DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND SOUTHWEST
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

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Ser RES.CH/466
13 Aug 08

From: Commanding Officer, Naval Facilities Engineering Command Southwest
To: Mrs. Roxie C. Trost, Field Manager, United States Department of the Interior Bureau of Land Management

Subj: APPLICATION FOR WITHDRAWAL OF PUBLIC LANDS

Ref: (a) 43 U.S.C. Section 155
(b) BLM Instruction Memorandum No. 2001-030 Nov 8, 2000 with change 1 Jan 23, 2002
(c) Identified Mineral Resources of the Needles 1X2 Map Quadrangle, California (USDI, Bureau of Mines Mineral Land Assessment Open File Report 14-93) pages 42-63, and 74-81

Encl: (1) Maps
(2) Legal Descriptions
(3) Geology and Minerals of the Proposed Twentynine Palms Marine Corp Expansion Area
(4) Geology of the Amboy Crater Area
(5) Geology of the Bristol Dry Lake Area

1. In accordance with references (a) and (b), priority processing of this application is requested in the interest of Homeland Defense and the War on Terrorism.

2. The Department of the Navy requests to withdraw approximately 421,270 acres of land, known as the Western, Southern, and Eastern expansion areas from the Public Domain on behalf of the Department of the Navy, United States Marine Corps for use as a military training range by the United States Marine Corps.

3. National defense requirements are rapidly evolving in response to changing world conditions, the Global War on Terrorism, developing technologies, and new emerging threats. Marine Corps doctrine, operational and tactical requirements, and the introduction of new weapons systems, such as the MV22 Osprey and the Joint Strike Fighter, are also evolving to respond to the requirements. The Department of the Navy's public land withdrawal request supports Marine Corps military training requirements. Included is land essential to accomplish Marine Expeditionary Brigade (MEB) sustained, combined arms live-fire and maneuver training.

4. The Department of the Navy will promptly notify the Bureau of Land Management if new developments change the stated purpose of this request requiring a new or revised withdrawal request. We will also notify the Bureau if the acreage proposed for withdrawal is not needed.

a. Name and Address of Applicant [43 CFR § 2310.1-2(c)(1)]; [Engle Act Section 3(1)].

(1) Name and address of person delegated the authority to file the application. Mr. David Bixler, Naval Facilities Engineering Command Southwest (NAVFAC SW), Real Estate Section, 937 Harbor Drive, San Diego, CA 92132; phone (619) 532-1104, email david.b.bixler@navy.mil.

(2) Name and address of using agency. United States Marine Corps, Marine Corps Installations West, PO BOX 555246, Camp Pendleton, CA 92057; and, Marine Air Ground Combat Center, Marine Air Ground Task Force Training Command, Box 788100 Bldg 1554, MCAGCC, Twentynine Palms, CA 92278.

(3) Name, address, and phone number of primary point of contact for all aspects in preparing and processing the application. Mr. Joseph Ross, Box 788106 Bldg 1554 Rm 138, MCAGCC, Twentynine Palms, CA 92278; phone (760) 830-7683, email joseph.ross@usmc.mil.

b. Statement of Designation and Delegation of Authority [43 CFR § 2310.1-2(c)(2)]. Secretary of the Navy (SECNAV) Instruction 11011.47A assigns responsibility and delegates authority to carry out Department of Navy policy for the acquisition, management, and disposal of real property and real property interests. Authority to accomplish real estate actions is delegated to the Commander, Naval Facilities Engineering Command (COMNAVFACENGCOM). Navy Manual P73 has procedural guidance and requirements for various real estate actions, including withdrawal application preparation and proposed legislation development. For this specific project, the geographic Facilities Engineering Command (FEC) is Naval Facilities Engineering Command, Southwest (NAVFAC SW) in San Diego, California.

c. Administration by agency other than the Department of the Interior [43 CFR § 2310.1-2(c)(3)]. All public lands subject to this application are under the administration of the Department of the Interior and are additive to those currently withdrawn by Public Land Order 985 of 30 July, 1954, and Public Land Order 1860 of 30 May, 1959. Public Land Order 985 enlarged and amended the earlier orders of the Secretary of the Interior of 7 January, 1942 and 17 April, 1942 that established, and subsequently amended, Air Navigation Site Withdrawal No. 174.

d. Type of withdrawal action requested [43 CFR § 2310.1-2(c)(3)]. The Department of the Navy requests the withdrawal of public lands from all forms of appropriation under public land laws including mining and mineral leasing laws, and the transfer of jurisdiction (pursuant to 43 CFR § 2310.3-6).

e. Location of the area involved [Engle Act Section 3(3)]. The area to be withdrawn is located in San Bernardino County, California. Enclosure (1) contains maps of the proposed withdrawal areas. Enclosure (2) provides the delineated legal location of the proposed withdrawal areas which will be formally described with BLM assistance.

f. Gross land and water acreage within the exterior boundaries of the requested withdrawal and legal descriptions [43 CFR § 2310.1-2(c)(5)]; [Engle Act Section 3(3)].

(1) The entire land area contains approximately 421,270 acres of land of which approximately 341,400 acres are BLM-managed public lands. A map of the proposed withdrawal area is provided in enclosure (1).

(2) There are no surface water areas within the requested withdrawal area with the exception of some dry lake beds and ephemeral streams.

(3) The legal description for the entire land area that falls within the exterior boundaries of the affected area is provided in enclosure (2).

(4) The acreage of all non-Federal lands, which could return to Federal ownership or be acquired and become subject to withdrawal are as follows:

(a) Private lands: approximately 75,780 acres

(b) State lands: approximately 6,820 acres

(c) The legal description of the private and state lands within the exterior boundaries of the area that will be excepted from the requested action is provided in enclosure (2).

g. Overlapping or existing withdrawals [43 CFR § 2310.1-2(c)(6)]. This withdrawal does not overlap any existing withdrawals, however; the proposed withdrawal would add approximately 421,270 acres to the 598,235 acres that are currently withdrawn by Public Land Order 985 of 30 July, 1954, and Public Land Order 1860 of 30 May, 1959.

h. Public Purpose or Statutory Program (43 CFR § 2310.1-2[c][7]).

(1) Withdrawal of this area is necessary to support national security objectives and provide for public safety within the context of Homeland Defense and the War on Terrorism. The withdrawal will support an emerging enduring requirement to provide realistic integrated training to Marine Expeditionary Brigade (MEB) sized Marine Air Ground Task Forces (MAGTFs), the Marine Corps' premier force for responding to smaller scale contingencies. Effective training of MEBs is critical to ensuring the full spectrum of military operations, particularly in the area of smaller scale contingencies which are so prevalent today and expected to continue into the foreseeable future, can be realized.

(2) Specific purposes for which the lands will be withdrawn are maneuver training; weapons firing; aerial gunnery; rocketry and ground support; range impact areas; electronic warfare and countermeasures training; explosives ordnance disposal training; improvised explosive device training; forward operating base activities; forward arming and refueling point activities; combat logistics support training; convoy operations; research, development, test, and evaluation; and other training and exercise activities along the training continuum that contribute to safely conducting integrated Marine Air Ground Task Force live fire and maneuver exercises. The withdrawal of these lands for military use is necessary to support this training.

(3) Unless legislated otherwise, an analysis of the manner in which the lands, including their natural and cultural resources, would be used to implement the withdrawal's purpose will be provided in the form of an Environmental Impact Statement (EIS). It is fully expected that lands and resources added to the existing withdrawn area would be managed with the same high degree of environmental stewardship in accordance with the MCAGCC's updated Integrated Natural Resources Management Plan.

i. Extent lands embraced in the application are to be withheld [43 CFR § 2310.1-2(c)(8)]. The Department of the Navy requests that the lands included in this application be segregated from settlement, sale, entry or location under the public land laws, including the mining laws and mineral leasing laws, and subject to valid existing rights, until Congress takes action on the proposed withdrawal. Extensions or renewals of the 2-year segregation period allowed by regulation at 43 CFR 2310.2(a) may be required. During the segregated period, the lands would remain under BLM jurisdiction and temporary land use authorizations could be allowed at the discretion of the local BLM field office manager and with the concurrence of the Executive Steering Committee, Land Acquisition / Airspace Establishment. Points of contact are shown in paragraph 3.o. of this application.

j. Type of temporary land use that may be permitted during the segregation period [43 CFR § 2310.1-2(c)(9)]. Licenses, permits, cooperating agreements, and discretionary land use authorizations, may be allowed during the segregative period

with the approval of the local BLM field office manager and with the concurrence of the Commanding General, MCAGCC Twentynine Palms. Points of contact are shown in paragraph 3.o. of this application.

k. Explanation why neither a right-of-way, nor cooperative agreement would adequately provide for the proposed use [43 CFR § 2310.1-2(c)(10)]. Safety is the primary reason for the proposed withdrawal. In the case of this area, a land withdrawal is the BLM's only authorization option that satisfies the Navy's and MCAGCC's requirements for safety and control of access to the lands. Military testing and training activities performed at the area cannot be statutorily accommodated under either a FLPMA right-of-way or a cooperative agreement. The Interior Board of Land Appeals has found that military training on BLM-managed lands is appropriately authorized by a withdrawal in the case of UXO contamination and BLM policy reflects that finding.

l. Duration of Withdrawal [43 CFR § 2310.1-2(c)(11)]; [Engle Act, Section 6]. The Navy is applying for a 25 year withdrawal of the area from the date enacted by Congress unless Congress deems it appropriate to withdraw the land for a longer timeframe.

m. Availability of alternative sites [43 CFR § 2310.1-2(c)(12)].

(1) In order to determine which regional area could best support MEB training, the Center for Naval Analyses (CNA) analyzed three regions within the Continental United States (CONUS): Middle Atlantic Coast (Morehead City, Cherry Point, Camp Lejuene, Ft. Bragg, Ft. AP Hill), Gulf of Mexico (Pensacola, Eglin MTRFB, Ft Polk, Avon Park), and Southwest CONUS (San Diego, Camp Pendleton, 29 Palms, Yuma). The resulting CNA report (completed in December of 2004) concluded the following:

(a) Existing Mid-Atlantic and Gulf of Mexico ranges required significant use of non-Marine Corps ranges, representational forces, and simulation support.

(b) Existing SW CONUS ranges were most supportive of MEB training but distributed operations and representational units would still be required unless the MCAGCC, Twentynine Palms expanded enough to support realistic, integrated live fire training for the required three battalion task force MEB.

(2) The Marine Corps will not further consider existing Mid-Atlantic and Gulf of Mexico ranges for the required MEB-level training due to inadequacy of the ranges to support maneuver training of a three battalion task force MEB and the prohibitive costs associated with rendering these areas usable for MEB-level training. The Marine Corps will study the possibilities of expanding MCAGCC, Twentynine Palms because expanding MCAGCC, Twentynine Palms is the only reasonable and feasible option.

(3) A land use requirements study (LURS) completed in July of 2005 investigated the adequacy of available training lands at the MCAGCC to support a MEB live-fire, combined-arms exercise program and the requirement for any additional training land and airspace to support such a training program. The LURS study was guided by the Required Capabilities Document (RCD – quantifies the land, air, and sea-space required to conduct MEB training), the MCAGCC "Training and Exercises 2015," and the Marine Corps' Training and Education Command's "MEB Training Transformation Campaign Plan." The LURS concluded that in order for the MCAGCC to support mission-essential live-fire and maneuver training of MEB-sized units, contiguous expansion of the training lands is necessary.

(4) The Marine Requirements Oversight Council's review of the analysis of the alternatives, as derived from the CNA study and LURS, determined that there were no suitable geographic or technical alternatives to expansion at the MCAGCC in Twentynine Palms and approved initiation of an expansion project at Twentynine Palms with subsequent approval by the ASN (I&E). Shortly thereafter, a request for a waiver to the Secretary of Defense land acquisition moratorium memo was submitted to the Office of the Secretary of Defense (OSD) in February of 2007. In June of 2007 the USD (AT&L) at OSD granted the waiver allowing the project to begin execution with already appropriated funds.

n. Statement of Water Requirements [43 CFR § 2310.1-2(c)(13)]; [Engle Act, Section 3(8)].

(1) The Marine Corps will need to control, appropriate, distribute or use water where current, valid existing rights have been acquired by the United States or others in conformity with State laws and procedures. The acquisition of rights to the use of water will be in conformity to state laws and procedures relating to the control, appropriation, use and distribution of water insofar as such laws and procedures are applicable to the United States.

Regarding the Marine Corps' use of the proposed western expansion area, coordination will take place with the applicable water agency and watermaster during the planning and analysis process. This includes the Mojave Water Agency, created in 1960 to manage the region's water resources to ensure a sustainable supply of water for present and future use, at 22450 Headquarters Drive, Apple Valley, CA, 92307; phone (760) 946-7000. The Mojave Basin Watermaster at 13581 John Glenn Road, Apple Valley, CA, 92307, phone (800) 254-4242, will also be consulted.

(2) Regarding the proposed southern expansion area, the Local Agency Formation Commission for San Bernardino County indicates that the Marine Corps' area of interest falls within a sphere of influence for the Twentynine Palms Water District. Government Code Section 56076 defines a sphere of influence as "a plan for the probable physical boundaries and service area of a local agency, as determined by the commission." It is

an area (defined by a planning boundary) within which the water district may expand, over an undefined period of time, through the annexation process. As a result of this, the Marine Corps will coordinate its planning and analysis efforts with the Twentynine Palms Water District to solicit their input and involvement on compatibility with their respective general plans. Twentynine Palms Water District is located at 72401 Hatch Road, Twentynine Palms, CA, 92277; phone (760) 367-7546.

(3) The primary usage of water within the Eastern expansion area is in conjunction with the liquid calcium chloride mining operations in the vicinity of Bristol dry lake. Consultation with the Twentynine Palms Water District indicated there was no regulating authority over water use rights in this area.

o. Location of Application Records (43 CFR § 2310.1-2[c][14]). Points of contact and documents pertaining to this withdrawal will be available for examination at the following locations:

Joe Ross
Range Expansion Program Manager
Bldg 1554, Room 138
MCAGCC, Twentynine Palms CA 92278
760-830-7683

Roxie Trost
U.S. Bureau of Land Management
Barstow Field Office
2601 Barstow Road
Barstow, CA 92311
760-252-6004

p. Summary of potential mineral activity in the subject area.

(1) The Barstow Field Office of the Bureau of Land Management has prepared a comprehensive report covering their jurisdiction entitled "Geology and Minerals of the Proposed Twentynine Palms Marine Corps Expansion Area," dated 30 April 2008. It thoroughly analyzes the potential mineral activity in the identified Western and Southern Expansion Areas and is attached as enclosure (3). All information presented is consistent with the BLM's West Mojave Plan.

(2) The Needles Field Office of the Bureau of Land Management has provided three documents that address potential mineral activity in the Eastern Expansion Area:

(a) Identified Mineral Resources of the Needles 1X2 Map Quadrangle, California (USDI, Bureau of Mines Mineral Land Assessment Open File Report 14-93), pp. i-ix, 42-63, and 74-81 (reference (c)).

(b) Geology of the Amboy Crater Area (encl (4)).

(c) Geology of the Bristol Dry Lake Area (encl(5)).

(3) Further, minerals management data is portrayed in the affected environment section of the *Proposed Northern & Eastern Colorado Desert Coordinated Management Plan and Final Environmental Impact Statement*, published in July, 2002 by the Bureau of Land Management, California Desert District and California Department of Fish and Game (Inland, Deserts, and Eastern Sierra Region). That plan states that "many varieties of mineral resources are present in the California Desert, including 45 different mineral commodities in the planning area. The largest mining operations are the open pit, heap leach gold mines in Imperial County and the salt extraction mines on Bristol and Cadiz playas in San Bernardino County. The former are few in number and cover a few thousand acres. The latter are many small disturbances (e.g., roads and pits) occupying 1-2 percent of each playa surface but scattered over about 15 percent of each of the two playas. While the active life of gold operations is relatively brief (5 to 15 years) - some are currently in rehabilitation phases,
the current nature and level of salt extraction is expected to remain constant for decades."

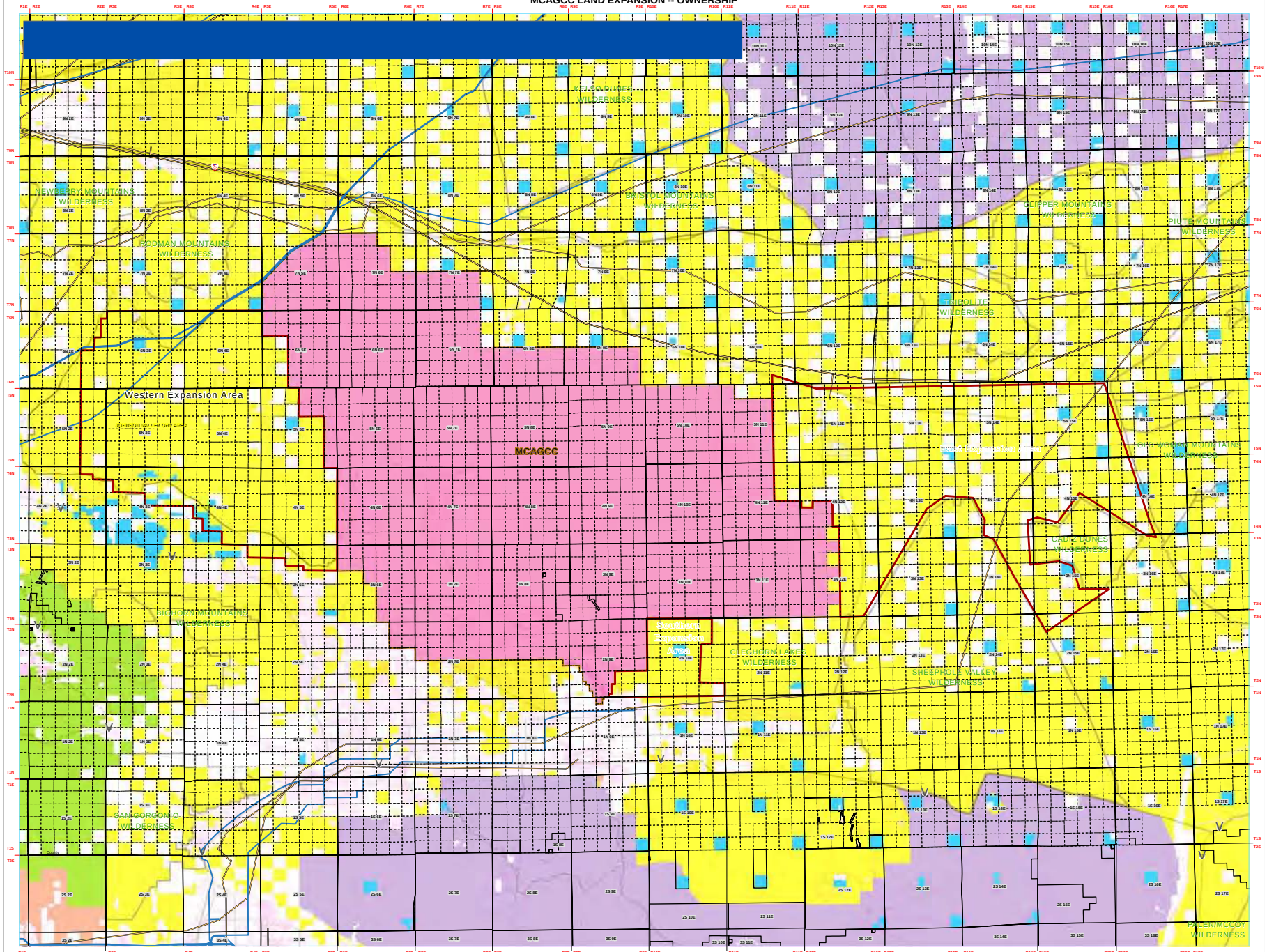
(a) Maps 3-8, 3-9, and 3-10 in that Plan's Appendix A show potential for metallic, construction, and industrial minerals in the planning area. Map 4-3 shows areas of high mineral development potential.

4. If additional information is required, please contact Mr. Joe Ross at (760) 830-7683 or by email at joseph.ross@usmc.mil.

D. B. BIXLER
By direction

Copy to:
CMC (LFL)
NAVFAC HQ (AM1)
CG MCI West
CG MCAGCC 29 Palms

SAN BERNARDINO COUNTY
MCAGCC LAND EXPANSION -- OWNERSHIP



MARINE CORPS AIR GROUND COMBAT CENTER, TWENTYNINE PALMS, CALIFORNIA

Sources:
MCAGCC/MAG/TFTC Installation Layers
created by MCAGCC GIS Office
Roads, Landmarks, Hydrology, and Urban areas
derived from ESRI Standard Data

Legend

- Expansion Areas
- Installation Boundary
- Johnson Valley OHVA
- BLM
- Forest Service
- National Park; National Preserve; National Recreation Area
- Native American Reservation
- OCD
- State
- Private
- Water
- Unknown
- Chloride Mine
- Southern California Edison Co
- Oil/Gas Pipeline
- Highway
- Major Road
- Local Road
- Major Railroad Lines

SCALE 1:175,000

0 1.25 2.5 5 7.5 10 Miles

0 2.5 5 10 15 20 Kilometers

Projection:
WGS 1984 UTM Zone 11N

Legal Description for the Proposed Military Land Withdrawal (see map for boundary delineation)

All legal locations are from the San Bernardino Base & Meridian. **Section locations indicated in bold-face have quantities of either State or Private lands.** Any Act of Congress or Public Land Order withdrawing land will make such withdrawal subject to valid existing rights. Should such existing rights interfere with the Navy's use of the lands, it will be necessary to acquire such rights through payment of just compensation.

Western Expansion Area:

T. 3N., R. 4E., Section 1

T. 3N., R. 5E., Sections 1, 2, 3, **4**, 5, 6; **Section 9, N1/2**; Section 10, N1/2; Section 10, SE1/4; Sections 11,**12**

T. 4N., R. 2E., Section 1; Section 2, N1/2

T. 4N., R. 3E., Sections **1**, 2, **3, 4**, 5, 6; Section 7, E1/2; Sections 8, 9, **10, 11, 12, 13, 14, 15**

T. 4N., R. 4E., Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, **16**, 17, **18**; **Section 19, E1/4**; Sections **20**, 21, 22, 23, 24, 25, 26, 27, **28**; **Section 29, E1/2**; Sections 34, 35, **36**

T. 4N., R. 5E., Sections **1**, 2-35, **36**

T. 5N., R. 2E., Sections **1**, 2, 11, 12, 13, 14, 23, 24, 25, 26, 35, **36**

T. 5N., R. 3E., Sections **1**, 2-8, **9**, 10-35, **36**

T. 5N., R. 4E., Sections **1**, 2-11, **12, 13**, 14-16, **17**, 18-24, **25**, 26-36

T. 5N., R. 5E., Sections 4, **5**, **6**, 7, 8, **9**, 14, 15, **16, 17**, 18, 19, 20, **21**, 22, 23, 26, 27, 28, **29**, 30, 31, 32, **33**, 34, 35

T. 6N., R. 2E., Sections 1, 2, 11, 12, 13, 14, 23, 24, **25**, 26, 35, **36**

T. 6N., R. 3E., Sections **1**, 2, 3, **4**, 5-15, **16,** 17-24, **25**, 26-30, **31**, 32-35, **36**

T. 6N., R. 4E., Sections 1-15, **16**, 17-24, **25**, 26, **27, 28**, 29-35, **36**

T. 6N., R. 5E., Sections **17**, 18, 19, 20, **29**, 30, 31, 32

Southern Expansion Area:

T. 2N., R. 9E., Sections 25, 26; Section 27, E1/2; **Section 34, NENW, SENW, NESW, SESW, SWSW, E1/2; Sections 35, 36**

T. 2N., R. 10E., Sections 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 15, **16**, 17, 18, 19, 20, 21, 22, 27, 28, 29, 30, 31, 32, 33, 34, 35, **36**; Section 14 eastward to wilderness boundary; Section 23 eastward to wilderness boundary; Section 26 eastward to wilderness boundary

Eastern Expansion Area:

(excluding all lands in the designated Sheephole Valley and Cadiz Dunes Wilderness Areas)

T. 3N., R. 12E., Sections **1**, 2, 3, 10-12, **13**, 14, 15, 22-24, **25**, 26, 27, 34, 35, **36**

T. 3N., R. 13E., Sections **1**, 2-4, **5,** 6-8**, 9,** 10-12**, 13,** 14-15**, 16-17,** 18-20**, 21,** 22-24**, 25,** 26-28**, 29,** 30-32, **33,** 34-35, **36** (excluding all designated wilderness in this township)

T. 3N., R. 14E., Sections **1,** 2-4**, 5,** 6-8**, 9**, 10-12, **13**, 14-15, **16-17,** 18-20**, 21,** 22-24**, 25,** 26-28**, 29,** 30-32, **33,** 34-35, **36** (excluding all designated wilderness in this township)

T. 3N., R. 15E., Sections **1**, 2, 3, 4, **5**, 6-8, **9**, 10-15, **16**, **17**, 18-20, **21**, 22-28, **29**, 30-32, **33**, **34**, **35**, **36** (excluding all designated wilderness in this township)

T. 3N., R. 16E., Sections 4, **5**, 6-8, 18, 19 (excluding designated wilderness in this township)

T. 4N., R. 11E., Sections 1, 2, 11, 12, **13**, 14

T. 4N., R. 12E., Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, **16, 17**, 18; **Section 19 N1/2**; **Section 21 E1/2; 22**, 23, 24, **25**, 26, 27, Section 28 E1/2; 34, 35, **36**

T. 4N., R. 13E., Sections **1**, 2-4, **5**, 6-8, **9**, 10-12, **13**, 14, 15, **16, 17**, 18-20, **21,** 22-24, **25**, 26-28, **29**, 30-32, **33**, 34, 35, **36** (excluding all designated wilderness in this township)

T. 4N., R. 14E., Sections **1**, 2, **3**, 4, **5**, 6-8, **9**, 10-12, **13**, 14, 15, **16, 17,** 18-20, **21**, 22-24, **25**, 26-28, **29**, 30-32, **33**, 34, 35, **36** (excluding all designated wilderness in this township)

T. 4N., R. 15E., Sections **1**, 2-4, **5**, 6-8, **9**, 10-12, **13**, 14, 15, **16, 17**, 18-20, **21**, 22-24, **25**, 26-28, **29**, 30-32, **33**, 34, 35, **36** (excluding all designated wilderness in this township)

T. 4N., R. 16E., Sections 6-8, **17**, 18-20, 28, **29**, 30-32, **33**

T. 5N., R. 11E., Sections **1**, 2, 3, 4, **5**, 11, 12, **13**, 14, 23, 24, **25**, 26, 35, **36**

T. 5N., R. 12E., Sections **1**, 2, **3, 4**, 5-7, **8**, 9, **10, 11**, 12-15, **16**, **17**, 18, **19, 20**, 21-27, **28**, **29, 30**, 31-35, **36**

Encl (2)

T. 5N., R. 13E., Sections **1**, 2, 3, 4, **5**, 6, 7, 8, **9**, 10, 11, 12, **13**, 14, 15, **16**, **17**, 18, 19, 20, **21**, **22**, 23, 24, **25**, 26, 27, 28, **29**, 30, 31, 32, **33**, 34, 35, **36**

T. 5N., R. 14E., Sections **1**, 2, 3, 4, **5**, 6, 7, **8, 9**, 10, **11**, 12, **13**, 14, 15, **16**, **17**, 18, **19**, 20, **21, 22, 23**, 24, **25**, **26**, 27, 28, **29**, 30, 31, **32, 33**, 34, **35, 36**

T. 5N., R. 15E., Sections **1**, 2, 3, 4, **5**, 6, 7, **8, 9**, 10, 11, 12, **13**, 14, 15, **16**, **17, 18**, 19, 20, **21**, 22, 23, 24, **25**, 26, 27, 28, **29**, 30, 31, 32, **33**, 34, 35, **36**

T. 5N., R. 16E., Sections 19, 30, 31

Encl (2)

GEOLOGY and MINERALS

Of the

Proposed Twentynine Palms Marine Corps Expansion Area

Bureau of Land Management
Barstow Field Office
4/30/08

Encl (3)

GEOLOGY AND MINERALS

Regional Geology

The study area is in the eastern portion of the Mojave Desert geomorphic province (Mojave Block) of California. Although Mesozoic-age and older rocks are present, the desert itself is a Cenozoic-age feature, formed as early as the Oligocene Epoch (23 million to 34 million years before present), presumably from movements related to the San Andreas and the Garlock faults. The eastern Mojave consists of alluvial filled basins between mountain ranges which are transitional from normal-fault-horst (up-thrown ridges)-graben (downthrown valleys) to thrust-fault-emplacement basin and ranges.

Local Geology

Overall, the mountain ranges in the proposed expansion area have a general northwest trend due to the structural control of strike-slip faults. One of these was active in 1992 when the 7.3 magnitude Landers earthquake accompanied ground rupture along the Emerson-Camprock Fault and other fault segments to the southeast.

The expansion area consists of an estimated 35 percent bedrock mountains, 60 percent gravel (alluvial) slopes, and 5 percent playas (dry lake beds). Elevations range from less than 800 meters (2,600 feet) to over 1,250 meters (4,000 feet) above mean sea level.

Rock types in the study area include Precambrian-age gneiss, Paleozoic-age marine carbonate rocks, Mesozoic-age volcanic porphyry complex and granitic rocks, and Quaternary (Pleistocene to Recent) basalt and non-marine sediments.

Mineral Potential and Development

The proposed western expansion area is in the Rodman Mountain Geology-Energy-Minerals Resource Area (GRA) of the California Desert Conservation Area. The proposed southern expansion area is in the Dale Lake GRA.

Mineral commodities that have been mined in the general area, including the surrounding area, include placer and lode (vein) gold, tungsten, iron, manganese, limestone, feldspar, borates, specialty clay, fluorspar, crushed stone, dimension stone, and volcanic cinders. Several mines within the Ord Mountains to the northwest have produced copper; however, none are active on BLM administered lands at the time of this report. The Ord Mountain Mine located in sections 13 and 24, T.7N., R.1E., SBM, along the west flank of Ord Mountain contains gold-bearing copper minerals in a discontinuous veins system. The ore bodies are discontinuous; most appear to be shallow and small. Mining claims were patented in 1884 and 1886.

There are no known producing mines on BLM administered lands within the proposed expansion area at the time of this report. There are no plans of operations for mineral

exploration within the study area. Mineral commodities that have been produced from the proposed expansion area are mentioned below:

Iron

Iron has been produced from the Bessemer mine, the New Bessemer mine, the Morris lode deposit, and the Ebony mine. The deposits are replacements in dolomite near contacts with granitic rock. The predominant mineral is magnetite but hematite and limonite are also present. Small shipments were made to Fontana and Japan, and a small tonnage was used in the cement industry (Scott & Wilson, 1980, p. 148).

Iron ore is important in the manufacture of Portland cement. It acts as a flux to lower the fusion temperature and save energy when the ingredients are heated in the rotary kiln to form a "clinker" when the fusion temperature is reached. Nearby Lucerne Valley is the center of most of the southern California cement industry, and Southern California represents about 10 percent of the nation's production of Portland cement (Waiwood, BLM mineral report, p. 9 & 10).

The Bessemer Mine is located in sections 27, 28, T.6N., R.4E., SBM, about 26 airline miles southeast of Daggett and about 16 airline miles northeast of Old Woman Springs. Pod-like bodies of magnetite were developed by open pits, shallow shafts, and tunnels. Fourteen bodies of iron oxide are exposed in an area roughly 3,000 feet long and 1,500 feet wide. Production consists of 2,000 tons in 1945 and 26,000 tons in 1951 (Bezore, et al., 1997, OFR 97-16, appendix A24). The deposit has been idle since 1954. When Thomas Dibblee prepared his report (Map I-430) in 1964, he listed the owner as Kaiser Steel Corp. These mining claims were patented in 1904. Lamey, in summarizing a survey made in 1942, estimates that the deposits contain 1,800,000 tons of ore of all grades, 30-65 percent iron, not more than 25 percent of which would be workable at normal peacetime prices.

The "New Bessemer" property, located in the SE1/4 Sec. 36, T.6 N., R.4 E., are part of a deposit that produced 4,000 tons of iron ore in 1949. Total production is not known. Ore on the property was developed from a large contact-metamorphic, tactite iron zone (Waiwood, 1994, BLM mineral report, p. 7 & 8). In 1994, when the mineral report was prepared for a proposed land exchange with the purpose of blocking up land for the Johnson Valley Off-Highway Area, approximately 62,000 short tons of iron ore were used in the manufacture of Portland cement in southern California. "Most of the ore comes from small deposits locally in San Bernardino County." (Waiwood, BLM mineral report, p. 9). According to Tom Anderson, approximately 164,000 tons of iron ore "reserves" remain on the property, with another 106,000 tons off-property. In 1994 Anderson valued the in-place mine reserves at $1.00 per ton for 70 percent Fe (iron) for a total value of iron on the property of $164,000. An estimated selling price of $25 per ton was made by Tom Anderson as cement additive (Waiwood, 1994, BLM mineral report, p. 11).

The Morris Lode Deposit, located in section 12, T.5N., R.4E., SBM, about 30 airline miles southeast of Daggett, CA. In 1949-50, the property produced 17,500 tons of ore for use by a cement company. The mining claims were patented in 1946.

The Ebony mine is actually two separate deposits. Magnetite scarn occurs along the margin of a dolomite pendant in Jurassic-age quartz monzonite (Bezore, et al., 1997, OFR 97-16, p. 32).. The more prominent deposit is 10 to 25 feet thick. It was mined from an open cut 200 feet long, 25-feet wide, and about 75 feet deep. A second deposit lies 100 feet to the southeast. It was mined from an open pit 50 feet across and 30 feet deep. Before mining, the resources were estimated to be 100,000 tons of ore containing 40 to 50 percent iron (Lamey, 1948; Moore, 1971; Dibblee, 1964, Map I-430).

Gold

Gold has been produced from vein deposits from several mines in the study area although production figures are lacking for most. Gold is often associated with copper and probably many of the copper prospects were developed in an attempt to find gold. Both the Blue Ribbon mine and Los Padres mine fall into the category of combined copper and gold deposits.

The Blue Ribbon mine is located in SW1/4 Sec. 3, SE1/4 Sec. 4, T.4 N., R.5 E., west of Emerson Lake. It consists of a group of narrow quartz stringers that contain small amounts of copper sulfides and gold reportedly in granite porphyry and worked by a 100-foot vertical shaft. The only workings seen in 1964 are along the Emerson fault, which bounds porphyritic biotite quartz monzonite to the southwest where there is a vertical zone 2 to 6feet wide of white pulverized rock altered to kaolinite along the fault, and prospected by trenches and shallow pits for half a mile (Dibblee, 1967, Map I-490). The area surrounding the Blue Ribbon mine has an above average density of mining claims and has high potential for the occurrence of gold and copper.

The Los Padres mine is at the center of projected Sec. 36, T.4 N., R.5 E., 3 miles south of Emerson Lake. A fractured quartz vein and stringers contain oxides and sulfides of iron and copper that carry gold, some in wire form, in gneiss near contact with the quartz monzonite of the Emerson Lake area to the northeast. The main vein is 2 to 3 feet wide, nearly vertical and strikes northwest. The deposit was developed from a 150-foot shaft inclined northwest and sunk on the vein, connecting with a drift adit at 50 feet, and a drift at 150 feet off a 700-foot crosscut. Drifts at these levels explored the vein for 380 feet. High-grade ore was reported from the upper workings (Dibblee, 1967, Map I-490).

At the Cumberland (High Hope)mine in SW1/4SE1/4 Sec. 25, T.6 N., R.2 E. free gold is associated with pyrite, marcasite, and hematite in a quartz vein which lies in a shear zone 1 to 3 feet wide in biotite quartz monzanite. The zone strike was explored by six shafts from 50 to 135 feet deep within 2,000 feet of the strike length and by several drifts. Ore was produced in 1939 (Dibblee, 1964, Map I-430).

At the Elsie mine in N1/2 Sec. 36, T.6 N., R.2 E. gold is associated with arsenopyrite, pyrite, and copper carbonates in a zone of quartz and iron oxides. The deposit was explored by two shafts 250 and 150 feet deep about 500 feet apart. Active in the early 1920s, output was probably appreciable. There was a small production in 1935 and 1940 and idle since (Dibblee, 1964, Map I-430).

At the Gold Peak mine in W1/2 Sec. 31, T.6 N., R.3 E. free gold is associated with pyrite in four parallel vertical north-striking veins mostly in biotite quartz monzonite. The deposit was mined from 120-foot vertical shaft with level workings at 50 and 100 feet, and from open cuts. Active in the early 1900s, reported output of more than $40,000 prior to 1914. Long been idle (Dibblee, 1964, Map I-430).

At the Red Hills prospect in SW1/4 Sec. 7, T.6 N., R.3 E. gold is erratically distributed in a vuggy, iron-stained quartz vein in contact with quartz latite with biotite quartz monzonite. The deposit was explored by two shallow shafts 200 feet apart and by 200-foot adit. Idle since 1945 (Dibblee, 1964, Map I-430).

At the Johnson mine in SE1/4? Sec. 36, T.6 N., R.2 E. gold is associated with pyrite and arsenopyrite in iron-stained quartz which lies in vertical shear zone 1 to 4 feet wide in biotite quartz diorite. The deposit was explored by a 400-foot crosscut adit and 250 feet of drifting each way along the zone. Long idle (Dibblee, 1964, Map I-430).

Copper

At the North Maumee prospects in S1/2 projected Sec. 10, T.4 N., R.5 E., west of Emerson Lake, a shear zone contains quartz and very small amounts of iron and copper sulfides in the biotite diorite on the west slope of the ridge. The deposit was prospected by an adit, driven southeast 20 feet. There is a shallow shaft a quarter of a mile southwest in a small quartz vein in the quartz monsonite (Dibblee, 1967, Map I-490).

At the Maumee prospects in S1/2 projected Sec. 15, T.4 N., R.5 E., 2 miles southwest of Emerson Lake, a vertical shear zone from 2 to 5 feet wide contains some copper and iron sulfides and possibly gold. The deposit was prospected by three vertical shafts, one more than 60 feet deep, about 300 feet apart, and by shallow trenches. There is a shallow shaft in another minor shear zone about a quarter of a mile south and two shafts in a minor shear zone half a mile southeast, all in the biotite diorite. Last active in early 1960s (Dibblee, 1967, Map I-490).

Other prospects, possibly carrying copper and gold, are located one mile southwest of Emerson Lake in Sec. 24, T.4 N., R.5 E. There are also prospects with blue copper oxides located 2 miles northeast of means Lake in NE1/4 projected Sec. 20, T.4 N., R.5 E. A shaft was noted 15 feet deep in 1964 1960s (Dibblee, 1967, Map I-490).

A copper prospect in NW1/4SE1/4 Sec. 6, T.6 N., R.4 E. was explored by shallow its in 1962. Coatings of malachite and chrysocolla occur on fracture and shear surfaces in small masses of garnet tactite which are engulfed in biotite quartz monzonite idle (Dibblee, 1964, Map I-430).

Silica

Silica resources occur in three zones of Paleozoic quartzite, one at the southern end of the Rodman Mountains, one at Red Hill to the southwest, and a zone of smaller deposits east of Red Hill (Bezore, 1997, OFR 97-16, Plate 4). Potential uses of quartzite include glass making, ceramics, and counter tops.

Roofing Granules

Roofing Granules have been produced from pre-1955 mining claims from the Green Rock mine in the Fry Mountains area in Sec. 25, T.5 N., R.2 E. The quarry site encompasses a mass of light green, very fine-grained epidote as wide as 50 feet that occurs within the contact zone between biotite quartz monzonite and a felsitic dike (Dibblee, 1967, Map I-518). The quarry has been developed by a series of open cuts, and mined material was transported down slope from the quarry to a mill site where the epidote was crushed for use as roofing granules (Taylor, 1994, OFR 94-06, p. 58). Operations ceased by 1980 partly because the deposit was becoming depleted and partly because of the declining health of the operator, Clayton Quarles.

Building Stone

Building stone was mined from about 80 acres in the S1/2 Sec. 32, T.2 N., R.10 E. in the Valley Mountain area and marketed as "Desert Mahogany" rubble stone in Yucca Valley and the Whitewater Rock stone yard in Riverside County. The volcanic rock, which is white on a fresh surface and coated with an attractive orange-brown patina, Ruble stone refers to rock that is too thick to be used as flag stone but used as decorative veneer for such things as fire places, walls, and concrete support structures for signs. The Barstow Field Office sold the stone in the 1990s for around $2.70 per ton in quantities of 25 to 70 tons. The last sale was made in 1999. The market decline may have been due to the depletion of flatter pieces of stone.

Occupancy Trespass on Mining Claims

The Kilo "gold mine" in sections. 9, T.4 N., R.5 E. contains about 80 acres trash, motor homes, inoperable vehicles, and milling equipment, all surrounded by a chain-link fence near a pit, mined prior to 1994 presumably for placer gold. A plan of operations (CACA 34346) for the mining and milling operation was originally filed in 1994 but with a change of operators in 2000. The responsible party is in noncompliance and refuses to remove his equipment and to backfill a dry well drilled for water.

Mining Claims

A review of the BLM mining claim records shows that there are approximately 469 active mining claims as of 4/30/08 in the proposed expansion area. The largest clusters of mining claims are associated with the iron deposits described above and in an area

extending south and southeast from the Blue Ribbon mine described above with the other gold deposits.

Access

The proposed boundary would cut off nearly three miles of Camp Rock Road, a maintained dirt road used by Sierra Aggregate to haul cinders to market from the Red Top cinder mine located 3 miles north of the study area.

Scientific Interest

The 1992 Landers earthquake along the Emerson-Camprock Fault and other fault segments to the southeast has generated interest among engineering geologists and seismologists. The area is a favorite field-trip study area to this day.

The main adit at the Lost Padre Mine in Sec. 36, T.4 N., R.5 E. has a highly sensitive seismograph installed by Lawrence Livermore Laboratories of Palo Alto (Vredenburgh, et al, 1981, p. 143).

Summary and Conclusion

The most important mineral resource in the proposed expansion area is iron ore with potential use as a flux additive for the manufacture of Portland cement. The larger iron deposits in southern California have been depleted and even small deposits that can be economically mined are few in number. Therefore, access to deposits such as those in Johnson Valley is of great importance to the cement companies.

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Geology of the Amboy Crater Area

The most recent eruption of Amboy Crater was approximately 10,000 years ago. Amboy crater is a mafic[1] cinder cone which is actually at least four coaxially nested cinder cones, indicating that at least four periods of "explosive" cinder eruptions occurred from the very nearly the same vent. The outer slopes of the main cone are gullied by erosion. Within the main outer cone, there is a remnant of a second cone on the west side; both cones are breached on the west. In addition to the two main cones, there are two relatively undisturbed cone walls within the main crater. These innermost cones are composed almost entirely of angular scoriaceous cinders. The cone rises 75 meters above the surrounding lava flows and is approximately 460 meters in basal diameter. It is composed of a loose accumulation of volcanic ejecta with secondary amounts of agglutinated scoriaceous tephra plus ropy, ribbon- and almond-shaped bombs.

The surrounding Amboy lava field covers an area of approximately 70 square kilometers and is composed of undifferentiated flow units of relatively dense, "degassed" pahoehoe lavas that form a hummocky terrain. The surface relief on this unit ranges from 2 to 5 meters. The flow is characterized by abundant tumuli and pressure ridges and, as is typical for this type of flow, a fractured surface. Lava tubes are not known to be present in any of the flows, a few lava channels are present. Low-lying areas on the flow are filled with windblown sediments which range from a few centimeters to more than 1 meter thick. The thickness of aeolian deposits increases toward the southwest part of the field. Sand-blasting is prevalent over the entire flow, and wind-faceted pebbles of basalt are common.

The oldest flows occur in the eastern and southeastern part of the field. They are characterized by numerous collapse depressions up to about 10 meters in diameter and several meters deep. Although the name would imply that "collapse" depressions formed by the collapse of a crust over fluid lava, at least some depressions may form as a result of inflation of an emplaced, but still plastic, crust by molten lava around a general void in the flow.

Amboy Crater is located on and divides Bristol Dry Lake into two playas, Bristol and Bagdad.

The Bristol, Cadiz, and Danby Dry Lakes are located within the Barstow-Bristol trough (also known as the Bristol-Cadiz-Danby trough), a conspicuous west-northwest trending physiographic feature which approximately straddles the boundary between the Mojave and Sonoran tectonic blocks. Mountain ranges of the seismically active Mojave block (western portion of Mojave Desert) trend northwest-southeast and are often bounded by active Quaternary faults. Mountain ranges of the seismically inactive Sonoran block (eastern portion of Mojave Desert) generally trend north-south and resulted from Tertiary tectonism with very few, if any, younger faults. The Barstow-Bristol trough appears as a major crustal structure which divides regional changes in tectonics, volcanics, seismicity,

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[1] Containing or relating to a group of dark-colored minerals, composed chiefly of magnesium and iron, that occur in igneous rocks

depth to the moho, and crustal heat flow. Tectonic extension along the northeastern edge of the Mojave block has allowed thick accumulations of playa sediments in graben-like valleys.

Undated playa sediments fill Bristol, Cadiz, and Danby Dry Lakes to depths in excess of 1007 ft., 500 ft., and 880 ft., respectively, according to core hole data collected by the USGS. The playa sediments most likely inter-finger with alluvial sediments in the subsurface around the margins of the playa deposits. In Bristol Dry Lake drilling encountered alternating beds of clay and salt with about 40% of the recovered core comprised of massive halite up to twelve feet thick. The lowest salt bed encountered was at 980 feet and is approximately 5 feet thick. In Cadiz Dry Lake several thin porous salt beds were encountered in the upper few feet with the lowest salt bed at 9 feet and one foot thick. Small quantities of gypsum were found to a depth of 400 feet in Cadiz Dry Lake. No salt was encountered in Danby Dry Lake although two intervals of crystalline gypsum were recovered, a 6 foot thick bed at 10 feet and a 210 foot thick bed at 310 feet.

Brines containing calcium and sodium chloride are found in the subsurface of both Bristol and Cadiz Dry Lakes. The brine at Danby Dry Lake contains predominately sodium chloride, but also calcium chloride at increasing concentration toward the west. Fossils indicative of shallow brackish water were recovered in core from Cadiz and Danby Dry Lakes below depths of 267 and 449 feet, respectively. A fracture or fault dipping 57 degrees was encountered in the Cadiz core at 256 feet, below which, beds were increasingly tilted from 10 to 35 degrees. A one inch thick layer of white volcanic tuff was encountered at a depth of 667 feet which could be indicative of late tertiary volcanics exposed on the surface in the surrounding area.

The playa deposits at Bristol Dry Lake have been mined for minerals since the early 1900s. Gypsum has been produced from surface deposits in several areas on the playa edges. Salt (sodium chloride) has been produced from surface deposits and occurs as interbedded massive beds up to 12 feet thick comprising approximately 40% of the playa sediments to a depth of about 980 feet. Aggregate thickness of salt beds at least one foot thick totals 142 feet and number more than 40. Both sodium chloride (NaCl) and calcium chloride (CaCl) have been and are produced from evaporation of brines. Although no attempts at production have occurred, lithium occurs in anomalous concentrations in brines and strontium occurs at varying concentrations in near surface rocks.

The high calcium chloride content of the Bristol and Cadiz Dry Lakes, and to a lesser degree western Danby Dry Lake, is unusual for playa lakes of the southern California deserts. No studies have apparently been undertaken to determine if the source of CaCl brines are derived from rocks surrounding Bristol Dry Lake or were perhaps influenced by hydrothermal fluids associated with Amboy volcanics.

Geology of the Bristol Dry Lake Area

Physiography

Bristol Dry Lake is located in the Bristol Valley of the central Mojave Desert Geologic Province in Eastern San Bernardino County, California. The northern edge of Bristol Dry Lake is approximately one mile south of the town of Amboy and approximately twenty-five miles east of the community of Ludlow. The valley is surrounded by the Bullion Mountains on the west, the Bristol, Marble, Granite, and Old Dad Mountains on the north, The Marble, Ship, and Calumet Mountains on the east, and the Calumet, Sheep Hole, and Coxcomb Mountains on the south. The greater Bristol Dry Lake was divided into two unequal portions by the lava flows and cinder cone of Amboy Crater approximately 10,000 years ago. The smaller portion known as Bagdad Dry Lake (a.k.a., Alkali Dry Lake) is located on the west and the much larger portion known as Bristol Dry Lake is located on the east.

The regional watershed which drains to Bristol Dry Lake is defined by mountain ranges and topographic divides that surround Fenner Valley, Orange Blossom Wash, and the Bristol Valley. The Fenner Valley watershed, which contributes the principal source of groundwater recharge to the area through Fenner Gap, includes all of Fenner Valley and perhaps a portion of Lanfair Valley. During past wetter climate conditions Bristol Dry Lake probably drained to Cadiz Dry Lake across a low surface drainage divide, located on the alluvial fan that formed downstream from Fenner Gap. Bristol and Cadiz Dry Lakes are located at the low points (elevations of 595 feet and 545 feet, respectively) on either side of this divide. Groundwater flow or drainage from Bristol to Cadiz to Danby Dry Lakes is suggested by calcium chloride brine chemistry decreasing in concentration across the three dry lakes.

The seasonal weather patterns of the Bristol Dry Lake area are primarily controlled by semi-permanent high and low pressure systems located over North America and the Pacific Ocean. During the summer months a semi-permanent high pressure cell (the Pacific High) centered over the Pacific Ocean, approximately 1600 miles west of the California coast, typically diverts low pressure, moisture carrying weather systems to the north of California. The Pacific High contracts and moves southward during the winter months allowing storms to cross California. Another semi-permanent high pressure cell (the Great Basin High) is centered over southern Idaho during the winter months and deflects Canadian cold low pressure weather cells to the east of the area. During the summer months a seasonal low pressure weather cell (the California Low) often develops or the Mojave Desert as a result of intense solar surface heating.

The average winter temperature for the Bristol Dry Lake area is between 50 and 55 degrees Fahrenheit (F), with the average daily maximum near 65 degrees F and the average daily minimum near 40 degrees F. The highest temperatures occur during the summer months, when the average daily temperature is more than 85 degrees F. Average

daily maximum temperatures in the summer months are typically around 100 degrees F, although temperatures in excess of 120 degrees F are not unusual. Average daily minimum temperatures during the summer months are around 70 degrees F. The daily temperature range is generally 20 to 30 degrees F. This range is greater during the summer months than during the winter months.

Most precipitation occurs during the months of November through March. However, the frequency and intensity of rainfall from year to year is unpredictable. Winter rainfall occurs in events lasting several hours to a day or more. These winter events are typically the result of frontal weather conditions, and rainfall during such events is generally steady. On average, 20 to 30 frontal systems move through the region each winter. However, most of these systems are relatively weak by the time they reach the area and have been reduced in moisture content by mountain ranges to the west. Early summer and late fall are typically periods of little rainfall. Mid to late summer rainfall is characterized by localized thunderstorms, induced by the California Low and the seasonal monsoonal weather pattern crossing Arizona. In general, summer thunderstorms deliver rain in intense bursts of short duration. These thunderstorms frequently result in flow on the major washes and occasionally result in flash flooding on the valley floor. Average annual precipitation from measured data is 3.6 inches on Bristol dry lake ranging up to approximately 12 inches in the surrounding higher elevations.

Amboy evaporation rates range from approximately five inches per month in December and January to more than 22 inches per month in July, with an average annual pan evaporation of 158 inches. The average annual daily relative humidity in the project area is less than 30 percent. Relative humidity is minimal and is often recorded at below 10 percent during the hottest part of the day. Relative humidity occurs at its maximum in the early morning hours, when it ranges from 30 to 50 percent. The higher early morning relative humidity readings are largely due to the range in daily temperatures.

Bristol Dry Lake is in the Mojave Desert Air Basin (MDAB). The MDAB is an assemblage of mountain ranges interspersed with long broad valleys that often contain dry lakes. Many of the lower mountains which dot the vast terrain rise from 1,000 to 4,000 feet above the valley floor. Prevailing winds in the MDAB are out of the west and southwest. These prevailing winds are due to the proximity of the MDAB to coastal and central regions and the blocking nature of the Sierra Nevada Mountains to the north; air masses pushed onshore in Southern California by differential heating are channeled through the MDAB. The MDAB is separated from the Southern California coastal and central California Valley regions by mountains where the highest elevations reach approximately 10,000 feet and whose passes form the main channels for these air masses. The Mojave Desert is bordered on the southwest by the San Bernardino Mountains, which are separated from the San Gabriel Mountains by the Cajon Pass (4,200 feet). A lesser channel, the Morongo Valley, lies between the San Bernardino Mountains and the Little San Bernardino Mountains.

The average annual low-altitude wind speed in the Mojave Desert region is

approximately eight miles per hour (mph), with the highest wind speeds recorded during the summer months. The prevailing wind direction is from the west. During the spring, the wind is generally from the southwest; during the summer, from the south-southwest; during the fall, from the west; and during the winter, from the northwest. Wind data measured near the project area at Fenner Gap between March and June 1999 indicate steady velocities (not including gusts) of up to 30 mph. Longer-term wind speed data, measured at the northern margin of Bristol Dry Lake, shows that winds having velocities greater than 21 miles per hour typically blow from the west and northwest. These high-velocity winds may be the most significant determinant in causing mobilization of fine-grained dust and silt from Bristol and Cadiz Dry Lakes.

Regional and Site Geology

The Mojave Desert Province is located south of the Basin and Range Province in eastern California. Although they share many lithologic units and similar structures, the Mojave Desert Province has a more subdued topography due to extensive and deeper erosion. The Mojave Desert Province lacks the tectonic extension that characterizes the Basin and Range and exhibits more exposure of Precambian metamorphic rocks but generally less exposure of bedrock units due to the predominance of alluvial cover.
Bristol Dry Lake is located in the central portion of the Mojave Desert. The Mojave Desert is wedge shaped and separated from the Basin and Range on the north by the Garlock Fault and on the southwest from the Transverse Ranges by the San Andreas Fault and extents to the Colorado River on the east. To the east, the distinctive fault boundaries become gradational on both the north and south. The Mojave Desert Province contains three zones of differing geologic character:

1. an eastern fold and thrust belt, which exposes Precambrian metamorphic core complexes exposed by detachment faulting and scattered exposures of cratonal to transitional miogeosynclinal, Precambrian to Paleozoic rocks, correlative with similar units in both the Basin and Range and the Colorado Plateau, and intruded by Mesozoic plutonic rocks (Sonoran tectonic block);
2. a central zone that is characterized by active strike-slip faults, with extensive exposures of Tertiary terrestrial sediments (Mojave tectonic block); and
3. an enigmatic western zone, largely covered by alluvium, but with scattered exposures of sediments offset by young detachment faults, and older enigmatic rocks (Mojave tectonic block). (website)

Jurrasic and Cretaceous age plutonic belts trend northwest-southeast across the Mojave Desert and link the Sierra Nevada batholith with plutonic terranes of Arizona and Mexico. These probably represent subduction related magmatic arcs. The Bristol Dry Lake area lies near the eastern margin of the Jurassic magmatic belt. Cretaceous age plutons occur throughout the Mojave Desert and eastward into central Arizona. Paleozoic epicontinental strata deposited on Precambrian crystalline rocks in the southeastern Mojave and Arizona and a thicker miogeoclinal sequence of the northwestern Mojave, Nevada and Utah both thicken from east to west across the region. (Miller, et. al., 1982)

The Bristol, Cadiz, and Danby Dry Lakes are located within the Barstow-Bristol trough (also known as the Bristol-Cadiz-Danby trough), a conspicuous west-northwest trending physiographic feature which approximately straddles the boundary between the Mojave and Sonoran tectonic blocks. Mountain ranges of the seismically active Mojave block (western portion of Mojave Desert) trend northwest-southeast and are often bounded by active Quaternary faults. Mountain ranges of the seismically inactive Sonoran block (eastern portion of Mojave Desert) generally trend north-south and resulted from Tertiary tectonism with very few, if any, younger faults. The Barstow-Bristol trough appears as a major crustal structure which divides regional changes in tectonics, volcanics, seismicity, depth to the moho, and crustal heat flow. (Miller, et. al., 1982) Tectonic extension along the northeastern edge of the Mojave block has allowed thick accumulations of playa sediments in graben-like valleys.

Scattered exposures of Precambian rocks exist in the mountains surrounding The Bristol Dry Lake area. Gneiss is exposed in the Calumet, Bullion, Ship, and Bristol Mountains. Granite is exposed in the Marble and Bristol Mountains and diorite in the Marble Mountains. Porphyritic granite dated at 1.4 – 1.5 b.y. is found in the Marble Mountains. (Miller, et. al., 1982) Figure __ is a generalized geologic map of the Bristol Dry Lake area.

Paleozoic sediments exposed in the Ship and Marble Mountains unconformably overlie the Precambrian crystalline rocks. About 500 meters of Cambrian strata (Tapeats Sandstone, Latham Shale, Chambless Limestone, and Cadiz Formation) are exposed in the Marble Mountains. These rocks are deformed by bedding plane faults in the Marble Mountains and are contact metamorphosed in the Ship Mountains. Although more strongly metamorphosed, similar rocks occur in the southern Bristol Mountains. Granodiorite in the Calumet Mountains contains pendants of metamorphosed Cambrian carbonates and clastic rocks. A nearly continuous section of metamorphosed Paleozoic strata occur in the Bristol Mountains which includes the Cambrian Bonanza King and Nopah Formations, Devonian Sultan Formation, Mississippian Monte Cristo Limestone, and lower portions of Permo-Pennsylvanian Bird Spring Formation. The Ship Mountains contain a 750 m section of the Bird Spring Formation. (Miller, et. al., 1982)

The Sheep Hole, eastern Bullion, and Calumet Mountains contain banded gneiss and calc-silicate rocks which may correlate with a metamorphosed section of the Lower Triassic Moenkopi Formation of the Old Woman and Little Piute mountains. Late Triassic or Early Jurassic cross-bedded arenitic metaquartzite outcrop at Bolo Hill and southeastern Bristol Mountains which probably correlate with the Aztec Sandstone. (Miller, et. al., 1982)

Two suites of Mesozoic plutonic rocks comprise belts of arc magmatism that trend northwest-southeast and cut across, and resulted in metamorphism of, the Paleozoic depositional strata. The older suite is apparently Jurassic in age and the younger, Cretaceous. The Bristol, Marble, Ship, Providence, eastern Bullion Mountains, and Lava Hills all contain exposures of the Jurassic suite. Other mountain ranges of the region

contain deformed equivalents of these rocks as skarns in Cretaceous Plutons. The Jurassic suite is composed of a wide variety of rock types as exemplified in exposures in the Bristol Mountains and Lava Hills. Rocks range in composition from monzodiorite and quartz diorite to quartz syenite and syeno-granite and are generally coarsely crystalline, variably porphyritic and biotite bearing. This suite of rocks intrudes finer grained small plutons in the central Bristol Mountains of varied compositions. There appears to be a general trend of decreasing quartz content to the northeast and perpendicular to the magmatic belt although quartz rich granite of the Marble Mountains contradicts this trend. (Miller, et. al., 1982)

The Cretaceous suite of plutons is comprised of the Cadiz Valley batholith and smaller plutons in the north of the region. The batholith is widely exposed and underlies the eastern Bullion, Sheep Hole, Calumet, Coxcomb and Iron Mountains. It is in sharp contact with the Jurassic suite in the Sheep Hole, Bullion, and northern Calumet Mountains and intrudes the Precambrian in the Calumet Mountains. The northern portion of the Cadiz Valley batholith appears to be buried in the Bristol-Cadiz-Danby trough. Composition of the batholith ranges from leucocratic granodiorite to granite. Composition of the northern portion of the Cretaceous suite ranges from monzogranite to leucocratic and hornblende granodiorites. (Miller, et. al., 1982)

Tertiary and younger volcanic strata and local continental sediments lie unconformably on older rocks throughout the region. Miocene volcanic and sedimentary rocks form a thick sequence in the northern Marble and Bristol Mountains and the Lava Hills. Smaller areas of outcrops of similar rocks occur in the Ship, Calumet, and Bullion Mountains. Tertiary dikes cut both crystalline basement rocks and Tertiary rocks and represent feeder dikes for the extrusive volcanics. Siliceous and intermediate volcanic and continental sedimentary rocks comprise the lower portion of the sequence. The upper most portion of the sequence is a welded tuff overlain by olivine basalt. The Tertiary sequence dips ten to thirty degrees to the east or northeast. Late tertiary breccias are found along the western Calumet Mountains and in the Bristol Mountains. (Miller, et. al., 1982)

Pliocene and Pleistocene course alluvial deposits are found in a wide area north of the Lava Hills. Wide spread active alluvial systems have shed coalescing younger Pleistocene and Holocene fanglomerates and alluvium from all mountain ranges of the area toward the Bristol and Cadiz Dry Lake basins. These Pleistocene alluvial sediments are usually capped by desert pavement composed of desert varnish coated gravels. (Miller, et. al., 1982)

Undated playa sediments fill Bristol, Cadiz, and Danby Dry Lakes to depths in excess of 1007 ft., 500 ft., and 880 ft., respectively, according to core hole data collected by the USGS (Bassett, et. al., 1959). The playa sediments most likely inter-finger with alluvial sediments in the subsurface around the margins of the playa deposits. In Bristol Dry Lake drilling encountered alternating beds of clay and salt with about 40% of the recovered core comprised of massive halite up to twelve feet thick. The lowest salt bed encountered was at 980 feet and is approximately 5 feet thick. In Cadiz Dry Lake several

thin porous salt beds were encountered in the upper few feet with the lowest salt bed at 9 feet and one foot thick. Small quantities of gypsum were found to a depth of 400 feet in Cadiz Dry Lake. No salt was encountered in Danby Dry Lake although two intervals of crystalline gypsum were recovered, a 6 foot thick bed at 10 feet and a 210 foot thick bed at 310 feet. (Bassett et. al., 1959)

Brines containing calcium and sodium chloride are found in the subsurface of both Bristol and Cadiz Dry Lakes. The brine at Danby Dry Lake contains predominately sodium chloride, but also calcium chloride at increasing concentration toward the west (personal communication with Salt Products, Inc personnel). Fossils indicative of shallow brackish water were recovered in core from Cadiz and Danby Dry Lakes below depths of 267 and 449 feet, respectively. A fracture or fault dipping 57 degrees was encountered in the Cadiz core at 256 feet, below which, beds were increasingly tilted from 10 to 35 degrees. A one inch thick layer of white volcanic tuff was encountered at a depth of 667 feet which could be indicative of late tertiary volcanics exposed on the surface in the surrounding area.

Several Holocene age mafic (alkali-olivine basalt) lava flows and at least four coaxial nested mafic cinder cones comprise Amboy Lava Field and Amboy Crater which was extruded onto the surface of Bristol Dry Lake approximately 10,000 years ago. The lava flows are composed of relatively dense, "degassed" pahoehoe lavas that form a hummocky terrain. The cinder cone which rises 75 meters above the surrounding lava flows and is approximately 460 meters in basal diameter, is composed of a loose accumulation of volcanic ejecta with secondary amounts of agglutinated scoriaceous tephra plus ropy, ribbon- and almond-shaped bombs. (Wood and Kienle, 1990)

Remnant gypsum capped pedestals suggest that the surface of Cadiz Dry Lake has been deflated by approximately 3 to 6 feet and resulted in the formation of dunes to the east side of the playa. Bristol Dry Lake also exhibits some aeolian deposits but the playa surface appears more resistant to deflation due to salt crystal formation and calcium chloride content. Low lying areas of the Amboy lava field are filled with aeolian deposits from a few inches up to four feet in thickness with thickness increasing toward the southwest and wind-faceted basalt pebbles are common.

Mineral Deposits

The playa deposits at Bristol Dry Lake have been mined for minerals since the early 1900s. Gypsum has been produced from surface deposits in several areas on the playa edges. Salt (sodium chloride) has been produced from surface deposits and occurs as interbedded massive beds up to 12 feet thick comprising approximately 40% of the playa sediments to a depth of about 980 feet. Aggregate thickness of salt beds at least one foot thick totals 142 feet and number more than 40. (Neumann and Leszcykowski, 1993) Both sodium chloride (NaCl) and calcium chloride (CaCl) have been and are produced

from evaporation of brines. Although no attempts at production have occurred, lithium occurs in anomalous concentrations in brines and strontium occurs at varying concentrations in near surface rocks.

The principal economic salt bed occurs at a depth of approximately 11 feet and is about 3 feet thick. This salt bed is saturated with brine rich in calcium chloride. This bed is the principal provider of brine to the collection and evaporation ditches. Salt beds encountered at depths greater than about 160 feet are described as massive salt in the USGS core description. Salt at depth does not have the crystal structure strength to withstand the lithostatic pressure of the overlying sediments and gradually deforms, or compresses, into a massive unit with little porosity and permeability. Salt, even under small deviatoric stresses, behaves like liquid, in the sense that it flows. Seismic activity (shaking and shock) accentuates compression of the salt beds. As the depth of salt beds increase they become less likely to contain large amounts of brines because of their limited porosity or permeability. Brines at depth are therefore more likely to occur in interbedded/interfingered clastic alluvial sediments comprised of more competent materials (silts, sands, or gravels) into which brines flowed upon compression/compaction of playa clays and salts. Therefore, economic brines may be encountered in sediments immediately surrounding the playa. TETRA does produce brines from wells near the northeastern edge of the playa.

Brines in more porous sediments surrounding the fine grained central playa sediments would maintain their integrity (concentration) due to the anticipated immiscibility barrier between brine and fresh or brackish water flowing toward the playa basin. Although salts and brines are regenerated at the surface from evaporation of runoff it is less likely that brines are regenerated at depth.

The high calcium chloride content of the Bristol and Cadiz Dry Lakes, and to a lesser degree western Danby Dry Lake, is unusual for playa lakes of the southern California deserts. No studies have apparently been undertaken to determine if the source of CaCl brines are derived from rocks surrounding Bristol Dry Lake or were perhaps influenced by hydrothermal fluids associated with Amboy volcanics.

The similar chemistry, low intervening hydrologic divides, and geologic/structural setting suggest that Bristol, Cadiz, and Danby Dry Lakes are hydrologically connected in subsurface sediments or fault zones, and that at least some past groundwater flow occurred from Bristol Valley to Cadiz Valley to Ward Valley (Danby Dry Lake) and probably on to the Colorado River via Rice or Vidal Valleys. Brine flow from Bristol Dry Lake to Cadiz Dry Lake has a higher probability of having occurred than from Cadiz Dry Lake to Danby Dry Lake. It is highly unlikely that brine would flow out of, or past, either Cadiz or Danby Dry Lakes due to immiscibility barriers and subsurface divides between succeeding valleys, particularly between Ward and Rice Valleys. There is a good possibility surface water flow may have occurred along this pathway during

wetter periods of the recent geologic past and before coalescing alluvial fans dammed the potential waterway between valleys.

Mining History

Mining of sodium chloride and calcium chloride from Bristol Dry Lake Playa has occurred continuously since 1908 using solar evaporation methods still employed today. Gypsum was mined from open pit areas at the playa edge until the mid 1920s. Rock salt was recovered using open pit methods until the mid 1970s. The original claims staked in the area of TETRA Technology, Inc.'s operations were located for calcium chloride and this has been the primary commodity produced since that time. Sodium chloride has been produced as secondary product as part of necessary removal (cleaning) from the evaporation ponds. Ownership has passed through several company ownerships. Mineral patents were issued in 1910, 1927, and 1936 and total approximately 2036 acres.

After *The 1872 Mining Law*, the public has the statutory right to secure claim to mineral deposits located on open public lands. Under the Mining Law a person has the statutory right, consistent with the *Federal Land Policy and Management Act of 1976*, applicable Federal and State environmental statutes and regulations, and County ordinances, to go upon the Federal Lands for purposes of mineral prospecting, exploration, development and extraction. In accordance with the Mining and Mineral Policy Act of 1970 and The Federal Land Policy and Management Act of 1976, it is the policy of the Department of the Interior to encourage the development of mineral resources. In 1980 Bristol Dry Lake was classified as a Known Sodium Leasing Area in accordance with 43 CFR 2400. Regulations at 43 CFR 3500.0-5(i) & (j) and 3594.1 require that the deposit be managed in a manner to yield the maximum ultimate recovery of the mineral resource.

With the passage of the *Federal Land Policy and Management Act of 1976* and California's *Surface Mining and Reclamation Act* (SMARA) the existing operations were required by the Bureau to develop a Plan of Operations and Reclamation Plan which were approved by the Bureau and the County of San Bernardino in September 1981 for a twenty year term. That approval expired in September 2001 and was renewed through re-application under SMARA for another twenty year period. Under federal regulations at 43 CFR 3809 mining operations could continue at the same manner and degree until approval of a modification.

The *Mineral Leasing Act of 1920*, established that all sodium minerals in federal ownership were subject to a lease system and no longer subject to disposal under the Mining Laws. Numerous mining claims were originally staked in the project area in the early 1900s. These claims in a portion of the project area were actively maintained by TETRA's predecessors until 1990 when TETRA acquired the property. These claims predated the Mineral Leasing Act of 1920 secured ownership of both calcium and sodium minerals for the claimants. Claims covering the remaining portion of the project area may have been allowed to lapse and new claims were located by TETRA's predecessors in 1986 and secured ownership of only calcium minerals.

In 1988 the Bureau determined that mining claims covering portions of the subject operations had been allowed to lapse after passage of the *Multiple Mineral Development Act of 1954*, which amended the mining and mineral leasing laws to permit multiple development of both locatable and leasable minerals on the same tract and reserved leasable minerals to the United States. With the lapse of pre Mineral Leasing Act/Multiple Mineral Development Act claims, all production and sale of sodium chloride from those lapsed claims required a sodium lease and payment of royalty to the federal government. Under current mining technology neither calcium chloride nor sodium chloride could be economically mined without production of the other. BLM informed TETRA's predecessor, Cargill (formerly Leslie Salt) that they would be required to submit a sodium lease application and pay past royalties of an amount negotiated at that time. The author is not aware of the negotiated amount of past due royalties nor whether or not those past royalties were paid.

After TETRA acquired the property from Cargill Salt they apparently failed to file affidavits of assessment work for any of the claims. LR 2000 data also indicates that no claim ownership transfer documentation, transferring ownership from Cargill to TETRA, was ever filed with BLM. All claims were declared null and void by Locke Decisions (1992 and 1994). TETRA relocated claims in 1992 and 2000. When the claims were allowed to lapse, production of all sodium minerals (NaCl) from unpatented lands in the project area became subject to lease and royalty payments. TETRA lost all ownership rights to sodium from mining claims within the project area due to the lapse of pre Leasing Act claims.

TETRA has a pending noncompetitive fringe acreage sodium lease application on file with the Bureau which was submitted November 22, 1989. Prior to issuance of a lease the Bureau must comply with the requirements of NEPA. Title 43 Code of Federal Regulations Section 3590 requires submission and approval of an Operating Plan for all operations conducted under a federal mineral lease. However, regulations do not preclude filing a Plan of Operations which meets the requirements for both 43 CFR 3590 and 3809. The proponent has filed a Plan of Operation with the Bureau of Land Management, Needles Field Office, to satisfy requirements under both 43 CFR 3590 and 3809. Any confidential information required by the 3590 regulations is a separate attachment and handled in accordance with 43 CFR 3590.1 Confidential Information.

The statutory right to develop mineral resources located within Public Lands under the Mining Laws carries with it the responsibility to assure that operations include adequate and responsible measures to prevent unnecessary and undue degradation of the Federal lands and to provide for reasonable reclamation. The Environmental Analysis (CA-690-EA01-02) conducted by the Needles Field Office satisfies NEPA requirements prior to issuance of a noncompetitive fringe acreage sodium lease, approval of an Operating Plan for mining sodium minerals under federal lease, and approval of a Plan of Operations for mining calcium minerals under the Mining Laws.

Mining and Related Operations

The TETRA Technologies, Inc. Amboy operation is located on the northern portion of the Playa at Bristol Dry Lake near Amboy, California. Access to the property is via public highways to both northern and western entrances. The northern entrance is via Saltus Road from the National Trails Highway east of Amboy. Saltus Road is a two lane paved road for approximately one mile where it intersects the Burlington Northern Railroad. South of the railroad it becomes a two lane dirt road. This is the main entrance to the operations. The western access is via a two lane dirt road from Amboy Road approximately three and a half miles south of National Trails Highway. Both entrances are gated. The western entrance is normally locked.

The operations are active 24 hours per day 7 days per week, however office personnel and mine workers are on site primarily during daytime hours. Minimum staff and security are on site during the night time hours. A maximum of approximately ten persons are on site at any one time.

Several office and work buildings are located at the mine site. Onsite equipment includes one tanker truck, one track mounted excavator, one bulldozer, one elevating scraper, seven cars, three pickup trucks, conveyors, truck scale, fuel and water tanks, crusher, sand screw washers, and other associated tools, equipment, and pipelines. Highway bulk trucks transport material and products to and from the site daily. A railroad siding, tank cars, and loading facilities are also part of the operations.

TETRA's operation is a solar evaporation operation and as such does not process ore. The Amboy operation recovers brines that are concentrated through the use of solar evaporation to produce granular solar salt and liquid calcium chloride. The brines are recovered from two sources. One source is a series of wells that provide a solution containing both calcium chloride and sodium chloride. These wells are along the northeastern boundary of the property along the playa edge. The other source is a collection of pits and trenches that provide calcium chloride solution. The pits are located in the southeastern portion of the property. The trenches are located in the evaporating complex in the southwestern portion of the property.

The brine wells produce a weak solution of calcium and sodium chloride that is concentrated by solar evaporation. During the calcium chloride recovery process, sodium chloride is recovered as the sodium chloride salt precipitates out. The sodium chloride is precipitated in several crystallizer basins and then recovered utilizing an elevating scraper.

Brine is extracted from the wells with submersible down-hole pumps. The down-hole pumps discharge the brine into surface piping that carries the brine to a polypropylene collection tank. Brine is pumped from the collection tank through a six-inch high-density

polyethylene pipeline to the first collection ditch. The collection ditch takes the weak brine to the mine area.

Once the brine is in the mine area, it is allowed to concentrate in one of three production areas. All of the brine concentration areas are sections of the prior open-pit mining operation that have been converted to evaporation basins.

As the brine traverses the collection ditch, some concentration takes place. When the brine reaches the mine area, it is placed in a weak brine concentrator and allowed to concentrate. At the appropriate concentration the brine is pumped into a salt crystallizer. As the brine continues to concentrate, salt crystallizes out on the bottom of the crystallizer. The majority of the salt is collected in the crystallizers before the brine is advanced.

Brine leaving the crystallizers is generally treated with lime to remove magnesium. Alternatively the brine is left untreated and allowed to concentrate further for sale as untreated material. The lime-treated brine is placed in settling basins, where the magnesium solids are allowed to settle out. When the treated or untreated brines reach marketable concentrations they are stored in finished product ponds. Pumping of the brine is done with centrifugal type pumps. The more frequently operated pumps are electric; others are diesel driven portable pumps. Interconnecting pipelines are made of a combination of steel and hi-density polyethylene.

The crystallized salt is harvested by draining the crystallizer, loosening the salt with a bulldozer, and picking up the salt with an elevating scraper. Once the salt is harvested, it is delumped and washed prior to sale. The de-lumper is a basic hammer mill. The salt washer is a sand screw utilizing countercurrent flow of wash solution that removes calcium sulfate precipitates.

A rubber-tired loader is used to load dump trucks. Pneumatic haul trucks are loaded using the loader and a conveyor/chute assembly. All of the equipment used in the process is of the semi-portable design found in much of the sand and gravel industry. All trucks leaving the site are weighted on a platform scale near the northern entrance to insure that they are not overloaded.

Along with the sodium chloride, small amounts of calcium-sulfate precipitate contaminates the sodium chloride. This problem is addressed by washing the salt crystals in a countercurrent sand screw washer. The finer sulfate precipitates are readily removed from the coarse salt crystals. The salt crystals are discharged to a stockpile and the calcium sulfate is discharged to a salt-wash-water holding basin where the sulfate is allowed to settle out. This process takes place in the evaporating complex.

The salt wash water basin is routinely recharged with weaker brine solutions as the stronger solutions are advanced to the salt crystallizers. The calcium sulfate solids are

periodically removed, once every several years, and placed on existing burden pile areas to dry. Liquid from these solids and runoff is allowed to drain back into the evaporation trenches. The washed sodium chloride crystals are shipped from the evaporating complex by bulk truck.

Brines from pits and trenches are gathered and combined with the partially concentrated brine discharged from the salt crystallizers. Two products are made from the brine: untreated calcium chloride solution and treated calcium chloride solution.

The untreated solution is simply allowed to continue concentrating through the solar evaporation process until it reaches a marketable concentration. The untreated material is segregated in storage ponds, located in the evaporating complex. From the storage ponds, it is sold in bulk truck and bulk rail quantities.

The treated calcium chloride solution has magnesium removed from it by contacting partially concentrated brine with a quick-lime solution ($CaO + H_20$). This temporarily elevates the pH of the brine causing magnesium hydroxide ($MgOH_2$) to precipitate. The reaction is rapid, and the brine quickly normalizes from an initially high pH value of about 9. The precipitated solids are allowed to settle out as the brine continues to concentrate in designated settling basins.

Once the treated brine reaches market grade strength, the clear brine is decanted from the settling basin and placed in storage ponds located in the evaporating complex. The treated calcium chloride is shipped from the site by bulk truck and rail.

The precipitated solids are allowed to collect in the settling basins. Periodically, every several years, the settled solids are removed and placed on overburden piles adjacent to the settling basins. The liquid that drains from the solids and any subsequent precipitation is allowed to run back into the settling basins.

The calcium sulfate is washed from the salt and allowed to settle in the salt wash water basin. On an as-needed basis in several year intervals, the salt wash water basin is drained and the precipitates are removed. The calcium sulfate is placed on existing berms in the immediate area of the wash basin and allowed to drain and dry. Based on the calcium sulfate content and volume of brines generated, 800 to 900 tons of calcium sulfate are generated per year on a dry weight basis. These solids are retained on site. The final disposition of the calcium sulfate is as backfill material during reclamation.

Magnesium hydroxide is created when partially concentrated brine is treated with a lime solution. After treatment the magnesium hydroxide is allowed to settle out in one of three settling/concentrating areas. The volume of precipitate produced varies with the market demands for treated calcium chloride. The volume of magnesium hydroxide generated on an annual basis ranges from 65 to 100 tons on a pure $MgOH_2$ dry weight basis. It is allowed to collect in the settling areas for a number of years. Periodically the solids are removed, placed on adjacent berms and allowed to drain and dry. Any liquids

that drain from the solids or from runoff are allowed to return to the settling basins. The solids remain on site. The final disposition of the magnesium hydroxide is as backfill material during reclamation as it is uneconomical to collect and market the small amounts produced.

The Amboy operation has been at its current level of operation for a number of years. During the period of this permit, it is anticipated that periodic cleaning and or replacement of wells, pits, trenches and evaporation areas will take place in order to maintain the operation.

TETRA Technologies, Inc. plans to expand the operation by refurbishing existing, or constructing more wells, pits and trenches within the permit boundary. Future phasing may include the construction of additional weak brine wells, additional strong brine wells and/or trenches on the playa. Plan modifications would be submitted for review and approval for any specific changes or additions to the operations.

The potential life of the mineral resource has not been determined. Past operating history and current operating conditions indicate that the Amboy operation should continue for the foreseeable future.

Domestic garbage is gathered into two on-site dumpsters. Currently, Sierra Environmental of Twentynine Palms, California provides the dumpsters, empties them and transports the domestic garbage to an approved landfill. Dumpsters are emptied twice per month.

In order to avoid disposal of bags, lime is purchased in bulk.

Sanitary waste for the seven to ten people in the operating areas is controlled through the use of portable toilets. Portable toilets are maintained weekly, by Omega, of Hesperia, California. The sanitary waste for the two to three person staff office building is provided for by use of a septic tank.

Approximately 200 gallons of oil and grease waste is produced by the operation per year. All oil and grease waste generated by the maintenance of on-site equipment is stored on site in a contained and covered area near the northern entrance to the property. The oil and grease waste is gathered every three to six months, by Advanced Environmental of Fontana, California. Advanced Environmental recycles or provides for final disposal of oil and grease waste.

TETRA Technologies, Inc. currently obtains brackish water from a well designated Well A1, located in Section 35 of Township 6 North, Range 12 East. The well, pipeline, and access road are granted under a Right of Way (CACA-020261) from the Bureau of Land Management. Water from this well is used to dilute the calcium chloride solution during the summer months, and to wash equipment.

Less than 20 gallons of fresh water are used per day (equivalent to approximately 0.0 14 gpm or 0.022 acre ft/yr). All fresh water is provided by rail tanker cars and is used for domestic water service only. Fresh water is not used in the processes utilized at the operation.

Drinking water is provided in five-gallon jugs by Culligan Water Conditioning. Approximately 30 jugs of water are delivered per month.

Explosives are not used in the operation and are not stored on site.

Reclamation would commence within one year of termination of the mining operation. Duration of reclamation is expected to be one to two years. As the estimated operating life of the project is more than 100 years, reclamation is not scheduled to occur before the year 2050. Although no concurrent reclamation is proposed, reclamation of those mining features no longer in use (i. e., pre-SMARA pits) would be required to be begun as soon as operations allow and completed within one year. In accordance with federal regulations and BLM policy, the Authorized Officer would monitor activities and may require periodic modification of the Plan of Operations, if conditions warrant.

A Conditional Use Permit (CUP SMA/DS 881-169/00) has been issued to TETRA by the County of San Bernardino Department of Land Use Planning. This permit contains a reclamation plan approved under the State of California Surface Mine and Reclamation Act (SMARA) and is subject to certain conditions of approval as stated therein. The County holds a reclamation bond in the amount of $425,259.00 which is payable upon demand to County of San Bernardino, or State of California Department of Conservation, or Bureau of Land Management. BLM is not limited to mitigation measures outlined in the County's SMARA CUP and will require certain mitigation measures according to BLM's environmental review which will be listed in the Conditions of Approval and lease terms.

Reclamation would entail the refilling of collection ditches, storage ponds and shallow evaporating ponds with native material that is currently stored alongside of the excavations. During reclamation, pits and trenches would be backfilled with native material, calcium sulfate precipitate, and magnesium hydroxide precipitate, stored in berms alongside the pits. Equipment to be used during reclamation would include, but not be limited to, a dozer, a wheel loader and a drag line. The reclaimed site would be returned to the natural topography (see Reclamation Plot Plan pages 1 & 2). Although the proponent has proposed that pre-SMARA pits would not be reclaimed (filled or leveled), reclamation of these sites would be required.

All buildings and associated structures would be removed from the property. Removal of buildings and associated structures would occur following leveling of pits and trenches. Buildings and other structures would be torn down using the appropriate equipment. Residual materials would be hauled to the nearest waste disposal site. As the estimated operating life of the project is more than 100 years, buildings would not be scheduled to be removed before the year 2050.

Although the operator has proposed to leave the flood control berm at the southern edge of the property boundary in place leveling of this feature would be required as part of reclamation.

Re-vegetation has not been proposed to be undertaken, as disturbed areas are confined to the unvegetated dry lake bed and the saline/brackish environment does not support plant life. There is no topsoil on the dry lake bed. A monitoring program to ensure the maintenance of successful revegetation would not apply to this reclamation plan. If future exploration occurs on the sparsely vegetated playa boundary, a Reclamation Plan would be developed for those areas to include revegetation.

No post closure water quality monitoring has been proposed. A post closure program to maintain public safety has not been proposed because the trenches and collection pits would be filled and leveled to ground surface.

A monitoring program for erosion control has not been proposed as part of the reclamation plan because the site is a topographic low with a depositional rather than erosional environment.

Financial assurance to guarantee reclamation of the site would be required in accordance with regulatory requirement. The reclamation bond required by the County satisfies this regulatory requirement. Additional financial assurance can be and should be required by BLM to provide for minimum royalty payments or other lease terms.

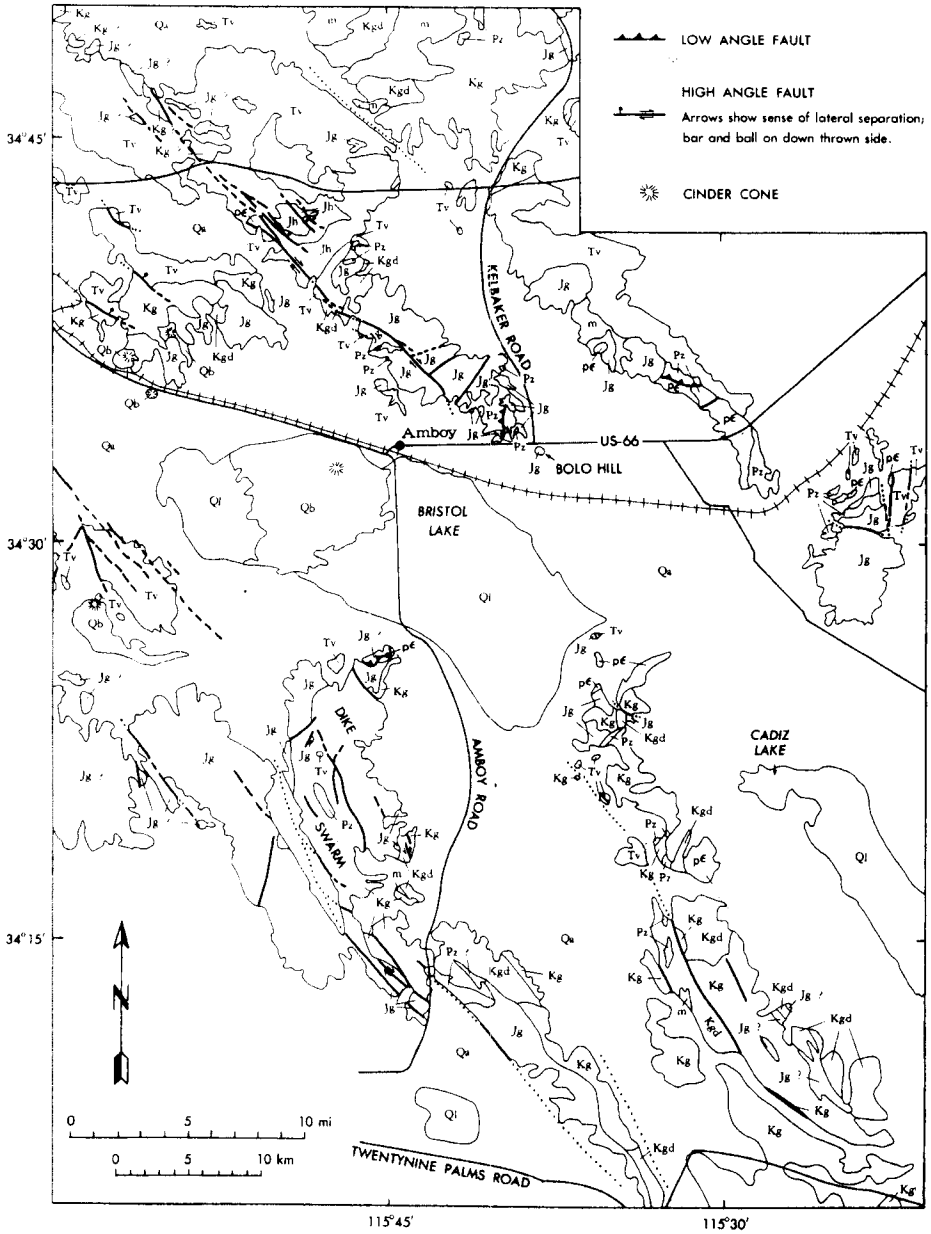
Mineral Potential

Mineral potential for locatable minerals is high for the occurrence and economic production of calcium chloride and gypsum. The potential for occurrence of lithium and strontium minerals is high but the potential for economic development of these minerals in the foreseeable future is low. No other locatable minerals are known to exist within the Bristol Dry Lake brines or playa sediments. Sodium chloride is the only leasable mineral known to exist in the brines and sediments of the playa. Potential for its economic production is high.

Four mining operations have produced minerals from Bristol Dry Lake: National Chloride, Hills Brothers, Coachella Valley Organic Fertilizers, and the subject TETRA Tech operation. Two operations are currently active: National Chloride and TETRA. The most recent production rate estimates range from 20,000 to 50,000 tons per year per company. Total production to date is estimated at 7 million tons. The United States Geological Survey (USGS) has estimated sodium chloride reserves from surface or near surface deposits at 26 million tons and 474 million tons of NaCl in brines. The USGS has also identified hypothetical resources of lithium contained in brines of 54,890 short tons and 10 million tons of the evaporate sequence contains strontium of varying concentrations. (Neumann and Leszcykowski, 1993) No formal estimates of gypsum

and CaCl have been reported. Gypsum deposits have not been accurately delineated, however, a large quantity is believed to be present on the playa, particularly, in the northern and northwestern portions. CaCl is produced in quantities similar to NaCl from brines (CaCl is only produced from brines) and could indicate a similar reserve.

No known potential for the occurrence of coal, potassium minerals, geothermal resources, or oil and gas exists within Bristol Dry Lake playa sediments or brines. Common variety saleable minerals such as clay and sand exist on and around the margins of the playa. However, no market exists for production of these materials except for local use as fill (roads and dikes) in the mining operation.



Encl (5)

ROCK UNITS

QUATERNARY	Qa	Surficial Deposits
	Ql	Playa Sediment
	Qb	Basaltic Rocks
TERTIARY	Tv	Volcanic and Sedimentary Rocks
CRETACEOUS	Kg	Granite to Granodiorite
	Kgd	Granodiorite
JURASSIC	Jg	Granitic Rocks
	Jh	Hypabyssal and Metavolcanic Rocks
PALEOZOIC & MESOZOIC	Pz	Paleozoic and Mesozoic Strata
PRECAMBRIAN	pЄ	Crystalline Rocks
	m	Metamorphic Rocks undivided

Figure 2. Generalized geologic map of the Bristol Lake region based on Bishop (1963) and Sabine (in Stein and Warrick, 1979); unpublished mapping by Howard and John, 1980, in the Calumet and Sheep Hole Mountains and the northeastern Bullion Mountains, and by Miller, 1980-1981, in the Bristol Mountains and Lava Hills south of highway I-40; and reconnaissance by John and Howard, 1980, in the Granite Mountains, by Howard, John and P. Stone in the Marble Mountains, and by P. Stone and Howard in the Ship Mountains.

From Miller, et. al., 1982

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