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Natural Resource Stewardship and Science

Abandoned Mineral Lands in the National Park System—Comprehensive Inventory and Assessment

Natural Resource Technical Report NPS/NRSS/GRD/NRTR—2014/906

ON THIS PAGE
Headframe over inclined shaft at Duchess Uranium Mine, Capitol Reef National Park, Utah. (NPS photo)

ON THE COVER
From upper left, clockwise: Kennecott Copper Mill, Wrangell-St. Elias National Park and Preserve, Alaska; open stull stope at Skidoo Gold Mine, Death Valley National Park, California; derailed ore cart covered in rock fall underground at Stone Cliff Coal Mine, New River Gorge National River, West Virginia; bat gate fabrication at Crest Trail Silver-Lead-Zinc Mine, Coronado National Memorial, Arizona. (NPS photos)

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the National Park Service, Geologic Resources Division (http://nature.nps.gov/geology/aml/inventory) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

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Executive Summary

Mining and other mineral resource development have occurred in many areas throughout the United States that are now units of the National Park System. Abandoned Mineral Land (AML) features are vestiges of a time when reclamation of mined areas was not required by federal or state laws and regulations. Many have serious safety issues and resource impacts. Commodities extracted include precious and base metals such as gold, silver, platinum, lead, copper, and zinc; industrial minerals such as clays, limestone, borates, and talc; energy commodities including uranium, coal, oil, and gas; building stone; and aggregate materials such as sand and gravel.

This report presents the details of the System-wide inventory and assessment of National Park Service (NPS) AML sites conducted from 2010 through 2013. This project had two primary objectives:

- Complete a comprehensive inventory of AML sites in units of the National Park System that categorizes high, medium, and low priority mitigation needs; and

- Estimate the resources needed to address priority mitigation needs at NPS AML features using a consistent, credible approach.

By addressing these two main objectives, this report addresses key issues raised by the Office of the Inspector General (OIG) in its July 2008 report entitled, Audit report: Abandoned mine lands in the Department of the Interior. It also is in response to a memorandum (dated October 2, 2008) from the NPS Director's Office which, in response to the OIG audit, directed regional and associate directors to update the NPS AML inventory and to identify the funding needed to address priority NPS AML features.

Through the inventory presented in this report, the NPS identified 37,050 AML features in 133 units of the National Park System. The vast majority of features (81%) are located in the Pacific West Region's southern California desert parks, but all seven NPS regions have AML features. Of the 37,050 features inventoried, 1,799 (4.9%) already have received long-term remedial action to address human health and safety and environmental problems, 3,814 (10.3%) in 76 NPS units are in need of remedial action, and the remainder (84.8%) have been inventoried to characterize each site but do not require action. Detailed site characterization for contaminants was beyond the scope of this study.

Through the assessment presented in this report, the NPS estimates that, starting in 2016, $141.0 million is needed over 12 years to treat the 3,814 AML features requiring remedial action. This estimate includes the actual cost to remediate those features and the administrative costs to systematically manage and coordinate the effort, including staff, contractors, travel, supplies, and inflation.

This report replaces the "interim" report that NPS released in January 2013 (Burghardt et al. 2013). Since publication of that report, the NPS completed its inventory, updated previous data, and added four parks to the inventory. The results reported here were current as of December 31, 2013, but will fluctuate as the NPS discovers new features, when remediation projects are completed, and when new lands that have AML sites are added to the National Park System.

Acknowledgments

We wish to acknowledge the contributions of many individuals whose assistance was invaluable to the field inventory and assessment effort, and to production of the interim and comprehensive reports.

In particular, the members of the NPS Abandoned Mineral Lands Advisory Committee (AMLAC) coordinated park inventories, provided technical expertise, and reviewed work products. They include Linda Stromquist and Sarah Venator of the Alaska Region, Linda Dansby of the Intermountain Region, Chris Holbeck and Leo Acosta of the Midwest Region, Chris Stubbs and Diane Pavek of the National Capital Region, Andy Steel of the Northeast Region, Bob Bryson and Ben Roberts of the Pacific West Region, and Tom Blount and Todd Knoedler of the Southeast Region.

Support of numerous park staff in each of the 133 parks that have AML was invaluable for field inventory coordination and data input.

Data management was coordinated by Pascha Enzi, Nate Irwin, and Timothy Barnhart. Report graphics were produced by Philip Reiker and Christie McDonald. Larry Beal and Paul Rothgery of the NPS Denver Service Center provided cost estimation guidelines and administered the AML inventory contract for the three eastern regions and portions of Pacific West Region. The inventory for California NPS units was conducted by the State of California Department of Conservation, Office of Mine Reclamation Abandoned Mine Lands Unit, spearheaded by David Tibor, Jon Mistchenko, and Sarah Reeves.

We thank our panel of subject-matter experts who provided the peer review of the interim version of this report in 2013: Sara Newman, George Stone, Mark Mesch, and Mike Garner.

Copyediting and layout services for the 2013 interim version of this report were provided by Schatz Publishing Group. All copyedit and layout updates for this comprehensive report were provided by Jeff Selleck, Jim Wood, and Jason Kenworthy.

Acronyms

AKR	NPS Alaska Region
AML	Abandoned Mineral Lands
AMLAC	Abandoned Mineral Lands Advisory Committee
ARRA	American Recovery and Reinvestment Act of 2009
BLM	Bureau of Land Management
DOI	Department of the Interior
IMR	NPS Intermountain Region
FMSS	NPS Facilities Management Software System
FY	Fiscal Year (federal government fiscal year is October 1 through September 30)
MWR	NPS Midwest Region
NCR	NPS National Capital Region
NER	NPS Northeast Region
NPS	National Park Service
OIG	Office of the Inspector General, Department of the Interior
PUF	Polyurethane Foam
PWR	NPS Pacific West Region
SER	NPS Southeast Region
SERI	Society for Ecological Restoration International
USGS	U.S. Geological Survey

General Terms

Abandoned mineral lands	Abandoned mineral lands (AML) are lands, waters, and surrounding watersheds that contain facilities, structures, improvements, and disturbances associated with past mineral exploration, extraction, processing, and transportation, including oil and gas features and operations, for which the NPS takes action under various authorities to mitigate, reclaim, or restore in order to reduce hazards and impacts to resources.
Ecological restoration	The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. The goals of restoration are the re-establishment of the pre-existing biotic integrity in terms of species composition and community structure. (Society for Ecological Restoration, 2004)
Features	Individual elements of an AML site, such as vertical shafts, adits, open stopes, open pits, highwalls, and prospects; structures such as headframes, mills, wellheads, and storage facilities; landform modifications such as access roads, drainage diversions, and drill pads; and piles of ore, protore (marginal-grade ore), waste rock, soil stockpiles, and hardrock or placer tailings. For a detailed listing of AML features and their definitions, see Appendix A.
Mitigation	Any action intended to avoid, reduce, or eliminate hazards or environmental damage. (Society for Ecological Restoration, 2004) This includes gating, plugging, and reclaiming an AML site or feature that requires remedial action. Many programs use this term to convey only temporary remedial measures such as posting warning signs or installing fencing, but throughout its history, the NPS AML Program has used the broader definition for mitigation.
Park	A general term commonly used to refer to any NPS unit regardless of its formal designation.
NPS unit	A distinct area of land or water set aside for protection as part of the National Park System. Included are designations such as national park, national monument, national historic site, national preserve, national recreation area, national river, and others.
National Park System	Any area of land and water now or hereafter administered by the Secretary of the Interior through the National Park Service for park, monument, historic, parkway, recreational, or other purposes. (36 CFR §1.4)
Reclamation	Stabilization of the terrain, assurance of public safety, aesthetic improvement, and usually a return of the land to what, within the regional context, is considered to be a useful purpose. (Society for Ecological Restoration, 2004)
Rehabilitation	The reparation of ecosystem processes, productivity, and services. (Society for Ecological Restoration, 2004)
Remediation	Similar to mitigation. However, as used by NPS, remediation always implies more permanent measures taken to avoid, reduce, or eliminate hazards or environmental damage. This includes "treatments" such as gating, plugging, reclaiming, and long-term water treatment.
Revegetation	Establishment of one or more plant species. Reclamation projects that are more ecologically based qualify as rehabilitation or restoration projects. (Society for Ecological Restoration, 2004)
Site	An area comprised of AML features grouped by past ownership, geographical, or other logical grouping containing facilities, structures, improvements, and disturbances associated with past mineral exploration, extraction, processing, and transportation operations.
Treatment	A specific remedial measure. (See "Remediation")

Introduction

This Abandoned Mineral Lands (AML)[1] inventory and assessment report presents the results of a four-year coordinated effort by the National Park Service (NPS) Washington Office, Natural Resources Stewardship and Science Directorate, Geologic Resources Division; NPS Abandoned Mineral Lands Advisory Committee (AMLAC); NPS Denver Service Center; and 133 parks known to have AML sites within their boundaries. This project had two primary objectives:

- Complete a comprehensive inventory of AML sites in units of the National Park System that categorizes high, medium, and low priority mitigation needs; and
- Estimate the resources needed to address priority mitigation needs at NPS AML features using a consistent, credible approach.

By addressing these two main objectives, this report responds to key issues raised by the Office of the Inspector General (OIG) in its July 2008 report entitled, Audit report: Abandoned mine lands in the Department of the Interior (DOI 2008). The OIG report found that there is a substantial workload throughout the National Park System to address hazards and reclamation issues, and that the NPS needs to provide an updated assessment of estimated costs to remediate these hazards and impacts. Characterization of contamination was beyond the scope of this project. However, the results and estimated mitigation costs from previous studies are included in the information presented.

This report also responds to direction from the NPS Director's Office contained in an October 2, 2008, memorandum to regional and associate directors, entitled Mitigating High-Risk Abandoned Mine Land Features (NPS 2008). The memorandum, also a response to the 2008 OIG report, directed the NPS to update the NPS AML inventory and to identify the funding needed to address priority NPS AML features.

This report supports the first of five primary focus areas that the Service identified as important resource considerations for addressing AML issues:

- site inventory, characterization, and prioritization;
- elimination of public safety hazards;
- rehabilitation of affected natural resources;
- preservation and interpretation of culturally significant sites; and
- maintenance of critical wildlife habitat and species of management concern.

Taken together, the five focus areas allow the NPS to follow its mission as stated in the agency's 1916 Organic Act "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

1 Most AML programs use the acronym, "AML," to denote "Abandoned Mine Lands," including only mined features. The NPS AML Program includes all forms of mineral development, including oil and gas sites. Therefore, the NPS uses the term, "Abandoned Mineral Lands."

Abandoned Mineral Lands in Parks

Historically, companies and individuals explored for and extracted a wide variety of metals, minerals, fossil fuels, and mineral materials from lands that are now part of the National Park System. Precious metals such as gold, silver, and platinum; and base metals such as copper, lead, and zinc have been extracted. Industrial minerals such as talc, limestone, and borates; building stone; and aggregate materials such as sand and gravel have also been mined. Coal mining and oil and gas development have also occurred in parks. Figure 1 is a map of the 133 parks identified with AML features during this inventory.

Abandoned mineral sites and features are remnants of a time when operators were not required by federal or state laws and regulations to perform reclamation. Now, reclamation is required by agency regulations that implement federal laws such as the Mining in the Parks Act of 1976, the Federal Land Policy and Management Act of 1976, and the Surface Mining Control and Reclamation Act of 1977. Individual state laws and regulations also require reclamation but vary from state to state.

The most common AML features inventoried on NPS lands are adits (horizontal underground openings), shafts (vertical or near-vertical underground openings), quarries, pits, and prospects. See Appendix A for a list and description of the kinds of AML features found in the NPS AML inventory.

The vast majority of AML features are located in the Pacific West Region, particularly in Death Valley National Park (California), Mojave National Preserve (California), and Lake Mead National Recreation Area (Arizona and Nevada). Precious metals, base metals, and industrial minerals were the primary targets of mining activity on land that would become those parks. Mines in parks of the Intermountain Region produced similar commodities as well as uranium, oil, and gas. Abandoned coal mines are the most common AML feature in the Northeast Region, while features associated with extraction of base metals, oil, and gas dominate the Midwest Region. The primary commodities targeted in the Southeast Region were coal, oil, and gas. Mines in the Alaska Region primarily produced precious and base metals. All regions contain sand, gravel, and rock quarries and pits.

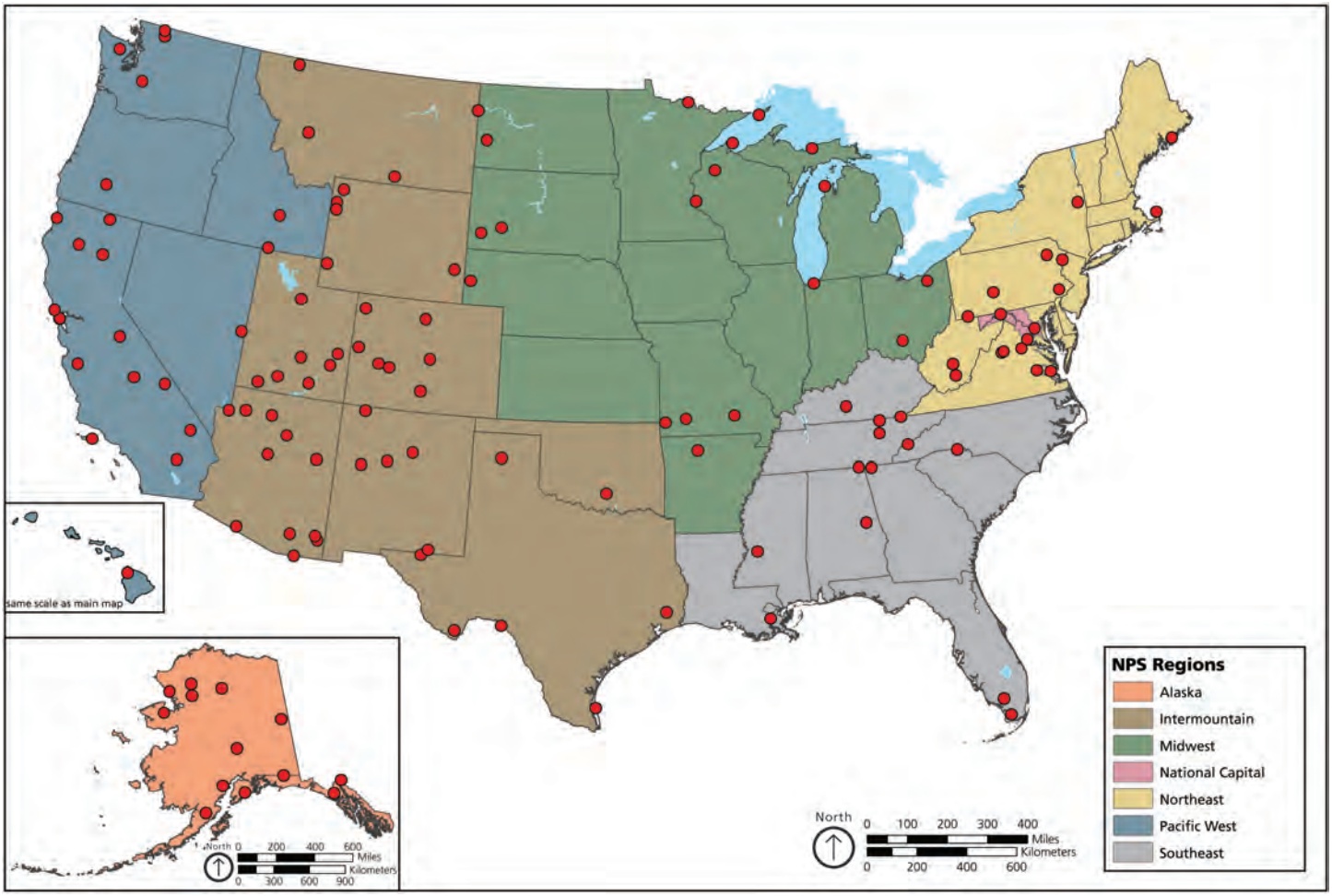

Figure 1. Map showing the location of parks with abandoned mineral lands. (NPS graphic. Data as of December 31, 2013)

Public Safety Hazards at Abandoned Mineral Lands

Abandoned mines present numerous public safety hazards, creating significant risk. According to the Mine Safey and Health Administration (2013a, 2013b), the principal cause of deaths at AML sites nationwide is drowning in water-filled quarries and pits. Water-filled features may contain deceptively deep and dangerously cold water. Steep, unstable, slippery walls can make climbing out of these features extremely difficult, and rock ledges and old machinery hidden beneath the water's surface add additional hazards. The second most common cause of AML deaths and serious injuries is from falls into vertical features such as shafts and open stopes at abandoned underground mines. Other risks to human health and safety derive from deadly gases and radioactive air trapped in confined underground spaces, unstable structures prone to collapse, steep and unstable pit highwalls, explosives, and other hazardous chemicals discarded during mining operations.

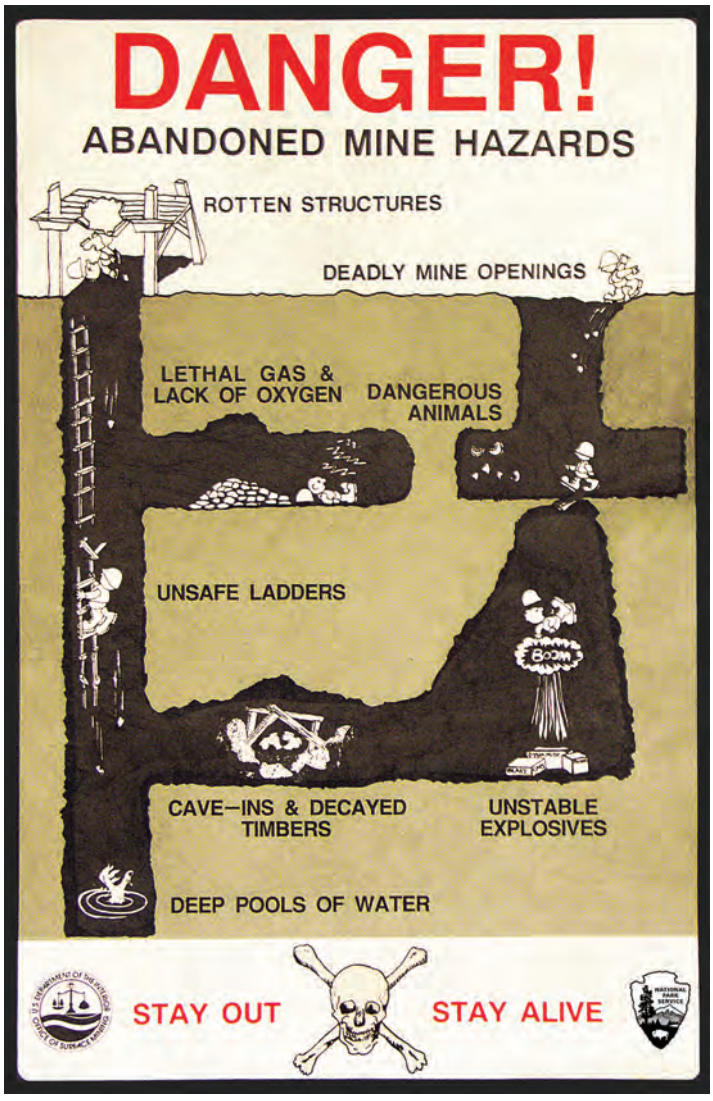

Figure 2. AML public safety hazards. Above: The falling hazard in this stope between levels is easy to see, but alpha radiation is an unseen danger at Epsilon Uranium Mine, Zion National Park, Utah. Upper right: Collapsing rock and failing support timbers are among numerous underground hazards at the multi-level Skidoo Gold Mine, Death Valley National Park, California. (NPS photos) Lower right: NPS Underground AML Safety Sign. (NPS graphic)

Natural Resource Impacts at Abandoned Mineral Lands

Abandoned mineral lands pose a risk not only to humans, but they can also have detrimental effects on the natural environment (BLM 2014). Contaminants from the mined materials may be released, affecting air, soil, and water quality as well as plant and animal health. Interruption of natural drainages by excavations or emplacement of tailings and waste rock piles can lead to extensive erosion and destabilization of the natural topography on- and off-site. An AML site can also affect the scenic values, or "viewshed" of an area, but it may also be an integral part of a park's historic or cultural landscape.

Figure 3. AML natural resource impacts. Upper right: Highly acidic, iron-stained drainage from Worley Coal Mine flows directly into the Cumberland River at Big South Fork National River and Recreation Area, Kentucky. Above: Aerial photo, roughly 3,000 feet across, showing impacts from surface and underground mining operations prior to reclamation in 2010 at Slate Creek Antimony Mine, Denali National Park and Preserve, Alaska. (NPS photos)

Cultural Resource Values of Abandoned Mineral Lands

Despite public safety issues and environmental degradation, mining comprises an important component of our nation's heritage. Long before the arrival of Europeans, American Indians mined flint, obsidian, and native copper for tools and weapons, turquoise and other stones for jewelry, and clay for pots and pipes. During the 16th century, the lure of gold and the prospect of great wealth drove Spanish explorers into North and South America. Later gold rushes and "Manifest Destiny" were responsible for Europeans settling much of the western United States. The industrial age of the 19th and 20th centuries introduced large-scale extraction of mineral resources such as coal, copper, iron, oil, and gas, leaving significant adverse environmental impacts on the land.

The NPS protects historic mines by addressing their safety and environmental issues in ways that do not compromise their cultural integrity. For example, some mine sites, such as Ellis/Mariscal Mercury Mine (Big Bend National Park, Texas) and Kennecott Mill (Wrangell-St. Elias National Park and Preserve, Alaska) (Figure 4), are nominated to the National Register of Historic Places in a process detailed in National Register Bulletin 42, Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties (Noble 1992, rev. 1997). AML exhibits at historic sites and in the visitor centers of parks where mining history is a significant theme can greatly enhance visitors' enjoyment and appreciation of a park. Ongoing preservation and stabilization of historically important sites and features is a long-term maintenance need at mine sites throughout the National Park System.

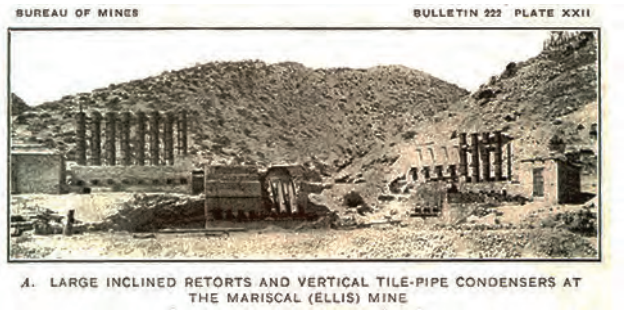

Figure 4. AML cultural resource values. Upper left: Mariscal/Ellis Mercury Mill site as it appeared in 1991. (NPS photo) Upper right: Ellis Mine furnaces (prior to Mariscal era) where miners "roasted" ore to liberate liquid mercury from 1917 to 1919 (Duschaak 1925), Big Bend National Park, Texas. Bottom left: Kennecott Copper Mill as it appeared in 2009, Wrangell-St. Elias National Park and Preserve, Alaska. (Bill Heubner photo) Bottom right: Water tower in need of stabilization at Maryland Gold Mine, Chesapeake and Ohio Canal National Historical Park, Maryland. (NPS photo)

Wildlife Habitat at Abandoned Mineral Lands

Abandoned mines may also be important for the wildlife habitat they provide. Biologists conduct external and internal surveys of underground mines to detect wildlife use by species such as bats. These surveys commonly utilize infrared cameras (Figure 5) or automated motion detectors and environmental sensors with dataloggers that record wildlife movement for periods up to several months. While public safety remains a primary objective, the NPS also preserves wildlife habitat in underground mines by installing a variety of wildlife-compatible closures where practical. These closures allow ingress and egress for particular species while restricting human access. Restricting human access protects people from injury and prevents them from having adverse impacts on the wildlife, including inadvertently spreading the fungus that causes white-nose syndrome: a disease that is killing millions of North American bats that depend upon caves and mines for hibernation (http://www.nature.nps.gov/biology/wns/index.cfm). Not only is wildlife habitat preservation advisable, it is mandated for resident wildlife species protected under the Endangered Species Act of 1973, including several bat species in numerous states and desert tortoise in the southwestern United States. Wildlife-compatible closures have benefits beyond protecting wildlife. For instance, bat gates with removable bars preserve a mine's "window" into the earth for authorized and properly trained researchers such as geologists, mine historians, and wildlife biologists who need to study the protected species in more detail.

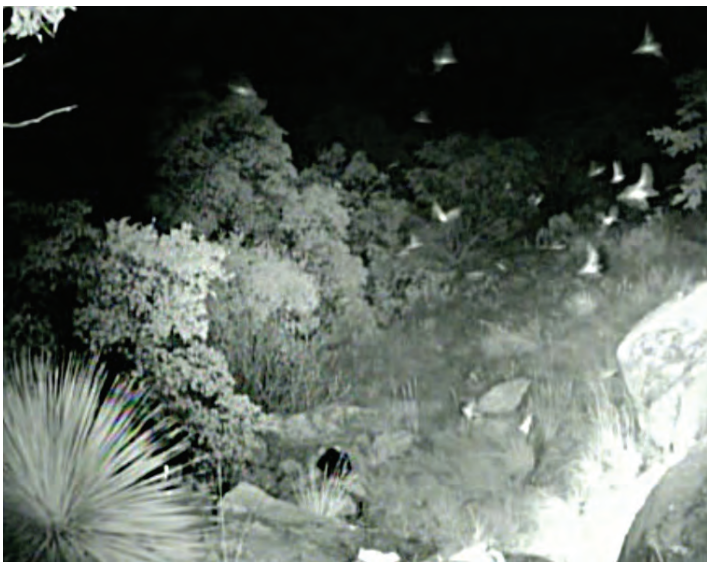

Figure 5. AML wildlife habitat. Upper left: A four-foot-deep guano pile beneath a urine-stained ceiling, documented during a winter survey, is evidence of a summer maternity colony of 5,000 cave myotis bats (*Myotis velifer*), Quillin Gold Mine, Fort Bowie National Historic Site, Arizona. (NPS photo) Upper right: Endangered desert tortoise (*Gopherus agassizii*) found in undisclosed mine location in Joshua Tree National Park, California. (NPS photo) Lower left and right: Infrared videography of lesser long-nosed bats (*Leptonycteris curasoae*) in a mine near Coronado National Memorial, Arizona. (Dave Dalton/Wildlife Engineering photos)

NPS AML Inventory and Assessment

Early NPS efforts to inventory abandoned mines began in 1983, with a questionnaire to parks requesting basic information about known AML sites. In the early 1990s, NPS replaced the questionnaire with a more extensive field inventory form that queried for detailed site location, individual feature characteristics, and prioritization information needed to develop Service-wide mitigation strategies. NPS compiled these data in a rudimentary database that underwent several modifications until the basic structure of the current NPS AML database was developed in 2009.

The AML inventory includes both features and sites. AML features are individual facilities, structures, improvements, and disturbances associated with past mineral exploration, extraction, processing, and transportation operations. Vertical shafts, adits, open stopes, open pits, highwalls, and prospects; structures such as headframes, mills, wellheads, and storage facilities; landform modifications such as access roads, drainage diversions, and drill pads; and piles of ore, protore, waste rock, soil stockpiles, and hardrock or placer tailings are all examples of AML features. For a detailed listing of AML features and their definitions, see Appendix A.

AML sites are areas with distinct past ownership, geographical, or other logical grouping that contain these features. For example, the NPS has identified 664 individual features at Skidoo Mine in Death Valley National Park, California, which is the biggest site in the System.

The NPS AML inventory was systematically undertaken by AML teams[2] using the following methodology:

- Potential abandoned mineral lands were identified on U.S. Geological Survey (USGS) topographic maps, historical mining claim records, through field investigations, and from previous AML inventories.

- The teams conducted field inspections of all identified sites, collected extensive data such as GPS coordinates, feature dimensions, feature condition, and mitigation needs, and photographed the sites and features.

- Features that had already been mitigated were inspected and a condition assessment or evaluation was noted in the database. Where data were available, the date, type, and specific costs of previous mitigation measures were also included.

- The teams ranked the severity of conditions for those features that required remedial action so that they could be prioritized for mitigation.

- Inventory information was entered into the NPS Service-wide AML database. Many teams used a mobile, hand-held data collector to edit, update, and transfer AML site and feature information directly to and from the database. This streamlined and standardized all data entry and eliminated potential human errors inherent to transferring data from notebooks and field data sheets to the AML database.

- The teams that conducted the field inventory compiled mitigation specifications and cost estimates to reflect existing, on-the-ground conditions and needs.

The NPS then extracted inventory and mitigation prioritization data from the AML database and summarized that data in this comprehensive report.

Table 1 summarizes the information that the inventory teams collected (See next page.). This is the fundamental information upon which the NPS bases its AML Program. The teams filled out all required fields that the NPS deemed essential to the inventory (those in boldface), and many ancillary fields were also filled out to more completely assess each site and feature.

These inventory data are stored in the Service-wide AML database, which resides on the NPS intranet where it is available only to authorized NPS users at: http://insidemaps.nps.gov/. Access to this data is limited because of the sensitivity of some wildlife and cultural resource information, and because it contains detailed AML closure cost estimates. Therefore, the NPS only posts summary information on its public-facing AML website (http://nature.nps.gov/geology/aml).

Members of the AMLAC determined where best to use park staff or contractors to conduct the AML inventory and assessment. As a result, they used multiple approaches to gather the inventory data, depending upon the availability, capabilities, and expertise of park and regional staff. The following is a summary of how each region conducted its AML inventory:

Northeast, National Capital, and Southeast Regions, and the Pacific West Region outside of California and Nevada NPS units used a contract administered through the NPS Denver Service Center.

2 AML teams consist of park staff, contractors, and partners who are trained in some aspect of the natural sciences with a solid working knowledge of mineral exploration and mining methods, equipment, and impacts. Survey teams usually have several members, each with their own area of expertise.

Alaska and Midwest Regions, Great Basin National Park, Lake Mead National Recreation Area, and the Nevada portions of Death Valley National Park inventoried their AML resources with regional and/or park staff, sometimes assisted by term and seasonal employees, and used a variety of contracts and/or cooperative agreements with local agencies.

Intermountain Region used two approaches to complete its inventory. Contractors completed their inventory and assessment at 300 AML sites in 17 parks, which included asessing their historical significance. Also, park staff reviewed, updated, and collected new data throughout the region.

Pacific West Region California NPS units were inventoried under a cooperative agreement with the State of California Department of Conservation, Office of Mine Reclamation, Abandoned Mine Lands Unit, using funds from the American Recovery and Reinvestment Act of 2009 (ARRA).

Table 1. Data collected for NPS AML inventory

Category	Fields In Database
Site -Specific	
General	**NPS region, NPS park code, site name, site type, state, county**, congressional district, watershed, site acres, **land ownership status, administrative use***, NPS Facilities Management Software System (FMSS) location ID, FMSS asset priority index, FMSS facility condition index, CERCLIS #, EDL #, general site notes
Geologic Resources	**general commodity**, specific commodity, geology notes
Natural Resource Impacts	**natural resource impacts significant*, effluent*, water pooling*, water running through tailings*, mineral staining on soils/rock*, sediment transport to surface waters*, vegetation health, total waste rock volume, visibility to visitors,** other impacts, natural resource impact notes
Cultural Resources	**cultural resource values significant*, National Register listing or nomination*, Cultural Landscape designation*,** eligible for National Register listing*, site interpreted (signs/pamplets)*, cultural values notes
Feature-Specific	
Identification / Status - General	**NPS Service-wide identification code, park-specific identification code, feature type, action required*, data source, latest revision date,** general feature notes
Access	**access method, distance from drivable road, distance from established path,** published information*, **designated wilderness*, evidence of visitation**, access notes
Geographic Description	USGS quadrangle map name, **latitude north (NAD83), longitude west (NAD83), elevation, location accuracy, GPS date, slope aspect, within park boundary***, UTM north, UTM east, UTM zone, meridian, township, range, section, quadrant
Dimensions	**dimension X (width), dimension Y (height), depth, depth unknown***, disturbed area, disturbed area length, disturbed area width
Biological Resources	**significant biological resources*, threatened/endangered species present*, other species of concern*, bat presence/evidence*,** biology notes
Hazards	**hazards in need of mitigation*, debris present*, highwall present*, rockfall hazards present*, falling hazards*, flooded or evidence of previous flooding*, explosives present*, contaminated air documented*, subsidence features present/potential*, underground fire/evidence*, hazardous substances present*,** hazard notes
Mitigation Required - Specific	**temporary safety method required, mitigation option 1, option 1 estimated cost, option 1 cost estimate year,** mitigation option 2, option 2 estimated cost, option 2 cost estimate year, NPS Project Management Information System number, FMSS asset ID, mitigation required notes
Mitigation Completed - Specific	**recovered naturally*, temporary safety method used,** date of temporary safety measure, **long-term mitigation technique used,** date of long-term measure, mitigation cost, funding source, mitigation agent, partners used, mitigation complete notes.
Sample and Ranking Data	water sample*, **effluent pH**, background pH, water contamination*, soil sample*, soil contamination*, contamination notes, **hazard danger rating (0-5), workings extensive*, access difficulty rating (0-5), resource importance rating (4/2/0), resource impacts severity rating (4/2/0)**
Monitoring	monitoring date, monitoring observations

* Fields evaluated by Yes/No/Unknown

Boldface fields were required for this 2010-2013 inventory and assessment. The remaining fields were optional for inventory teams and may have been filled out in previous assessments.

Ranking Methodology for AML Features and Sites

Prioritization of Individual AML Features

The objectives of this project include determining which of the inventoried AML features require mitigation, then prioritizing the features that require mitigation into high, medium, and low categories. Appendix B includes a complete description of the numerical ranking system that the NPS has used since the mid-1990s to prioritize features for mitigation.

In addition to inventorying and ranking AML features for future remedial actions, the AML inventory also included important ancillary feature information. The AML database distinguishes these features from those that require remedial action, including the examples listed below.

- Features that have already been mitigated were recorded so that costs and closure dates can be tracked, and so that closures can be monitored routinely to check for damage from vandalism, failure of materials, and natural processes such as weathering and subsidence.
- Cultural features such as mining claim monuments, mining and milling equipment, and buildings or their remnant foundations were recorded for historical purposes.
- Individual piles of waste rock, ore that was never processed, tailings, and stockpiled topsoil were measured and recorded in case contaminants are later found or the rock and soil are needed for site restoration, either of which require accurate volume measurements.
- Logistical features that will aid in remedial actions were recorded, such as material staging areas and landing zones for helicopter-assisted remedial operations.

For this report, the NPS prioritized AML features that require mitigation according to the severity of public safety hazards and the intensity of impacts on natural and cultural resources. Due to the risk of serious accidents, the NPS ranks all features with a hazard rating greater than or equal to 3 as high priorities for mitigation, regardless of rankings under the other criteria. Focusing on hazards and resource impacts, the NPS assigns high, medium, and low priority rankings to each AML feature according to the combinations shown in Table 2.

The NPS ranking system also has ratings for accessibility (may indicate likelihood of visitation) and resource significance. As described in Appendix B, the NPS uses these criteria for further prioritization within the broad high, medium, and low categories presented below.

Table 2. Prioritization of features that require mitigation

Priority	Criteria
High	Hazard Level of 3, 4, or 5 or Resource Impact Level of 4; these AML features are top priorities for mitigation.
Medium	Hazard Level of 2 or Resource Impact Level of 2.
Low	Remaining features that require mitigation but do not meet the criteria for "High" or "Medium" priority.

Prioritization of AML Sites

Because AML features typically are clustered together, and often at very large and complex sites, NPS has established a site-level ranking system in addition to individually ranking each AML feature. Important reasons to prioritize and mitigate AML features at the site level include:

- *Number of features requiring action* – Sites with multiple features tend to attract more visitors, increasing the risk of exposure to hazards. Sites with multiple features also are likely to have more resource impacts.
- *Cultural resource values* – If an AML property is listed on the National Register of Historic Places, the listing is usually comprised of the entire site, including many or all of its features.
- *Cost savings* – The average cost to mitigate AML features drops substantially when all features at a given site are remediated together, primarily because of reduced overall mobilization costs.
- *Less environmental impact* – There is considerably less impact on natural and cultural resources when all of the features at a site are mitigated at the same time, because the site will only be disturbed once rather than multiple times.
- *Planning and compliance* – Park planning and compliance are usually done for all features at a given site.

Given these considerations, it is appropriate to treat all of the features requiring action at a site at the same time rather than just those that are highly ranked and then returning later to treat the remaining features. The NPS uses a site prioritization scheme in this report, ranking each site according to its highest-ranked feature relative to the same criteria used in Table 2. Additional criteria used to rank AML features such as site access and cultural resource significance are considered during project implementation, when determining how to allocate program funding and sequence remediation projects. The total number of sites that require remedial action Service-wide is an approximate measure of the number of individual projects it will take to address all NPS AML issues.

Cost Estimation Procedure for AML Feature Mitigation

The teams that conducted the inventories estimated mitigation costs for each AML feature using field data and a variety of cost estimation techniques. Where available, comparable costs from nearby and recently completed AML projects were used as proxies. Where no comparable costs were available, teams made estimates based on an assessment of required labor, equipment, materials, and travel, with appropriate markups as outlined in Appendix D. NPS considers the ranking elements shown in Table B-1 (degree of hazard, extent of workings, accessibility, resource significance, and resource impacts) in determining the appropriate mitigation technique and in calculating mitigation costs. Cost estimates may also include pre- and post-closure wildlife surveys, project planning and compliance requirements, construction monitoring to ensure compliance with plans and specifications, and natural and cultural resources monitoring during and after mitigation.

Mitigation Techniques for AML Features

The inventory teams developed preferred mitigation options and associated costs for each feature that requires mitigation. Mitigation measures used to address AML risks vary depending upon site conditions, access, and specific mitigation needs. Treatment of large, contaminated AML sites can be expensive. Therefore, NPS AML mitigation to date has focused on long-term closures of the most hazardous features or temporary closures such as fencing to mitigate hazards until funding is available for long-term remediation. If a given AML feature is particularly hazardous or if the resources associated with it are sensitive or severely damaged, the park superintendent may close access under an administrative order until the hazard or resource impact has been adequately mitigated.

The NPS uses a "landscape approach" to plan and implement mine closures rather than assessing individual mine openings as isolated entities. This landscape approach considers the treatments that are required in the broader context of the site or district. This approach is consistent with Department of Interior goals for impact mitigation and landscape-level mitigation planning identified in Secretarial Order 3330 (DOI 2013), and is encouraged by Bat Conservation International in its publication, Managing Abandoned Mines for Bats (Sherwin et al. 2009).

A list of AML mitigation techniques typically used at NPS AML sites is shown below. The estimated remediation costs for the NPS AML Program are based on the following types of mitigation measures.

- Warning Signs are used to prohibit access at AML sites with public safety hazards (Figure 6).
- Fences ranging from 3-strand wire fences to heavy chain-link fences restrict access to AML sites (Figure 7).
- Steel wire mesh and cable nets prohibit access to large mine openings or areas of potential subsidence (Figure 8).
- Earthen backfills prevent entry into horizontal or vertical mine openings, and are often preferred when wildlife habitat, historic significance, and heavy equipment access are not primary considerations (Figure 9).
- Polyurethane foam (PUF) plugs fabricated on-site are bases for earthen backfill, enabling a large hole to be plugged with a relatively small amount of material being transported to the site. PUF is formed by combining two liquids that react when mixed, expanding up to 30 times their original volume within 15 minutes. PUF has an impermeable closed-cell structure that is chemically inert. PUF plugs with proper earthen backfills are considered permanent closures. This method is highly portable, time- and cost-efficient and particularly useful in designated wilderness or other sensitive backcountry sites where re-opening old access routes with heavy equipment would create unacceptable impacts (Figure 10).
- Rock or concrete barrier walls are often used on horizontal mine entrances to restrict access to the mines (Figure 11).
- Oil and gas well plugging prevents leakage of oil and gas at the wellhead and prevents subsurface groundwater contamination. Plugging crews remove surface equipment and underground pipe, set cement plugs to protect useable quality groundwater zones, and reclaim the surface (Figure 12).
- Steel gates and grates prevent access to underground mine workings and usually have lockable hatches to allow access when needed (Figure 13).
- Wildlife-accessible steel gates and cupolas allow free movement of important wildlife species such as bats and desert tortoise, with or without lockable bars for human access (Figures 14 and 15).
- Reclamation, as defined by the Society for Ecological Restoration (2004), stabilizes the terrain and returns it to its approximate original contour, assures public safety, provides aesthetic improvement, and usually returns the land to what is considered a useful purpose (Figure 16).
- Explosives mitigation by removal or neutralization in-place eliminates the public safety hazard (Figure 17).

- Interpretive signs are used to explain history and other important aspects of AML sites (Figure 18).

All mitigation projects should be routinely monitored for damage caused by vandalism, subsidence, or weathering, and corrosion or failure of materials.

Figure 6. Administrative closure sign. The administrative closure in 2008 prohibited public access to the popular Keane Wonder Gold Mine site (Death Valley National Park, California) when testing revealed high levels of lead and other contaminants in the soils. (NPS photos)

Figure 7. Fencing of large open stopes. With open stopes as large as large as 215 long by 30 feet wide by 200 feet deep, fencing and warning signs seemed the most reasonable closure method in 1966 at El Portal Barite Mine, Yosemite National Park, California. Because these fences have occasionally been vandalized or circumvented, additional safety measures were installed in 2010 at some of the more hazardous underground locations. (NPS photo)

Figure 8. Cable mesh over open stull stope. An open stope was closed with cable nets and wire mesh at Skidoo Gold Mine, Death Valley National Park, California. This feature is pictured on the cover prior to closure. (NPS photo)

Figure 9. Backfill of adit with mine waste rock and soil. This closure prevents access to extensive and highly radioactive underground mine workings at Rainy Day Uranium Mine, Capitol Reef National Park, Utah. (NPS photo)




Figure 10. Polyurethane foam (PUF) plug installation and backfill with mine waste rock. From upper left, clockwise: Mixing of two components causes a 30-fold expansion of PUF against a lightweight backstop, which then fills the opening to near the surface where it is backfilled with three feet of dirt at Mantle Gold Mine, Outlier Adit, Dinosaur National Monument, Colorado. (NPS photos)

Figure 11. Native rock and masonry wall with mine waste rock backfill. Left: Rock wall under construction inside adit at Jomac Uranium Mine, Glen Canyon National Recreation Area, Utah. Right: Backfill in progress to the entrance using the mine's waste rock. (NPS photos)

Figure 12. Oil and gas well plugging operation. Plugging operation in progress at orphan well on Darrow Ridge in Big South Fork National River and Recreation Area, Tennessee. (NPS photo)

Figure 13. Steel grate installed over vertical shaft. Grates are used where wildlife habitat is not an issue, as with this vertical shaft at Mariscal Mercury Mine, Big Bend National Park, Texas. (NPS photo)

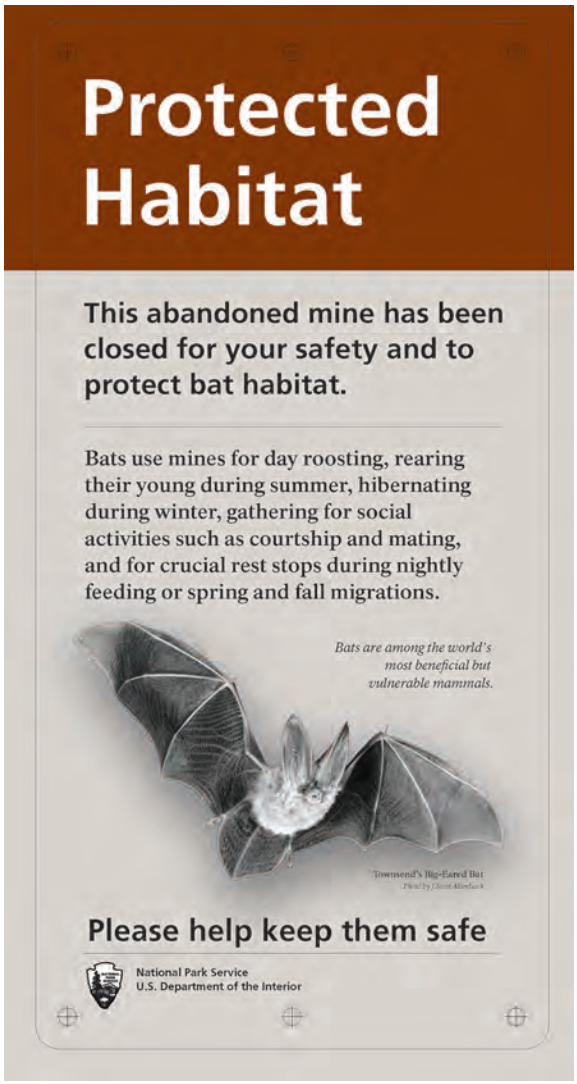

Figure 14. Bat cupolas installed over vertical shafts. Protected habitat sign. Middle left: Bat cupola installed over vertical shaft at Skidoo Gold Mine, Death Valley National Park, California. (NPS photo) Lower left: Low-profile bat cupola installed over vertical shaft at Rattlesnake Gold Mine, Mojave National Preserve, California. (David Tibor, State of California photo) Right: NPS protected habitat sign, placed at bat-compatible closures. (NPS graphic with photo of Townsend's big-eared bat (*Corynorhinus townsendii*) by Dr. J. Scott Altenbach)

Figure 15. Bat gates installed in mine portals.
Upper left: Monte Cristo Zinc Mine 3, Buffalo National River, Arkansas. Upper middle: Bat gate with desert tortoise access at Katherine Access Gold Mine, Lake Mead National Recreation Area, Arizona. Upper right: Bat gate with truck access in Indigo Railroad Tunnel, Chesapeake and Ohio Canal National Historical Park, Maryland. Right: Culvert-mounted bat gates where ventilation and bat access needed to be maintained in two collapsing inclines at Skidoo Gold Mine, Death Valley National Park, California. (NPS photos)

Figure 16. Gravel pit restoration. Left: Site within Great Sand Dunes National Park and Preserve, Colorado, at the beginning of restoration in 2010. Right: The same site after restoration in 2012. This project eliminated public safety hazards, restored a wetland and fishing pond, and removed "whirling disease" from the native trout population in Sand Creek. (NPS photos)

Figure 17. Explosives found at abandoned mines. Upper: Dynamite found in underground mine. This explosives cache was discovered during a field inspection in 2000 at El Cid Gold Mine in Joshua Tree National Park, California. The local sheriff's department removed the dynamite shortly thereafter. Lower: Hercules-brand dynamite box found in explosives magazine shed at undisclosed mine in Capitol Reel National Park, Utah. (NPS photos)

Figure 18. Cultural resource interpretive signs. Upper: Cultural resource interpretive sign outside a bat-gated adit at Kaymoor Coal Mine, New River Gorge National River, West Virginia. Lower left and right: Interpretive and safety sign at the Skidoo Gold Millsite, Death Valley National Park, California. (NPS photos)

NPS AML Program Accomplishments

An ancillary purpose of this inventory and assessment project was to compile an accurate inventory of the features that the NPS has already mitigated. Parks have closed and restored high-priority AML sites for decades using various funding sources. A great deal of work has been accomplished through partnerships, especially with state AML programs that have funding and a shared interest in remediating AML sites. Partnerships with nongovernment groups such as Bat Conservation International have facilitated substantial AML inventory and mitigation work.

Centralized funding to mitigate AML sites and features at multiple parks include:

- 68 AML projects were completed between 1998 and 2009 at a cost of $2,884,000.
- Several large mine closure projects were completed in California NPS units in 2008 and 2009 at a cost of $1,655,000.
- 49 large NPS AML mitigation projects including 923 high priority hazardous or environmentally damaging AML features in 31 NPS units were mitigated between 2010 and 2012 using American Recovery and Reinvestment Act of 2009 (ARRA) funding totaling $24.57 million.

As of the publication of this report, there is no Service-wide funding dedicated to systematic mitigation of the remaining AML sites.

AML Inventory and Assessment Results

This inventory and assessment project was the first time that the NPS conducted a thorough, systematic inventory of all its AML sites and features. The results shown in this report will change as the NPS discovers new features, as remediation projects are completed, and as new lands that have AML sites are added to the National Park System.

Number and Prioritization of AML Sites and Features

The current AML inventory contains information on 37,050 features at 3,421 sites in 133 NPS units entered in the AML database as of December 31, 2013 (Figure 19). A detailed breakdown by region and park of these features is included in Appendix C, Table C-1.

Of all of the AML features that have been inventoried System-wide, 3,814 features at 1,270 sites in 76 NPS units require remedial action (Figure 20). The majority of the AML features (31,437, or 84.8%) do not require remedial action. These are the ancillary features discussed in the "Prioritization of Individual AML Features" section, such as small prospects that present no hazard, cultural features, rock piles, and logistical features that may aid remedial actions in the future.

Table 3 shows the high, medium, and low prioritization of sites and the associated number of features that require remedial action. The features that require remedial action comprise 10.3 % of the total number of inventoried features.

The regional ranking for AML sites and their associated features that require remedial action are shown in Table 4 and Figure 21. The majority fall into the high category, where there is a risk of serious injury or severe natural or cultural resource damage. Even though the majority of features that require remedial action are in the Pacific West Region, the data collected in this inventory demonstrate that each region has significant AML remediation needs.

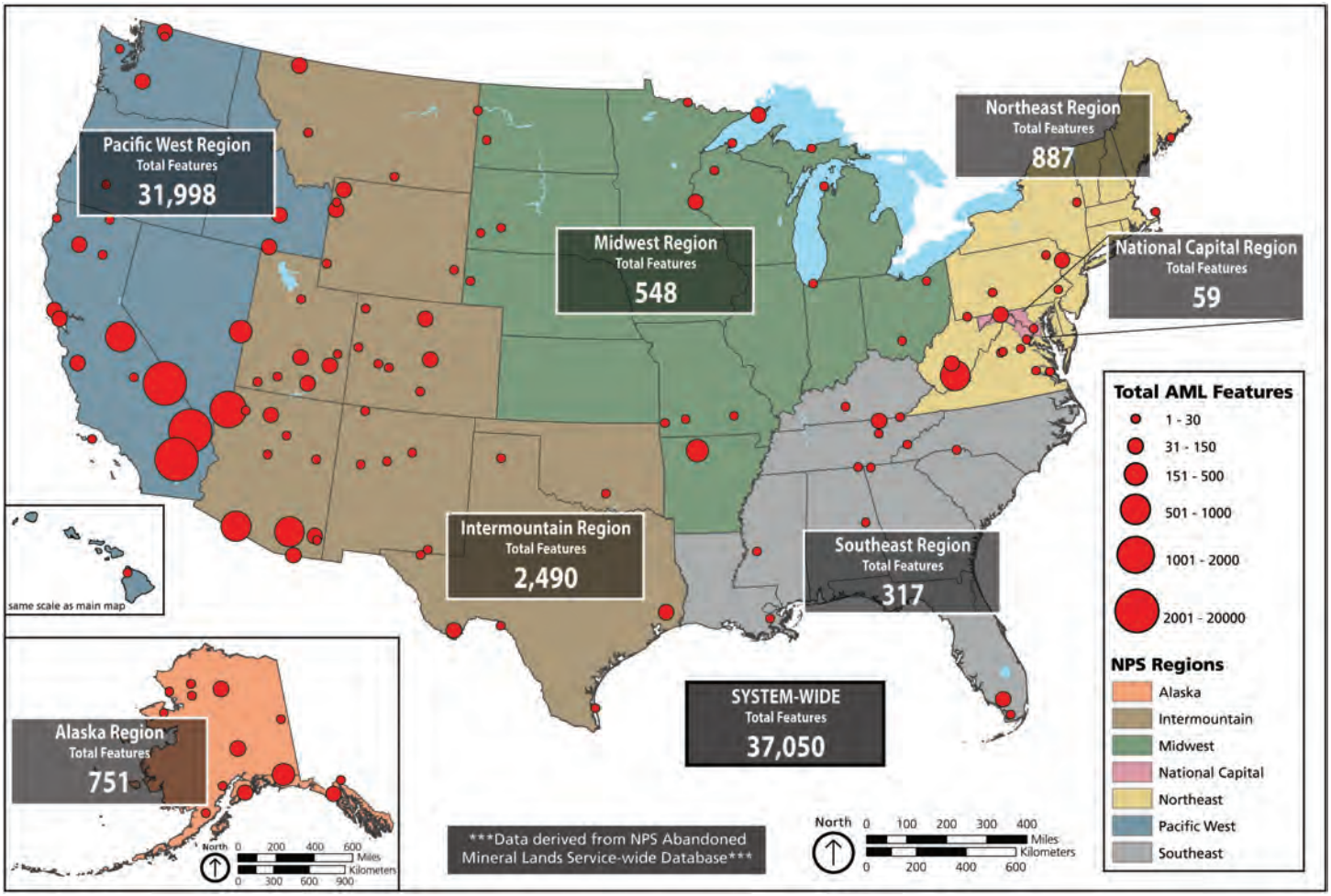

Figure 19. Distribution of AML features in parks. There are 37,050 features System-wide in 133 parks, in all seven NPS regions. (NPS graphic. Data as of December 31, 2013)

Table 3. Site prioritization results for features that require mitigation

Priority	Sites		Features		Percentage of Service-wide Features
	Number	%	Number	%	
High	920	72.4	3,317	87.0	9.0
Medium	142	11.2	232	6.1	0.6
Low	208	16.4	265	6.9	0.7
Total	1,270	100.0	3,814	100.0	10.3

(Data as of December 31, 2013)

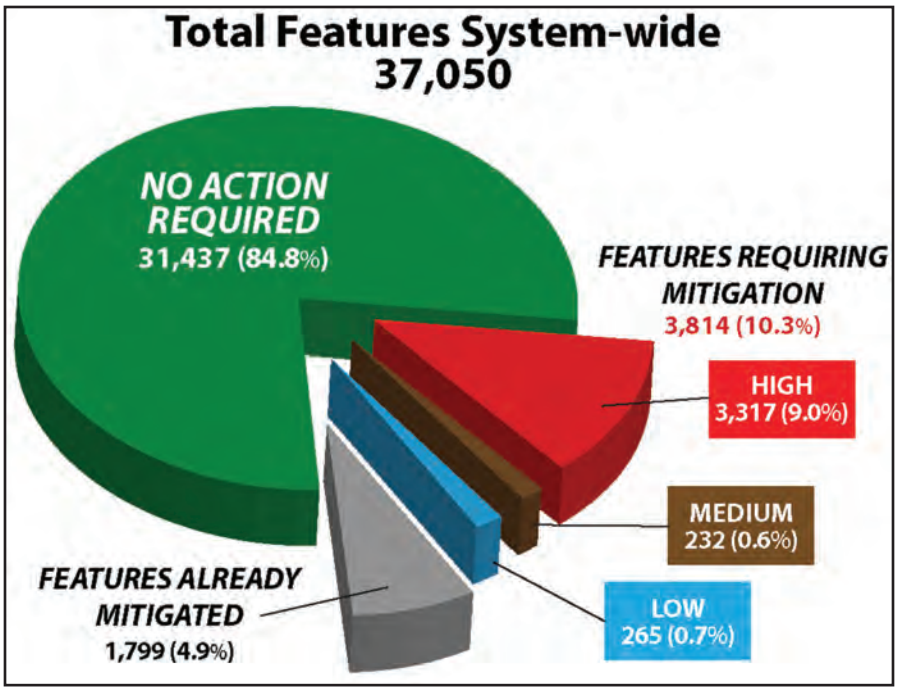

Figure 20. AML feature summary: no action, already mitigated, and those that require mitigation. (NPS graphic. Data as of December 31, 2013)

Table 4. Prioritization by region of AML sites and features that require mitigation

Region (NPS units that have AML features)	Sites and Associated Features Requiring Mitigation								
	High		Medium		Low		Total		
	Sites	Features	Sites	Features	Sites	Features	Sites	Features	NPS units where mitigation is required
Alaska (13)	28	40	9	13	1	1	38	54	6
Intermountain (44)	146	622	36	59	128	146	310	827	29
Midwest (19)	5	22	18	33	21	44	44	99	6
National Capital (4)	4	7	1	1	0	0	5	8	2
Northeast (15)	48	121	16	20	5	6	69	147	10
Pacific West (25)	672	2467	48	92	53	68	773	2,627	18
Southeast (13)	17	38	14	14	0	0	31	52	5
Service-wide Totals (133 NPS units)	**920**	**3,317**	**142**	**232**	**208**	**265**	**1,270**	**3,814**	**76**

Data as of December 31, 2013

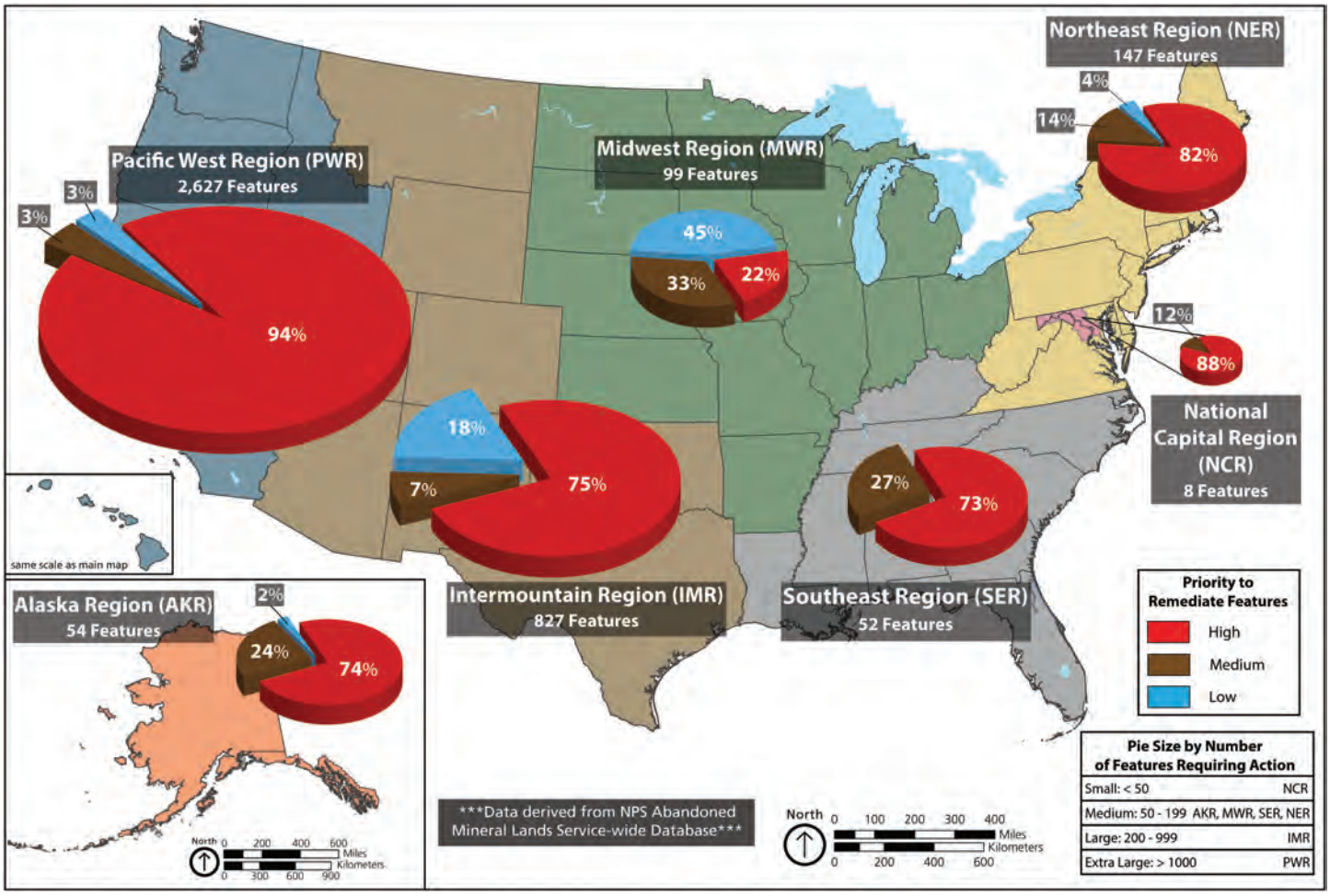

Figure 21. Regional prioritization of AML features that require mitigation. (NPS graphic. Data as of December 31, 2013)

Cost Estimate to Remediate AML Sites and Features

The AMLAC believes that twelve years is a reasonable timeframe to remediate the 3,814 AML features at 1,270 sites System-wide that require action. Table 5 shows a cumulative cost of $141.0 million to complete the remedial actions documented in Table C-1 over the course of twelve-years, beginning in 2016. All cost estimates shown in Table 5 are escalated 4% per year from the 2013 point-in-time cost estimates made by the AML inventory teams, which are shown in Appendix C, Table C-1. Direct, cumulative project costs are $118.0 million over the 12-year period. The costs of permanent NPS staff and temporary contractors necessary to administer and coordinate this remediation are $14.2 million and $5.8 million, respectively. Travel, equipment, and ancillary fees are estimated at $3.1 million. Beginning in year 13, $750,000 per year is necessary to maintain the closures due to vandalism, subsidence, weathering, and corrosion or failure of materials. Two central office coordinators would be retained to administer the AML program in year 13 and beyond at an annual cost of $520,000, inclusive of salary, benefits, and expenses. The year 13 costs would also need to be escalated at 4% per year in subsequent years.

This cost estimate will need to be revised if program funding begins after fiscal year 2016, project timeframes are extended beyond the 12-year cost estimate, additional hazardous conditions are discovered, or if large areas with high concentrations of AML sites are added to the National Park System.

Table 5. Total cost to address all current AML Program needs, beginning in fiscal year 2016

Category	Personnel		12-year cost esclated 4% per year (millions)	Percent of Total Funding	Year 13 and following escalated 4% per year (millions)
	Permanent or Term	Contract			
AML Project Funding	N/A	N/A	$118.0	83.70	$0.75
Central Office Program Coordination	3	N/A	$6.7	4.72	$0.50
Regional Coordinators	4	N/A	$7.5	5.29	N/A
Regional Project Managers	N/A	4	$5.8	4.09	N/A
Program Support	N/A	N/A	$3.1	2.19	$0.02
Total	**7**	**4**	**$141.0**	**100.00**	**$1.27**

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Appendix A. NPS AML Feature Types and Descriptions

AML ***features*** are facilities, structures, improvements, and disturbances associated with past mineral exploration, extraction, processing, and transportation operations. Included are vertical shafts, adits, open stopes, open pits, highwalls, and prospects; structures such as headframes, mills, wellheads, and storage facilities; landform modifications such as access roads, drainage diversions, and drill pads; and piles of ore, protore, waste rock, soil stockpiles, and hardrock or placer tailings. Table A-1 provides a description of all feature types used in the NPS AML inventory, organized by underground, surface, and other categories.

Table A-1. Feature types and descriptions used in NPS AML inventory

Feature	Description	Dimensions as Specified in Database		
		Dim_X	Dim_Y	Depth
Underground Excavations				
Adit	Horizontal (or near-horizontal) entrance to underground mine. No hoisting system was required to transport people and equipment or to extract ore. Easy to walk in and out.	width	height	horizontal distance into mine
Shaft	Vertical (or near-vertical) entrance to underground mine. "Cage" hoisting system (mine elevator) was necessary to transport people and equipment and to extract ore. Climbing is required to get out.	short horizontal dimension	long horizontal dimension	vertical distance down shaft
Incline	Sloped entrance to underground mine, mined from the surface usually along the dip of a vein or stratigraphic horizon. Sometimes called "decline," or "declined shaft." Steep enough that rail-mounted skip hoist system was necessary to extract ore. Clambering is required to get out.	width	height	slope distance into mine
Tunnel	Horizontal (or near-horizontal) underground mine passageway with openings to the surface at both ends.	width	height	horizontal distance through mine
Open Stope	Linear opening mined from underground to the surface along the course of a vein or mineralized zone.	short horizontal dimension	long horizontal dimension	vertical/slope distance down into stope
Vent Raise	Vertical (or near-vertical) feature mined from underground to the surface to aid in mine ventilation. Looks identical to a shaft, but there is no waste rock pile nearby since it was not mined from the surface.	short horizontal dimension	long horizontal dimension	vertical/slope distance into raise
Glory Hole	Broad opening mined and collapsed from underground – differentiated from "Shaft" in that it is usually has irregular dimensions and there is no waste rock pile nearby, since it was not mined from the surface. Differentiated from "Subsidence" in that it is completely collapsed, exposing underground workings.	short horizontal dimension	long horizontal dimension	vertical distance down glory hole
Subsidence	Any subsidence feature resulting from collapse of subsurface mine workings. Describe in Feature_Notes field.	short horizontal dimension	long horizontal dimension	maximum depth
Prospect	Any mined feature, horizontal to vertical, less than 6 feet deep.	(adit or shaft dimensions, as appropriate)		
Surface Excavations				
Surface Mine	Hardrock or coal open pit, open cut, or strip mine; rock quarry, sand & gravel pit, cinder pit, borrow pit, etc.	short horizontal dimension	long horizontal dimension	vertical depth
Highwall	Vertical or near-vertical wall that results at end of broad excavation into a hillside - may require stabilization/mitigation even if surrounding excavation is not fully reclaimed. Differentiated from steep walls on all sides of an open pit mine, portal area of an underground mine, or steep area uphill from road / bench cut.	width	N/A	height
Trench	Linear surface excavation for conveyance of water, drainage diversion, outcrop exposure, etc.	width	length	depth

Table A-1 (continued)

Feature	Description	Dimensions as Specified in Database		
		Dim_X	Dim_Y	Depth
Other Features				
Waste Rock	(aka "spoil pile," or "spoils." Waste rock pile also called "dump.") Unmineralized rock mined to expose and access an orebody. Can be "overburden" from pit mine that was stripped to get down to the ore zone, or barren rock mined underground to access a vein or other mineralized zone. Distinguishing characteristics are variable rock size and scant mineralization. Waste rock is usually dumped as close to the mine as possible to minimize transportation costs.	short horizontal dimension	long horizontal dimension	height of pile
Tailings	At hardrock mine sites, tailings have been ground to a consistent sand or powder grain size to facilitate metal extraction. The potential for residual metals and processing chemicals, as well as fine grain size, make hardrock tailings highly susceptible to erosion and leaching of contaminants into the environment. At placer AML sites, this term refers to coarse rocks and boulders cast alongside stream channels that were dredged for gold or other commodities, whereas finer tailings were most likely washed downstream. Resulting landform is unnatural and difficult to revegetate due to absent soil and sandy components.	short horizontal dimension	long horizontal dimension	height of pile
Ore Pile	Abandoned pile of high-grade mineralized rock that was set aside to be processed, but never made it to the mill. Includes "protore," which is mid-grade material that is set aside awaiting better market conditions or processes that would make it economic to process in the future.	short horizontal dimension	long horizontal dimension	height of pile
Topsoil Stockpile	Topsoil stockpiled on-site for future use in reclamation phase of the operation. Usually stripped at beginning of operation from areas to be mined or areas to be used for support facilities (e.g., mill site, buildings, and pads for ore and equipment storage).	short horizontal dimension	long horizontal dimension	height of pile
Road	Road / mine access bench	width	length	N/A
Impoundment	Impoundment for water, tailings, ore processing solutions, etc.	short horizontal dimension	long horizontal dimension	vertical distance to bottom
Embankment	Bank, mound, dike, etc., resulting from site clearing, barricading, or other ground surface modifications.	short horizontal dimension	long horizontal dimension	height of pile
Building	e.g., mill, office, shop, dry (clothing/showering facility), residence, etc.	short horizontal dimension	long horizontal dimension	height of building
Structure	e.g., headframe, ore storage bin, ore chute, tipple, loadout, pad, foundation for equipment or building, etc.	short horizontal dimension	long horizontal dimension	height of structure
Equipment	e.g., ore car, hoist, trommel, generator, compressor, pressure tank, storage tank, front-end loader, mucker, bulldozer, drill rig, etc.	short horizontal dimension	long horizontal dimension	height of equipment
Well	e.g., oil, gas, geothermal, water (including hand-dug wells, which tend to be rectangular, and drilled wells, which a cylindrical). NOTE: For drilled wells, record diamater in feet (e.g., 4" = 0.33 feet).	short horizontal dimension	long horizontal dimension	depth
		diameter	0 (zero)	depth
Hazmat Cache	Hazardous materials cache that is not associated with another feature (e.g., hazmat stash inside an adit should be entered as Feature_Type = "Adit").	short horizontal dimension	long horizontal dimension	average height of pile
Artifact Concentration	Any pile of historically significant artifacts, e.g., machinery parts, drill bits, core samples, empty food cans. Describe in Feature_Notes field.	short horizontal dimension	long horizontal dimension	average height of pile
Trash Pile	Discrete trash pile worthy of separate GPS location - to be distinguished from general debris scattered around a site or feature. Also do not confuse with "dump," which in mining terminology refers to a waste rock pile (mined material that was not sent to a mill). Describe further in Feature_Notes field.	short horizontal dimension	long horizontal dimension	average height of pile
Explosives Cache	Onsite explosives cache that is not associated with another feature (e.g., not a small adit that is used for an explosives magazine). If explosives are present, make note in Feature_Notes field and describe further in Haz_Notes field.	short horizontal dimension	long horizontal dimension	average height of pile
Miscellaneous				
Other	Anything that does not fit above – include description in Feature_Notes field.	(as deemed appropriate)		
Unknown	Use only as a placeholder for legacy data where feature type is not specified and current staff are not familiar with site. Please update next time site is inspected by entering new feature record (with specific feature type identified) into database, then delete "Unknown" feature record. [This feature type does not show on field inventory forms.]			

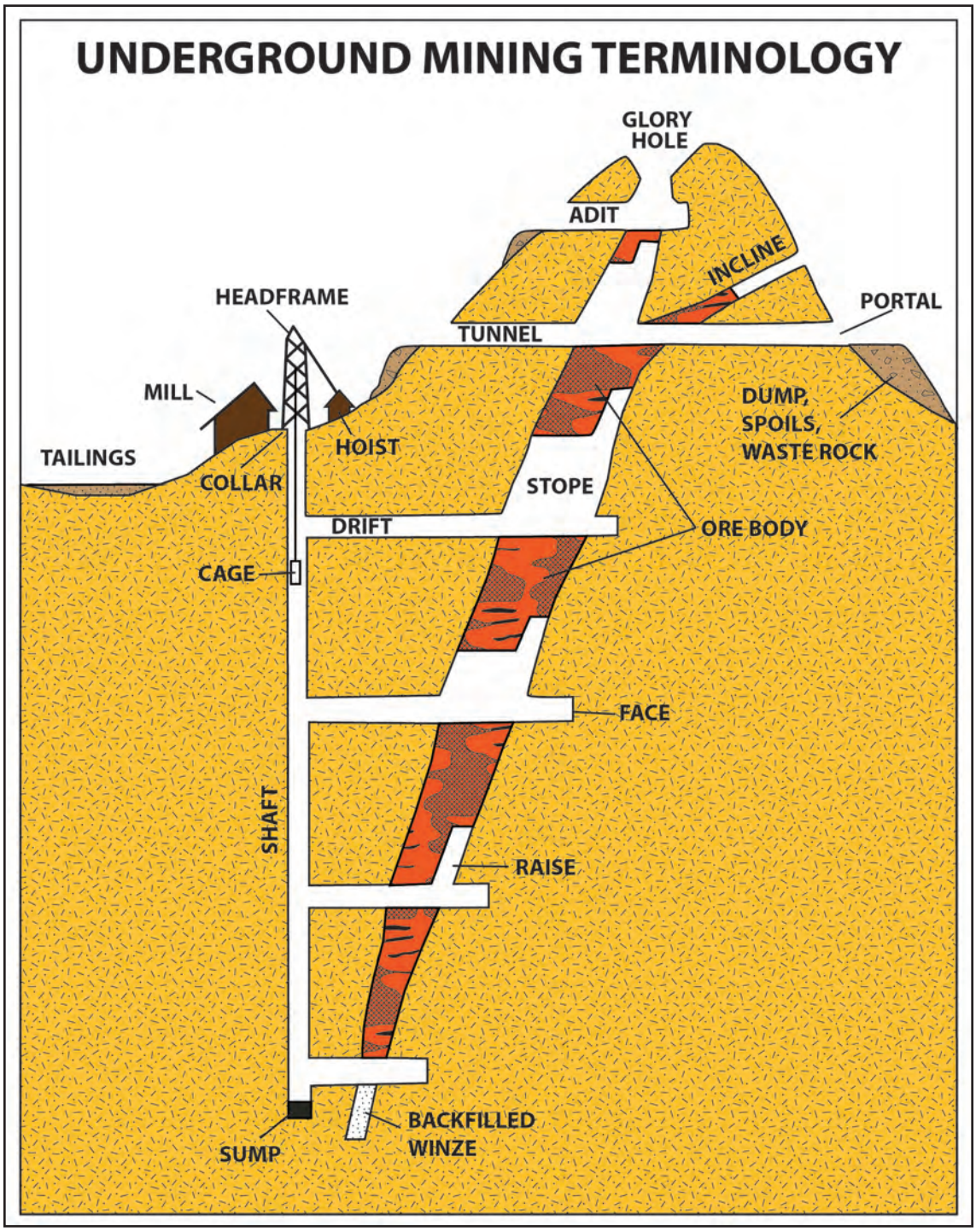

Figure A-1. Diagram illustrating general mining terminology. This diagram displays some of the more common features and a few other underground features that are not called out specifically in the database, because underground access was denied for most of the field survey teams. (NPS graphic)

Appendix B. AML Feature Ranking Criteria Considered for Prioritization

During the AML inventory, the NPS recorded hazard, extent, access, resource significance, and resource impacts so that they could be used to develop feature- and site-specific mitigation recommendations, cost estimates, and priorities (Table B-1). These ranking elements were assessed and listed separately in the database so that they could be applied to the specific needs of a project or funding source that focuses on one or more of the elements shown below.

- Hazard: Possible ratings are 0, 1, 2, 3, 4, or 5 (5 being the most hazardous). Hazards with a rating of 3 or higher are considered "high priority." Due to the risk of a serious accident, injury, or death (defined in Table B-1), the NPS determined that hazard ratings of 3 and above should be considered a "high" priority for remediation. A ranking of 2 is considered "medium priority" while rankings of 0 or 1 are considered "low priority" hazards.

- Extensive Workings: An additional point is added for "Extensive Workings," which are multi-level features or those with underground workings in excess of 500 feet. The extra point is added because larger, multi-level mines are more likely to be hazardous, more prone to provide habitat (especially for bat species), and more likely to be culturally significant.

Table B-1. Criteria used to prioritize NPS AML features for remedial action

Rank	Element	Priority
Hazard Rating (possible score: 0 to 5)		
5	• Any coal mine • Vertical shafts, winzes, or underhand collapsed stopes > 6' • Irrespirable air • Instantaneous fatal injury could occur due to mine-related hazard	High
4	• Large unstable structures • Deep pools of water from which it would be difficult to climb out. • Potential fatal injury could occur • Major collapse zones	
3	• Radiation potential • Large stopes overhead - seemingly stable • Highwalls > 10' drop-off not apparent from above • Serious injury could occur	
2	• Highwalls > 10' - drop-off apparent from above • Rubble around but rock is generally stable • Moderate injury could occur	Medium
1	• Minimal injuries could occur like tripping, bumping head, cutting oneself • Highwalls < 10' in area where such drop-offs are common naturally • Minimal injury possible	Low
0	• No inherent hazards; no injury potential above normal condition	
Extensive Workings		
1	If underground mine feature is extensive (i.e., known to have over 500' of workings or multiple levels), 1 point will be added to the total ranking score because complex mines tend to be more hazardous and better wildlife habitat.	
Access Rating (likelihood of visitation - possible score: 0 to 5)		
5	Good road with mine as the specific destination; car accessible	High
4	Good dirt road, but mine is not specific destination	
3	Dirt road or path without specific destination; no car access; easy hiking access < 1 mile	Medium
2	Near a road/path (within 1 mile); Easy hike > 5 miles or moderate hike < 5 miles	
1	> 1 mile from road/path; Moderate hike > 5 miles or hard hike < 5 miles	Low
0	Hard hike > 5 miles; site not easily seen	
Resource Significance Rating (possible score: 0, 2, or 4)		
4	Endangered species present or site is listed on National or Local Historic Register	High
2	Species of concern present or site has significant cultural values	Medium
0	No species of concern present and site has minimal cultural value	Low
Resource Impacts Rating (possible score: 0, 2, or 4)		
4	Highly elevated contaminants or greatly altered pH in water/soils; High visual impact	High
2	Moderately elevated contaminants or pH alteration in water/soils; Moderate visual impact	Medium
0	Minimal contaminants or pH alteration in water/soils; Minimal visual impact	Low

- Access: Possible ratings are 0, 1, 2, 3, 4, or 5 (5 being the most accessible). Easy access (rating of 4 or 5) is considered "high priority", moderate access (2-3) is considered "medium priority", and difficult access (less than 2) is considered "low priority". Therefore, remote features are lower in priority than those that are more accessible based on easier access being more likely to attract visitors. For reasons discussed below, the NPS decided not to include access in the prioritization process used for this report.

- Resource Significance: Possible ratings are 0, 2, or 4 (4 being most important, or "high priority"). A rating of 2 indcates "medium priority" and a rating of 0 indicates "low priority." This rating can be further differentiated by cultural and natural resource values based on answers to fields in the site inventory forms under those headings, which yields a sixth ranking field.

- Resource Impacts: Possible ratings are 0, 2, or 4 (4 having the most impacts, or "high priority"). A rating of 2 indicates "medium priority" and a rating of 0 indicates "low priority." Impacts usually pertain to natural resources, such as contamination of soils or water quality, but may also pertain to cultural resources, such as impacts to the viewshed or to historic structures.

Table B-2 shows the distribution of high, medium, and low rankings for the NPS AML features that require remedial action. Much of the legacy data does not include values for the resource impacts and resource significance ranking elements because the NPS added these elements long after the hazard and access fields. In addition, some hazard and access rankings were not recorded in the new inventory. Where ranking fields were blank, NPS assumed a value of zero (low priority) until such time as ranking values are entered into the database.

A list of all features, sorted by cumulative scores, might seem to yield a good scheme for prioritizing projects, but this simple evaluation does not fully take into consideration program priorities, which is why treatment priorities are established by site in this report (see rationale for ranking by site in the "Prioritization of AML Sites" section).

The percentages in Table B-2 show that high priority ratings are mostly due to hazards. Fewer features have associated resource impacts, but those impacts can be very significant and mitigation can be costly, so resource impacts are another principal concern in the NPS ranking scheme.

Based on the OIG (2008) audit report's emphasis on safety and the data in the Service-wide AML database, the NPS decided to prioritize AML sites and features using hazards and resource impacts rankings. This resulted in the majority of NPS AML features requiring mitigation to be assigned as "high priority." This ranking scheme is not the same as has been used by other agencies such as the Bureau of Land Management (BLM 2013). After careful consideration by the AMLAC, the NPS mandate to protect resources while providing for appropriate visitor use—put forth by the agency's 1916 Organic Act "…to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations"— supports the prioritization scheme used in this inventory and assessment project.

During the inventory, accessibility to the AML site was an important factor considered when ranking individual features. Greater visitation typically occurs at sites that are more accessible; however, many remote NPS AML sites are also popular destinations for park visitors. NPS staff have observed that even the most remote sites or the deepest parts of underground mines have evidence of visitation such as trash and graffiti. In many cases, the only access to a remote park area is an old mine road or trail that has a mine site as the final destination. Rescue, recovery, and remediation at remote

Table B-2. System-wide summary of ranking elements for the 3,814 individual AML features that require mitigation

	High		Medium		Low		Not Ranked		Features Requiring Mitigation
Parameter	Features	%	Features	%	Features	%	Features	%	
Hazard	3,052	80.0	194	5.1	455	11.9	113	3.0	3,814
Access	638	16.7	2,574	67.5	497	13.0	105	2.8	
Resources Significance	536	14.1	2,454	64.3	563	14.8	261	6.8	
Resources Impacts	72	1.9	321	8.4	3,224	84.5	197	5.2	

sites are more complex and have increased associated risks compared to more accessible sites.

NPS management policies (NPS 2006) prioritizes visitor safety to the greatest extent possible. Because park visitors go to remote backcountry AML sites, a truly hazardous feature should not be ranked as medium or low priority due to its remoteness or limited accessibility. However, accessibility will be considered when ranking one site or project against another during project implementation.

Similarly, the NPS determined that natural and cultural resource significance, while important, should not be considered in developing high, medium, and low prioritization. Natural and cultural resource significance rankings developed for the inventory are typically not the results of detailed sampling for contaminants, site characterization, or studies such as Determinations of Eligibility for listing on the National Register of Historic Places. Rather, these are initial impressions by AML team members designed to identify features and sites where more detailed assessments may be warranted. As more information is gathered, it is likely that more of the features will be placed in the medium and high categories for natural and cultural resources significance.

The rankings provided in this report are for planning purposes only. Flexibility in project selection will be required during project implementation.

Appendix C. Summary of AML Data by Region and Park

Detailed data reside in the Service-wide AML database. These figures were extracted from the database on December 31, 2013. Custom data reports can be generated according to specific region and park needs. These numbers will change as new features are found, as closure projects are funded and implemented, and as new lands that have AML sites are added to the National Park System.

Table C-1: Summary of data from all NPS units containing AML features

NPS Unit	Features			Sites											Total Cost ($)
						Sites and Associated Features Requiring Mitigation									
						High			Medium			Low			
	Total	Already Mitigated	Mitigation Required	Total	Total Requiring Mitigation	Sites	Features	Cost ($)	Sites	Features	Cost ($)	Sites	Features	Cost ($)	
Alaska Region															
Bering Land Bridge National Preserve	4	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Cape Krusenstern National Monument	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Denali National Park and Preserve	174	37	10	81	6	3	5	2,471,780	3	5	923,602	0	0	0	3,395,382
Gates of the Arctic National Park and Preserve	54	1	0	17	0	0	0	0	0	0	0	0	0	0	0
Glacier Bay National Park and Preserve	50	6	4	22	4	4	4	182,575	0	0	0	0	0	0	182,575
Katmai National Park and Preserve	18	2	1	11	1	0	0	0	1	1	350,000	0	0	0	350,000
Kenai Fjords National Park	50	12	7	14	4	2	4	650,628	2	3	648,001	0	0	0	1,298,629
Klondike Gold Rush National Historical Park	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Kobuk Valley National Park	20	4	0	5	0	0	0	0	0	0	0	0	0	0	0
Lake Clark National Park and Preserve	17	0	3	8	2	0	0	0	2	3	80,042	0	0	0	80,042
Noatak National Preserve	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Wrangell-St. Elias National Park and Preserve	317	44	29	92	21	19	27	2,886,683	1	1	56,636	1	1	32,020	2,975,339
Yukon-Charley Rivers National Preserve	41	3	0	14	0	0	0	0	0	0	0	0	0	0	0
13 NPS Units - Alaska Totals	**751**	**109**	**54**	**270**	**38**	**28**	**40**	**6,191,666**	**9**	**13**	**2,058,281**	**1**	**1**	**32,020**	**8,281,967**
Intermountain Region															
Amistad Recreation Area	3	0	2	1	1	0	0	0	0	0	0	1	2	20,000	20,000
Arches National Park	4	2	1	1	1	0	0	0	1	1	10,000	0	0	0	10,000
Aztec Ruins National Monument	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Big Bend National Park	98	23	0	16	0	0	0	0	0	0	0	0	0	0	0
Bighorn Canyon National Recreation Area	13	10	0	13	0	0	0	0	0	0	0	0	0	0	0
Big Thicket National Preserve	52	0	30	44	25	8	9	2,650,000	1	1	0	16	20	273,100	2,923,100
Black Canyon of the Gunnison National Park	10	2	5	9	5	0	0	0	1	1	3,500	4	4	10,500	14,000
Bryce Canyon National Park	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Canyonlands National Park	74	19	14	24	10	2	3	9,000	4	7	25,000	4	4	30,000	64,000
Capitol Reef National Park	62	20	15	14	9	2	3	13,500	6	11	25,980	1	1	5,000	44,480

Table C-1: (continued)

NPS Unit	Features			Sites											Total Cost ($)
						Sites and Associated Features Requiring Mitigation									
						High			Medium			Low			
	Total	Already Mitigated	Mitigation Required	Total	Total Requiring Mitigation	Sites	Features	Cost ($)	Sites	Features	Cost ($)	Sites	Features	Cost ($)	
Carlsbad Caverns National Park	11	0	0	9	0	0	0	0	0	0	0	0	0	0	0
Chickasaw National Recreation Area	2	0	2	2	2	2	2	140,000	0	0	0	0	0	0	140,000
Chiricahua National Monument	13	4	0	5	0	0	0	0	0	0	0	0	0	0	0
Colorado National Monument	10	1	0	9	0	0	0	0	0	0	0	0	0	0	0
Coronado National Memorial	65	59	5	8	3	2	4	18,000	0	0	0	1	1	5,000	23,000
Curecanti National Recreation Area	7	1	0	6	0	0	0	0	0	0	0	0	0	0	0
Dinosaur National Monument	18	0	1	2	1	0	0	0	0	0	0	1	1	20,000	20,000
El Malpais National Monument	28	0	27	6	6	2	11	38,004	4	16	60,000	0	0	0	98,004
Florissant Fossil Beds National Monument	93	0	3	24	3	3	3	9,000	0	0	0	0	0	0	9,000
Fort Bowie National Historic Site	32	11	10	6	1	1	10	10,000	0	0	0	0	0	0	10,000
Fossil Butte National Monument	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Fort Laramie National Historic Site	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Glacier National Park	47	1	25	27	20	4	6	145,000	5	5	65,000	11	14	206,000	416,000
Glen Canyon National Recreation Area	99	23	6	39	3	2	5	100,200	0	0	0	1	1	48,000	148,200
Grand Canyon National Park	75	8	16	38	12	4	7	99,282	7	8	215,919	1	1	28,613	343,814
Grant-Kohrs Ranch National Historic Site	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Great Sand Dunes National Park and Preserve	29	13	7	4	3	3	7	35,710	0	0	0	0	0	0	35,710
Grand Teton National Park	45	0	4	45	4	2	2	30,750	1	1	1,530,000	1	1	1,000	1,561,750
Guadalupe Mountains National Park	23	10	4	5	3	0	0	0	0	0	0	3	4	18,100	18,100
John D. Rockefeller, Jr. Memorial Parkway	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Lake Meredith National Recreation Area	2	1	0	2	0	0	0	0	0	0	0	0	0	0	0
Organ Pipe Cactus National Monument	789	14	410	25	25	22	407	3,681,509	0	0	0	3	3	12,600	3,694,109
Padre Island National Seashore	18	0	18	7	7	3	9	1,090,000	1	1	500,000	3	8	855,000	2,445,000
Pecos National Historic Park	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Petrified Forest National Park	21	3	5	17	2	2	5	220,000	0	0	0	0	0	0	220,000
Petroglyph National Monument	3	2	1	3	1	1	1	40,000	0	0	0	0	0	0	40,000
Rocky Mountain National Park	53	0	1	49	1	0	0	0	0	0	0	1	1	12,000	12,000
Saguaro National Park	541	198	127	177	79	75	122	6,454,572	3	4	46,330	1	1	4,000	6,504,902
Timpanogos Cave National Monument	3	0	3	3	3	3	3	24,000	0	0	0	0	0	0	24,000
Tuzigoot National Monument	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
White Sands National Moument	4	0	2	3	2	2	2	34,000	0	0	0	0	0	0	34,000
Wupatki National Monument	19	0	12	15	8	0	0	0	1	1	23,884	7	11	94,300	118,184
Yellowstone National Park	85	9	69	84	69	1	1	3,000	0	0	0	68	68	359,400	362,400

Table C-1: (continued)

NPS Unit	Features			Sites											Total Cost ($)
						Sites and Associated Features Requiring Mitigation									
						High			Medium			Low			
	Total	Already Mitigated	Mitigation Required	Total	Total Requiring Mitigation	Sites	Features	Cost ($)	Sites	Features	Cost ($)	Sites	Features	Cost ($)	
Zion National Park	26	0	2	20	1	0	0	0	1	2	16,000	0	0	0	16,000
44 NPS Units - Intermountain Totals	**2,490**	**436**	**827**	**775**	**310**	**146**	**622**	**14,845,527**	**36**	**59**	**2,521,613**	**128**	**146**	**2,002,613**	**19,369,754**
Midwest Region															
Apostle Islands National Lakeshore	4	2	0	4	0	0	0	0	0	0	0	0	0	0	0
Badlands National Park	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Buffalo National River	361	6	62	47	17	5	22	220,428	6	11	168,912	6	29	452,520	841,860
Cuyahoga Valley National Park	18	0	15	18	15	0	0	0	0	0	0	15	15	455,008	455,008
Fort Union Trading Post National Historic Site	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0
George Washington Carver National Monument	5	3	0	1	0	0	0	0	0	0	0	0	0	0	0
Hopewell Culture National Historic Park	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Indiana Dunes National Lakeshore	6	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Isle Royale National Park	36	7	0	14	0	0	0	0	0	0	0	0	0	0	0
Mississippi National River and Recreation Area	43	13	0	1	0	0	0	0	0	0	0	0	0	0	0
Ozark National Scenic Riverways	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Pictured Rocks National Lakeshore	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Saint Croix National Scenic Riverway	20	2	1	12	1	0	0	0	1	1	1,080	0	0	0	1,080
Scotts Bluff National Monument	4	0	4	1	1	0	0	0	1	4	30,240	0	0	0	30,240
Sleeping Bear Dunes National Lakeshore	15	2	13	9	7	0	0	0	7	13	111,240	0	0	0	111,240
Theodore Roosevelt National Park	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Voyageurs National Park	20	5	4	15	3	0	0	0	3	4	18,360	0	0	0	18,360
Wilson's Creek National Battlefield	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Wind Cave National Park	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
19 NPS Units - Midwest Totals	**548**	**40**	**99**	**136**	**44**	**5**	**22**	**220,428**	**18**	**33**	**329,832**	**21**	**44**	**907,528**	**1,457,788**
National Capital Region															
Chesapeake & Ohio Canal National Historical Park	38	9	5	3	2	2	5	35,436	0	0	0	0	0	0	35,436
George Washington Memorial Parkway	6	3	3	6	3	2	2	108,000	1	1	10,800,000	0	0	0	10,908,000
National Capital Parks - East	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Prince William Forest Park	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0
4 NPS Units - National Capital Totals	**59**	**12**	**8**	**14**	**5**	**4**	**7**	**143,436**	**1**	**1**	**10,800,000**	**0**	**0**	**0**	**10,943,436**

Table C-1: (continued)

NPS Unit	Features			Sites											Total Cost ($)
						Sites and Associated Features Requiring Mitigation									
						High			Medium			Low			
	Total	Already Mitigated	Mitigation Required	Total	Total Requiring Mitigation	Sites	Features	Cost ($)	Sites	Features	Cost ($)	Sites	Features	Cost ($)	
Northeast Region															
Acadia National Park	12	0	0	12	0	0	0	0	0	0	0	0	0	0	0
Allegheny Portage Railroad National Historic Site	28	1	3	6	2	1	2	18,338	1	1	5,742	0	0	0	24,081
Appalachian National Scenic Trail	5	0	3	1	1	1	3	45,185	0	0	0	0	0	0	45,185
Cape Cod National Seashore	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Colonial National Historical Park	1	0	1	1	1	0	0	0	0	0	0	1	1	32,400	32,400
Delaware Water Gap National Recreation Area	56	3	3	37	2	2	3	17,483	0	0	0	0	0	0	17,483
Fredericksburg and Spotsylvania County Battlefields Memorial National Military Park	4	2	1	3	1	0	0	0	0	0	0	1	1	7,593	7,593
Friendship Hill National Historic Site	5	3	1	3	1	0	0	0	1	1	551	0	0	0	551
Gauley River National Recreation Area	39	0	21	5	5	5	21	129,919	0	0	0	0	0	0	129,919
New River Gorge National River	696	124	105	122	49	39	92	761,659	10	13	43,158	0	0	0	804,817
Richmond National Battlefield Park	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Saratoga National Historical Park	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Shenandoah National Park	27	2	8	17	6	0	0	0	4	5	92,290	2	3	21,713	114,004
Steamtown National Historic Site	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Valley Forge National Historical Park	9	2	1	7	1	0	0	0	0	0	0	1	1	0	0
15 NPS Units - Northeast Totals	**887**	**137**	**147**	**219**	**69**	**48**	**121**	**972,584**	**16**	**20**	**141,741**	**5**	**6**	**61,707**	**1,176,033**
Pacific West Region															
Channel Islands National Park	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0
City of Rocks National Reserve	67	2	3	13	2	1	1	0	1	2	12,797	0	0	0	12,797
Crater Lake National Park	15	0	5	15	5	0	0	0	5	5	25,170	0	0	0	25,170
Craters of the Moon National Monument and Preserve	53	43	0	5	0	0	0	0	0	0	0	0	0	0	0
Death Valley National Park	16,158	349	1,088	376	217	209	1,073	12,959,788	6	11	0	2	4	0	12,959,788
Golden Gate National Recreation Area	23	3	0	5	0	0	0	0	0	0	0	0	0	0	0
Great Basin National Park	281	38	93	15	9	5	69	658,260	3	23	525,420	1	1	12,960	1,196,640
Joshua Tree National Park	1,768	101	159	151	65	59	146	1,035,288	4	11	0	2	2	324	1,035,612
Lake Chelan National Recreation Area	8	2	0	8	0	0	0	0	0	0	0	0	0	0	0
Lake Mead National Recreation Area	1,295	85	154	515	101	51	90	1,032,790	19	26	211,032	31	38	753,733	1,997,555
Lassen Volcanic National Park	10	2	0	10	0	0	0	0	0	0	0	0	0	0	0
Lava Beds National Monument	23	0	12	16	9	0	0	0	0	0	0	9	12	232,119	232,119

Table C-1: (continued)

NPS Unit	Features			Sites											Total Cost ($)
						Sites and Associated Features Requiring Mitigation									
						High			Medium			Low			
	Total	Already Mitigated	Mitigation Required	Total	Total Requiring Mitigation	Sites	Features	Cost ($)	Sites	Features	Cost ($)	Sites	Features	Cost ($)	
Mojave National Preserve	11,548	300	1,028	585	318	314	1,024	18,958,595	4	4	756	0	0	0	18,959,351
Mount Rainier National Park	48	2	5	32	2	0	0	0	0	0	0	2	5	6,480	6,480
North Cascades National Park	73	2	13	38	8	5	9	119,076	3	4	47,436	0	0	0	166,512
Olympic National Park	25	0	7	13	3	1	2	8,249	2	5	15,750	0	0	0	23,999
Parashant National Monument	12	12	0	1	0	0	0	0	0	0	0	0	0	0	0
Pinnacles National Monument	24	2	4	4	3	3	4	30,996	0	0	0	0	0	0	30,996
Point Reyes National Seashore	47	4	1	1	1	1	1	2,160	0	0	0	0	0	0	2,160
Puukohola Heiau National Historic Site	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Redwood National Park	27	6	6	25	6	0	0	0	1	1	3,780	5	5	19,656	23,436
Ross Lake National Recreation Area	21	2	1	11	1	1	1	4,031	0	0	0	0	0	0	4,031
Sequoia & Kings Canyon National Parks	122	0	17	16	8	8	17	127,440	0	0	0	0	0	0	127,440
Whiskeytown-Shasta-Trinity National Recreation Area	131	29	13	31	11	10	12	75,600	0	0	0	1	1	0	75,600
Yosemite National Park	216	9	18	6	4	4	18	177,660	0	0	0	0	0	0	177,660
25 NPS Units - Pacific West Totals	**31,998**	**993**	**2,627**	**1,894**	**773**	**672**	**2,467**	**35,189,933**	**48**	**92**	**842,141**	**53**	**68**	**1,025,272**	**37,057,346**
Southeast Region															
Big Cypress National Preserve	91	0	0	15	0	0	0	0	0	0	0	0	0	0	0
Big South Fork National River & Recreation Area	144	48	34	40	23	10	21	3,723,841	13	13	466,697	0	0	0	4,190,538
Chickamauga & Chattanooga National Military Park	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Cumberland Gap National Historical Park	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0
Everglades National Park	17	0	0	17	0	0	0	0	0	0	0	0	0	0	0
Great Smoky Mountains National Park	21	4	11	2	2	2	11	125,007	0	0	0	0	0	0	125,007
Horseshoe Bend National Military Park	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Jean Lafitte National Historical Park and Preserve	11	7	4	8	4	4	4	102,864	0	0	0	0	0	0	102,864
Kings Mountain National Military Park	3	1	0	3	0	0	0	0	0	0	0	0	0	0	0
Mammoth Cave National Park	16	9	0	16	0	0	0	0	0	0	0	0	0	0	0
Natchez Trace Parkway	4	0	1	4	1	0	0	0	1	1	1,993	0	0	0	1,993
Obed Wild & Scenic River	3	0	2	2	1	1	2	33,947	0	0	0	0	0	0	33,947
Russell Cave National Monument	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
13 NPS Units - Southeast Totals	**317**	**72**	**52**	**113**	**31**	**17**	**38**	**3,985,658**	**14**	**14**	**468,690**	**0**	**0**	**0**	**4,454,348**
133 NPS Units - System-wide Totals	**37,050**	**1,799**	**3,814**	**3,421**	**1,270**	**920**	**3,317**	**61,549,232**	**142**	**232**	**17,162,298**	**208**	**265**	**4,029,140**	**82,740,671**

Data as of December 31, 2013. Programmatic costs through time are not included.

Appendix D. NPS Standard Construction Approach to Estimating AML Mitigation Costs

NPS Denver Service Center — Abandoned Mineral Lands Inventory and Assessment

Overview

This appendix presents the standard construction cost estimating approaches that are used for the generation of mitigation costs associated with Abandoned Mineral Land (AML) sites and features located in National Park Service units.

Cost elements to include and associated percentages

Class C estimates (http://www.nps.gov/dscw/definitionsdc_c.htm) represent costs for a project without having the scope of work fully defined. The generally accepted industry accuracy range of Class C construction cost estimates is -30% to +50%.

The cost estimate for mitigation options shown in the AML database should contain the following direct cost elements of a Class C cost estimate. These direct costs assume that work will be contracted and not completed with park or volunteer resources.

- Labor – Actual estimated costs for labor
- Equipment – Actual estimated costs for equipment (operator costs not included with these costs)
- Materials – Actual estimated costs for materials
- Travel cost for remote or off-road features

The following markups should also be included with the mitigation cost Class C estimates:

- Location adjustments (location factors, remoteness, Davis-Bacon wage rates specific to location): 0–20% depending on location
- General conditions (standard and government): 20%
- Historic preservation factor: 5% if applicable, otherwise use zero
- Bond: 1%
- Overhead: 10%
- Profit: 10%
- Contracting method adjustment: 15%
- Construction management: 8%
- Contingency (design and construction): 10%
- Compliance: 5% or more

Markups shall be applied in the order outlined in Table D-1.

The NPS Service-wide AML database assesses costs on an individual feature basis. Undoubtedly, construction efficiencies will be realized by bundling multiple features into each mine closure project, which will lower the costs per feature represented here. Construction efficiencies vary based on such things as size of the project budget, proximity of the features from one another, and the type of work to be performed. No attempt has been made to estimate an average construction efficiency factor, but cost savings will be realized on larger projects. The individual feature costs in this analysis therefore constitute a high-end cost estimate. Compliance is a separate overall program funding request. Because the percentage would vary depending on approach and needs of a region, it is assessed separately rather than as a fixed number in Table D-1.

Cost elements to exclude

- Inflation escalation (calculated separately)
- Assumptions about government furnished materials
- Builder's risk insurance
- Cost savings resulting from the mitigation of multiple features within a single contract. At this time, there is no way to know how funding will be allocated for mitigation.

Estimating resources

The following resources are recommended for development of mitigation cost estimates:

- National Park Service Cost Estimating Requirements Handbook (NPS 2011), available at http://www.nps.gov/dscw/upload/CostEstimatingHandbook_2-3-11.pdf.
- RSMeans (http://rsmeans.reedconstructiondata.com/) and other construction commercial cost indices.
- Historical data for AML mitigation (ARRA projects, in-house, other contracted, etc.), which are kept by the Denver Service Center, NPS Geologic Resources Division, and/or the parks and regions that have completed this work. This information, when known, was recorded in the Service-wide AML database.

Table D-1. Elements in Class C estimate of AML mitigation

Line	Cost Type	Calculation	Total
A	Direct costs (labor, equipment, material)	Actual estimated costs	$1,000.00
B	Location Adjustment	Direct Costs x 0.10	$100.00
C	*Subtotal*	*Sum of Lines A and B*	*$1,100.00*
D	General Conditions	Line C x 0.20	$220.00
E	Historic Preservation*	Line C x 0.00	$0.00
F	*Subtotal*	*Sum of Lines C, D, and E*	*$1,320.00*
G	Bond	Line F x 0.01	$13.20
H	*Subtotal*	*Sum of Lines F and G*	*$1,333.20*
I	Overhead	Line H x 0.10	$133.32
J	Profit	Line H x 0.10	$133.32
K	*Subtotal*	*Sum of Lines H, I, and J*	*$1,599.84*
L	Contracting Method Adjustment	Line K x 0.15	$239.98
M	*Subtotal*	*Sum of Lines K and L*	*$1,839.82*
N	Construction Management	Line M x 0.08	$147.19
O	Contingency (Design and Construction)	Line M x 0.10	$183.98
P	***Total Estimate For Mitigation***	***Sum of Lines M, N, and O***	***$2,170.99***

* Historic preservation costs should only be included when applicable.

$1,000 is used as an example direct cost.

Cost estimation terms and definitions

The following definitions can be found in the NPS Cost Estimating Requirements Handbook (NPS 2011).

Bonds	A form of security guaranteeing fulfillment of some obligation. In the construction industry, bonds are typically provided by surety companies to project owners. If the contractor does not perform according to the terms of the bond, the surety company will pay the project owner the amount specified by the bond.
Compliance costs	Costs necessary to finance special studies such as Environmental Assessments or other studies/surveys necessary to be complete prior to construction activities.
Construction management costs	Costs associated with project management and monitoring of the project. These costs may include any special inspections required during construction.
Contingency	Costs associated with unknowns in the project. (design and construction)
Contract method adjustment	A majority of the construction contracting for the National Park Service is not performed using typical low bid procurement processes. As a result, there is a limitation on competition for most projects, which tends to increase project costs. The primary procurement method used by NPS is competitive negotiation where award is based on negotiating a price with the most technically qualified contractor. This method may typically add 5% or more to the cost of contracting over the lowest-price, competitive bid procurement processes. The NPS also awards many contracts through the Small Business Administration 8(a) Business Development, Service-Disabled Veteran-Owned Business, and Historically Underunitized Business Zones (HUBZone) programs. These awards may be made on either on a limited competitive or sole source negotiated basis. Depending on the procurement method chosen, costs can be affected 10–15% or more.
Equipment	Costs associated with operating owned or rented equipment used for construction activities. Mitigation of abandoned mineral land sites/features typically involves some or all of the following: welding machines, backhoe, front-end loader, pickup truck, trailers, generators, helicopters, and pumps. Hand tools (shovels, picks, drills, etc.) are not typically included with equipment costs.
Federal wage rate	Costs used to adjust the labor costs of an estimate to reflect the difference between the location factor, adjusted labor data used to prepare an estimate, and the federally mandated Davis-Bacon Act labor rates in effect for the project location.
General conditions	A set of guidelines that defines many of the rights, responsibilities, and limitations of authority of the owner and contractor, and includes the general procedures governing the performance of the work.
General conditions (standard)	These are the project indirect costs incurred by the contractor that are typically defined in the Division 1 specifications for a project (http://www.cppm.umn.edu/assets/pdf/standards/division1.pdf). The costs associated with temporary utilities, field offices, fencing, field engineering, operation and maintenance manuals, etc., are all included as standard general conditions. Also included in the General Conditions percentage should be the cost of construction permits, bonds, and insurance.

General conditions (government)	These costs, which are not included in the Standard General Conditions, are the costs of doing work for the United States government and the National Park Service. Many of these government costs are attributable to the increased administrative requirements and quality requirements, along with sensitivity to the NPS mission of protecting the cultural and natural resources while allowing the public access and enjoyment.
Historic Preservation	Many projects within the National Park Service involve work in and around historical structures or cultural landscapes. It is part of the National Park Service mission to preserve and maintain the integrity of the original architectural construction, historical fabric, and cultural appearance of the assets at or near the proposed work. This requirement often creates additional access control issues, protection process requirements, and coordination problems during construction, which lead to additional cost impacts to a project. In some cases, material costs increase significantly because of the need to select compatible materials. The range for this factor can vary significantly, and considerable judgment is required to formulate an appropriate factor. The rationale and justification for the Historic Preservation Factor should be well documented in the Basis of Estimate Statement.
Inflation Escalation	Independent government and architectural/engineering company (A/E) estimates are generally prepared well in advance of contract procurement. Therefore, some sort of factor needs to be applied to an estimate's total cost to account for a changing market over time. All direct unit costs within the estimates should be priced using current (date of estimate) costs. An adjustment for inflation is then added to the bottom line total of the estimate. This escalation must be based on a careful analysis of current market trends and published construction economics predictions. Escalation should be dated to the proposed mid-point of construction. If historical costs from the park or project location are used to develop the direct costs, it may be necessary to escalate the costs from the time in which they were incurred to present values first, and then escalate them to the mid-point of construction.
Labor	Labor costs include the cost for equipment operators, laborers, welders, supervisors, and others to complete the scope of work. This does not include overhead labor. Overhead labor is included with the overhead markup.
Location Factor	This factor adjusts generic national average cost data to regional or local construction market pricing for labor, material, and/or equipment. If using a local cost database rather than national data, a location factor adjustment will not be required.
Materials	Mitigation of abandoned mineral land sites/features may require the use of metal, concrete, PUF, wood, hardware, fencing, soil stabilization, and/or explosives. Material costs include costs for all materials necessary to complete the scope of work.
Overhead	The cost that a contractor has for staying in business. A general contractor has expenses not directly related to the construction of a project but vital to the contractor's business operations. These include fixed overhead (federal and state unemployment costs, Social Security tax, builder's risk insurance, and public liability costs) and variable overhead (Worker's Compensation insurance, office overhead, etc.).
Profit	The cost or fee that a contractor charges to provide a return on their investment and to compensate them for assuming risk on a project. The amount of profit charged is highly variable and dependent on a number of factors, including local market conditions, the size of job, the amount of risk associated with the work, the contractor's total work volume, and the company size. Contractors generally take more profit on a smaller job. One factor often overlooked in preparing independent government estimates and A/E estimates is that not only is the general contractor entitled to compensation for overhead and profit, but so are any subcontractors or independent installers that they employ to perform the work. Some cost databases include installer overhead and profit in a separate column.

Remoteness Factor	A majority of NPS park units are not located in one of the nearly 700 cities listed in the RSMeans City Cost Index or in similar indexes. They are remotely located away from significant source areas of labor pools, material vendors, and equipment suppliers. Because of the remote nature of most national parks, an adjustment typically needs to be made for mobilization/demobilization, labor pool per diem, compensated commute times, and shipping costs of materials, as well as less tangible impacts of managing remote operations. If labor, equipment, and materials can be delivered to the project site by over-the-road transportation, the NPS Denver Service Center generally uses a remoteness factor of 1% for each 10 miles that the project is located away from the commercial center used in determining the location factor. Considerations should also be made for sites that are difficult to access (e.g., unimproved roads, backcountry areas, or where water or aerial access is required). If a project site is significantly remote from normal vehicle transportation access, some attempt should be made to estimate the direct transport costs (pack teams, boat/barge, off road vehicles, or helicopters), or estimators can add an allowance cost or other percentage allowance based on their best estimating judgment or professional experience.
State and Local Taxes	Construction contractors for the National Park Service are required to pay local and state taxes on material and rental equipment used on the project. Most find the paperwork for exemption cumbersome and simply try to pass the taxes along to the government, but the contract officer should ensure that all applicable tax exemptions are applied.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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