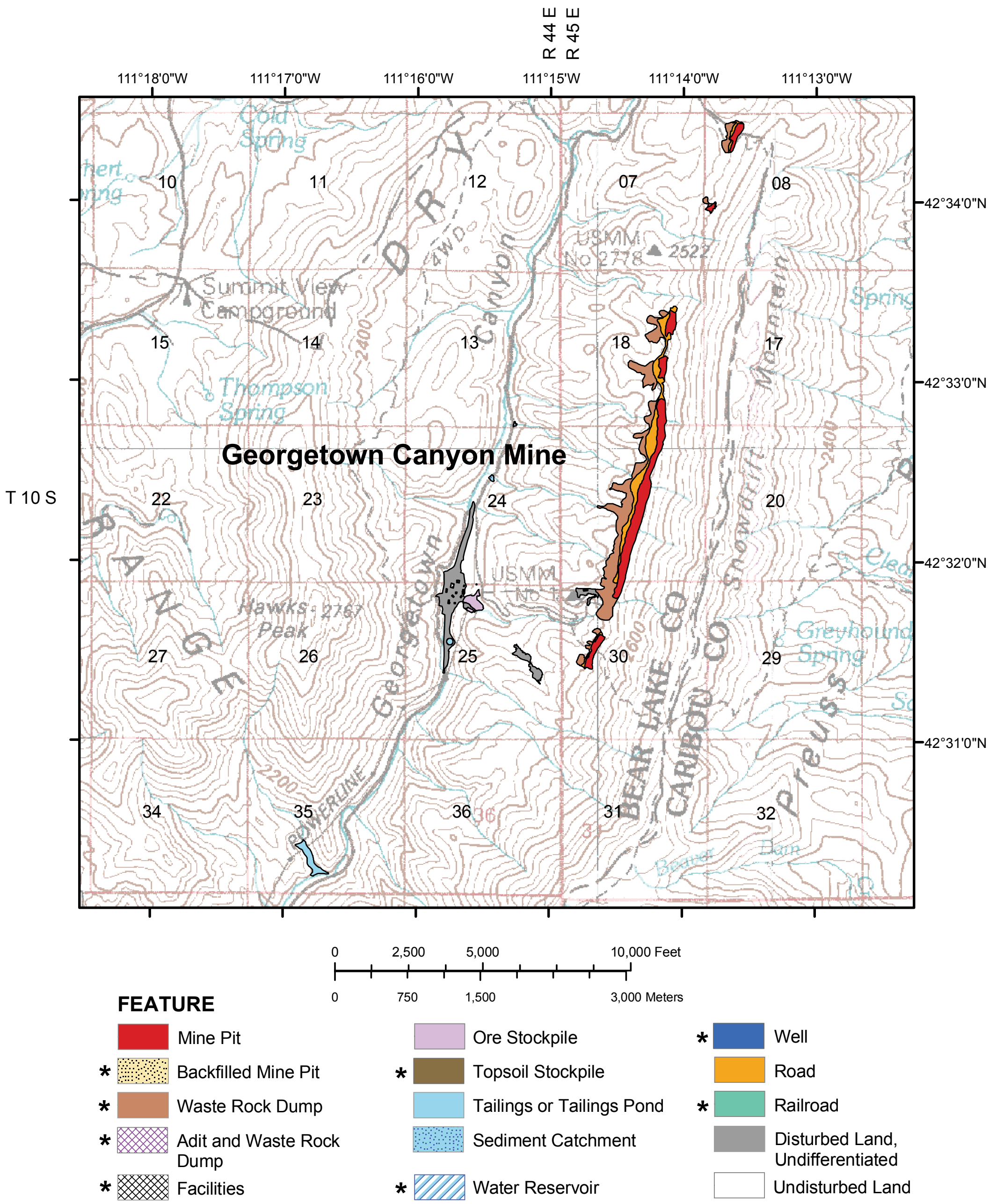

Figure 10. Map of phosphate mining-related features at the Georgetown Canyon Mine and processing plant, Bear Lake County, Idaho. (Features shown with an asterisk are not on this figure.)

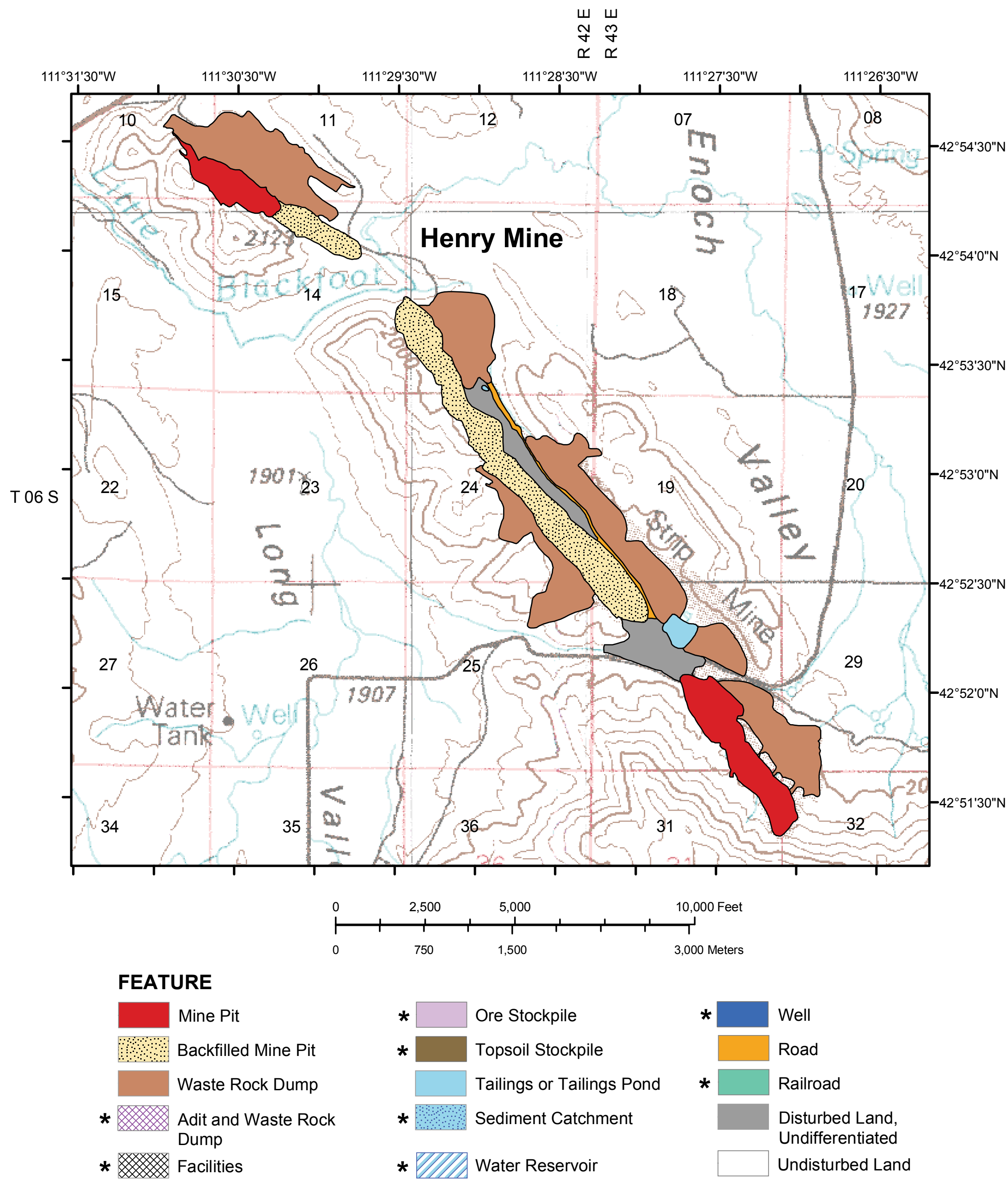

Figure 11. Map of phosphate mining-related features at the Henry Mine, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

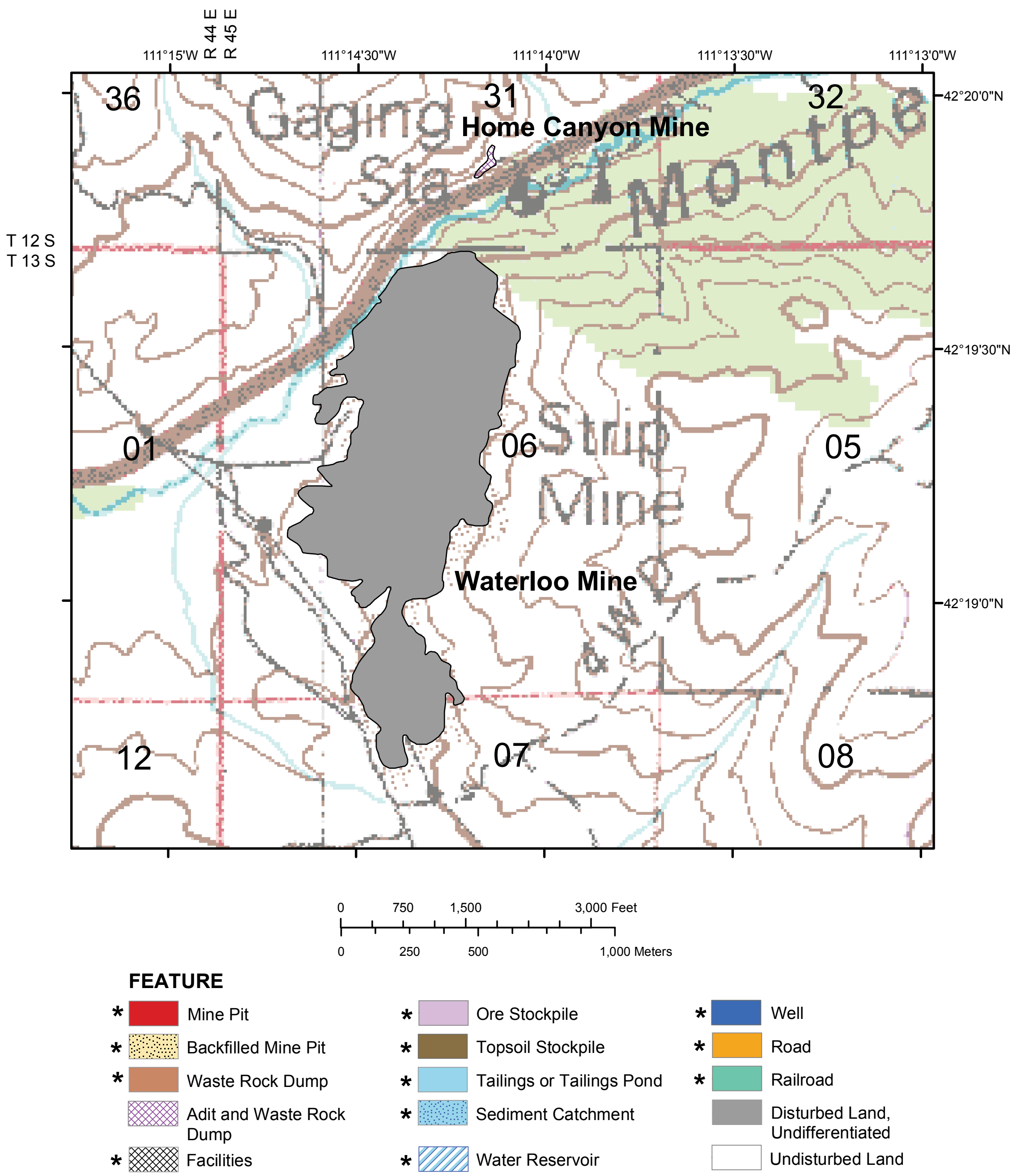

Figure 12. Map of phosphate mining-related features at the Home Canyon and Waterloo Mines near Montpelier, Bear Lake County, Idaho. (Features shown with an asterisk are not on this figure.)

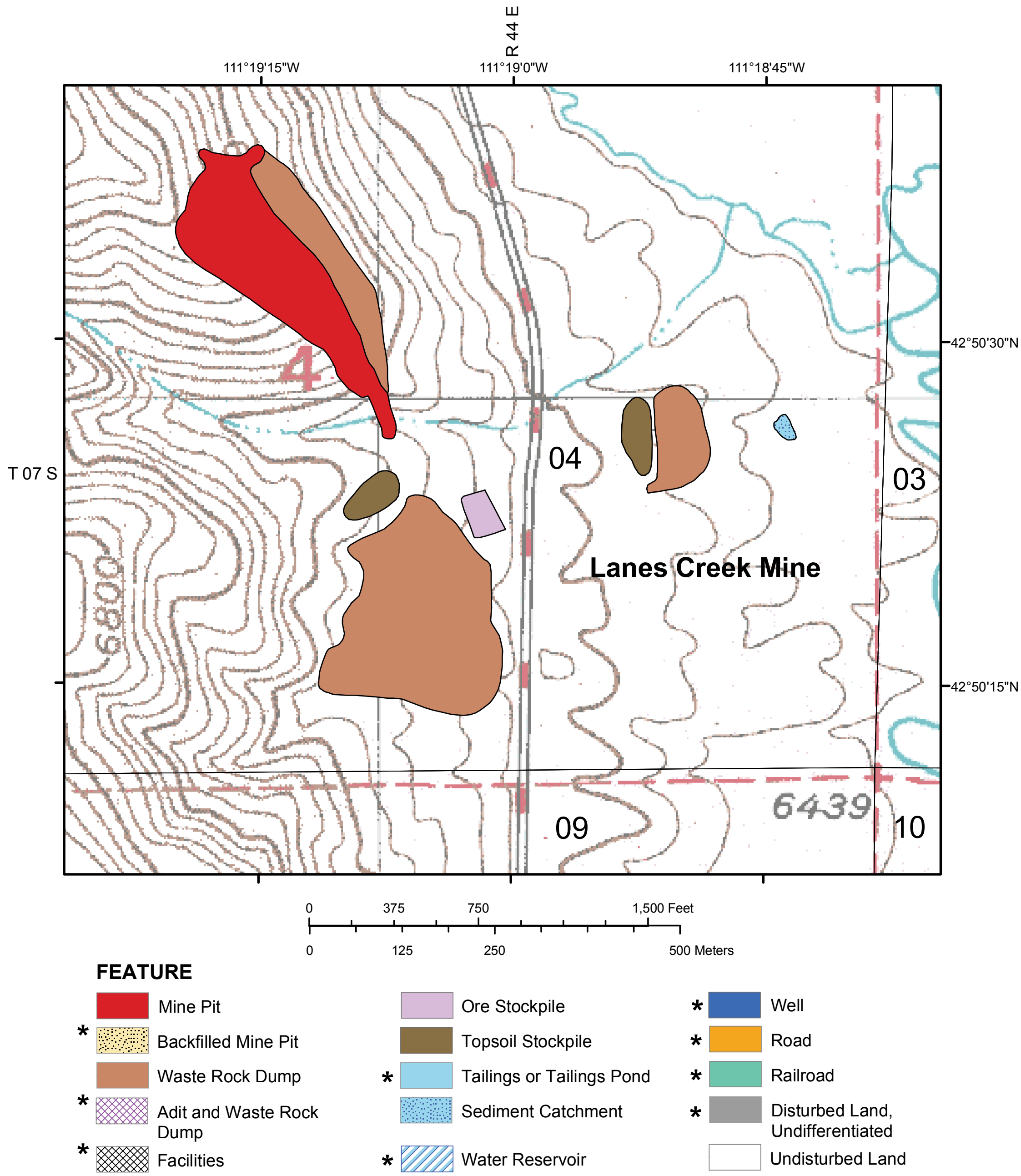

Figure 13. Map of phosphate mining-related features at the Lanes Creek Mine, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

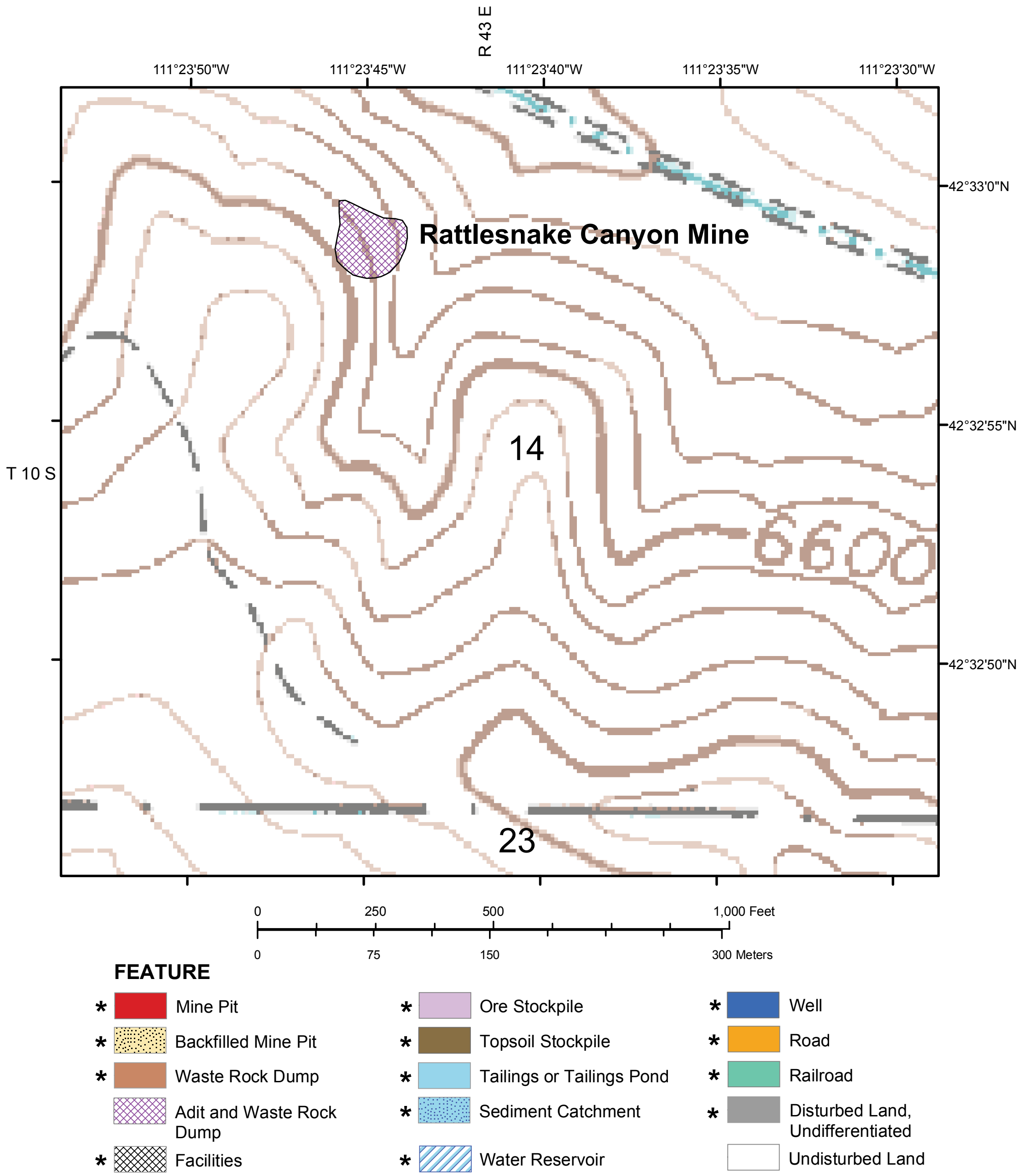

Figure 14. Map of phosphate mining-related features at the Rattlesnake Mine, Bear Lake County, Idaho. (Features shown with an asterisk are not on this figure.)

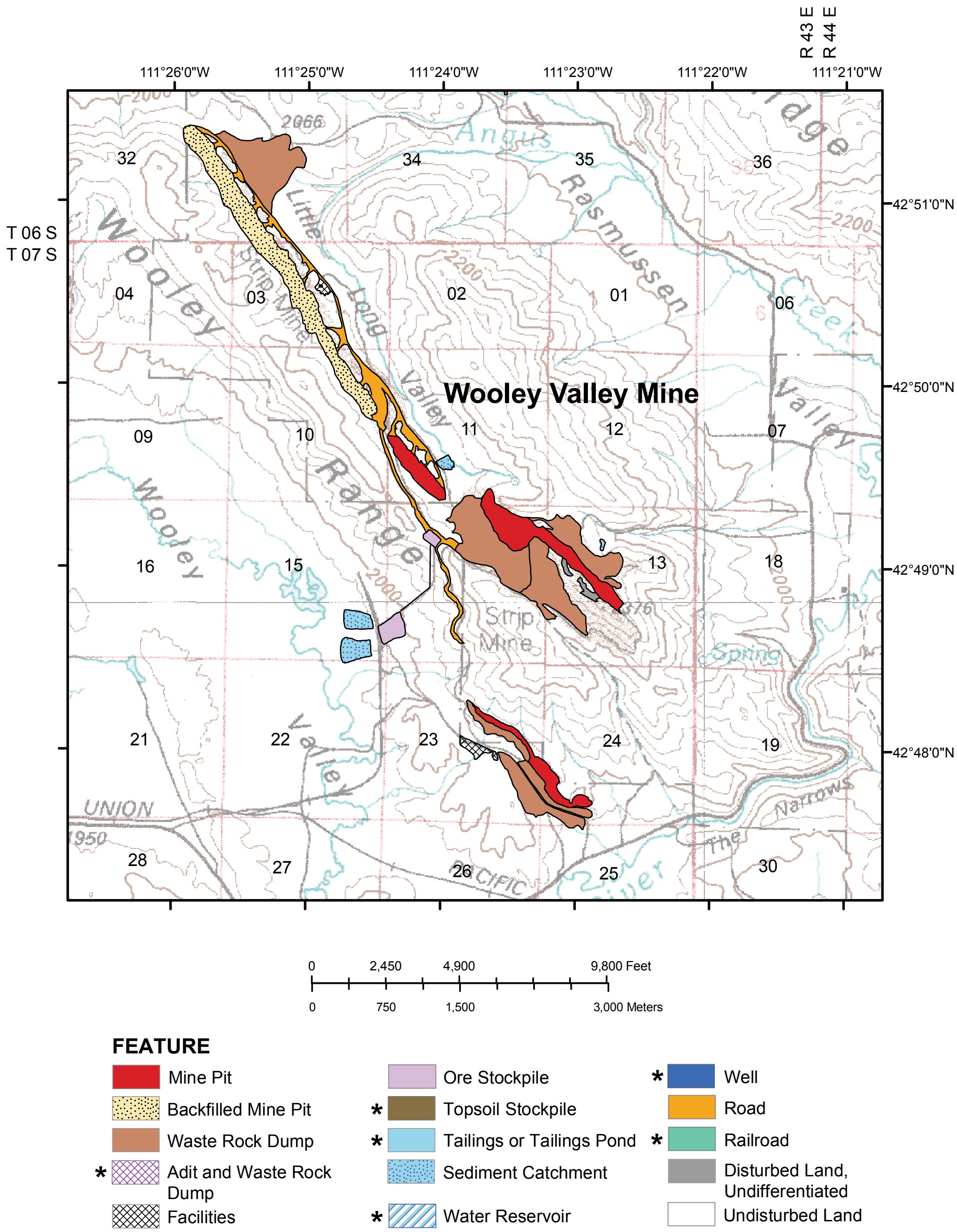

Figure 15. Map of phosphate mining-related features at the Wooley Valley Mine, Caribou County, Idaho. (Features shown with an asterisk are not on this figure.)

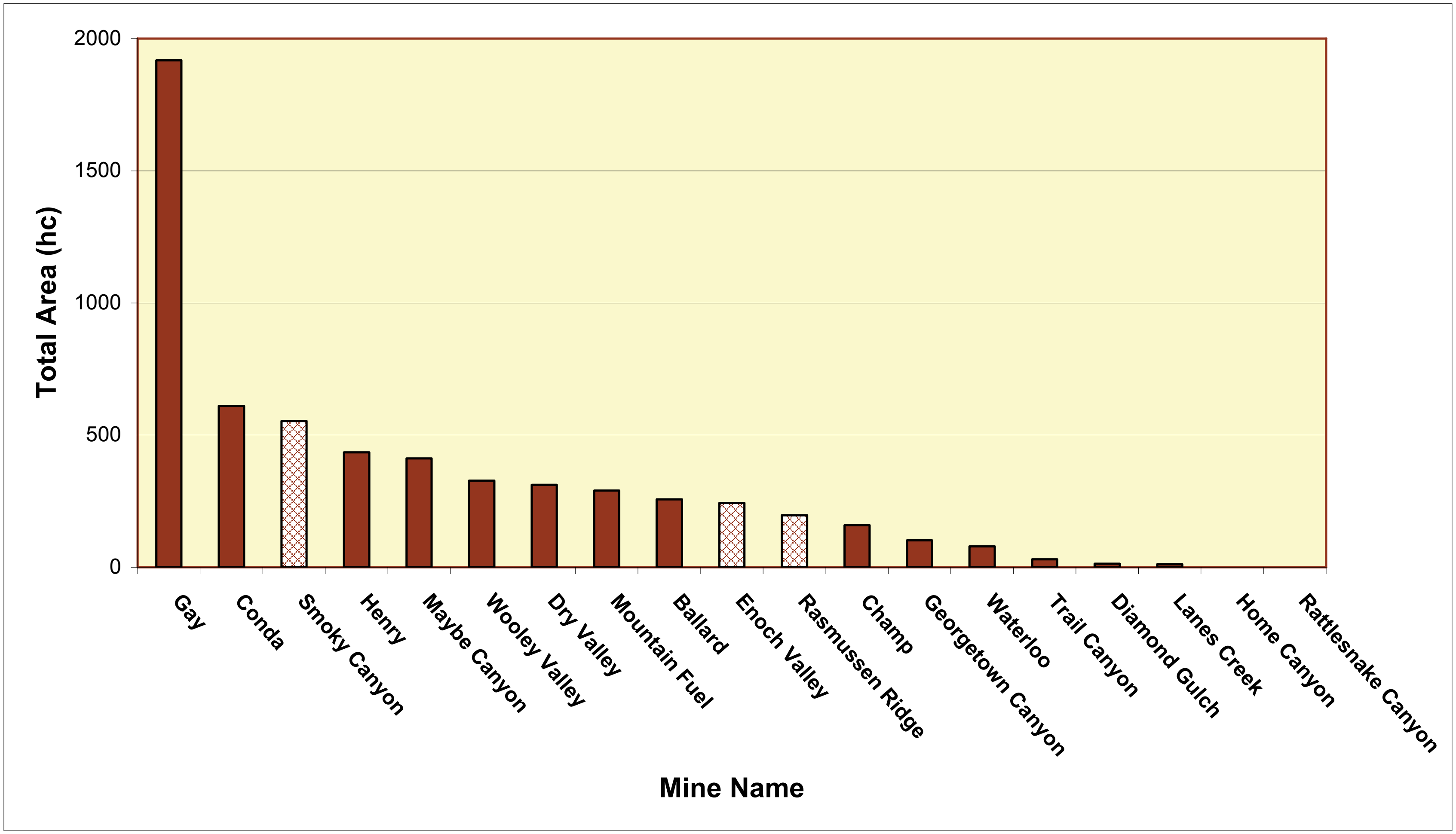

Figure 16. Chart of phosphate mining-related disturbed lands in active (hatched) and inactive (brown) mines in southeastern Idaho; mines ranked by total area of surface disturbance.

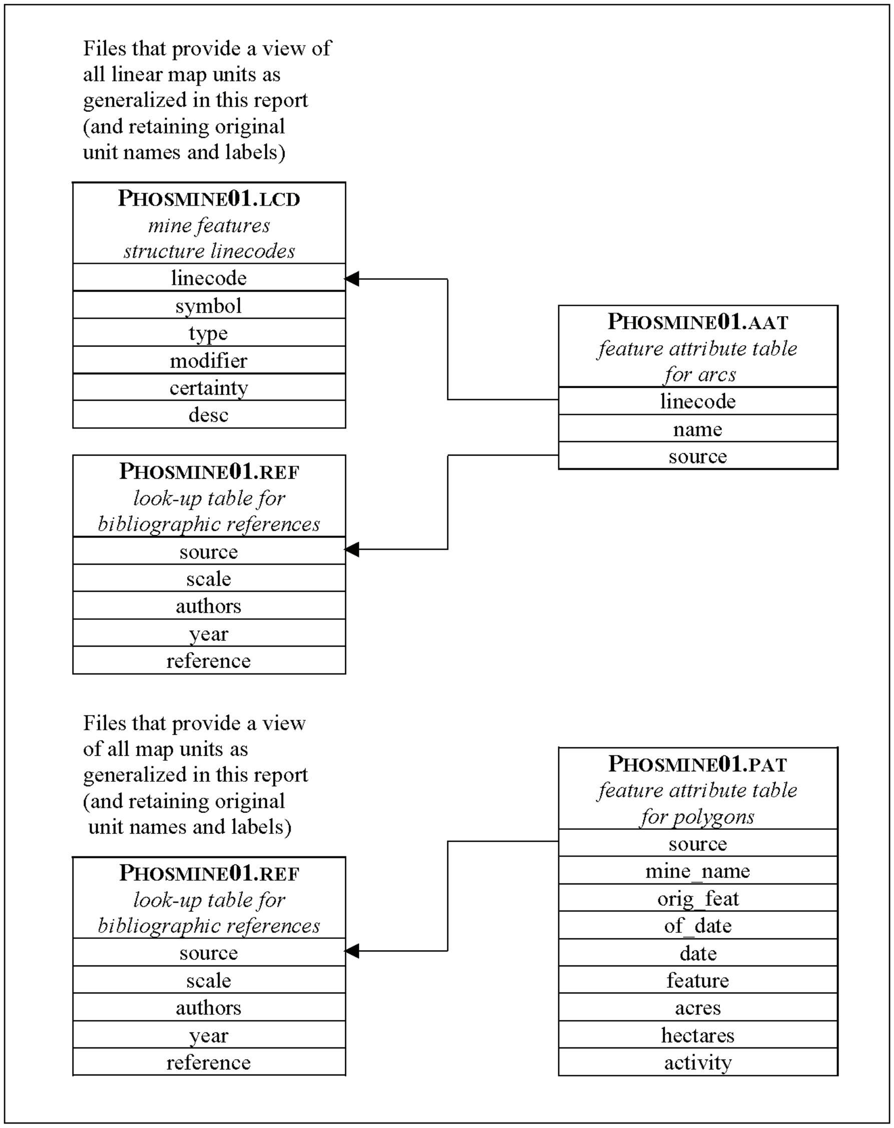

Figure 17. Relationships between the arc attribute table (PHOSMINE01.AAT) and associated look-up tables (PHOSMINE01.LCD and PHOSMINE01.REF) in the PHOSMINE01 mine features spatial database and the relationships between the polygon attribute table (PHOSMINE01.PAT) and associated look-up tables (PHOSMINE01.REF) in the PHOSMINE01 mine features spatial database.

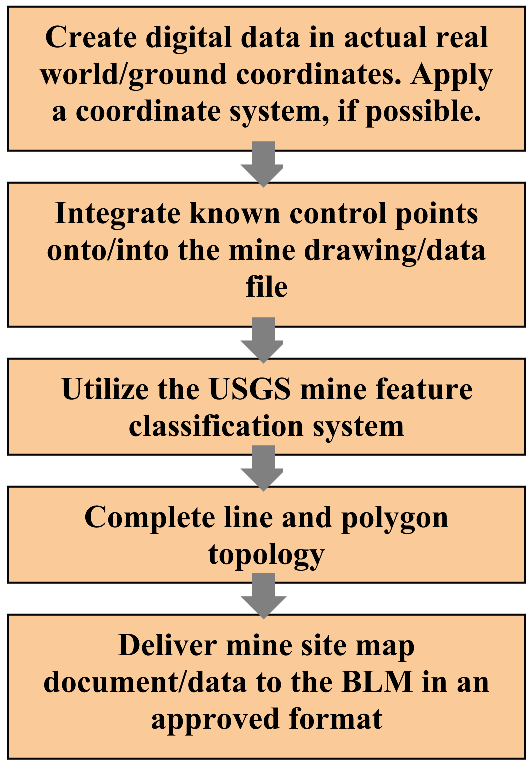

Figure 18. Flow chart for updating the mining spatial database using the mining company materials.

Table 1. List and descriptions of reclassified mine feature terms.

MINE FEATURE NAME	DESCRIPTION OF MINE FEATURE
Adit and Waste Rock Dump	An adit is a horizontal or nearly horizontal passage driven (excavated) from the surface for exploration and/or the working of an underground mine. An accompanying waste rock dump contains the excavated waste material.
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, undifferentiated" classification may include additional backfilled pits that were not evident to the authors.
Disturbed Land, Undifferentiated	Ground that has been re-landscaped or disturbed as a result of a variety of activities 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 maps of mine features, inadequate resolution on DOQQs or aerial photos, or insufficient time for verification in the field. For example, due to the lack of maps of mine features and a thorough field reconnaissance, the entire area affected by the Waterloo mine is classified as disturbed land, undifferentiated.
Facilities	Any buildings, related structures, or areas constructed and maintained to support the phosphate mining and processing operation. Examples of original feature terms include building, building foundation, maintenance shop, office, parking area, plant, prill silo, and spare equipment storage area. Note that the "disturbed land, undifferentiated" classification may include additional facilities that were not evident to the authors.
Mine Pit	An open pit or strip mine excavation (open to the surface) that may expose overburden, low-grade waste, and phosphate ore in situ for the purpose of mining. The typical modern phosphate mine pit in southeast Idaho 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 mine

MINE FEATURE NAME	DESCRIPTION OF MINE FEATURE
	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, undifferentiated" classification may include additional mine pits that were not evident to the authors
Ore Stockpile	Phosphatic ore stored on the surface prior to being shipped for further processing. Note that the "disturbed land, undifferentiated" classification may include additional ore stockpiles that were not evident to the authors.
Railroad	Rail transport system used to haul phosphate ore from the mine loading facility or tipple to the processing plant.
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.
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.
Tailings or Tailings Pond	Fine-grained material (in dry or slurry form) which has been rejected during the processing of phosphate ore and which is usually stored in an impoundment. Note that the "disturbed land, undifferentiated" classification may include additional tailings features that were not evident to the authors.
Topsoil Stockpile	Topsoil stored in surface impoundment and typically reserved for mine reclamation.
Undisturbed Land	Areas of natural landscapes (unaffected by mining or reclamation) that are included with or are enclosed by areas of phosphate mining-related surface disturbance.
Waste Rock 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

MINE FEATURE NAME	DESCRIPTION OF MINE FEATURE
	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, undifferentiated" classification may include additional waste dumps that were not evident to the authors.
Water Reservoir	A fresh water storage area. The water reservoir at Conda provides make-up water for a phosphate slurry pipeline that transports phosphate produced at the Smoky Canyon mine to the processing plant in Pocatello.
Well	A shaft or hole drilled to obtain water.

Table 2. Index of original mine feature names from all data sources and reclassified mine feature names.

NO.	ORIGINAL MINE FEATURE (from company or field survey)	RECLASSIFIED MINE FEATURE (classification system, table 1)
1	2002 Pit	Mine Pit
2	85 Pit	Mine Pit
3	Active Dump	Backfilled Mine Pit
4	Active Dump	Waste Rock Dump
5	Active Dump	Backfilled Mine Pit
6	Active Fill	Backfilled Mine Pit
7	Active Fill	Waste Rock Dump
8	Active Pit	Mine Pit
9	Active Pit	Road (a special circumstance)
10	Adit and Dump	Adit and Dump
11	Atrium Shop\Office	Facilities
12	Backfill	Backfilled Mine Pit
13	Backfill Dump	Backfilled Mine Pit
14	Backfilled Pit	Backfilled Mine Pit
15	Blasting Supply Area	Facilities
16	Bone Yard	Facilities
17	Building	Facilities
18	Buildings & Facilities	Facilities
19	Center Dump	Waste Rock Dump
20	Clarifier Pond	Tailings or Tailings Pond
21	CME North Dump	Waste Rock Dump
22	Disturbance	Disturbed land, Undifferentiated
23	Disturbance, Undifferentiated	Disturbed land, Undifferentiated
24	Disturbed Land	Disturbed land, Undifferentiated
25	Drano Pond	Water Reservoir
26	Dump	Waste Rock Dump
27	Dump and Catchment Basin/Pond	Waste Rock Dump
28	Dump Area 5	Waste Rock Dump
29	Dump Area F	Waste Rock Dump
30	Dump Disturbance	Waste Rock Dump
31	Dump Reclamation	Waste Rock Dump
32	East C-Dump	Waste Rock Dump

NO.	ORIGINAL MINE FEATURE (from company or field survey)	RECLASSIFIED MINE FEATURE (classification system, table 1)
33	East Dump	Waste Rock Dump
34	East Limb Dumps	Waste Rock Dump
35	East Mill Dump	Waste Rock Dump
36	El Paso Dump	Waste Rock Dump
37	Exclusion	Undisturbed Land
38	External Dump	Waste Rock Dump
39	Facilities	Facilities
40	Facilities and Railroad	Facilities
41	GSMA	Topsoil Stockpile
42	Haul Road	Road
43	Haul Road Reclaimed	Disturbed land, Undifferentiated
44	Haul Road Reclamation	Road
45	Haulage Road	Road
46	Inactive Pit Backfill	Backfilled Mine Pit
47	Land Farm	Mine Pit
48	Mine Pit	Mine Pit
49	Mine Pit	Backfilled Mine Pit
50	Miscellaneous Disturbance	Disturbed land, Undifferentiated
51	Miscellaneous Disturbed	Disturbed land, Undifferentiated
52	Miscellaneous Dumps and Roads	Waste Rock Dump
53	Miscellaneous Reclaimed	Disturbed land, Undifferentiated
54	Miscellaneous Reclaimed	Road
55	Miscellaneous Reclamation	Disturbed land, Undifferentiated
56	N.W. Waste Dump	Waste Rock Dump
57	No Data	Undisturbed Land
58	North Dump Reclamation	Waste Rock Dump
59	North Maybe Pit	Mine Pit
60	North Pit	Mine Pit
61	North Pit Backfill	Backfilled Mine Pit
62	Not Disturbed	Undisturbed Land
63	Office	Facilities
64	Ore Stockpile	Ore Stockpile
65	Ore Stockpile Residue	Ore Stockpile
66	Overburden Reclaimed	Waste Rock Dump
67	Overburden	Waste Rock Dump

NO.	ORIGINAL MINE FEATURE (from company or field survey)	RECLASSIFIED MINE FEATURE (classification system, table 1)
68	Overburden	Road
69	Overburden Disturbance	Waste Rock Dump
70	Overburden Disturbed	Waste Rock Dump
71	Overburden Disturbed	Disturbed land, Undifferentiated
72	Overburden Reclaimed	Waste Rock Dump
73	Overburden Reclamation	Road
74	Overburden Reclamation	Waste Rock Dump
75	Overflow Ditch	Sediment Catchment
76	Pit	Mine Pit
77	Pit #1	Mine Pit
78	Pit #2	Mine Pit
79	Pit and Dump	Disturbed land, Undifferentiated
80	Pit Disturbance	Mine Pit
81	Pit Disturbed	Mine Pit
82	Pit Pond	Sediment Catchment
83	Pit Reclamation	Mine Pit
84	Pit Reclamation	Backfilled Mine Pit
85	Pond	Sediment Catchment
86	Prill Silo	Facilities
87	Production Well	Well
88	Proposed N.M.M.E Pit	Undisturbed Land
89	Railroad	Railroad
90	Railroad Dump	Waste Rock Dump
91	Reclamation	Disturbed land, Undifferentiated
92	Reclaimed Dump	Waste Rock Dump
93	Reclaimed Dump 1988	Waste Rock Dump
94	Reclaimed Pit	Backfilled Mine Pit
95	Reclaimed Pit	Mine Pit
96	Reclaimed Road	Disturbed land, Undifferentiated
97	Reclamation	Waste Rock Dump
98	Reclamation	Backfilled Mine Pit
99	Road	Road
100	Road Disturbance	Disturbed land, Undifferentiated
101	Road Disturbance	Road
102	Road Reclaimed	Disturbed land, Undifferentiated

NO.	ORIGINAL MINE FEATURE (from company or field survey)	RECLASSIFIED MINE FEATURE (classification system, table 1)
103	Road Reclamation	Disturbed land, Undifferentiated
104	Road Reclamation	Road
105	Roads and Service	Road
106	Saddle Dump	Waste Rock Dump
107	Sediment Catchment	Sediment Catchment
108	Sediment Catchment Basin/Pond	Sediment Catchment
109	Seeps & Ponds	Sediment Catchment
110	Settling Basin	Sediment Catchment
111	Settling Pond	Sediment Catchment
112	Silt Pond	Sediment Catchment
113	South Dump Reclamation	Waste Rock Dump
114	South Maybe Dump	Waste Rock Dump
115	South Maybe Pit	Mine Pit
116	South Pit	Mine Pit
117	Stockpile & Tipple	Ore Stockpile
118	Stockpile Area	Ore Stockpile
119	Swamp	Undisturbed Land
120	Tailing Disturbance	Tailings or Tailings Pond
121	Tailings	Tailings or Tailings Pond
122	Tailings Pond	Tailings or Tailings Pond
123	Top Soil	Topsoil Stockpile
124	Top Soil Pile	Topsoil Stockpile
125	Topsoil Stockpile	Topsoil Stockpile
126	U of Idaho Selenium Test Site	Facilities
127	Undisturbed	Undisturbed Land
128	Unit 4 Dump	Waste Rock Dump
129	Unknown	Disturbed land, Undifferentiated
130	Unknown Disturbance	Disturbed land, Undifferentiated
131	Unnamed Disturbance	Disturbed land, Undifferentiated
132	Valley Dump	Waste Rock Dump
133	Vehicle Maintenance Area	Facilities
134	Waste Dump	Waste Rock Dump
135	Waste Dump	Waste Rock Dump
136	Water Reservoir	Water Reservoir
137	Water Tower	Facilities

NO.	ORIGINAL MINE FEATURE (from company or field survey)	RECLASSIFIED MINE FEATURE (classification system, table 1)
138	Well	Well
139	West Dump	Waste Rock Dump
140	West Limb Pit	Mine Pit
141	West Mill Dump	Waste Rock Dump

Table 3A. Individual mine feature acreages for 19 phosphate mines for southeastern Idaho phosphate resource area.

MINE NAME	ADIT AND WASTE ROCK DUMP (m^2)	MINE PIT (m^2)	BACKFILLED MINE PIT (m^2)	WASTE ROCK DUMP (m^2)	ORE STOCKPILE (m^2)	FACILITIES, RAILROAD, & ROAD (m^2)	SEDIMENT CATCHMENT, WATER RESERVOIR, & WELL (m^2)	TAILINGS & TAILINGS POND (m^2)	TOPSOIL STOCKPILE (m^2)	DISTURBED LAND, UNDIFFERENTIATED (m^2)	UNDISTURBED LAND (m^2)
ACTIVE MINES											
Enoch Valley	0	160,000	820,000	1,000,000	0	350,000	43,000	0	0	36,000	360,000
Rasmussen Ridge	0	380,000	810,000	310,000	0	310,000	33,000	0	65,000	56,000	1,100,000
Smoky Canyon	0	2,300,000	730,000	1,500,000	30,000	460,000	7,200	0	0	440,000	420,000
Active mine subtotals[1] =	0	2,900,000	2,400,000	2,900,000	30,000	1,100,000	83,000	0	65,000	530,000	1,900,000
INACTIVE MINES											
Ballard	0	870,000	0	400,000	0	2,400	0	0	0	1,300,000	13,000
Champ	0	220,000	250,000	820,000	58,000	0	0	0	0	240,000	46,000
Conda	0	1,700,000	0	2,400,000	0	1,100,000	410,000	360,000	0	200,000	1,600,000
Diamond Gulch	0	5,900	0	0	0	0	0	0	0	130,000	0
Dry Valley	0	1,200,000	110,000	1,100,000	88,000	300,000	71,000	0	80,000	250,000	1,200,000
Gay	0	460,000	0	92,000	0	620,000	6,400	0	0	18,000,000	8,900,000
Georgetown Canyon	0	260,000	0	340,000	24,000	160,000	3,600	34,000	0	200,000	0
Henry	0	620,000	980,000	2,200,000	0	64,000	1,900	53,000	0	410,000	46,000
Home Canyon	3,300	0	0	0	0	0	0	0	0	0	0
Lanes Creek	0	36,000	0	72,000	2,300	0	640	0	6,500	0	0
Maybe Canyon	630	1,300,000	0	2,200,000	31,000	490,000	4,000	0	0	30,000	810,000
Mountain Fuel	0	840,000	150,000	1,600,000	0	160,000	0	0	0	120,000	5,300
Rattlesnake	1,700	0	0	0	0	0	0	0	0	0	0
Trail Canyon	0	270,000	0	31,000	0	0	6,700	0	0	0	0
Waterloo	0	0	0	0	0	0	0	0	0	790,000	0
Wooley Valley	0	550,000	610,000	1,500,000	73,000	420,000	130,000	0	0	26,000	330,000
Inactive mine subtotals[1] =	5,600	8,300,000	2,100,000	13,000,000	280,000	3,300,000	630,000	450,000	86,000	22,000,000	13,000,000
Total all mines[1] =	5,600	11,000,000	4,500,000	16,000,000	310,000	4,400,000	720,000	450,000	150,000	22,000,000	15,000,000

1/ Totals may not equal sums of individual feature areas due to rounding to two significant figures.

Table 3B. Total mine acreages for 19 phosphate mines for southeastern Idaho phosphate resource area.

MINE NAME	TOTAL[1] AREA (m^2)	TOTAL[1] AREA OF DISTURBANCE (without Undisturbed Land)) (m^2)	(hc)	(km^2)	(acres)	(mi^2)
ACTIVE MINES						
Enoch Valley	2,800,000	2,400,000	240	2.4	600	0.94
Rasmussen Ridge	3,000,000	2,000,000	200	2.0	490	0.76
Smoky Canyon	6,000,000	5,500,000	550	5.5	1,400	2.1
Active mine subtotals[1] =	12,000,000	9,900,000	990	9.9	2,500	3.8
INACTIVE MINES						
Ballard	2,600,000	2,600,000	260	2.6	640	1.0
Champ	1,600,000	1,600,000	160	1.6	390	0.61
Conda	7,700,000	6,100,000	610	6.1	1,500	2.4
Diamond Gulch	130,000	130,000	13	0.13	33	0.051
Dry Valley	4,400,000	3,100,000	310	3.1	770	1.2
Gay	28,000,000	19,000,000	1,900	19	4,700	7.4
Georgetown Canyon	1,000,000	1,000,000	100	1.0	250	0.39
Henry	4,400,000	4,400,000	440	4.4	1100	1.7
Home Canyon	3,300	3,300	0.33	0.0033	0.81	0.0013
Lanes Creek	120,000	120,000	12	0.12	29	0.045
Maybe Canyon	4,900,000	4,100,000	410	4.1	1,000	1.6
Mountain Fuel	2,900,000	2,900,000	290	2.9	720	1.1
Rattlesnake	1,700	1,700	0.17	0.0017	0.42	0.00066
Trail Canyon	310,000	310,000	31	0.31	76	0.12
Waterloo	790,000	790,000	79	0.79	200	0.31
Wooley Valley	3,600,000	3,300,000	330	3.3	810	1.3
Inactive mine subtotals[1] =	63,000,000	50,000,000	5,000	50	12,000	19
Total[1] all mines =	74,000,000	60,000,000	6,000	60	15,000	23

1/ Totals may not equal sums of individual feature areas due to rounding to two significant figures.

Table 4. List of digital files provided in this data release.

FILE NAME	FILE DESCRIPTION
METADATA	
Phosmine01_meta.xml	Description of information in the mine features map database (Phosmine01.e00) in a parseable format [exported as FGDC CSDGM (XML) format].
SPATIAL DATABASE	
Phosmine01.e00	Regional mine features map (ESRI interchange-format file).
NON-SPATIAL FILES	
Phosmine01_map.pdf	1:100,000-scale mine features map in portable document format.
Phosmine01_arc .lyr	Layer file used to symbolize the polygons with the correct color for the corresponding map unit.
Phosmine01_poly.lyr	Layer file used to symbolize the arcs with the correct line decoration for the corresponding linecode.