YMP/92-30

U.S. DEPARTMENT OF ENERGY

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YUCCA MOUNTAIN

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

FLOODPLAIN ASSESSMENT OF SITE CHARACTERIZATION ACTIVITIES AT THE YUCCA MOUNTAIN SITE NYE COUNTY, NEVADA

AUGUST 1992

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Yucca Mountain Site Characterization Project
Yucca Mountain Site Characterization Project Office
U.S. Department of Energy
Las Vegas, Nevada

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1.0 INTRODUCTION

Pursuant to Executive Order (EO) 11988, Floodplain Management, each federal agency is required, when conducting activities in a floodplain, to take action to reduce the risk of flood damage; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by the floodplains. U.S. Department of Energy (DOE) regulations implementing this EO are presented in Title 10 of the Code of Federal Regulations (CFR) Part 1022, Compliance with Floodplain/Wetlands Environmental Review Requirements.

In compliance with 10 CFR 1022, the DOE published a Determination of Floodplain/Wetlands Involvement for the Yucca Mountain Site Characterization Project (YMP) in the Federal Register (54 CFR 6318) on February 9, 1989. At that time, the proposed action consisted of conducting surface-based investigations and constructing an underground exploratory studies facility (ESF) consisting of two vertical shafts connected by lateral drifts. Shortly after publishing the Determination of Involvement, alternative design studies for the ESF were initiated by DOE. As a result of those alternative design studies, the ESF design was revised (see below).

In August 1991, a floodplain assessment was prepared to address potential floodplain impacts from surface-based investigation activities (DOE, 1991a). These activities include borehole drilling, dirt road construction, and excavation of trenches. The August 1991 assessment was followed by a Floodplain Statement of Findings published in the Federal Register (54 FR 49765) on October 1, 1991. The Statement of Findings (SOF)

concluded that the benefits resulting from locating some surface-based investigations in the 100-year floodplain outweighed the potential adverse environmental impacts. The SOF also stated that the ESF and associated surface support facilities and cumulative impacts would be addressed in a supplemental assessment and Statement of Findings.

The purpose of this proposed action and floodplain assessment is to address the cumulative impacts of surface-based investigations and the ESF. The proposed ESF now consists of surface facilities and two nominally parallel ramps constructed (i.e., mined) into Yucca Mountain from which a variety of subsurface tests will be conducted. An optional vertical shaft may subsequently be constructed. The subsurface tests are essential for evaluating the suitability of the Yucca Mountain site as the location of the nation's first underground high-level radioactive waste repository. The ESF will require site preparation, access road construction and improvement, utility services, construction of surface and support facilities and structures, construction of ramps and underground rooms, and the transportation, storage, and disposal of mined materials.

This assessment does not address wetlands. Since there are no wetlands inventory maps for the Yucca Mountain area, the U.S. Fish and Wildlife Service (USFWS) was contacted to determine if there are any wetlands in the vicinity of Yucca Mountain that may be impacted from site characterization activities. The USFWS determined that "...site characterization activities should not affect any wetlands on or near the Yucca Mountain site" (USFWS, 1988).

10 CFR 1022.4 defines flood or flooding as "a temporary condition of partial or complete inundation of normally dry land areas from....the unusual and rapid accumulation of runoff of surface waters..." The limited precipitation of southern Nevada (approximately 5.7 inches annually at Yucca Mountain) occurs primarily as infrequent thunderstorms, often intense and of short duration. The rapid accumulation of runoff from ridges, fan piedmonts, and alluvial fans results in flooding of the normally dry washes. It is these normally dry washes of the Yucca Mountain area, which are temporarily inundated with stormwater runoff, that are addressed in this assessment.

10 CFR 1022.4 identifies floodplains that must be considered in a floodplain assessment as the "base floodplain" and the "critical action floodplain." The base floodplain is defined as the area inundated by a flood having a one percent or greater chance of occurrence in any given year (also known as the 100-year floodplain).

The critical-action floodplain, defined as the 500-year (0.2 percent) floodplain, was considered as the floodplain of concern for the ESF surface support facilities located on the north and south portal pads. "Critical action" is defined as any activity for which even a slight chance of flooding would be too great (e.g., storage of highly volatile, toxic, or water-reactive materials.) The critical action floodplain was considered for these areas because petroleum, oil, and lubricants (POLs) will be stored there for use. There is also the potential for storing and using other regulated materials at those sites. The critical action floodplain was not considered

for the other ESF surface support facilities or for surface-based investigations because they will not involve critical action activities.

10 CFR 1022.11 requires DOE to utilize the Flood Insurance Rate Maps (FIRMs) or the Flood Hazard Boundary Maps (FHBMs) to determine if a proposed action is located in the base or critical action floodplain. On Federal or State lands where FIRMs or FHBMs are not available, DOE is required to seek flood information from the land management agency or from agencies with floodplain analysis expertise. The U.S. Geological Survey (USGS) completed a flood study of Fortymile Wash and its principal southwestern tributaries in which areas of probable inundation resulting from 100-year, 500-year, and regional maximum floods were designated (Squires and Young, 1984). Fortymile Wash is the main drainage channel that conveys runoff from Yucca Mountain south to the Amargosa River. Dry washes of the Yucca Mountain area are also included in the Squires and Young report. Therefore, those areas designated by Squires and Young as areas of probable inundation associated with the 100-year and 500-year floods were considered in this assessment as the base floodplain and the critical action floodplain, respectively. The 100-year and 500-year floodplains delineated by Squires and Young are depicted on Plate 1.

The regional maximum flood (RMF) considered by Squires and Young is a larger flood event than the 100-year and 500-year floods, and is estimated on the basis of data for floods of unusually large magnitude in a multi-state region without reference to recurrence interval. The RMF was not considered in this assessment since there is no regulatory basis for considering such an event. However, the RMF, as delineated by Squires and Young, is reproduced

on Plate 1 to illustrate the location of site characterization activities in relation to a larger flood event than is required by the floodplain assessment regulations.

While the purpose of this assessment is to evaluate potential effects from site characterization activities that occur in floodplains, it should be noted that the siting of, and flood control designs for, the ESF are based on the probable maximum flood (PMF). The PMF is a flood that could result from the probable maximum precipitation event, which is estimated from National Weather Service hydrometeorological reports, and considers the convergence of maximum precipitation events that have been recorded in a region occurring at the same time. The PMF analysis is a technique commonly used to predict a "worst possible case" flood scenario. PMF magnitudes and associated inundation maps have been developed for the Yucca Mountain area by the U.S. Bureau of Reclamation (USBR)(Bullard, 1986) and Sandia National Laboratories (Bertram, 1984). These PMF estimates are currently being updated by the USBR to include debris-loading factors and to more accurately delineate flood inundation areas.

The PMF is similar in magnitude to the RMF (i.e., a larger event than the 100-year and 500-year floods). As with the RMF, the PMF was not considered in this assessment since there is no regulatory basis to do so. Probable areas of inundation due to the PMF are not depicted on Plate 1 because they are similar to the RMF and any differences between the two events will have no bearing on this assessment. The primary reason for the minimal potential effects of site characterization on floodplains, particularly with regard to activities and facilities associated with the ESF

(discussed in Section 4.0), is DOE's consideration of the PMF in selecting facility locations and designing stormwater runoff controls (discussed as mitigation measures in Section 5.0).

Under the Clean Water Act (CWA)(33 U.S.C. 1344), and implementing regulations in 33 CFR 320.2(f), any Federal agency, State, or individual that plans to dredge, fill, or modify navigable waters or waters of the United States, as defined in the CWA, must first receive a Section 404 permit from the U.S. Army Corps of Engineers (COE). In November 1989, the COE made a formal determination that disturbing small segments of several dry washes along the east side of Yucca Mountain during site characterization would require Section 404 permitting, to be authorized under a Nationwide General Permit. As such, the COE issued DOE a nationwide permit in July 1990 for YMP activities (COE, 1990).

2.0 PROJECT DESCRIPTION

The U.S. Department of Energy (DOE) is in the process of conducting site characterization studies to determine the suitability of Yucca Mountain as a potential site for the nation's first underground repository for the disposal of high-level radioactive waste. Yucca Mountain is located about 100 road miles northwest of Las Vegas, Nevada (see Figure 2-1).

Site characterization studies are being conducted in accordance with the Nuclear Waste Policy Act of 1982, as amended. The site characterization studies consist of geologic and hydrologic investigations to determine if regulatory standards for geologic repositories can be met. Regulatory standards for repositories of high-level radioactive wastes have been established by the DOE, the Environmental Protection Agency, and the Nuclear Regulatory Commission. In order to support site characterization studies, the DOE proposes to construct surface support facilities such as boreholes with drill pads, fault trenches, access roads, utility lines, and an underground Exploratory Studies Facility (ESF). Included with the latter are underground access ramps, drifts, ramp portals, conveyer belts, an excavated rock stockpile, topsoil stockpile, powerline, water distribution system, septic tanks and leach fields, waste water disposal system, surface support facilities and structures (e.g., control center, change house, warehouse, microwave tower, temporary field offices) and, possibly, a shaft.

The location of the ESF and its associated support facilities shown on Plate 1 are as depicted in the YMP Title I Design Summary Report for the ESF (RSN, 1991). Also depicted on Plate 1 are the projected locations of surface

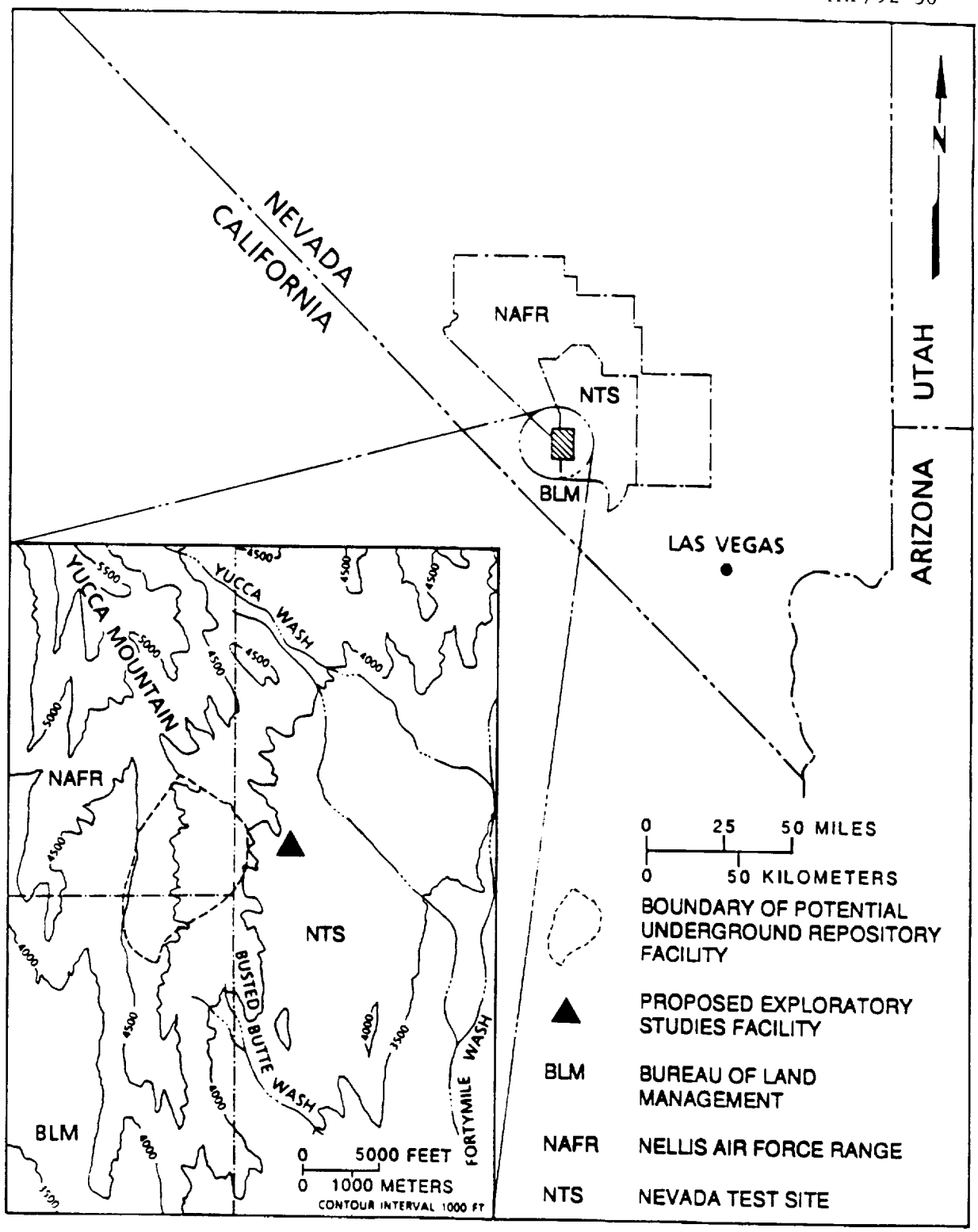

Figure 2-1. Location of Yucca Mountain Site in Southern Nevada.

support facilities for site characterization activities that are within or near the areas of probable inundation.

The facilities, structures, and activities of the proposed action are described in this section of the assessment. Surface-based investigations are described first, followed by the ESF activities.

2.1 SURFACE-BASED INVESTIGATIONS

The initial component of the site characterization program for Yucca Mountain consists of surface-based investigations involving borehole drilling, dirt-road construction, excavation of trenches across fault zones, and other minor surface disturbances. A complete description of proposed surface-based investigations can be found in Section 8.4.2.2 of the Site Characterization Plan (SCP) (DOE, 1988b).

Surface-based investigation support facilities proposed for construction in or near dry washes, and which have the potential of being inundated by runoff from a 100-year storm event, include approximately 10 new borehole drill pads, a limited number of small trench excavations, and approximately 8 miles of dirt and/or gravel access roads (DOE, 1991a). Site preparation for surface-based investigation support facilities in previously undisturbed areas (i.e., no previous disturbances that resulted in grading and excavation activities) will require grubbing and clearing of large boulders and woody vegetation, removing and stockpiling topsoil, and cut-and-fill as necessary to provide level sites for facility construction. The tentative locations of

proposed boreholes and roads are indicated on Plate 1. Several of the proposed boreholes will not require drill pads (e.g., shallow holes drilled to monitor percolation rates in the unsaturated zone). Therefore, proposed boreholes are categorized as those requiring construction of a drill pad and those that do not. Existing boreholes and roads (which were constructed prior to initiation of site characterization) are also shown on Plate 1. Trench locations are not identified because locations are dependent on reconnaissance surveys (which have not taken place for most proposed trenches) and pre-excavation field investigation [which includes digging small, temporary test pits to accurately locate the subsurface feature (i.e., fault) of interest].

2.2 EXPLORATORY STUDIES FACILITY

The ESF will be constructed to provide access for conducting a program of in situ exploration and testing above, at, and below the depths at which high-level nuclear waste would be emplaced if Yucca Mountain is determined to be suitable as a repository. This proposed action for the ESF differs from that described in the SCP in that access ramps and exploratory drifts will be constructed (i.e., mined) to access in situ test areas, as opposed to vertical shafts and in situ test rooms.

The principal components of the ESF for this proposed action include two nominally parallel underground access ramps, each of which will extend from a surface portal to the proposed repository horizon. These two ramps are referred to as the north ramp (which provides access to the northern

portion of the proposed repository horizon) and the south ramp (which provides access to the southern portion of the proposed repository horizon). A vertical shaft may or may not be drilled into the repository horizon (this shaft is referred to as the optional shaft). The ramps and drifts will be constructed (i.e., mined) with Tunnel Boring Machines. Excavated rock will be removed to the surface by conveyer belt.

Associated with each ramp will be surface facilities and structures. The portal sites, referred to as the north and south portal pads, will accommodate portal control centers, change houses, shop/warehouses, electrical substation control buildings, electrical switch-gear buildings, conveyer drives and transfers, airlock buildings, microwave towers, ventilation fans and control buildings, and vehicle parking. The north portal pad will support the majority of underground testing activities. Therefore, it will accommodate more trailers and laydown areas to support testing, an Integrated Data System, and additional vehicle parking. Additional ESF auxiliary sites and facilities include conveyer belts that lead to an excavated rock stockpile, a topsoil storage pile, an aggregate borrow area, a concrete batch plant and aggregate stockpile, an explosives storage area, waste water (evaporation) ponds, septic tanks and leach fields, water distribution lines and storage tanks, and paved, graveled, and dirt access roads.

Site preparation for ESF support facilities and structures in newly disturbed areas (i.e., no previous disturbances that resulted in grading and excavation activities, such as existing drill pads and roads) will require grubbing and clearing of large boulders and woody vegetation, removing and

stockpiling topsoil, and cut-and-fill as necessary to provide level sites for facility construction. Site preparation and facility construction for ESF surface support facilities are described in the following paragraphs.

2.2.1 Access Roads

Most of the ESF access roads will consist of upgrading existing roads, which were constructed prior to site characterization. Less than 5 miles of new road construction will be required. The main access road, the north and south portal access roads, and access road to the optional shaft collar will consist of two-lane asphalt roads. Other roads will consist of either two-lane oil and chipped or two-lane compacted aggregate roads.

2.2.2 North and South Portal Areas

Following the removal and stockpiling of topsoil, the portal pad areas will be excavated to bedrock. A vertical rockwall face, referred to as a highwall, will be excavated into the hillside portion (west side) of each site to allow portal construction. A level pad, with a two percent grade away from the portal entrance, will be excavated at each site. The pad area will be of sufficient size to accommodate the required surface support facilities mentioned previously. Since the north portal pad will be used as the main support pad for testing activities, it will be larger than the south portal pad.

2.2.3 Excavated Materials Stockpile and Conveyer Belt

All excavated rock material will be stored on the excavated materials stockpile site. Following topsoil removal from this site, the subsurface materials will be graded, compacted, and sloped to the center and to the northeast end of the site. Following grading and compaction, a perforated pipe collection system will be installed down the center of the pile to collect water from the rock and discharge it into a small, lined collection and evaporation basin at the northeast end of the site.

Following the initial construction of the portals, a conveyer belt system will be constructed to remove mined rock from underground and convey it to the surface and then overland to the excavated materials stockpile. The overland portion of the belt will extend from each portal to the rock storage stockpile. The belt will be nominally 4 to 6 feet above the ground surface and will be covered with a rain hood (installed primarily for dust control).

2.2.4 Topsoil Stockpile

Topsoil that is removed from ESF sites prior to construction of surface support facilities, including pads and roads, will be salvaged for later use in reclaiming those sites, as required by the YMP Reclamation Implementation Plan (RIP) (DOE, 1991c). Topsoil will be hauled to the topsoil stockpile site for storage until the ESF surface support facilities are decommissioned and reclaimed.

2.2.5 Aggregate Borrow Area

Aggregate to be used in the construction of the ESF will be extracted from a borrow area or areas located at or in the vicinity of Yucca Mountain. Two potential borrow area locations have been identified and include the bottom of Drillhole Wash (included on Plate 1) and a potential borrow area near Fran Ridge. Borrow areas in other locations could also be considered for use.

2.2.6 Optional Shaft Collar Site

The DOE has not yet determined if a vertical shaft located within the proposed repository boundary is needed to support site characterization. However, since it is a possibility, it is addressed in this floodplain assessment. The proposed location of the optional shaft collar site is west of Drillhole Wash on the southeastern slope of Yucca Ridge. A mechanical excavation method would be used for shaft construction to minimize rock damage.

2.2.7 Auxiliary Sites

Several other support facilities will be constructed to support the ESF. These "auxiliary sites" include the booster pump station, batch plant and aggregate stockpile, explosives storage area, and water storage tank sites. The concrete batch plant and aggregate stockpile site will consist of a graded, level working area located off the southwest side of the aggregate

borrow area. The explosives storage site will be located southwest of the batch plant.

2.2.8 Busted Butte Testing Facility

For purposes of conducting long-term underground tests in the Topopah Spring and Calico Hills units, it has been proposed that a smaller facility be constructed prior to completion of ESF ramps and drift construction. This potential facility would be located approximately 3 miles south of Yucca Mountain on the northern slope of Busted Butte. The Busted Butte facility would include ramps to access underground rock units, a surface support facility pad, and surface support facilities similar to those planned for the ESF. The facility is not shown on Plate 1 because it is only being considered at this time.

2.2.9 Water Distribution System

Water will be supplied to the ESF through a newly installed water pipeline. This pipeline will run from well J-13 to a booster pump station located at the intersection of the main access road and the north portal access road. From the booster pump station, water will be supplied to two water storage tanks located above each portal site through water distribution lines. The main line and the distribution lines will all be buried to minimum depths of 3 feet.

2.2.10 Sanitary System

The sanitary system, which will provide for the collection and treatment of sanitary waste generated within the north and south portal buildings, will consist of a septic tank and leach field to be installed at both the north and south portal sites. The waste system will collect sanitary waste water from the portal buildings in a main line that will be sloped to the respective septic tanks at each portal site. The septic tank will be sized, constructed, and installed in accordance with the requirements specified in the Nevada Administrative Code, Chapter 444. The septic tank will provide for the collection and treatment of solids from the sanitary system. A leach field will be connected to each septic tank to utilize the soil for absorption and treatment of the septic tank effluent.

2.2.11 Waste Water Disposal System

The waste water disposal system will collect and handle non-sanitary waste water produced from underground (i.e., water used for dust control during mining and fire suppression, in the event of an underground fire). Non-sanitary waste water will be collected in sumps and routed to the surface in a pressure-rated pipeline. Water from the pipeline will be discharged into settling basins equipped with an oil skimmer and then into non-discharging evaporation ponds. A settling basin/evaporation pond will be constructed at both the north and south portal sites. As stated previously, leachate produced from the excavated rock placed in the rock storage stockpile will be routed to a retention/evaporation pond constructed at the northeast point of the stockpile site.

A site drainage system has been designed for ESF surface support facility sites to control runoff resulting from a 100-year storm event and protect sites from flood waters associated with the PMF event. Diversion ditches and berms will be used to divert runoff. Runoff from areas upslope of all ESF support sites (i.e., facility pads) will be routed around the sites via interceptor ditches and/or berms and into dry drainages downslope from the sites.

Secondary containment will be provided around all fuel storage tanks and petroleum, oil, lubricant, and hazardous material storage sites on the portal pad sites. Lined secondary containment pallets or bermed areas will be provided for the accumulation of any hazardous wastes generated during ESF construction and in situ testing.

3.0 EXISTING ENVIRONMENT

3.1 GENERAL DESCRIPTION

Yucca Mountain, a long north-south aligned volcanic ridge with an elevation of 1,494 meters, is a major topographical feature of the YMP area (DOE, 1988a). Yucca Mountain slopes steeply at 15 to 30 degrees west to Crater Flat (elevation 1,189 meters) and gradually slopes eastward at 5 to 10 degrees, in a series of highly dissected ridges, to valleys of approximate 915 meter elevation. The large basin, Jackass Flats (elevation 1,097 meters), and its associated Fortymile Canyon drainage (see Plate 1), lie to the east of Yucca Mountain (DOE, 1988a).

The EA for the Yucca Mountain site describes Yucca Mountain as being located in the southern Great Basin of the Basin and Range Province (DOE, 1986). The hydrologic system of this region is characterized by low precipitation, high evaporation rates, deep groundwater tables, and closed topographic and groundwater basins. Perennial streams do not exist at or near the Yucca Mountain site. (For a complete description of the Yucca Mountain site including present use, geologic and hydrologic conditions, land use, terrestrial ecosystems, air quality, noise, archaeological and cultural resources, radiological background, and aesthetics, see the EA.)

3.2 SOILS

Soils on fan piedmonts and on lower slopes and narrow canyons consist of moderately deep to deep well-drained soils. Soil textures are very gravely sandy loams with 35 to 70 percent rock fragments. These soils are calcareous and moderately to strongly alkaline. The soils of the ephemeral stream channels and alluvial fans consist of very deep well- to excessively-drained soils. Soil textures are very gravelly fine sands and sandy loams with 35 to 60 percent rock fragments. Alluvial fan and ephemeral stream soils are calcareous and moderately alkaline (DOE, 1990). These soils do not meet the criteria for wetlands, nor do they meet the definitions of prime farmland soils, both of which are frequently associated with floodplains.

3.3 BIOLOGICAL RESOURCES

Two major floristic zones occur within the YMP site: the Mojave Desert, a warm desert occurring below 1,220 meters, and a transition zone, often called the Transition Desert, which extends in a broad east-west corridor between the Mojave and the cooler and wetter Great Basin Desert (located north of the YMP site at elevations above 1,525 meters) (DOE, 1988a). Three major vegetation associations occur throughout the study area within these two floristic regions: Larrea-Ambrosia (Creosote Bush-Bursage), Larrea-Lycium-Grayia (Creosote Bush-Boxthorn-Hopsage), and Coleogyne (Blackbrush) (DOE, 1988a). The flora and fauna of the dry washes comprising the floodplains do not differ significantly from the biota found in adjacent upland areas at the same elevation. Vegetation on lower slopes of canyons,

alluvial fans, and dry washes is generally sparse with the dominant species being varieties of Bursage (Ambrosia dumosa), Creosote bush (Larrea tridentata), Range ratany (Krameria parvifolia), Mormon tea (Ephedra nevadensis), Menodora (Menodora spinescens), a species of Wolfberry (Lycium spp), and Saltbush (Artiplex spp). There are no unique species in dry washes and species are typical of the Mojave Desert and Transition desert.

3.4 ENDANGERED SPECIES

The Desert Tortoise (Gopherus agassizii) is an important species which is present in the YMP site vicinity. Currently, this species is protected under the Endangered Species Act and is also protected by the State of Nevada (DOE, 1988a). As such, the tortoise may not be captured, moved, or destroyed except under special permit by the Nevada Department of Wildlife. Sightings and radiotracking of desert tortoises on the YMP site provide no evidence, to date, indicating the animals within the area prefer floodplains for their burrows (EG&G/EM, 1991). It is possible, however, that under other than the current drought conditions, tortoises may be more numerous in or near floodplains due to the availability of water and a stable food supply. Only continuing observation of these animals, as well as tortoises in other areas of the site, will determine whether the species exhibits a preference for the floodplain habitat (DOE, 1991a).

The Mojave Fishhook cactus is a species of concern (it is listed as a Category 3 species by the USFWS) that is potentially present at Yucca Mountain (no plants have been observed to date during pre-activity surveys).

As a species of concern, attempts will be made to avoid this species if practicable. Where disturbance is unavoidable, the plants will be collected and transplanted elsewhere.

3.5 CULTURAL RESOURCES

An analysis of archaeological site distribution in the Yucca Mountain region led to a hypothesis identifying three distinctive aboriginal settlement patterns as follows: 1) a linear pattern of sites along major ephemeral drainages and along ridgetops; 2) sites along terrace edges of these drainages, as well as temporary camps established in the uplands of Yucca Mountain, away from the drainages; and 3) alluvial fan or small rockshelter sites in the Yucca Mountain uplands, with few sites located along major drainages. These later sites were usually located near localized water sources, suggesting a reliance on these small seasonal water sources and an apparent lack of significant water in drainages (DOE, 1991b).

Intensive surveys for cultural resources were conducted in Midway Valley, corresponding to a U.S. Bureau of Land Management (BLM) Class III survey, and sample surveys were performed along Yucca Wash and in lower Fortymile Canyon, covering approximately 25 percent of the survey universe along those drainages (DOE, 1991b). The Yucca Wash and Fortymile Canyon surveys were conducted in areas expected to sustain indirect effects of project activities resulting from increased access to these remote areas (DOE, 1991b).

Items of paleontological and archaeological interest have been associated with Fortymile Wash (see Plate 1). Packrat (i.e., Woodrat, Neotoma lepida) middens in the walls of the channel contain evidence of climatic and vegetational changes over many thousands of years. However, observations indicate that middens are no more numerous in the channel walls than in vertical surfaces and rock outcroppings elsewhere (EG&G/EM, 1991). In addition, there is likely nothing unique in these middens that cannot be found by examining the contents of middens in adjoining areas. On occasion, human artifacts (i.e., man-made artifacts) have been found in the soil at ground level above the wash (DOE, 1991a).

3.6 EXISTING FLOOD DATA

Yucca Mountain area precipitation averages approximately 5.7 inches annually, but thunderstorms can produce significant amounts of precipitation for short durations in localized areas (DOE, 1986). Flood histories of individual drainages in the area are not well-known due to limited streamflow data.

As stated previously in Section 1.0, the floodplains considered in this assessment are based on U.S. Geological Survey (USGS) estimates of 100- and 500-year floods for the washes on the east side of Yucca Mountain (see Plate 1). These flood estimates are based on available peak discharge and geomorphic data (Squires and Young, 1984). Squires and Young based their estimates of 100- and 500-year flood magnitudes on regression analyses of approximately 20 years of peak discharge data from 12 gauging stations on

ephemeral streams in the Yucca Mountain area. Standard errors for these estimated discharges are relatively large due to the short period of record and extreme areal variability of flood flows in arid climates.

Squires and Young (1984) also examined geomorphic evidence of past flood elevations. Floodplain boundaries were delineated on the basis of flood data at various cross-sections interpolated according to the topography of the area (see Plate 1). Estimates of regional maximum floods (RMF) by Squires and Young were based on a graphical boundary curve developed by Crippen and Bue (1977). Squires and Young described projected flood conditions in their study area as follows (RMF data are presented for comparison purposes only; again, the RMF is not considered in this assessment):

- Fortymile Wash is a well-defined incised channel, with a cross-section 15 to 21 meters deep and 300 to 450 meters wide. The estimated values of the 100-year, 500-year, and regional maximum floods indicate that the flow would stay within the confines of the wash. Estimated flood water depths and velocities in the stream channel are:

	Water depth (meters)	Velocity (meters/second)
100-year flood	0.9 to 2.4	1.8 to 2.7
500-year flood	1.8 to 3.3	3.3 to 4.3
Regional maximum flood	6.4 to 8.8	7.0 to 8.5

- The Busted Butte Wash drainage basin varies from a shallow valley with meandering ephemeral streams to a deeply incised canyon in the upstream reaches. Drillhole Wash is characterized by deep canyons extending from Yucca Mountain to its mid-drainage area. Estimated floodwater values for both washes are:

	Water depth (meters)	Velocity (meters/second)
100-year flood	0.3 to 1.2	1.2 to 2.4
500-year flood	0.9 to 3.0	1.5 to 3.3
	(Channel breached in several places)	
Regional maximum flood	1.5 to 3.7	2.1 to 4.9
	(All flat-fan areas inundated)	

- Yucca Wash is an incised channel approximately 14 meters deep and 240 meters wide at its confluence with Fortymile Wash. The estimated values of the 100-year, 500-year, and regional maximum floods indicate that the flow would stay within the steep side slope stream banks of the floodplain. Estimated flood water depths and velocities in the stream channel are:

	Water depth (meters)	Velocity (meters/second)
100-year flood	0.9 to 1.5	1.5 to 2.7
500-year flood	1.5 to 2.7	2.4 to 3.7
Regional maximum flood	2.7 to 7.0	2.7 to 6.7

Subpart B of 10 CFR 1022 requires that the project description of the floodplain assessment delineate "high hazard areas" and discuss the nature and extent of the potential hazard associated with high hazard areas. Subpart A of 10 CFR 1022 defines high hazard areas as "...those portions of

riverine and coastal floodplains nearest the source of flooding which are frequently flooded and where the likelihood of flood losses and adverse impacts on the natural and beneficial values served by floodplains is greatest." There are no areas at Yucca Mountain that are frequently flooded. There are no permanent structures or dwellings in the vicinity of Yucca Mountain to be lost to flooding. There are no unique or special biologic, agronomic, or hydrologic features, such as wetlands, prime farmland, or alluvial valley floors, associated with the floodplains at Yucca Mountain. Therefore, the natural and beneficial values served by the "floodplains" at Yucca Mountain are minimal, if any exist at all. It is, therefore, concluded that high hazard areas do not exist in the Yucca Mountain area.

4.0 FLOODPLAIN EFFECTS

According to 10 CFR 1022.12(a)(2), a floodplain/wetlands assessment is required to discuss the positive and negative, direct and indirect, and long- and short-term effects of the proposed action on the floodplain. Also, the effects on lives and property, and on natural and beneficial floodplain values, shall be evaluated. The floodplain assessment evaluates the potential environmental effects from those site characterization activities on floodplains at the location of the activity and on downstream flood-prone areas. The effects on floodplains due to characterization activities will be localized and short-term. The primary impact to those areas of probable inundation by runoff resulting from a 100-year storm event will be from surface-disturbing activities associated with the construction of structures and facilities needed to support site characterization.

As illustrated on Plate 1, the majority of surface disturbances and construction activities will not occur in areas delineated as floodplains. The primary source of potential effects to floodplains will be disturbances associated with construction and upgrading of access roads.

In addition to access roads, some excavation and fill activities will likely occur in and along the dry washes designated as floodplains. The proposed action, as described in Section 2.0 and depicted on Plate 1, will not result in re-routing flows in the dry washes that presently convey runoff from Yucca Mountain.

Surface-based investigations are relatively small-scale, temporary activities for which construction of permanent structures or facilities is not necessary. Any structures and facilities that are constructed to support surface-based investigations will be decommissioned and reclaimed following the completion of investigations. Total surface disturbance in floodplains resulting from surface-based investigations, which include construction of trenches, dirt roads, and drill pads, is estimated to be approximately 74 acres of previously undisturbed land (DOE, 1991a).

Surface structures and facilities that are constructed to support the ESF will be larger in area and utilized for a longer time period than surface-based investigation facilities. The structures and facilities that support the ESF will also be decommissioned and reclaimed upon completion of their intended purpose. Few ESF construction activities will occur in areas delineated as floodplains (see Plate 1). As stated in Section 1.0, this design is primarily a result of considering the PMF in locating the ESF and its associated facilities. ESF construction activities that will occur in the 100-year floodplain are limited to a small portion of the excavated materials conveyer belt (less than one quarter of an acre), a small portion of the potential Drillhole Wash borrow area (approximately 3.5 acres), and new access road construction (approximately 2.5 acres). Both the north and south portal areas, and their surface support facilities, are located at elevations above the 500-year, or critical action, floodplain. Total surface disturbance to floodplains associated with the ESF is estimated to be approximately 6 acres.

The direct effect on areas of probable inundation due to surface-disturbing activities is the removal of vegetation and soils from both the floodplain-designated areas and from drainage basins that add runoff to the washes and lowlands that comprise the floodplains. The removal of vegetation and native soils has the potential of increasing runoff velocities and erosion, which would increase suspended materials in runoff water and eventual deposition in the floodplain washes. The potential impacts of increased runoff, erosion, and sedimentation can be mitigated through construction and use of runoff control diversions and erosion control structures and practices. These are addressed in Section 5.0.

The removal of vegetation and soils, through both construction activities and erosion, has the potential to directly affect wildlife habitat at Yucca Mountain. The most significant, current wildlife concern in the Yucca Mountain vicinity is the status of the desert tortoise, officially designated as "threatened" by the U. S. Fish and Wildlife Service (USFWS) in April of 1990. After formal consultations with the DOE (in compliance with the Endangered Species Act), the USFWS declared on February 9, 1990, that site characterization activities are not likely to jeopardize the continued existence of the species. Providing that certain stipulations protecting the tortoise are observed, the DOE may proceed with its proposed site investigations. Procedures for protecting the desert tortoise are stipulated in the Biological Opinion (USFWS, 1990).

Surface disturbance and erosion also have the potential to directly affect cultural resources that may be present in the floodplain areas. The Desert Research Institute has conducted an intensive archaeological survey of

areas likely to be disturbed by site characterization activities (Pippin, 1984). Two sites containing significant cultural resources were identified in Drillhole Wash. Both sites have been collected in consultation with the State Historic Preservation Officer, and surface-based investigations will proceed under the provisions of a Programmatic Agreement with the Advisory Council on Historic Preservation (DOE, 1988c).

Potential indirect impacts of proposed activities on flora and fauna include increased fugitive dust emissions, elevated noise levels, and increased human activities associated with construction of structures and facilities. The Yucca Mountain EA (DOE, 1986) considered the impacts of all site characterization activities and concluded that construction emissions would not be expected to create adverse air quality effects; no significant long-term noise impacts to wildlife are anticipated; and wildlife displaced by human activities would probably return once the activity has ceased. Since the same type of site characterization activities that will take place in the floodplain are included in the EA evaluation, it is apparent that such activities would not be expected to make a significant contribution to overall indirect impacts.

Since all structures and facilities associated with site characterization will eventually be decommissioned and reclaimed, no long-term effects are anticipated. There are no perennial sources of surface water at or downstream from Yucca Mountain that could be impacted by the proposed action over the long-term. The EA also found that neither the quality nor quantity of groundwater would be affected significantly over the long-term by site characterization activities (DOE, 1986).

Positive effects from the proposed action may result from integrating the use of runoff and erosion control measures into the construction of site characterization support structures and facilities, which would have the potential of decreasing localized flow velocities and erosion. Examples of localized decreases in flow rates include construction of roads across washes, which will restrict and slow flow rates, and excavation of the borrow area, which will result in a wider and flatter drainage channel resulting in slower flow rates. Localized decreases in flow rates will also result in localized increases in sedimentation, which could result in deeper soils with the potential of increasing vegetation growth. This could result in an indirect positive effect on flora and fauna.

The nearest population center to Yucca Mountain is approximately 12 miles downstream. In contrast to storms in less arid regions, the majority of desert storms are quite localized, and the resulting high-velocity flood waters tend to slow substantially once downstream of the affected tributaries. The load-bearing capacity of the water diminishes rapidly, and rocks, gravel, and silt are generally deposited before damage and siltation can occur much beyond the confluences of the contributing waterways. Also, long-time residents of the west understand desert storms sufficiently to avoid construction in or near washes. Therefore, it is highly unlikely that disturbances to the floodplain at Yucca Mountain will affect lives and property downstream.

The potential exists for flood waters resulting from a 100-year storm event to affect site characterization support structures and facilities that are constructed in the floodplain. The potential for such effects will be

minimized through the use of runoff control measures, described in Section 5.0. If the structures and facilities (e.g., powerline poles or access roads) are affected by a 100-year flood, necessary repairs will restore all functions as needed, until eventual decommissioning and reclamation occur.

Based on the descriptions of the existing environment in Section 3.0, no natural and beneficial values exist as a result of Yucca Mountain Floodplains that have the potential of being effected by the proposed action.

5.0 MITIGATION MEASURES

According to 10 CFR 1022.12(a)(3), "measures that mitigate the adverse effects of actions in a floodplain or wetlands, including but not limited to minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas shall be addressed." This section addresses the measures that will be considered and, where necessary and feasible, implemented during surface-based investigations and construction of the ESF for the Yucca Mountain Site Characterization Project (YMP) to mitigate impacts to disturbed areas in the floodplain and to areas potentially disturbed downstream.

5.1 GENERAL SITE MITIGATION

The DOE has identified those environmental resources that have the potential of being adversely impacted by site characterization activities, and has developed measures to monitor and mitigate significant impacts. The environmental resources and monitoring and mitigation measures are described in the YMP Environmental Monitoring and Mitigation Plan (EMMP)(DOE, 1988d). The primary method for monitoring potential impacts is the pre-activity survey, which is conducted prior to approving the initiation of each proposed activity. These pre-activity surveys establish that proposed work will not adversely impact biological or archaeological resources.

In the event that a proposed activity is found to pose a significant threat to a biological or archaeological resource, and modification or

relocation of the activity cannot be accomplished without loss of essential data and information, appropriate mitigation measures, as described in the EMMP, are developed. Site-specific mitigation measures developed from pre-activity surveys of individual locations are incorporated into the design of the activity.

5.2 FLOOD CONTROL

Mitigation measures adopted to prevent adverse effects from heavy rainfall events (e.g., flooding, erosion, sedimentation) include constructing diversion channels to direct water away from areas subject to flooding and erosion, installation of rip-rap to support slopes or access roads, and construction of berms around activity sites to prevent inundation from runoff floodwater.

These mitigation measures will be incorporated into a site drainage system design to protect the site against potential floodwater, control runoff, and minimize erosion. Drainage ditches will be constructed to contain and route runoff associated with a 100-year storm event. The grades of ditches will conform to the general slopes of the existing topography to the extent practical to minimize scouring and erosion. Reduced gradients and rip-rap protection will be used, where necessary, to further minimize scouring and erosion in channels and ditches. Pads that are constructed to support surface facilities and structures will be sloped at 2 to 3 percent grades away from facilities to allow precipitation to run off. Fill slopes will be compacted with maximum slopes constructed at 2 horizontal to 1

vertical (the portal pad fill slopes are designed at 3 to 1). Drop culverts will be installed where necessary to prevent slope erosion. Access roads will be constructed to prevent excessive ponding of water (i.e., water will not accumulate to more than a 6-foot depth) to prevent flash flooding. Culverts will be installed in roadways where necessary to convey runoff.

5.3 RECLAMATION

Reclamation guidelines will be incorporated into the design criteria for each activity (including the ESF) to mitigate potential adverse, long-term effects that might occur once the site characterization activity has been completed. The Reclamation Implementation Plan (RIP) (DOE, 1991c) provides detailed, technical descriptions of planned reclamation guidelines and the methods for implementing those guidelines during and after site characterization. Reclamation (i.e., site restoration/revegetation) guidelines in the RIP have been developed for each activity associated with both YMP surface-based investigations and the ESF. Reclamation guidelines include removal and salvage of topsoil (or topsoil-like material) prior to disturbance, stabilizing and protecting soil resources and the disturbed site from erosion, dismantling and removal of structures and facilities (including plugging boreholes, ripping up pavement and compacted aggregate from roads, as appropriate), grading areas to approximate original drainage patterns, ripping to alleviate compaction, replacement of stockpiled topsoil, and revegetation.

The objective of the DOE reclamation program, as described in the Reclamation Program Plan (RPP) (DOE, 1989), is to return land disturbed by site characterization activities to a stable ecological state with a form and productivity similar to the predisturbed state. Based on this objective, all activities, structures or facilities occurring in floodplains will be dismantled, removed and reclaimed to its approximate original state. Final reclamation of disturbances to floodplains should eliminate any long-term adverse effects.

Final reclamation activities at each disturbed area will commence with the completion of the activity. The life-time of the ESF is dependent on whether or not the Yucca Mountain site, after site characterization, is deemed suitable for construction and operation as a repository for the permanent disposal of high-level radioactive waste. If the site is deemed suitable, the ESF will be incorporated into the design and operation of the repository, and thus, the structures and facilities would not be decommissioned and reclaimed until the repository is closed. If the site is deemed unsuitable, the ESF would be decommissioned and reclaimed upon the completion of site characterization. A third option for ESF structures and facilities would involve an alternative use by the land management agency on which the structure or facility is located. The use of the ESF in the operation of a repository or for an alternative use will require a separate floodplain assessment, since this assessment is limited only to site characterization activities (i.e., surface-based investigations and the ESF) at Yucca Mountain. Field compliance inspections will be conducted to verify that the activities are located and performed in accordance with the design

requirements and criteria developed during preactivity surveys. Adherence to the reclamation guidelines and compliance with the RIP will also be verified.

6.0 ALTERNATIVES

According to 1022.12(a)(3), alternatives to the proposed action are to be addressed. Alternatives for site characterization, location of surface-based investigations, the ESF location, and the no action alternative are discussed in this section.

Site characterization activities are necessary to obtain geologic, hydrologic, and meteorologic information to determine the adequacy of a site to meet the performance and siting requirements for an underground repository for high-level nuclear waste. Based on current understanding, data to be generated from the proposed surface-based testing and underground testing in the proposed ESF are necessary to adequately assess the performance of the Yucca Mountain site as a potential repository. Alternatives regarding the type of testing, numbers of tests, or testing activities are beyond the scope of this assessment. The performance assessment program for the Yucca Mountain site is discussed in Section 8.3 of the SCP (DOE, 1988b). Planned site characterization activities and potential performance impacts are discussed in Section 8.4 of the SCP. The alternatives addressed in this assessment are limited to discussions concerning the locations of activities, and will not address alternatives such as conducting only surface-based or underground testing versus both surface-based and underground testing.

6.1 ALTERNATIVE LOCATIONS FOR SITE CHARACTERIZATION

The Yucca Mountain EA (DOE, 1986) describes the process whereby Yucca Mountain was selected as one of several possible sites for a nuclear waste repository. The 1987 Amendments to the Nuclear Waste Policy Act modified the site-selection process by selecting Yucca Mountain as the only site to be characterized. Consequently, no alternative sites for site characterization were evaluated.

6.2 ALTERNATIVE LOCATIONS FOR SURFACE-BASED INVESTIGATIONS

The locations of proposed surface-based investigations shown on Plate 1 are tentative for many activities. Final locations need to be verified in the field by the responsible principle investigator, and in some cases, activity locations are dependent on data that will be collected from as yet completed investigations. Therefore, alternative locations at Yucca Mountain will be considered for each proposed surface-based investigation if preactivity surveys reveal that the activity might adversely affect the floodplain (e.g., the proposed location of a borehole may require construction of a drillpad in the floodplain). If it is possible to relocate an activity that is proposed in an area designated as a floodplain without causing an adverse impact to performance assessment and/or other resources, the activity will be relocated in order to minimize adverse impacts to the floodplain and downstream areas.

It should be noted that proposed locations for planned surface-based investigations are dependent on performance assessment and/or siting information needs, which place constraints on the location of activities. For example, three boreholes to be drilled in Fortymile Wash are intended to obtain infiltration and percolation measurements to be used in the Fortymile Wash recharge study. (Fortymile Wash is considered to be the major source of groundwater recharge in the Yucca Mountain vicinity.) The location of these boreholes are within the Fortymile Wash "floodplain" (i.e., the area of probable inundation due to runoff in Fortymile Wash from a 100-year storm event). Relocating these boreholes outside the floodplain would have a significant impact on the intended use of data. Therefore, it may not always be possible to relocate an activity in order to minimize potential affects to the floodplain. Where information needs eliminate the possibility of relocating the proposed activity, flood control mitigation measures (as described in Section 5.2) will be employed to mitigate short-term impacts, and disturbances will be reclaimed (as described in Section 5.3) to mitigate long-term impacts.

It is also possible that an alternative location may be desirable from the standpoint of protecting floodplains but may be unsuitable due to conflicts with other resources. Certain special resources (e.g., desert tortoises and their habitat, kit fox dens, Native American artifacts) are of such significance that their presence automatically initiates a consideration of alternative actions. These resources, and the protocol for making decisions that affect them, are discussed in the EMMP (DOE, 1988d). Situations involving such sensitive resources will be evaluated on a site-by-

site basis, and the alternative creating the least adverse impact, while enhancing long-term ecological stability, will be selected.

6.3 ALTERNATIVE LOCATIONS FOR THE ESF

The proposed ESF location, configuration, and method of construction were selected based on a comparative evaluation of ESF-repository design options that identified and rank-ordered 34 ESF-repository options. This evaluation, led by Sandia National Laboratories, was performed for the DOE Yucca Mountain Site Characterization Project Office and is described in the Exploratory Studies Facility Alternatives Study: Final Report (Sandia, 1991). The ESF alternatives study was performed in response to objections raised by the U.S. Nuclear Regulatory Commission and the Nuclear Waste Technical Review Board (an independent oversight committee) regarding various features of the ESF, described in the SCP. These objections led to a systematic evaluation of alternative design options. A criterion considered in this comparative evaluation was potential impacts from flood events. Technical specialists used existing PMF magnitudes and associated inundation maps (from Bullard, 1986) to evaluate potential impacts from a worst possible case flood scenario. Other criteria were also used in the comparative evaluation including, but not limited to, performance assessment, potential impacts to the repository horizon, mining technologies, and cost. The proposed location, configuration, and method of construction was the number one-ranked option.

Alternative locations will be considered for individual ESF structures and facilities if pre-activity surveys reveal that the structure or facility might adversely affect the floodplain. If it is possible to relocate the structure or facility without causing an adverse impact to the functional design of the ESF, the structure or facility will be relocated. If not, flood control measures will be included in the design of the structure or facility.

6.4 NO ACTION ALTERNATIVE

Since the proposed action is to conduct site characterization activities at Yucca Mountain, the no action alternative would result in no further site characterization at Yucca Mountain. Selection of the no-action alternative would avoid impacts to the floodplain associated with construction activity. However, the positive aspects of taking no action are considered small when compared to the benefits of the proposed action (i.e., obtaining sufficient scientific data to determine the suitability of the site for a repository). The consequences of the no-action alternative are very significant and include non-compliance with the Nuclear Waste Policy Amendments Act.

6.5 PROPOSED ACTION ALTERNATIVE

The proposed action alternative is not expected to cause any significant adverse effects to floodplains, people, or property. The design of the proposed facilities and structures will incorporate mitigation measures, such as runoff and erosion controls, to minimize the potential for adverse impacts

to floodplains. Any effects to floodplains are considered localized, short-term effects, which will be mitigated over the long-term by reclaiming all sites following completion of their intended purpose. Design plans will also incorporate measures to ensure that operational safety is not compromised. Biological and archaeological surveys will be conducted prior to commencement of any surface-disturbing activities. These surveys will include identification of any threatened, endangered, or special-interest plant or animal species, as well as designation of sensitive and/or unique areas.

7.0 CONCLUSIONS

This document was prepared in compliance with 10 CFR 1022 in order to assess effects on floodplains based on cumulative impacts of surface-based investigations and the exploratory studies facility (ESF) for the Yucca Mountain Site Characterization Project in Nye County, Nevada.

Dry washes and bordering areas at Yucca Mountain are considered to be floodplains based on the probability of inundation due to runoff water from 100-year and 500-year floods. However, there are no "high hazard areas", as defined in 10 CFR 1022.

Impacts to floodplains from surface-based investigations are expected to be insignificant and of short duration (DOE, 1991). Although the ESF consists of facilities and structures that will be utilized over a longer time period, the overall impacts to floodplains from the ESF are also expected to be insignificant.

The majority of disturbances associated with the ESF will be located in areas outside (i.e., above) the probable area of inundation associated with the runoff from a 100-year storm event. When facilities are located within areas of probable inundation by runoff from a 100-year storm event, appropriate and adequate mitigation measures will be implemented. Since all structures and facilities associated with site characterization will eventually be decommissioned and reclaimed, no long-term effects are anticipated (DOE, 1986).

Based on this assessment, the cumulative impacts of the proposed project on floodplains in the Yucca Mountain area will be insignificant and/or mitigated to a level of insignificance. It is, therefore, concluded that the proposed action, as analyzed in this document, will adequately protect the floodplain environments.

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