

Broken Top Trail Project

Environmental Assessment



Summary: The National Park Service (NPS) proposes to develop a 1.5 to 2.5 mile loop hiking trail incorporating both new and existing trail segments. The objective of this proposal is to provide a safe educational field site for school groups and the general public. Existing loop trails lack the diversity of interpretive features and educational benefits found in the Broken Top area. A secondary objective is to provide a longer loop trail for recreational hikers. None of the existing loop hiking trails within the monument exceed .5 miles in length. Portions of the existing Buffalo Caves Trail are very rough with numerous tripping hazards and sharp rocks protruding from the trail surface. The proposed project is located at the end of the Tree Molds spur road 4 miles south of Highway 93 and is bounded on the north by Broken Top, on the south by Big Cinder Butte, the Wilderness Trail on the east, and the Tree Molds Trail on the west.

The National Environmental Policy Act (NEPA) requires federal agencies to assess the environmental impact of proposed projects and compare the environmental consequences of feasible alternatives. Comments on this proposed project are requested by August 14, 2001. Submit comments to:

Superintendent
Craters of the Moon National Monument
P.O. Box 29
Arco, Idaho 83213

U.S. Department of the Interior
National Park Service
Craters of the Moon National Monument

1.0 Purpose of and Need for Action

1.1 The National Park Service (NPS) is proposing to develop a 1.5 to 2.5 mile loop hiking trail incorporating both new and existing trail segments. The objective of this proposal is to provide an improved educational field site for school groups and the general public. Existing trails lack the diverse interpretive features and educational benefits found in the Broken Top area. A secondary objective is to provide a longer loop trail for recreational hikers. None of the existing loop hiking trails within the monument exceeds .5 miles in length. The proposed project is located at the end of the Tree Molds spur road (see Figure 1) and is bounded on the north by Broken Top, on the south by Big Cinder Butte, the Wilderness Trail on the east, and the Tree Molds Trail on the west.

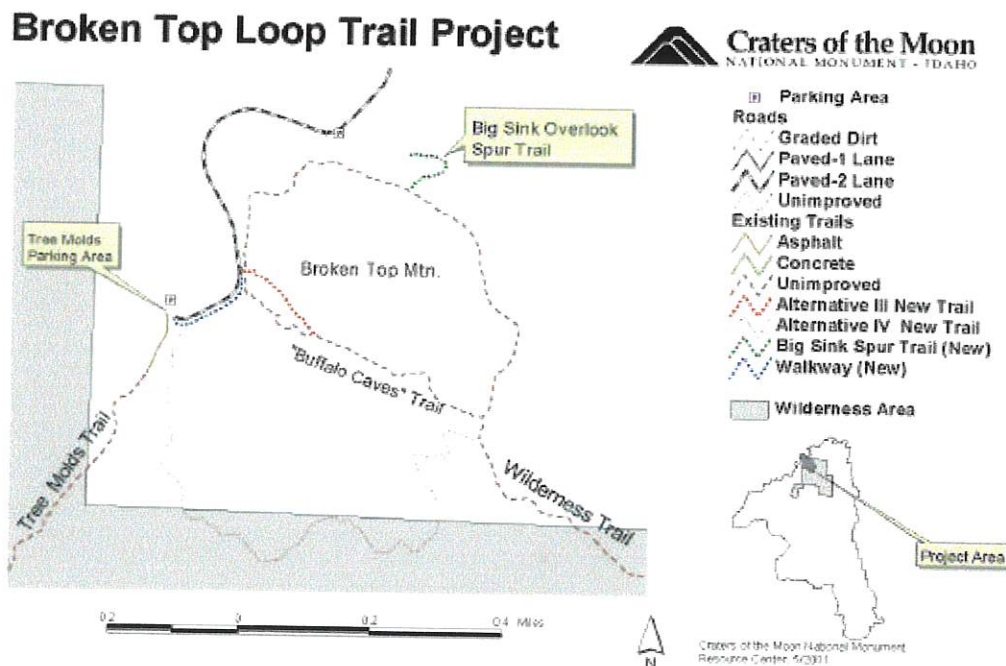


Figure 1 Project Area

This proposal has three components which entail new trail construction; 1) a .16 mile pedestrian walk way from the Tree Molds parking area to the Wilderness Trailhead, 2) a .13 mile spur trail from the Wilderness Trail to an overlook and wayside exhibit interpreting the Spatter Cones/Big Sink/Caves area, 3) extensive improvement of a very rough 265' segment of the existing Buffalo Caves trail route or a major realignment to a new route.

1.2 Related Plans and Environmental Assessments

The Craters of the Moon National Monument General Management Plan (USDI, 1992) lists development of a means to interpret the Big Sink area as a planned

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

PHYSICS 341

LECTURE 1

action. Since this proposal was conceptual the environmental assessment of that plan lacks specific analysis of its effects. A Broken Top Loop Trail Concept Plan was developed with the cooperation of the NPS Denver Service Center in 1989. A Wilderness Management Plan was completed in 1989 and revised in 1996.

1.3 Scoping of Issues and Alternatives

Internal scoping for this project began in June of 1998 with monument staff and an NPS Planner examining options for interpretation of the Big Sink area. These options included; 1) a trail from a new parking area across the lava flow to the rim of the Big Sink, 2) a trail from the existing parking area to a hill top over look, 3) utilize the existing Tree Molds parking area and incorporate the existing Wilderness Trail and Buffalo Caves Trail along with a spur trail to the hill top overlook to create a loop trail. The first option was discarded due to impact on the geologic features, visual intrusion and high costs. The second option, while shorter in overall length, would have required extensive switch backs to maintain an appropriate grade and was likely to have problems with hikers developing short cuts down the slope with subsequent erosion on social trails. Incorporation of Big Sink interpretation with broader goals for a trail with an educational focus and recreational hiking became a project objective.

Internal scoping then focused on the return leg of the loop trail and potential to either upgrade the existing trail route from Buffalo Caves to the Wilderness Trail trailhead or an alternate route. The existing route crosses an extremely rugged section of a lava flow for approximately 265 feet. The existing route, a second slightly longer alternate route, and a third much longer alternate route were identified as feasible alternatives to meet the project objectives. Monument staff conducted an internal scoping meeting in November, 2000 and made several onsite visits to the project area (10/2000 and 4/2001) to identify and discuss issues and alternatives. An issue is an effect (or a perceived effect, risk, or hazard) on a physical, biological, social or economic resource.

Internal scoping identified the following relevant issues;

- 1) Direct or indirect adverse impacts to geologic resources. Direct impacts on geologic features from trail construction and potential indirect impacts from subsequent use on features adjacent to the trail. Trampling from off-trail use often breaks brittle rock formations or collectors illegally remove rare or unusual rocks (e.g. lava bombs, etc.).
- 2) Direct or indirect adverse impacts to cultural resources. Direct impacts on subsurface archeological sites from trail construction and potential indirect impacts from subsequent use on surface features adjacent to the trail. Loss of site data from known or unknown archeological sites from increased use as a result of improved access to previously remote sites.
- 3) Impacts of construction and use of new trails in the Wilderness area on Wilderness values.
- 4) Safety for public crossing lava field and difficulty of NPS emergency medical response due to distance or terrain.

- 5) Pedestrian safety getting from the Tree Molds parking area to the Wilderness Trail.
- 6) Impacts on vegetation and wildlife. Loss of cover or food for wildlife from trail construction. Disturbance of wildlife from new or increased use of area.

1.4 Other Permits Required

New trail construction will require compliance with Section 106 of the National Historic Preservation Act.

2.0 Alternatives Including the Proposed Action

This section describes the alternatives being analyzed in Chapter four. This section also provides a summary of the environmental consequences of the alternatives. All of the alternatives being described are reasonable means of achieving the project objectives but vary in their environmental consequences. The completed trail is intended to serve the educational needs of school groups. Time constraints of school groups influence the maximum trail length and safety concerns influence the type of terrain crossed. Terrain also influences the difficulty and expense of trail construction. An interdisciplinary team of monument staff developed the alternatives and the environmental analysis of the environmental consequences of the alternatives.

Each alternative represents a different approach to providing a trail segment to achieve the objective of a loop-type trail with a total distance between 1.5 and 2.5 miles in length. Improvements of the existing trail or a short realignment would require extensive trail construction and localized impacts to geologic features over a relatively short distance. A major rerouting of the trail to the south side of the Broken Top lava flow would be less expensive to build but would result in a longer trail and less intensive but more widespread impacts to previously undisturbed areas. The context and intensity of impacts to geologic features, Wilderness values, and public safety vary which each alternative. All but the "No Action" alternative provide for a spur trail to an interpretive overlook of the Big Sink and a pedestrian walkway from the Tree Molds parking area to the Wilderness Trail trailhead.

2.1 Alternative A (No Action)

The "No Action" alternative would retain the current uses and existing trails, including the Wilderness Trail and Buffalo Caves Trail in their current condition. This 1.5 mile loop trail would continue to be used by school groups and the general public. Both trails would continue to be used as the primary means of access to the Wilderness Area. This alternative is intended to serve as a baseline against which the other alternatives can be compared. No new trails or walkways would be developed nor would any existing trails be improved.

2.2 Alternative B (Environmentally Preferred)

Existing Route with significant improvements including a pedestrian walkway and spur trail to a interpretive overlook of the Big Sink. This alternative would incorporate .9 mile of the Wilderness Trail from the trailhead to the Buffalo Caves Trail junction and the .5 mile Buffalo Caves Trail. A hard surfaced .16 mile pedestrian walkway would be built from the Tree Molds parking area to the Wilderness Trailhead (parallel to the Tree Mold spur road). A .13 mile spur trail would be built from the Wilderness Trail to a 200 square foot overlook of the Big Sink area. Interpretive exhibits explaining the geologic relationship of the Big Sink to other features and the trail would be installed at the overlook and at the Tree Molds parking area. Major trail improvements would be required to provide safer access across rugged lava flow over an existing but unimproved 265-foot segment of the Buffalo Caves Trail. The total trail distance would be 1.7 miles with .3 mile of new trail and 265 feet of major trail construction. Construction on this 265-foot segment would require extensive rock retaining walls and depositing of fill material to even out the extremely rough trail surface (See Figure 2). Material for retaining walls and fill would be obtained locally and moved into place using hand labor. The location of the site would not permit the use of any heavy mechanical equipment. A tread width of 4 feet for this section of trail would match existing segments of this trail.



Figure 2. View of Buffalo Caves Trail segment requiring extensive trail tread improvement (Alternative B).

2.3 Alternative C

This alternative would be identical to the Alternative B with one exception. A 950 foot segment of the Buffalo Caves Trail, including the 265 foot segment requiring major improvement in Alternative B, would be eliminated and replaced with 800 feet of new trail located parallel to and just northeast of the existing segment. Total trail distance would be 1.7 miles with .44 miles of new trail construction. Construction on the 800 foot segment would require extensive imported fill and moving of large boulders on site to create an even trail surface across a rugged boulder field (See Figure 3). Since this trail segment extends to the road heavy equipment would be utilized to build the trail by starting from the road and building east. The use of heavy equipment would result in wider trail tread of 6 feet. The trail construction imprint would be approximately 15 feet wide.



Figure 3. View of the Alternative C route (view north towards Tree Molds spur road).

2.4 Alternative D (NPS Preferred Alternative)

This alternative would include the pedestrian walkway and Big Sink Overlook spur trail described in Alternative B. However this alternative would eliminate all but .1 mile of the Buffalo Caves Trail with a new 1.14 mile return trail

routed from the Wilderness Trail southwesterly across the Broken Top Lava Flow to the foot of Big Cinder Butte and then along the base of Big Cinder Butte before turning north back to the Tree Molds parking area. A 500 foot spur trail from the Wilderness Trail west to Buffalo Caves would be retained. Approximately .5 miles of new trail along the base of Cinder Butte would lie within the designated Craters of the Moon Wilderness Area (a maximum of 420 feet inside the boundary). Total trail distance would be 2.4 miles with 1.5 miles of new trail.

The type of terrain traversed would simplify trail construction on this longer alternative. All but 1,200 feet of this route crosses cinder deposits which require limited work to establish a suitable tread for the trail. The remainder of this route crosses a relatively smooth lava flow (in comparison with Alternatives B and C) which will not require extensive fill material to create a even trail surface. Fill material would be obtained on-site. Where the trail crosses cinder areas with dense shrub vegetation a 4-5 foot trail tread would be cleared. Where the trail crosses essentially bare lava the route would be delineated with log rails and or posts (See Figure 4). All work on this alternative (with the exception of the pedestrian walkway) would be accomplished with hand tools.



Figure 4. View northeast across lava flow from base of Big Cinder Butte, towards Broken Top.

In the second part, the focus shifts to the management of cash flow. It highlights the need for a clear understanding of the company's current financial position and the ability to forecast future cash requirements. The document suggests implementing a system of budgeting and monitoring cash flow to avoid liquidity issues. It also mentions the importance of maintaining a healthy relationship with creditors and suppliers to ensure timely payments and favorable terms.

The third part of the document addresses the issue of taxation. It provides an overview of the various tax obligations that a business may face, including income tax, sales tax, and property tax. The document advises consulting with a tax professional to ensure compliance with all applicable laws and regulations. It also discusses strategies for minimizing tax liability through legitimate means, such as claiming deductions and credits.

Finally, the document concludes with a section on the importance of financial planning. It stresses that a well-thought-out financial plan is essential for the long-term success of any business. This plan should take into account all aspects of the company's financial health, including its assets, liabilities, and cash flow. The document encourages businesses to review their financial plans regularly and make adjustments as needed to stay on track with their goals.

Construction of new trails within the Craters of the Moon Wilderness Area has been Monument policy for many years (USDI, NPS, 1989). In this case the terrain in the project area is only suitable for trail development in a few areas. Delineating a trail route across lava flows has proven difficult on other trails throughout the Monument. The proposed return route in this alternative takes advantage of mostly level terrain across open cinder fields at the base of Big Cinder Butte. The cinder areas require minimal trail construction or disturbance to surrounding areas. The trail skirts along the edge of the Wilderness boundary never intruding further than 420' into the interior of the area. From the area of the new trail existing improvements (Tree Molds spur road and parking area) are already visible.

2.5 Alternatives Considered but Eliminated from Detailed Study

As described in Section 1.3, several alternatives to interpret the Big Sink were studied initially but have been eliminated from further study. The reasons for eliminating those options are stated in Section 1.3.

Table 1. Summary Comparison of Alternatives

Issue Indicators	Alternative A (No Action)	Alternative B	Alternative C	Alternative D
Loop trail distance ¹	1.7 miles	1.7 miles	1.67miles	2.4 miles
New trail construction ²	0	.34 miles	.44 miles	1.5 miles
Estimated Volume of Imported Fill ³	0	20 yards ³	66 yards ³	0
Estimated Volume of Fill obtained on site ⁴	0	66 yards ³	0	36 yards ³
New trail within Wilderness Area	0	0	0	.5 miles
Loss of vegetative cover ⁵	0	.07 acres	.07 acres	.39 acres
Disturbance of Wildlife	unchanged	Basic route now in use would remain in use with some potential for increased trail use	Only a minor change in route, otherwise the same as alternative B.	1 mile of new trail through area not previously accessed by hikers on a regular basis.
Public Safety	No changes to a very rough section of trail with numerous tripping hazards, sharp rocks, and difficulties for extraction of	Elimination of most tripping hazards and sharp rocks on the trail but some impediments to extraction of injured persons due to steep	Elimination of tripping hazards, sharp rocks and steep grades.	Elimination of most tripping hazards, sharp rocks and steep grades. Longer overall trail distance and time to reach and

Broken Top Loop Trail
Environmental Assessment

Issue Indicators	Alternative A (No Action)	Alternative B	Alternative C	Alternative D
	injured persons.	grades.		extract injured persons.
Trail Use & Condition	No change	An increase of 10-25% is likely due to trail surface improvements.	An increase of 10-25% is likely due to trail surface improvements.	An increase of 10-25% is likely due to trail surface improvements. However, the longer distance may discourage some hikers.

1. Miles of trail associated with the loop. Relates to the ability of school groups to complete the loop trail while meeting their educational objectives, difficulty of emergency medical response, and value as a recreational trail.
2. Miles of new trail which would need to be built.
3. Fill material originating from sources outside of the Project Area described in Section 1.1.
4. Fill material from sites within the Project Area (not including material obtained within the trail corridors described in Sections 2.1 - 2.4).
5. This estimate represents the maximum loss based upon a trail width of 5 feet and continuous vegetative cover. Actual vegetative cover in limber pine/bitterbrush types is approximately 50%.

2.6 Preferred and Environmentally Preferred Alternatives

The preferred alternative describes actions the NPS has proposed to carry out. A final decision whether to adopt this or another of the alternatives will be based upon the analysis contained within this document and additional information obtained as a result of the public review process.

The environmentally preferred alternative is the alternative which will best promote the objectives of the National Environmentally Policy Act (NEPA). These objectives include:

- fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
- preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
- achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

2.7 Consistency with Sections 101 and 102(1) of NEPA

All of the alternatives analyzed in this environmental assessment are consistent with sections 101 and 102 of the NEPA and other environmental laws and policies of the U.S. Department of the Interior and National Park Service.

3.0 Affected Environment

This section describes the existing condition of relevant resources or issues within the project area. The issues discussed in section 1 and the extent to which one of the alternatives (described in Section 2) effects these resources or issues determine relevancy of a resource.

3.1 Geology

Based on stratigraphic relationships, Broken Top is one of the youngest volcanic cones within the Craters of the Moon lava field. (i.e. the Blue Dragon flow wraps around this spatter rampart on the south edge of the eruptive fissure that helped build the Broken Top cinder cone and partially in-fills the fissure). The Broken Top flow is slightly older than the Blue Dragon Flow which is approximately 2,100 years old. The Broken Top flow is the youngest flow, being slightly younger than the Blue Dragon flow. A proposed routes in alternative would skirt the base of Big Cinder Butte, pass by flow fronts of the Sawtooth flow and rafted blocks from Big Cinder, and return along the flank of the unnamed cone by the parking lot. All of these features along the proposed alternate route are believed to be part of the 6,000-year-old eruptive period. The Sawtooth flow has been dated at 6,020 years old (± 160 years).

The Blue Dragon flow in the area has many good examples of slab and spiny pahoehoe. The Broken Top flow exhibits textures suggesting both very hot and fluid flow as well as more intermediate viscosities. Portions of the Broken Top flow are extremely good examples of shelly pahoehoe. Blisters, toes, tumuli, pressure ridges, inflation and deflation structure, lava ropes and billows are all present within the study area. All four types of volcanic bombs described in the geologic features section are present. Eruptive and non-eruptive fissures, examples of flank eruptions, and a classic pressure plateau are present. There are rafted blocks from both Broken Top and Big Cinder Butte present in the study area. This area has the best assemblage of geologic features for educational purposes in the easily accessible portion of the Monument.

Current Geologic Resource Conditions of the existing Loop Trail:

Parking Lot to Wilderness Trail Head—the classic slab pahoehoe or slab lava along the road has had negligible impact from visitors over the years probably due to its extreme roughness discouraging anyone from trying to cross it.

Wilderness Trail Head to entry into open limber pine forest—other than compaction and minor rill erosion that occurs along the trail periodically after a thunderstorm, there is no apparent degradation of geologic resources. It is possible that some bombs may be missing from the lower portion of this trail segment where they occur more commonly.

Entry into the forest to the NE corner of loop—this trail segment follows the old road. In 30 years the plants have reclaimed much of the road width. At approximately the exit from the open forest area, a small barrow pit area is still visible. Beyond this a sizeable bank of iridescent cinders remains largely undisturbed aside from the bench cut for the old road. Despite many years of use by hikers heading into the Wilderness, daily guided walks in the summer, and educational use by thousands of school children every year for the past several years, geologic features show little impact.

NE corner to Buffalo Caves turn off—this segment, which follows the old road, appears to have narrowed over the past 30 years through down slope movements of cinders from human and deer traffic, as well as the ubiquitous pull of gravity. The lava toe area at the base of the slope has had some significant damage to the glassy crusts of the lava exposing the oxidized zone beneath missing fragments.

Buffalo Caves turn off to Buffalo Caves—this segment is generally in good condition, with the exception of the feature called "Dumbo", which has had a portion of the front leg removed. The cave area is in good condition and has examples of lava curbs, stacked tubes, and hot and cold collapse features. The backdoor has an unstable ceiling, which has been closed for visitor safety. Lava stalactites and sulfate crystals adorn much of the ceiling within the cave.

Buffalo Caves to Eruptive Fissure—this segment passes the steep up tilted edge of the pressure plateau or lava lake and is the best example readily available to the public in this end of the monument. The trail passes non-eruptive fissure on the flank of Broken Top and a long lava toe or finger. The crust on the finger shows some damage and a lodgepole fence now serves to discourage further damage. Crusts on some of the cow-pie bombs in close proximity to the trail show minor damage attributed to foot traffic. A viewing area delimited by a low lodgepole fence has been erected to protect a textbook example of inflation structure with offset ropes and a striated slip face. There has been no damage to the feature and nearby glassy crusts have also been protected by the fenced off viewing area. A classic series of pahoehoe ropes has also been fenced with pole log barriers and is in pristine condition.

Edge of eruptive fissure to backside of spatter rampart—trail crosses a very rough section of Blue Dragon flow that partially fills the eruptive fissure. The first portion of the segment follows the contact between the Blue Dragon flow and breakouts from the pressure plateau of the Broken Top flow. This rough segment is about 280 feet long and was delineated with poles to encourage hikers to stay on trail.

Rampart to Road—lava billows at the start of this segment show some damage and were railed off with lodgepole rails in 1998 to deter further damage. Minor damage to glassy crusts on the Blue Dragon are evident in places from the billows to the road. The trail was rerouted around the two segments with the most damage so that the trail now follows cinder areas rather than crossing the lava directly.

2. The second section focuses on the role of technology in modern record-keeping. It highlights how digital tools can streamline the process, reduce errors, and provide real-time access to data. The author argues that embracing technology is not just a convenience but a necessity for staying competitive in today's fast-paced environment.

3. The third part of the document addresses the challenges of data security and privacy. It notes that as more information is stored digitally, the risk of breaches and unauthorized access increases. The text provides several recommendations for safeguarding sensitive data, including regular security audits, employee training, and the use of encryption techniques.

4. The fourth section explores the legal implications of record-keeping. It discusses various regulations and standards that organizations must adhere to, depending on their industry and geographical location. The author stresses that compliance is not a one-time task but an ongoing process that requires constant vigilance and updates to policies.

5. The final part of the document offers practical advice for implementing a comprehensive record-keeping strategy. It suggests starting with a clear assessment of current practices, identifying areas for improvement, and then developing a phased plan to address those needs. The text concludes by encouraging organizations to view record-keeping as a strategic asset that can provide valuable insights and support decision-making.

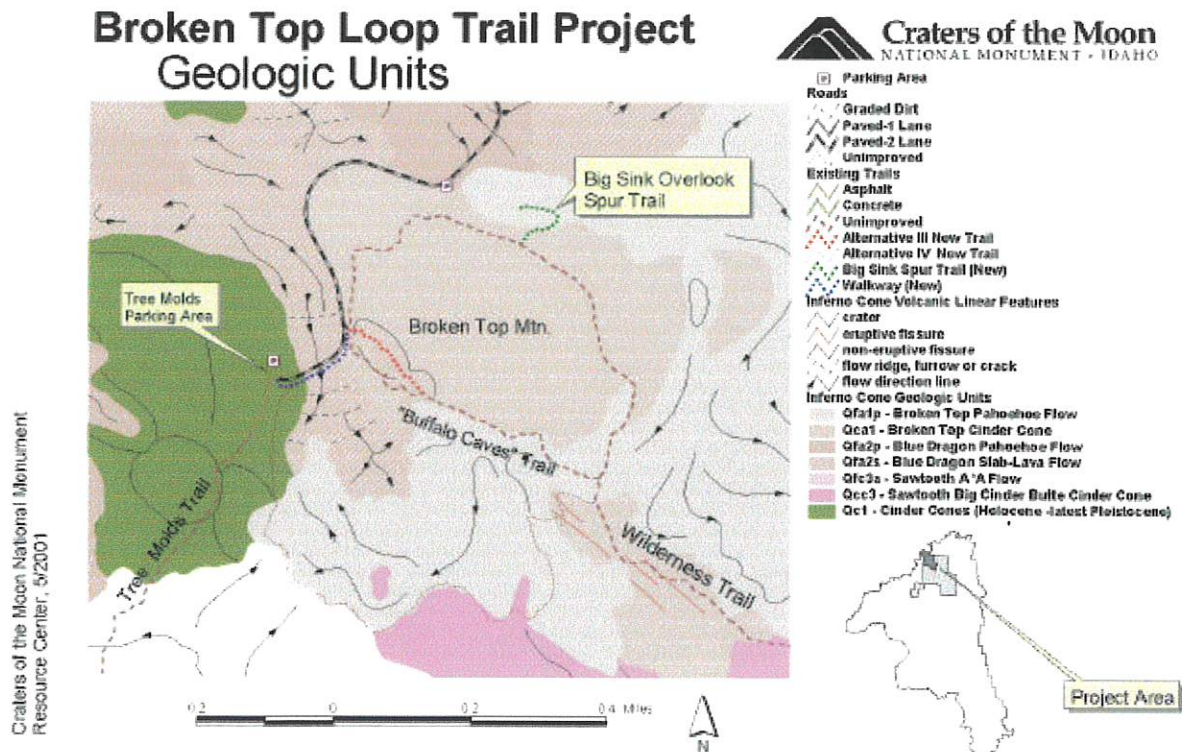


Figure 5

3.2 Vegetation

Much of the project area is covered by sparsely vegetated lava flow or cinder gardens. However, a portion of the area has fairly dense vegetative cover including bitterbrush shrubs and limber pine (see Appendix C for a detailed description of these vegetative communities). Bitterbrush often forms a dense understory among open stands of limber pine.

Broken Top Loop Trail Project

Vegetative Cover

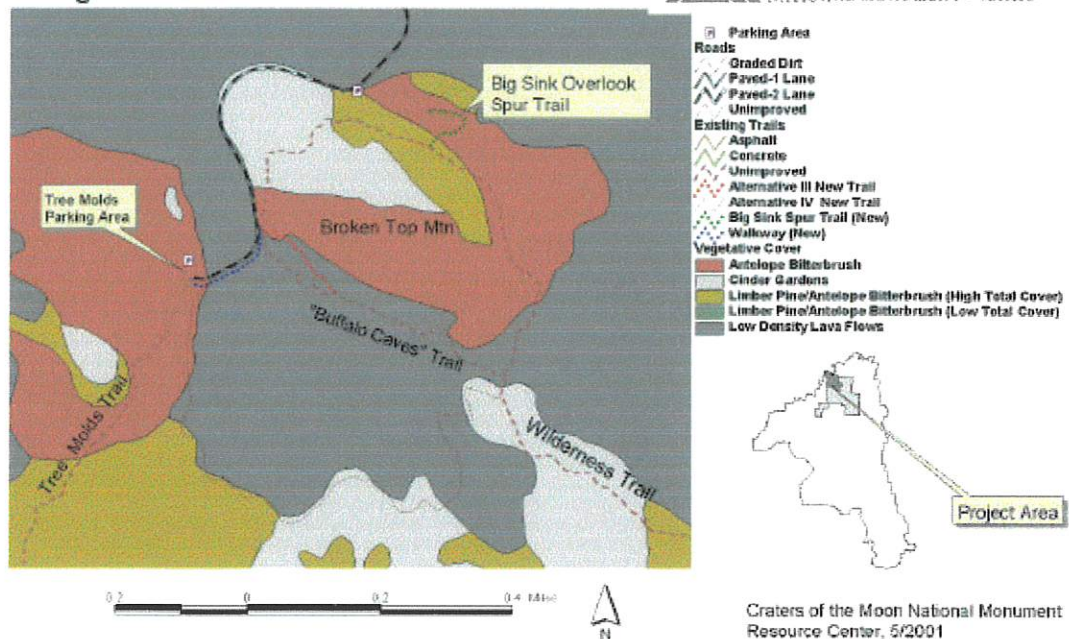


Figure 6

3.3 Wildlife

Many wildlife species in the project area are nocturnal and rarely seen. These include numerous small mammals, bats, and some birds. Many of the species occurring in the area are either shrub-steppe or rocky habitat specialists. Mule deer are the only large mammal known to regularly use the area. Deer pass through this area during both spring and fall migration and may also utilize the area for browse and cover during the summer. Both the existing trail and proposed segments are part of the deer migration trails. These trails receive heavy use by deer during the spring and fall migrations (Griffith 1983).

3.31 Species of Special Concern

The Bald Eagle is only species listed by the U.S. Fish and Wildlife Service (USFWS) as threatened or endangered which is known to utilize the northern area of the monument. However it has never been recorded in the project area nor is it not likely to occur there. There are no USFWS candidate species known to occur in the monument. Of 40 Monument species which have been identified as sensitive by either Bureau of Land Management, Idaho Department of Fish and Game, or USFWS, most are riparian species not found in the project area except for occasional migratory birds. Several sensitive species, the Rufous hummingbird, Calliope hummingbird, red-naped sapsucker, and Lewis'

woodpecker frequent limber pine stands along the existing Wilderness Trail and proposed route.

Four bats species that are listed as sensitive may use caves for part of their daily or annual patterns. Within in the project area, Buffalo Caves already receives several thousand visitor entrances annually. Surveys conducted in 1990s did not reveal any of these species in the project area.

Several sagebrush obligates are known to use the monument. These are Pygmy Rabbit, Sage Grouse, Loggerhead Shrike, Gray Flycatcher, Green-tailed Towhee, Brewer's Sparrow, Sage Sparrow, and Sagebrush Lizard. Sage grouse have not been reported in the project area but all of the others have been recorded along the existing Wilderness Trail (CRMO Wildlife Observation database).

The entire known range for subspecies of pika, yellow-pine chipmunk, and yellow-bellied marmot occurs within the immediate area of the original 53,440 acre monument. All of these animals have been documented in the project area (CRMO wildlife observation records). There are also numerous other species which may be common or widespread in North America but have limited range or habitat in the Snake River Basin or within the monument. Many of these are prairie species which reach into the lightly vegetated areas of the Great Basin and Snake River Plain. One of these is the Common Poorwill. Poorwills are widespread throughout the Western United States but locally are found only in the scattered sagebrush areas in the south central portions of the Idaho (Burleigh, 1972). The only nest documented in the monument was on the route of the new trail section in alternative D.

3.4 Trail Condition and Use

Within the project area, most of the Wideness Trail route has been in continuous use since the Monument was established. This route evolved from an early wagon road to an NPS administrative fire road prior to designation of the Craters of the Moon Wilderness Area in 1970. Since then the road has been closed to vehicles and is used as a hiking trail. A new hiking trail segment replaced the northern end of the Fire Road sometime after 1974 (Hentges, 1974). Exact trail use numbers for the project area are not available but a very rough estimate would place the total use at no more than 3,000 persons per year. Most use occurs from May through August during the mid-day period (10 AM to 4 PM).

The Wilderness Trail is open to stock use (day use only) but actual use is negligible. All other trails in the project area, existing or proposed, are closed to stock use. Overnight camping is permitted within the wilderness area.

3.5 Wilderness

The project area is bounded on the south and west by the Craters of the Moon Wilderness Area (Figure 1). The Tree Molds Trail (1.0 miles) and Wilderness Trail

(5.3 miles) were developed prior to Wilderness designation. The Wilderness Trail evolved from a wagon road in the 1920's to a jeep road by the 1960's. It was then closed to all mechanized transportation with Wilderness designation in 1970. Approximately 4.3 miles of the Wilderness Trail and .8 mile of the Tree Molds Trail lie within the Wilderness Area. Trails have not been considered essential for public enjoyment of the Wilderness Area. Although the current Wilderness and Backcountry Management Plan (USDI, 1989) for the area states "Trails will not be constructed or maintained in the wilderness.", a specific exception is made for maintenance of the Tree Molds Trail. This policy reflects the open terrain of the Great Rift which permits cross-country travel and encourages a largely self-directed Wilderness experience.

The plan describes two management zones for the Wilderness Area. Most of the Wilderness lands within the project area are classified as "Primitive". Primitive includes the most visited portion of the Wilderness (an area along the Wilderness Trail to The Watchman). This area is described as having the "highest potential for social encounters...a moderate amount of human impact and social contacts are acceptable...". The 1989 plan was completed prior to NPS policy changes which require preparation of an environmental assessment for all Wilderness management plans.

Recreational use of the Wilderness area is very limited. On average fewer than 100 people a year obtain overnight camping permits. Day use numbers on the Wilderness Trail are higher but are still probably fewer than 1,000 persons a year. Day use of the Tree Molds Trail is probably higher (1,000-2,000 persons/year) although no accurate counts are available.

3.6 Cultural Resources

Previous cultural resource surveys have recorded two archeological sites within the project area. One additional site associated with the new route described in Alternative D was recorded during cultural resource surveys for this project. One of the previously recorded sites has chipping detritus and a semi-circular rock ring structure. A second site is a quarry site.

The Wilderness Trail began as a crude wagon road used to access spring grazing at Little Prairie prior to designation of the Monument in 1924 (Louter, 1995). By 1940 the wagon road had been improved sufficiently to permit limited motor vehicle use (Louter, 1992). At some point prior to Wilderness designation in 1970, the route had been closed to public use but remained in administrative use for fire control purposes. The spur road to the Tree Molds parking area was not developed until the 1950s. Proposals to extend the Monument road system southward along the Great Rift had been proposed as early as 1939. None of these proposals were ever formally adopted and any further road development is now legally precluded by the Wilderness Act (78 Stat. 890; 16 U.S.C. 1132(c)).

3.7 Public Safety

The existing Wilderness and Tree Molds trails provide safe trail conditions for most hikers. The return trail from the Wilderness Trail across the Broken Top lava

flow includes a third of a mile of extremely rough lava flow with no real trail tread improvements other than log barriers to indicate the route (see Figure 2). The trail surface in this area has numerous protruding rocks, open cracks and uneven surfaces which pose a tripping hazard to hikers. Pedestrian access to the Wilderness Trail requires walking .1 mile along the road shoulder from the Tree Molds parking area to the trail head.

4.0 Environmental Consequences

This section of the environmental assessment represents the scientific and analytic basis for comparison of the alternatives. This section describes the probable consequences (impacts, effects) of each alternative on the resources discussed in Section 3. For each resource type an assessment is also made whether the impacts associated with the alternatives would result in impairment of park resources. Impairment is defined in NPS Management Policies (USDI, NPS, 2001):

"The impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Whether an impact meets this definition depends on the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact to any park resource or value may constitute an impairment. An impact would be more likely to constitute an impairment to the extent that it affects a resource or value whose conservation is:

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- Identified as a goal in the park's general management plan or other relevant NPS planning documents.

An impact would be less likely to constitute an impairment to the extent that it is an unavoidable result, which cannot reasonably be further mitigated, of an action necessary to preserve or restore the integrity of park resources or values."

4.1 Geologic Features

Alternative A (No Action) - Existing impacts to geologic features due to illegal collecting and breakage of surface features by off-trail hiking would continue.

Alternative B -

- (I) Parking Lot to Wilderness Trail Head—construction of a concrete sidewalk along the southeast side of the road will largely be built on cinders that were brought in during the construction of the road. By not having the sidewalk on the northwest of the road where it would be in close proximity to the slab pahoehoe, which does have some nice blue glass on it in places, it is likely to assure continued resource protection.
- (II) Spur to proposed overlook—proposed spur follows a course across cinders with sagebrush, bitterbrush, and rubber rabbitbrush shrub

communities. Anticipated consequence is compaction of cinders within the footprint of the spur trail.

- (III) Return Trail Construction - A 265 foot section of the existing trail route would require extensive improvements to provide a smoother surface. This would be accomplished using approximately 66 cubic yards of loose rock gathered onsite (most within 25 yards of the trail) and approximately 20 cubic yards of imported fill. Rock obtained onsite would be moved by hand labor. Imported material would be transported to the site using a power wheelbarrow or similar equipment. The use of on-site material would alter the existing appearance of the surrounding landscape but this change would not be apparent to the casual observer.

Alternative C - In addition to I and II above:

- (IV) Alternate return from edge of eruptive fissure to road—Approximately 66 cubic yards of imported fill would be required to cover the existing boulders for a distance of 800 feet to create a trail surface 6 feet wide. Heavy equipment would be required to place the fill and it is estimated this would produce a construction imprint up to 15 feet wide. The slope immediately next to the proposed segment is in excess of the normal angle of repose for cinders. It is armored by spatter, which periodically has failed resulting in rock fall and the accumulation of debris at the base of the slope where the proposed trail would be built.

Alternative D - In addition to I and II above:

- (V) Return from Wilderness Trail via base of Big Cinder Butte to Parking Area:

- (A) Segment from Wilderness Trail to main body of the Broken Top flow (pressure plateau or lava lake) south of Broken Top—this segment follows a low cinder hill back towards Buffalo Cave, but further south than the existing trail. This area is strewn with all types and sizes of volcanic bombs. Many of the bombs are of relatively small size and would be subject to illegal collection. People at Buffalo Caves might be tempted to short cut directly to this segment of trail if they saw people on it, rather than backtracking to the wilderness trail. Over time a series of social trails might develop. Prior to reaching the lava, a segment of the rift that runs between the non-eruptive fissure on Broken Top and the non-eruptive fissure on the northeast flank of Big Cinder Butte is crossed by the trail. For safety, the trail in this area should be probed for stability and well delineated to assure visitor safety.
- (B) Edge of lava to edge of Big Cinder Butte—this segment, which crosses the top of the pressure plateau, is not particularly vulnerable to damage from walking across it, because most of it lost its glass early in its formation. Approaching the edge near Big Cinder there are squeeze-ups, much like what was called "Devil's Sewer" which was lost to vandals near North Crater Flow Trail. There is at least one pipe like squeeze-up covered with blue glass in that area that might be a

tempting for someone to remove, though it is likely that all they would succeed in doing is destroying it in the process.

- (C) Edge of Big Cinder Butte north to Tree Molds Parking Lot—this segment of the trail passes along the north edge of Big Cinder Butte, by several flow fronts of the Sawtooth flow, and by rafted blocks from Big Cinder. The area is strewn with breadcrust, spindle, and ribbon bombs subject to illegal removal.

Impacts to geologic features in Alternative B would primarily be the use of on-site rock materials to build retaining walls and provide fill for a smooth trail surface. The impacts would be restricted to nearby areas close enough to move rock materials with hand labor. In Alternative C both imported and rock obtained on-site fill would be transported and placed with heavy equipment. This would result in a wider construction imprint along the completed trail but less off-site impacts caused by the relocation of loose rocks from areas around the trail. Trail construction impacts in Alternative D would be far less per foot of trail and overall amount of rock or fill needed for construction. This is due to the terrain being primarily smooth lava or cinders. Indirect impacts, such as theft or destruction of geologic features would be more likely along the new trail segment in Alternative D than in B or C. The routes used in the latter alternatives have already been impacted by these indirect impacts.

Impacts that would occur under Alternatives A-D would not result in impairment of geologic resources or the values associated with them.

4.2 Vegetation

New trail construction would result in a removal of .07 acres of vegetative cover in Alternative B and C, .4 acres in Alternative D, and none in Alternative A.

Vegetative cover consisting primarily of bitterbrush (*Purshia tridentata*) shrubs would be removed to accommodate a trail averaging 5 feet in width. Other plants associated with the bitterbrush/limber pine types are described in Appendix C. There are no plant species listed as threatened or endangered under the Endangered Species Act (nor any species of special concern) known to occur or likely to occur within the project area.

Vegetation would be removed using hand tools. Only those plants within the trail route would be directly effected. Final layout of the trail route will be done to minimize the amount of vegetation impacted. Much of the area requiring new trail construction is either bare rock or exposed cinders. No trees would need to be removed but a few low limbs may need to be pruned. Several areas associated with the new trail routes have some potential for off-trail impacts associated with persons taking short cuts cross country. The trail routes have been laid out to minimize this potential. Impacts that would occur under Alternatives A-D would not result in impairment of vegetative resources or the values associated with them.

4.3 Wildlife

Impacts to wildlife would be associated with the direct loss of vegetation for cover and browse discussed in the previous section and potential disturbance from persons using the trail.

Alternative A

The "No Action" alternative would not change any of the impacts of the current trail system and any associated impacts on wildlife due to disturbance to either animals or habitat.

Alternative B

This alternative utilizes 1.4 miles of existing trail and 0.3 miles of new trail would be constructed. The 0.16-mile walkway along the roadway from the parking area to the trailhead would primarily be the road fill which already a disturbed area with little vegetation. The effect on wildlife habitat would then be a result of habitat loss due to removal of plants in the construction of the 0.13 miles of the new spur trail. The major effect on wildlife would likely be disturbance from the presence of people on the trails. The amount of increased use the trail would get after construction is unknown. Therefore, the level of disturbance from hiking traffic is unknown. Spring monitoring would continue of both birds and mule deer in the area.

Alternative C

Alternative C is essentially the same as alternative B except for the abandonment of 950 feet of trail and the construction of 800 feet of new trail approximately 50 to 75 yards north of the existing route. Construction of the new trail would result in an imprint 10 feet wide. Both routes are through essentially non-vegetated areas and not likely have different levels of foot traffic or at different times of day. Thus, the disturbance effects should be the same as alternative B. As with alternative B, monitoring of birds and mule deer would continue in the affected area.

Alternative D

As with alternatives B and C the effects on wildlife would result from the removal of vegetation for the construction of trail and the subsequent disturbance from the increased or new foot traffic. The amount of vegetation removed should have minimal effect on wildlife species in the area. Vegetative cover is sparse over most of the effected area. There should be little or no edge effect that could favor edge species or discourage interior species. The primary effect would then be a result of the disturbance of increased hiking traffic on wildlife.

The proposed route along the base of Big Cinder Butte utilizes several hundred yards of trails known to be used by mule deer migrating from winter range on the Snake River Plain (Griffith, 1983). There is little available information on how an increase foot traffic might affect this use by deer. However, deer have moved their trail to constructed hiking trails elsewhere in the monument. Deer beds have been found within 100 yards of the existing Wilderness Trail. This circumstantial

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

... ..

evidence suggests that deer might largely be unaffected by the new trail particularly if off trail use does not increase. Substantial off trail use by hikers would likely have some affect on use of the area by deer. This could be manifested as a change in day time bedding areas used. Substantial off trail could also result in the rerouting of pathway used by deer or even modify the temporal use of these trails and potentially the movements of deer throughout the monument. The Broken Top area is bordered by extensive lava flows and represents a narrow migration corridor used by mule deer.

Birds which are dependent upon sagebrush steppe habitat are likely to be affected more by disturbance than the minimal loss of habitat. Several species of small birds do show reduced activity in areas around people. This is frequently referred to as "a donut effect " where there is significantly reduced activity of small birds around an observer (Savard and Hooper 1995). If this same pattern is associated with trail uses then new trail through shrubsteppe habitat may reduce use of the area several yards out from the center of activity (the trail). On the Columbia Basin, Savard and Hooper (1995) recorded significantly reduced detection within 30 feet of the observer. If trail use is heavy enough to duplicate this effect for extended periods then approximately 100 to 125 acres of habitat would be rendered useless for these species. This is potentially most important for those species that are already marginally sustainable in the area due to habitat or other constraints.

The common poorwill has only been recorded in a few areas of the monument and the only recorded nest was recently discovered on the proposed route in this alternative. Many ground nesting birds, like the common poorwill are sensitive to disturbance while on the nest and substantial off trail use of this area could render the area along the trail unsuitable for nesting by this species. Predicted trail use is discussed in the following section.

The impacts associated with Alternatives A, B, C, and D would not result in the impairment of wildlife resources or the values associated with them.

4.4 Trail Condition and Use

Public use of the project area is not likely to increase substantially but increased use of areas not currently accessed by trails is likely to be substantial. These include the spur trail proposed in Alternative B, C, and D, as well as the one mile of new trail on the northwest side of Big Cinder Butte in Alternative D. These increases would be from a current level of near zero.

An unknown is the extent increase in human activity or timing of that activity which might occur in this area following the proposed trail improvements. Public use figures for the Monument indicate that overall visitation at the Monument leveled off at approximately 200,000 persons per year over 25 years ago. The Broken Top area has been historically regarded by Monument staff as one of the

least visited sites (actual use figures are not available) along the seven mile loop road. Peak use periods are during the mid day hours from June to mid August.

Trail use may increase regardless of which alternative is implemented but total trail use numbers are not projected to substantially increase (not exceed 25%). Increased trail use is most likely to increase with the improvements described in alternatives B, C, and D. Alternative D would increase the number of hikers in an area previously only accessed by a few off-trail hikers. If future use remains consistent with existing use of the area, 2,000 to 3,000 hikers (an average of 25 people a day over the 120 day hiking season) might visit this newly accessible area. The distance (2.4 miles) involved in hiking the trail proposed in Alternative D may discourage some hikers compared to the shorter routes in Alternatives A, B or C. Wilderness hikers may choose the new trail segment in Alternative D (along the base of Big Cinder Butte) instead of the existing trail over Broken Top. Trail surface conditions would remain unchanged in Alternative A. Trail improvements or reroutes in Alternative B and C would eliminate or avoid the most difficult portions of the existing route. The route proposed in alternative D would avoid that portion but add an additional .7 miles of mostly level hiking.

The impacts associated with Alternatives A, B, C, and D would not result in the impairment of trail resources or the recreational values associated with them.

4.5 Wilderness

Alternatives A, B, and C would have no direct effects on Wilderness. Indirect effects could result from an increase in use of the loop trail which might bring more people closer to the Wilderness Area boundary on the existing Wilderness Trail.

Alternative D would have both direct and indirect effects on Wilderness. Direct impact would result from ½ miles of new trail construction just within the wilderness boundary (see Figure 1). The maximum distance inside of the Wilderness Area boundary would be .08 miles (420 feet). This proposal is not intended to reverse the policy expressed in the 1989 wilderness plan which does not support additional trail development for wilderness access. The trail segments proposed in Alternative D which fall just inside the wilderness boundary are not designed for wilderness access. The segments are an incidental part of a loop trail designed as an educational trail for school groups and the general visitor.

Due to sparse vegetative cover, the visual impact of the trail in this area would not be substantial. The largely open terrain would not require extensive clearing of vegetation or rock. The open terrain in the area already affords views of the Tree Molds road and parking area from many points along the proposed trail including the segments within the Wilderness. Other indirect impacts to the Wilderness area could come from increased off-trail use of previously remote areas afforded by improved trail access.

Mitigation - Overnight camping would not be permitted in this area due to the proximity to the trailhead and the high potential for impacts from camping

activities. Construction and maintenance on this segment of the trail would be entirely with hand tools.

Alternative A,B and C would not cause impairment of Wilderness resources. The impact of the proposed trail on wilderness resources and values is minimal due to the short trail distance to be constructed, the low impact construction required, the short distance into the Wilderness Area which the trail is routed. The proposed trail segments are in close proximity to an existing paved road, parking area, and trailhead.

4.6 Cultural Resources

Three archeological sites have been recorded within the project area (Sneed, 1963 and Cresswell, 2001). One is directly adjacent to an existing section of trail. One previously recorded site in the vicinity of proposed trail construction in Alternative D could not be located during a cultural resource survey conducted in May 2001. A third new site was located during the above-mentioned survey. The latter site was located within a proposed trail corridor.

Mitigation - A survey of the proposed trails recorded one new site and all trails would be routed away from the site.

No impairment of cultural resources would result from any of the alternatives described in this environmental assessment.

4.7 Public Safety

Alternative A (no action) would have no material effect on improving or degrading public safety. Alternatives B, C, and D would reduce the potential for injuries caused by tripping on protruding rocks or falling in small cracks in the trail. The new 800 foot trail segment on the west side of Broken Top described in Alternative C is directly below a steep unstable slope with substantial rock fall hazard (Owen, 2001). If it were necessary to extract injured or ill persons from the trail, Alternative D proposal would require the longest carryout (1 mile). However, this distance is not substantially longer than the distance involved with the existing Tree Molds Trail.

4.71 Construction Worker Safety

Alternative A (no action), No construction worker safety issues.

Alternative B, 265 feet of this trail is in need of major rehabilitation. Lava rock retaining walls, checks and fill would have to be cut, hand moved and then fitted into place using hand and power tools in order to accomplish the rehabilitation of this section of trail. This work would require using a very skilled crew with the knowledge of dry wall masonry. Lava rocks in excess of 100 pounds would have to be moved by hand from a quarry site 50 yards away from the project site over a very rough lava flow. Hand moving and fitting of lava rock in these conditions would present many potential hazards to the workers. Risk of serious injury would be high in this work environment.

Alternative C, Since the majority of this 800 foot long trail section would be built by mechanical means (Dozer), the risk to workers would be much less than

Alternative B. Potential for injury does exist. The use of heavy equipment would help mitigate safety concerns to workers.

Alternative D, The proposed 1.5 miles of new trail would be constructed with hand labor and hand tools. Risk to workers would be higher than Alternative A but less than either Alternative B or C. Large lava rock would not need to be moved, only cinder size material must be placed or excavated along this section of trail. In this alternative the potential for worker injury is greatly reduced since large rock does not need to be moved across rough lava flows.

4.8 Other Resources

There are no wetlands, floodplains, sole or principle drinking water aquifers, or prime farmlands within or adjacent to the project area that would be effected by the alternatives analyzed in this assessment.

4.9 Unavoidable Adverse Effects

Adverse effects have been avoided whenever possible.

4.10 Relationship of Short-term Uses and Long-term Productivity

Long-term productivity of all resources in the project area would not be effected by the implementation of any of the alternatives.

4.11 Irreversible and Irretrievable Commitments of Resources

There are no irreversible or irretrievable commitments of resources proposed in any of the alternatives.

5.0 List of Preparers

John Apel, Resource Program Manager

Mike Munts, Biological Science Technician

Doug Owen, Park Ranger/Geologist

6.0 List of Agencies, Organizations, and Persons Consulted

Lisa Cresswell, Archeologist, Bureau of Land Management, Shoshone Field Office, Shoshone, Idaho.

David Clark, Chief of Interpretation, Craters of the Moon National Monument

Dwayne Moates, Facility Manager, Craters of the Moon National Monument

Bill Aierstuck, Maintenance Mechanic, Craters of the Moon National Monument

John Lee, Herpetologist, Ph.D. Candidate, Idaho State University, Pocatello, Idaho.

Tammie Henderson, Park Ranger, Craters of the Moon National Monument

Mountie Morris, Visitor Use Assistant, Craters of the Moon National Monument

Jim Morris, Superintendent, Craters of the Moon National Monument

7.0 Consultation and Public Review

This Environmental Assessment will be available for a 30-day public review period from July 16, 2001 to August 14, 2001. A notice will be mailed to a list of persons and agencies who have expressed interest in Craters of the Moon National Monument proposed actions and events. This document's availability will also be posted on the park's web site located at: <http://www.nps.gov/crmo>

Comments on this Environmental Assessment should be directed to:

Superintendent
Craters of the Moon National Monument
P.O. Box 29
Arco, Idaho 83213

Following the review period, information in this Environmental Assessment and any pertinent information obtained from reviewers, may be used to prepare a Finding of No Significant Impact (FONSI) which will be sent to the Regional Director, Pacific West Region for final signature and approval of the proposed action. Should any information obtained from reviewers indicate that the proposed project would have a significant adverse effect on the environment, the project would be redesigned and reassessed or cancelled.

For additional information concerning this Environmental Assessment or for additional copies, please call, please contact Resource Program Manager, John Apel at (208) 527-3257, extension 501.

Appendix A

References Cited

- Burleigh, T. 1972. Birds of Idaho. Caxton Printers, Caldwell ID, 466 pp.
- Cresswell, Lisa. 2001. Idaho Bureau of Land Management Archeological and Historical Inventory Record. Project Title: Craters of the Moon National Monument Broken Top Loop Trail, BLM Report Number :ID-076-01-24, dated May 9, 2001.
- Day, Thomas A. and R. Gerald Wright 1985. The Vegetation Types of Craters of the Moon National Monument. Bulletin Number 38, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow Idaho.
- Griffith, Brad. 1983. Ecological Characteristics of Mule Deer: Craters of the Moon National Monument, Idaho. Rep. B83-2 , Cooperative Park Studies Unit, University of Idaho, Moscow.
- Hentges, Robert J. 1974. Memorandum to the Regional Director, Pacific Northwest Region, NPS, July 29, 1974.
- Kuntz, Mel A., et al. 1989. Geologic Map of the Inferno Cone Quadrangle, Butte County, Idaho. U.S.D.I. U.S. Geologic Survey.
- Louter, David, 1992. Craters of the Moon National Monument: An Administrative History. Cultural Resource Division, Pacific Northwest Region, Seattle WA.
- Louter, David, 1995. Craters of the Moon Historic Context Statements. Cultural Resource Division, Pacific Northwest Region, Seattle WA.
- Owen, Doug. 2001. Geologic Assessment of the Broken Top Loop Trail Project. 7 pages.
- Ryser, F. 1985. Birds of the great basin. Univ. of Nevada Press, Reno. NV 604pp.
- Savard, J, and T. Hooper. 1995. Influence of survey length and radius size on grasssland bird surveys by point count at Williams Lake, BC in CJ Ralph, J Sauer, and S. Droege eds. Monitoring bird populations by point counts. Gen. Tech. Rpt. PSW-GTR-149. USDA Forest Service., 181pp.
- Sneed, Paul G. 1967. An Archaeological Reconnaissance of Craters of the Moon National Monument. Tebiwa 10:37-52. Idaho Museum of Natural History, Pocatello.

4. The fourth part of the document discusses the implications of the findings. It suggests that the results have significant implications for the field of study and may lead to further research in this area.

5. The fifth part of the document concludes the study. It summarizes the main findings and provides a final statement on the importance of the research.

U.S. Department of the Interior, National Park Service, 1989. Craters of the Moon Wilderness and Backcountry Management Plan.

U.S. Department of the Interior, National Park Service, 1992. General Management Plan, Craters of the Moon National Monument, Idaho. Denver Service Center, Denver Colorado.

U.S. Department of the Interior, National Park Service, 1998. Broken Top Loop Trail Concept Plan, Craters of the Moon National Monument, Idaho. Denver Service Center, Denver Colorado.

U.S. Department of the Interior, National Park Service, 2000. National Park Service Management Policies 2001. 137 pp.

Appendix B

Geologic Unit Descriptions

Qca1 - Broken Top flow and related vent and ash deposits (Holocene)

Broken Top cinder cone- West flank of cone mantled by agglutinated spatter (aa1) from eruptive fissure on west side of cone. West flank of cone is cut by northwest-trending fissures and normal faults having less than 1 m displacement. Bulk of cone may have formed by eruptions from fissure of west side of cone, possibly at same time as eruptions from eruptive fissures in Trench Mortar Flat. Arcuate scarps on east and south sides of cone are generally concentric with apex of cone and probably formed by collapse during eruption of Broken Top flow. (GQ-1632; Kuntz et. al, 1989)

Qfa1p - Broken Top flow and related vent and ash deposits (Holocene)

Pahoehoe basalt flow- Surface-fed flow from obscure vents and short fissures, arcuate cracks, and small, spatter-encrusted vents on east and southeast flanks of Broken Top cinder cone (ca1). Vents probably formed during partial collapse of Broken Top cinder cone. Flow is hummocky, rough-surfaced, and cut by widely spaced polygonal joints. A lighter color and relative abundance of grass and low bushes distinguish the Broken Top flow from underlying Blue Dragon pahoehoe flow (fa2). Unit also includes inclined slabs of basalt, as thick as 5 m, and accumulations of agglutinated spatter that lie on northeast-, east-, and south-facing slopes of Broken Top cinder cone. Only distal parts of two lobes of flow occur in The Watchman quadrangle. (GQ-1632; Kuntz et. al, 1989)

Qc1 - Cinder cones (Holocene and latest Pleistocene)

A group of cinder cones along the Great Rift that have no identifiable associated lava flows; thus, exact ages cannot be assigned to them. Age of cones in map unit encompasses nearly the entire time span of Craters of the Moon lava field. In this quadrangle, unit includes Paisley Cone, Inferno Cone, Half Cone, Echo Crater, and other unnamed cinder cones. (GQ-1632; Kuntz et. al, 1989)

Qcc3 - Sawtooth flow and related vent and ash deposits (Holocene)

Big Cinder Butte cinder cone- Inner walls of crater are mantled by agglutinated spatter and thin lava flows. Cone is about 240 m high, 1 km wide, about 3 km long, and has a volume of about 0.2 km³. Stearns (1928) reported that Big Cinder Butte ranks among the largest, purely basaltic cinder cones in the world. East and southeast flanks of cone are cut by aligned, elongated, and circular craters that are part of Trench Mortar Flat eruptive-fissure system. Cone is open to southeast. Cone is source vent for Sawtooth and Big Cinder Butte northwest flows (fc3) and possible source vent for Indian Wells North (fc1) and Indian Wells South (fc2) flows of the North Laidlaw Butte quadrangle (Champion and others, 1989). (GQ-1632; Kuntz et. al, 1989)

Qfc3a - Sawtooth flow and related vent and ash deposits (Holocene)

A'a trachyandesite flow- Surface-fed, long, steep-sided flow that contains numerous lobes having steep fronts. Only proximal parts of flow occur in this quadrangle, distal parts of flow are in adjacent quadrangles. Flow is mantled by as much as 2 m of unmapped ash in its proximal parts. Flow issued from source vent at south end of Big Cinder Butte cinder cone (cc3). Unit includes Big Cinder Butte Northwest a'a flow, a short (< 1 km long), blocky flow on northwest flank of Big Cinder Butte cinder cone. (GQ-1632; Kuntz et. al, 1989)

Qfa2s - Blue Dragon flow and related vent deposits (Holocene)

Slab-lava flows- Formed near rootless vents from degassed, more viscous lava erupted late in eruptive sequence and where degassed, more viscous, lava traversed rough topography or flowed down relatively steep slopes. (GQ-1632; Kuntz et. al, 1989)

Appendix C

Vegetation Community Descriptions

Twenty-six distinct vegetation types have been described within Craters of the Moon (Day, 1985). The following types are found within the Project Area.

1. Cinder Gardens - Cinder gardens are characterized by a cinder surface and low total plant cover (generally less than five percent in mid-summer). Common species are dwarf buckwheat, silverleaf phacelia, Douglas Chaenactis, two species of monkey flower, dwarf onion, and bitterroot *Lewisia*. Some areas of this type are devoid of higher plants due to extremely harsh conditions.

2. Low Density Lava Flows - Low density lava flows are generally the youngest in the monument and have relatively low plant cover. Shrubs, which provide less than 5% of total cover, include tansybush, ocean spray, mock orange, dwarf goldenweed, and in favorable microsite, antelope bitter brush and lava phlox. Mountain big sagebrush is common in this vegetation type in the southern parts of the monument. Common forbs are scabland penstemon and desert parsley. Sandberg bluegrass and squirreltail are the most common grasses.

16. Antelope Bitterbrush - The antelope bitterbrush type covers large areas of the larger cones. Plant cover is generally more than 50%. Antelope bitterbrush is the dominate shrub. Rubber rabbit brush and wax currant are common shrubs. Limber pine and mountain big sagebrush are scattered in this type. Common forbs are Anderson larkspur, sulfur buckwheat, dwarf buckwheat, dwarf monkeyflower, and silverleaf phacelia. Squirreltail, Thurber needlegrass, and Sandberg bluegrass are the common grasses.

22. Limber Pine/Antelope Bitterbrush (High Total Cover) - The limber pine/antelope bitterbrush (high total cover) type is found on medium-aged cinder cones. Because lava blocks are absent, the total vegetative cover is higher than type 21. The dominant antelope bitterbrush is a relatively low form. Rubber rabbitbrush and wax currant are common. Mountain big sagebrush is common on favorable soil sites. Common forbs are *Eriogonum umbellatum*, *Erigonum ovalifolium*, *Mimulus nanus*, and *Gayophytum decipiens*.

