Soils Report

For:
Burnt Ranch Estates Mutual Water Company
Burnt Ranch, CA 95527

Report Provided For:
Burnt Ranch Estates Mutual Water Company
PO Box 102
Burnt Ranch, CA 95527

Report Provided By:

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December 2023
Job #1754

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ATTACHMENTS:

Introduction

Trinity Valley Consulting Engineers, Inc. (TVCE) was secured by The Burnt Ranch Estates Mutual Water Company - BREMWC (client) to evaluate the existing conditions for the Burnt Ranch Estates. The client is proposing domestic water treatment, storage, and distribution upgrades within the Burnt Ranch Estates Community.

The proposed Burnt Ranch Estates Community Water System Improvement Project will mainly provide upgrades and increased capacity to the existing water treatment, storage and distribution system. The goal is to add two additional water storage tanks, replace the entire distribution system, replace all fire hydrants and replace all water meters. This project will not increase the number of water service connections. Furthermore, this project does not alter the existing water right held by the Burnt Ranch Estates Mutual Water Company BREMWC. McDonald Creek is the source of water for BREMWCO and is gathered from a dam on BREMWC property. The proposed activities do not involve disturbance of the water inlet nor the riparian corridor through which the creek flows.

The following is an outline of our findings and recommendations.

Project Site Location

Upper Water Tank:
The existing main tank is located on assessor parcel number (APN) 008-790-003-000. The existing tank is rectangular and is constructed of concrete blocks. It is approximately 20' x 15' and sits on a flat area cut into on a moderately steep hillside, which was excavated and constructed on in the mid-1970s. The plan is to extend this flat to the north by extending the excavated area into the same hillside to bring its new angle of repose to a stable condition. The area to be excavated into is part of the cut slope created during the original construction and part the native hillside. The existing slope ranges from 30-50% in steepness. The area to be excavated occupies about 0.25 acres. It is presently covered with a moderately dense mixture of brush and trees. The proposed water tank will be 80,000-gallon bolted steel tank with concrete foundation.

Lower Water Tank:
The lower tank is located on APN: 008-800-005-000 and is approximately 0.25-acre lot owned by the BREMWC, about 1 mile from Highway 299 on Pony Express Way. Like the upper tank, the existing lower tank is comprised of concrete blocks and was constructed in the 1970s. The old tank will be removed and the new tank located on the same site. The new tank will be approximately 40,000 gallon and constructed from bolted steel with a concrete foundation. The site is clear of all vegetation. This area is naturally flat and was graded to accept the current tank in the 1970s. Very little new grading will be necessary in order to accommodate the new tank.

Water Mains:
The length of the main water line is approximately 10,000 feet. It largely runs underneath the main access roads, Horseshoe Lane, Pony Express Way, and Stage Coach Drive. These

roads are County maintained. The plan is to replace the aging water line, which is a combination of galvanized and plastic pipe, with new HDPE water lines, to the start of each domestic inlet, including shut off valves and cross connection prevention devices. Existing water mains will be removed where encountered and abandoned in place otherwise.

Project Site Geology

The site is located in Burnt Ranch. The site lies within Klamath Mountain Geomorphic Province (Irwin, 1966), and geologically, within the Rattlesnake Creek Terrane (Irwin, 1972). The site is mapped as being underlain by a large dormant-old Quaternary landslide deposit (Qls) that flanks from the eastern terminus of a northeasterly spur that originates from South Forth Mountain. The pond site appears to lie within the highly rounded scarp of this dormant slide body. Subjacent to the landslide deposit, Middle Jurassic to Permian age Broken formation of volcanic rocks (JT_RPrc) and mélange of the Rattlesnake Creek Terrane are present. Irwin (2010) describes this formation as dominantly sheared and dislocated mafic volcanic rocks, including pillow basalt, flows, tuffs, volcanic breccia, and volcanoclastic rocks that containing locally interbedded red and gray to black, thin bedded radiolarian chert, minor amounts of intermediate and silicic volcanic rocks, and lenses and knockers of serpentinite (um) which is dominantly serpentinized peridotite but includes metasomatized mafic rocks of uncertain origin as well as minor amounts of sheared-in volcanic rocks and chert.

Proposed Project

The proposed project for this site is to perform a general soils investigation to evaluate present-day site conditions and provide general recommendations for the developments associated with the project. The developments will mainly consist of constructing water tanks, retaining walls, and installation of water lines.

Soil and Site Conditions

A field investigation was conducted by TVCE on May 21, 2023 for visual observation and soil sample collection. This investigation consisted of site observations, general observations of the location of the proposed development, and collection of soil samples (see attachment 4). In addition, a desktop reconnaissance was conducted utilizing available public databases.

Site Soil Evaluation

Conservatively, site soils will yield a bearing pressure of one thousand five hundred (1,500) pounds per square foot (psf) for vertical bearing and one hundred (100) psf for lateral bearing (2022 California Building Code, Table 1806.2).

Seismic and Hazards Considerations

The parcel is located near the Mad River fault zone which is located approximately 22 miles to the west of the project site. The Mad River Fault Zone (Fault ID # 13) is considered active by the State of California, with the last surface rupture within the last 15,000 years.

The following coefficients shall be used for seismic design (See Attachment 6 for Seismic Hazard Data):

Site Class	D
Mapped Spectral Response Acceleration (short), S_s:	1.94 g
Mapped Spectral Response Acceleration (1-sec), S_1:	0.73 g
Site Coefficient, F_a:	1.2
Site Coefficient, F_v:	1.5
Acceleration Spectral Response (short), S_{DS}:	1.54 g
Acceleration Spectral Response (1-sec), S_{D1}:	1.06 g
Seismic Design Category:	D
Risk Category:	IV
Importance Factor:	1.5

Based on the location and geographical setting, the project site lies outside any flood prone areas. The https://amplify.asce.org/project parcel has not been mapped within a FEMA flood area (FIRM Panel 750 of 2075).

Non-engineered fill soils are not present on-site within the anticipated building footprints. However, if encountered during excavation of foundation elements, undocumented and/or non-engineered fill soil should be considered unsuitable as foundational load bearing soils due to the potential for excessive total and differential settlement. It will be required to over-excavate (approximately 3′ to 8’) so foundational elements be founded on suitably-dense, in-place and undisturbed native granular soils. A qualified professional shall inspect the subgrade of all foundational elements.

Due to the site soils, depth to groundwater, and distance to the nearest known quaternary fault, the potential for liquefaction, surface rupture, soil strength loss, or faulting at this site is Low. Mitigations to hazards associated with the proposed development are those described in the section above and in the following recommendations prescribed within the following *Recommendations* Section.

Conclusion

This report documents the history, present conditions and subsurface materials, as well as the geologic hazards associated with the site. Included in this report are design and construction recommendations based on the site conditions encountered, the requirements of the 2022 CBC and County of Trinity grading ordinance. Based on our review of

historical data, site exploration and observations, it is in our opinion that if our site-specific recommendations are implemented as intended, then no further actions will be necessary.

Recommendations

The following recommendations are general recommendations for any future grading activities to be performed:

Site Preparation

All earthwork, including but not limited to, site clearing, grubbing, and stripping should be conducted during dry weather conditions, generally mid-April through mid-October.

Strip and remove all topsoil and vegetation from the project area, and for a minimum of three feet to the outside of the working area.

Any undocumented fill soils, fine-grained residual soils, and any other debris encountered at or below the existing ground surface shall be removed at the locations receiving any potential fills.

Fills

Fills shall be constructed as controlled and compacted engineered fills and fillslopes graded to no steeper than 2:1 (h:v) without written approval of a qualified design professional.

Fills should be free of: 1) organics, 2) rocks larger than 3-inches in diameter, and 3) other deleterious materials.

Fill material should be placed in loose lifts no more than 8-inches thick, at uniform moisture content at or near optimum, and compacted mechanically.

Sufficient testing and inspection should be performed to monitor the suitability of fill materials and assure compliance with the recommended compaction standards.

Fill, if required, may be imported for use as non-expansive structural fill beneath floor slabs and for pavement subgrade. Select fill should be a soil/rock mixture free of organic material and other deleterious material. The select fill material should contain low plasticity clay, well-graded sand, and/or gravel. Select fill should contain no rocks larger than 3 inches in greatest dimension, nor more than 15 percent larger than 2 inches. Additionally, the material should meet the following specifications:

Plasticity index: <12
Liquid Limit: <30
Percent passing No. 200 sieve: 50 maximum, 5 minimum

Aggregate base material may be used for pavement subgrade, placed beneath footings or floor slabs, used as trench backfill, or used as roadway surfacing. This material should meet the requirements in the Caltrans Standard Specifications for Class 2 Aggregate Base (3/4-inch maximum particle size).

Compaction Standards

Fills shall be compacted in 8-inch loose lifts with clean native materials at optimum moisture content as determined by testing and approved by the engineer. Non-structural fills shall be compacted to a firm unyielding surface as approved by engineer.

It is recommended that any materials proposed for structural fill material to support any foundations or structural building elements, and associated utilities be compacted as specified below:

Fill Placement Location	Compaction Recommendations (ASTM D 1557-Modified Proctor)	Moisture Content (Percent Optimum)
Structural fill supporting footings	95%	-1 to +3 percent
Structural fill supporting slabs-on-grade	90%	-1 to +3 percent
Structural fill placed within 3 feet beyond the perimeter of the building pad	90%	-1 to +3 percent
Utility trenches within building and any pavement areas	95%	-1 to +3 percent
Utility trenches beneath landscape and grass areas	90%	-1 to +3 percent

Drainage and Landscaping

The site should be graded to provide drainage such that no water is allowed to: 1) pond anywhere on the site, 2) migrate beneath the proposed developments, or 3) pond at the base of cuts.

Site drainage/run-off should be directed away from all fill slopes. Impermeable surfaces should be minimized to encourage infiltration.

Roadways – Gravel Surface

The upper six inches of graveled roadways supporting vehicle loadings should be compacted to a firm and unyielding surface that is stable under construction traffic prior to placement of aggregate base. Aggregate base rock supporting vehicle traffic shall be a minimum of 4 inches of ¾” minus and a maximum of 1-1/2” minus.

Roadways – Paved Surface

The upper six inches of pavement subgrades supporting vehicle loadings should be scarified, moisture conditioned to at least the optimum moisture content and uniformly compacted to at least 95 percent of the ASTM D1557 maximum dry, and must be stable under construction traffic prior to placement of aggregate base. Final subgrade processing and compaction should be performed just prior to placement of aggregate base, after construction of underground utilities is complete.

Setback Requirements

We recommend that the face of the footings be set back at least twenty feet (20′) from a break in top of slopes. Given the minimal setback from the break in slope, the greater embedment is recommended to provide vertical and lateral support for the foundation without detrimental settlement. Where slope is steeper than 1:1, the required setback shall be measured from an imaginary plane at 45 degrees to the horizontal, projected upwards from the toe of the slope.

Foundational Design Recommendations

All foundations should be constructed of reinforced concrete. The following foundation recommendations assume a one-story commercial structure will be constructed on this site. In our opinion, the proposed structure can be supported by mat slab or a stiffen slab on grade provided that the foundation is designed to resist differential settlement of the underlying soil. A foundation of this type is suitable for site conditions provided that it is constructed in accordance with our recommendations and specifications and designed to meet the standards of the 2019 CBC.

Below are additional recommendations associated with the foundation development:
Footings

- Foundations are not anticipated to be located in areas of undocumented fill or fill soils of varying depth. A foundation system for this site should be rigid to limit potential structural damage due to differential settlement resulting from liquefaction;
- If necessary to mitigate undocumented fill soils excavate and replace with suitable engineered fill, placed and compacted as recommended. Alternately, footings may be built on controlled low strength material (CLSM, e.g., concrete slurry) backfilled footing trenches, excavated into the bearing soil indicated in this report;
- Foundations should be embedded a minimum of 12 inches into suitably dense, undisturbed native bearing soils. Based on the soil profile observed in the building footprint, the base of footings should therefore be approximately 18 inches below existing grade, at minimum; or engineered for differential settlement

- Footings within 20 feet (at minimum) of the top of slope should be embedded approximately 2 feet below finished grade;
- Minimum width of footings should be 12 inches, and the minimum thickness should be 6 inches, per CBC Section 1809.

Floor Slab Design

- The stiffened concrete floor slab-on-grade or mat slab should have a minimum thickness as specified by the engineer, and should be reinforced and underlain by at least 6 inches of compacted select fill consisting of 4 inches of Class 1, Type A permeable material (per Caltrans), or an approved equivalent, to act as a capillary moisture break, and 1 inch of sand as described below;
- To reduce the possibility of moisture migration through any floor slab-on-grade, a minimum 6 mil plastic membrane (vapor retarder) should be placed on the prepared of Class 1, Type A gravel subgrade;
- Joints between the sheets and utility piping openings should be lapped and taped;
- Care should be taken during construction to protect the plastic membrane against punctures. To protect the membrane during steel and concrete placement, and to provide for a better concrete finish, cover the membrane within at least 1 inch of clean sand;
- The difference, if any, between the 6 inches of select fill and sand under the slab and the depth to firm undisturbed native soil may be made up with additional select fill or engineered fill that is placed as specified in the Structural Fill section of this report.
- If bearing on undisturbed / native soil is not obtained, slab shall be designed with sufficient stiffness so as to resist differential settlement.

Grading

Grading must meet compliance with the California Building Code (2019) Appendix J, County of Trinity Grading Ordinance and ASTM regulations.

All cuts and fills shall be setback at a minimum of ten (10) feet from all ascending and descending slopes greater than 30%.

Any grading or structures shall be in conformance with the most recent version of the California Building Code (CBC).

Final site grading shall not create areas of concentrated flow over the existing fill slopes. An inspection of the subgrade must be inspected by a qualified professional. Subsequent visits during and at project termination will be required for quality assurance and control.

Erosion Control

Site-specific erosion/sediment control and stabilization recommendations are presented in the bulleted list below. As used herein, *exposed soil areas* and *disturbed areas* include all grading and excavation work performed in connection with the proposed project.

- Storm water erosion and pollution prevention measures should be taken as soon as possible prior to the onset of the winter rains.
- Trinity County Erosion Control Standards should be viewed as *minimum* standards for erosion and sediment control at this site.
- Revegetate all disturbed areas immediately by seeding with Caltrans erosion control mix (or equivalent).
- To protect against erosion, heavily mulch all exposed soil areas with straw, or an approved alternate material.
- Poke the straw mulch into the upper 2 inches of the soil to limit loss of straw.
- Stake straw wattles parallel to slope contours into any side cast fills.
- Install silt fencing at toes of any new side cast fill slopes.
- Replant the site with trees and shrubs native to the area.
- Cover any soil stockpiles with 6-mil (min) plastic sheeting, securely anchored to prevent wind disturbance.
- Native gravel-surfaced roadways to the proposed residence and other areas where vehicle traffic may occur; should be maintained in good condition.
- Drive and park vehicles only on gravel-paved areas during wet weather.
- Monitor the site before and after runoff-generating rainfall events to verify suitable and appropriate functioning of all erosion-control measures.
- Promptly repair all erosion-control measures as needed.

Limitations

This report, recommendations, and conclusions are solely intended for the site discussed above. The information contained in this report is only intended for use at the stated site using the stated uses. This report should not be used as justification for any other project or site, and only be used for information purposes if referenced and reviewed for other projects. TVCE recognize that the site is in a dynamically active area and conditions can and will change. TVCE has used the best professional judgment to assess the present and future risks and assist the landowner in proposing development that does not increase the risk to the resources present in the project area or subject the landowner to untenable hazards. If conditions different from those described in this report are encountered during construction, the project engineer/builder/owner should contact this office to review the new conditions and evaluate their bearing on the validity of any recommendations provided herein.

The opinions presented herein have been developed using a degree of care and skill ordinarily exercised, under similar circumstances, by reputable civil engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report.

The analyses and recommendations contained in this report are based on the data obtained from subsurface exploration. The methods used indicate subsurface conditions only at the specific locations where soils were observed, and only to the depths penetrated, and cannot always be relied on to accurately reflect stratigraphic heterogeneity that commonly exist between sampling locations.

Do not apply any of this report's conclusions or recommendations if the nature, design, or location of the project changes. If changes are contemplated, the author of this report should be consulted to review the impact on the applicability of the recommendations in this report. The author of this report is not responsible for any claims, damages, or liability associated with any other party's interpretation or the subsurface data or reuse this report for other projects or at other locations without written consent.

Please contact TVCE at (530) 629-3000 if any questions may arise.

Eric Keyes
Professional Engineer, P.E. C 90533

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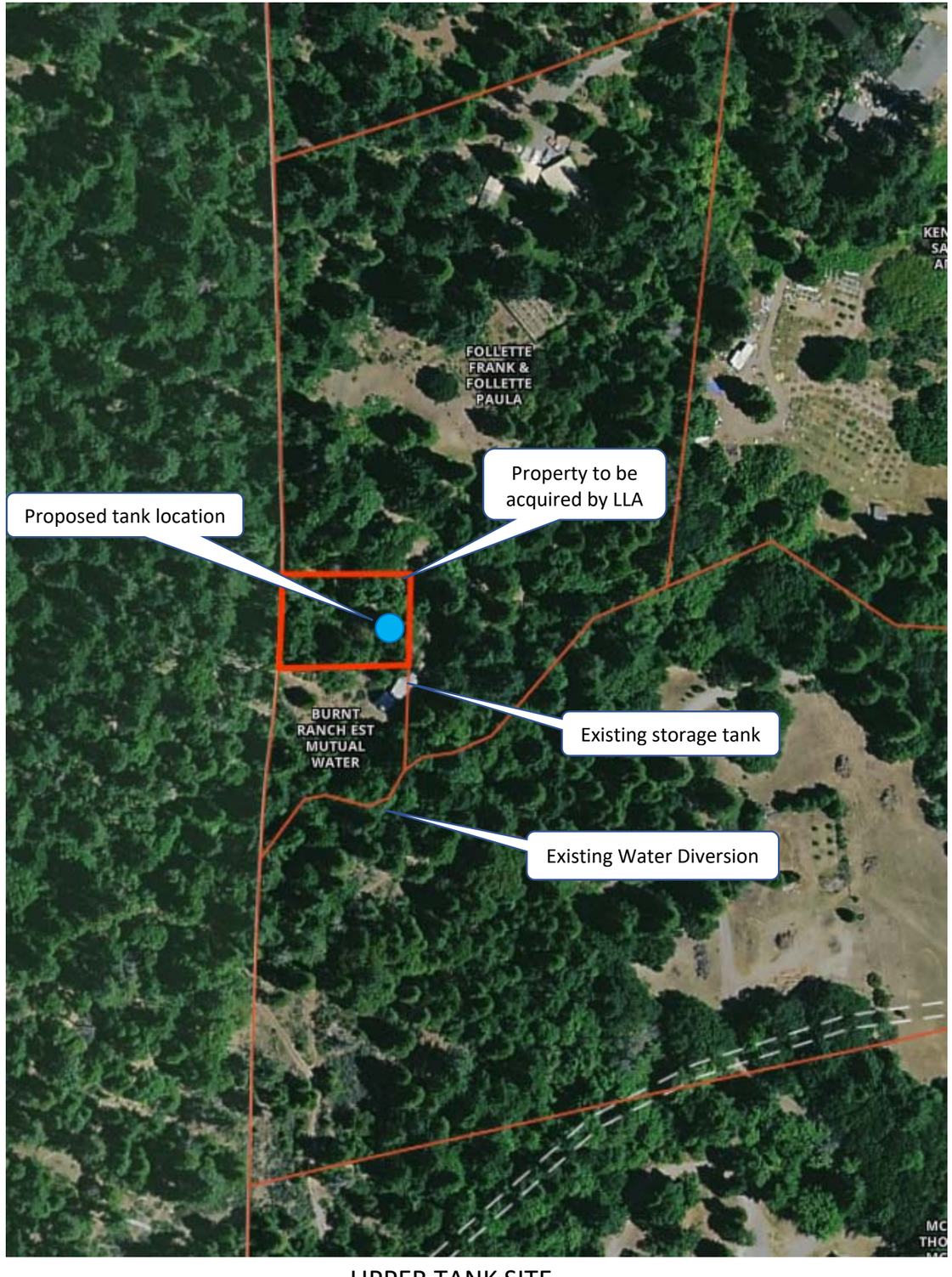
ATTACHMENT 1:

Location Map

BURNT RANCH ESTATES MUTUAL WATER COMPNAY - OVERALL SITE PLAN

BURNT RANCH ESTATES MUTUAL WATER COMPNAY – TANKS SITE EXPANDED VIEW



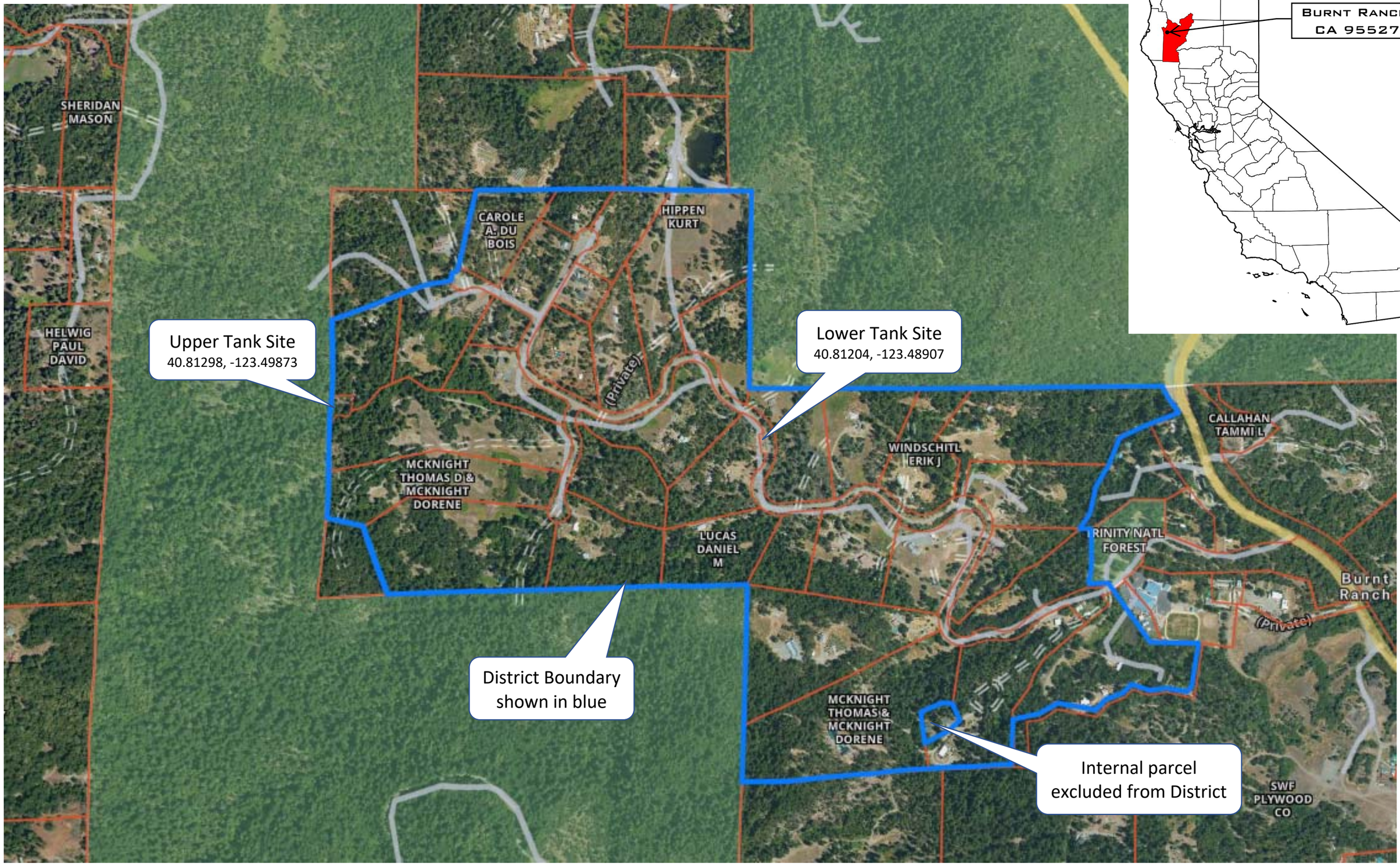
UPPER TANK SITE

LOWER TANK SITE

ATTACHMENT 2:

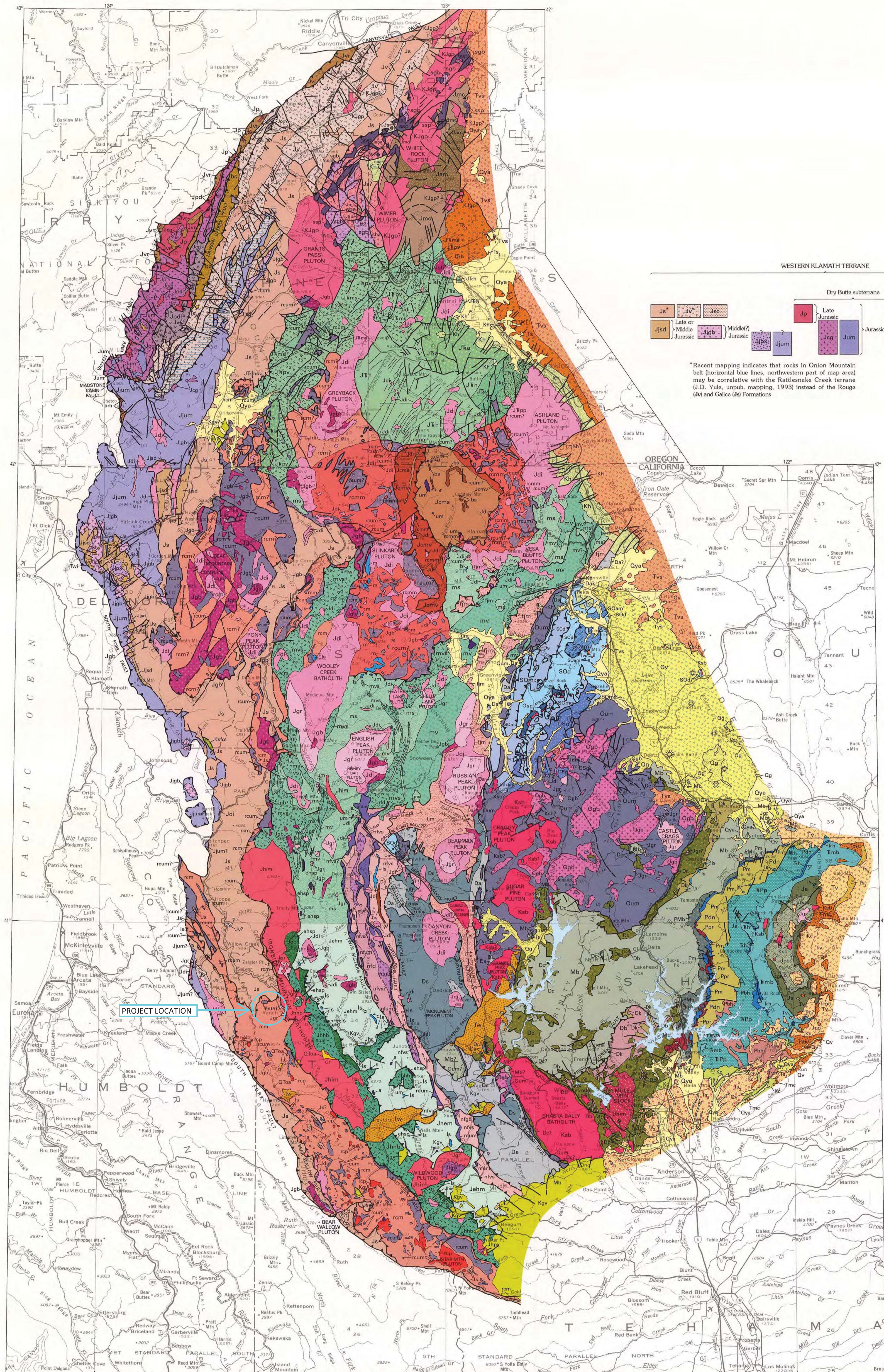
Site Map

BURNT RANCH ESTATES MUTUAL WATER COMPNAY – DISTRICT BOUNDARY



ATTACHMENT 3:

Geology Map



Base from U.S. Geological Survey State of California, 1968 (revised 1981); State of Oregon, 1964–65 (revised 1982)
Lambert Conformal Conic projection; standard parallels 33° and 45°

SCALE 1 : 500 000
10 0 10 20 30 40 MILES
10 0 10 20 30 40 50 60 KILOMETERS

Geology compiled in 1985–89
Edited by Sean Stone and Taryn Lindquist; cartography by M. Vicki Chmill, Colleen Maurer, Maureen Kelly, and Douglas S. Aitken
Manuscript approved for publication January 25, 1990

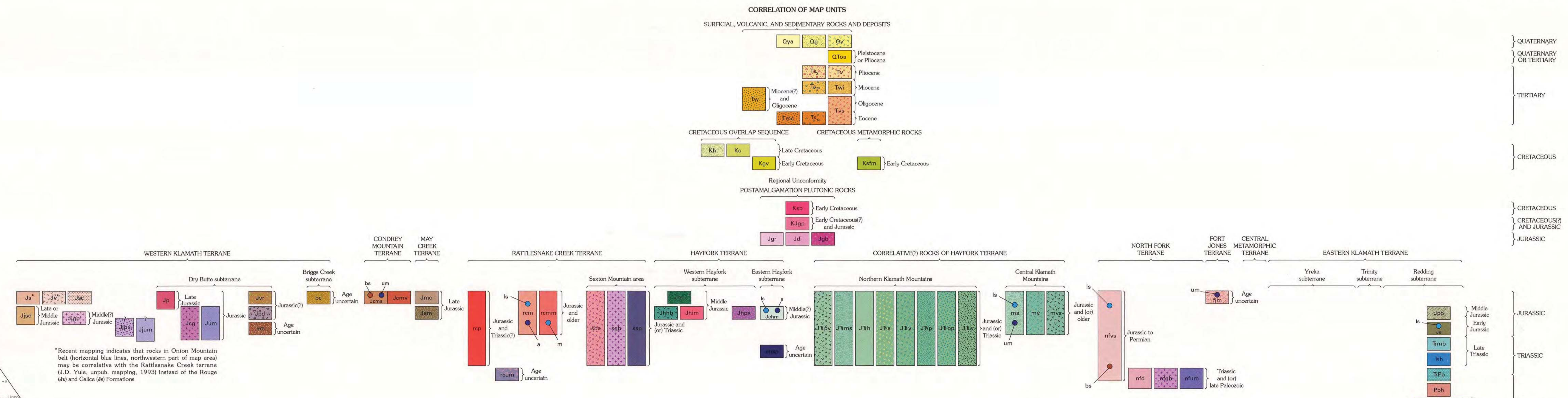
INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1994

GEOLOGIC MAP OF THE KLAMATH MOUNTAINS, CALIFORNIA AND OREGON

Compiled by
William P. Irwin

1994

CORRELATION OF MAP UNITS



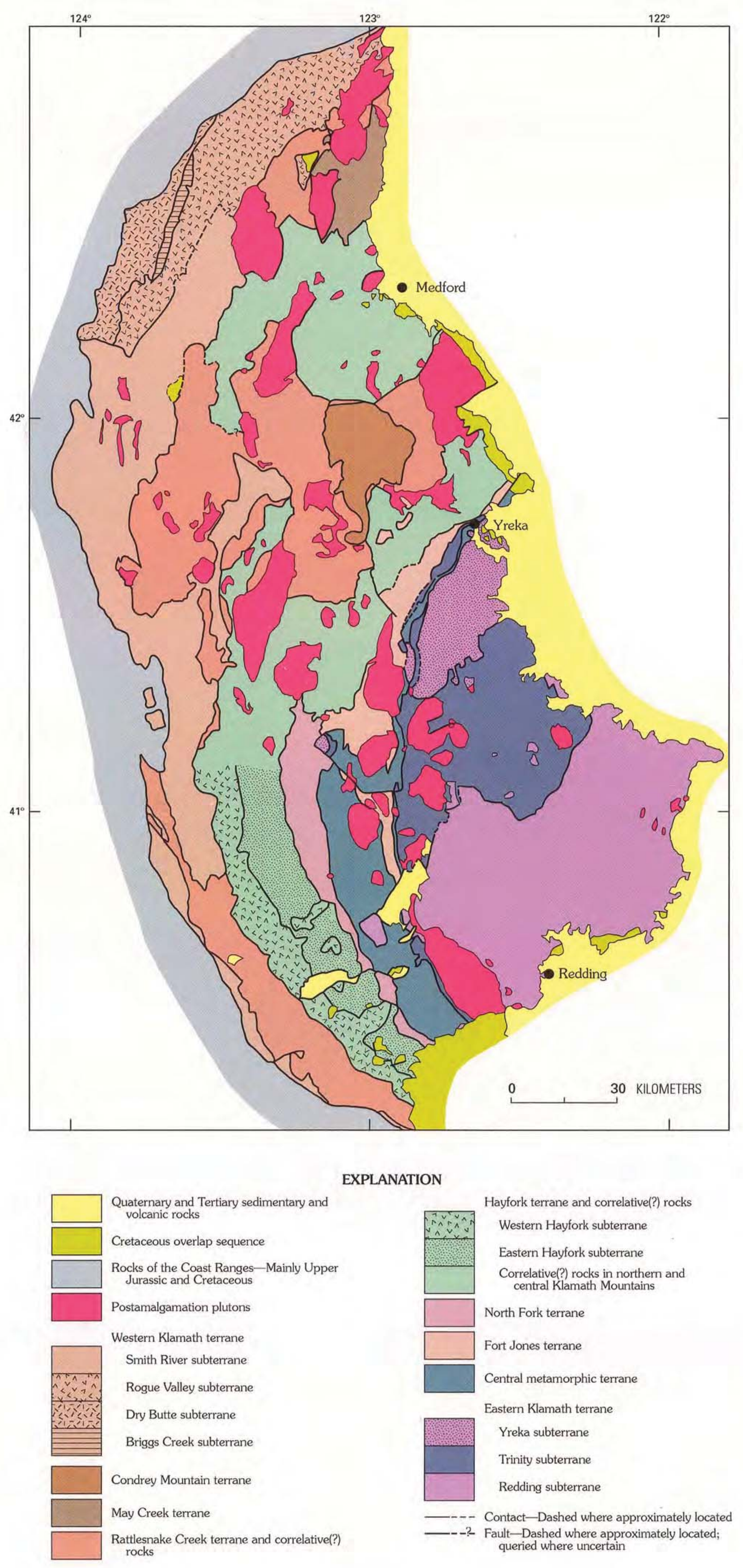


Figure 1. Terranes, subterranes, and other lithotectonic units of Klamath Mountains province

DESCRIPTION OF MAP UNITS

SURFICIAL, VOLCANIC, AND SEDIMENTARY ROCKS AND DEPOSITS

Qya **Younger alluvial deposits (Quaternary)**—Unconsolidated silt, sand, and gravel along modern streams, on terraces, and as valley fill. Includes some areas of Pleistocene pediment gravels (Red Bluff Formation) along south border of map area. Unit is shown along east and south borders of map area, but only a few large areas are shown within Klamath Mountains province

Qg **Glacial deposits (Quaternary)**—Unconsolidated glacial debris. Shown principally in Mount Shasta region at east edge of map area; numerous small patches within Klamath Mountains province not shown

Qv **Volcanic rocks (Quaternary)**—Basaltic and andesitic flows and pyroclastic rocks of Cascade Ranges along east edge of map area; includes large areas of chaotic volcanic landslide deposits northwest of Mount Shasta

QToa **Older alluvium (Pleistocene or Pliocene)**—Weakly consolidated nonmarine silt, sand, and conglomerate associated with high-level remnants of old land surfaces

Ts_3 **Sedimentary rocks (Pliocene)**—Unit includes (1) the Tehama Formation along south border of map area in western part of Great Valley, consisting of weakly consolidated sand and gravel and including the Nomlaki Tuff Member of the Tehama Formation near base of the Tehama, and (2) the Tuscan Formation along south border of province in eastern part of Great Valley, consisting of volcanic-derived siltstone, sandstone, and conglomerate and tuff. Thin veneer of pediment gravels of the Red Bluff Formation (Pleistocene) that unconformably overlies and conceals much of the Tehama and Tuscan Formations is not shown

Tv **Volcanic rocks (Pliocene)**—Basaltic and andesitic flows, breccia, and tuff of Cascade Range along southeast border of map area

Ts_2 **Sedimentary rocks (Miocene)**—Nonmarine sandstone, shale, conglomerate. Found as small patches containing minor coal in southwestern Oregon. Overlain by Pliocene volcanic rocks at easternmost edge of map area

Twi **Wimer Formation (Miocene)**—Weakly consolidated marine siltstone and sandstone. Found as high-level erosional remnants in Smith River region

Tw **Weaverville Formation (Miocene? and Oligocene)**—Weakly consolidated siltstone, sandstone, conglomerate, and tuff; nonmarine; locally contains coal beds. Late Oligocene and early Miocene(?) in age on the basis of palynomorphs (Barnett, 1982)

Tvs **Volcanic and sedimentary rocks (Oligocene and Eocene)**—Andesitic and basaltic flows, breccia, tuff, minor rhyolitic tuff, and intercalated sedimentary units of Cascade Range along east border of map area

Tmc **Montgomery Creek Formation (Eocene)**—Weakly indurated, thick-bedded arkosic sandstone, conglomerate, and shale; nonmarine and mostly fluviatile; locally includes coal beds. Approximately 800 m thick. Rests unconformably on Late Cretaceous and older rocks along southeast border of map area

Ts_1 **Sedimentary rocks (Eocene)**—Mainly fluvial sandstone and conglomerate. Mostly nonvolcanic and derived from underlying older rocks. Unconformably overlies the Hornbrook Formation along east border of map area in Oregon

CRETACEOUS OVERLAP SEQUENCE

Kh **Hornbrook Formation (Late Cretaceous)**—Shallow- and deep-water marine and nonmarine shale, sandstone, and conglomerate. Unit is about 1,200 m thick (Nilsen, 1984) and lies unconformably on Klamath basement rocks. Unit is mainly Cenomanian to Maestrichtian in age but includes minor Albian rocks (T.H. Nilsen, written commun., 1990)

Kc **Chico Formation (Late Cretaceous)**—Marine shoreline and shallow-shelf deposits of siltstone, sandstone, and conglomerate of Turonian and Santonian age (Sliter and others, 1984). Unit lies unconformably on Klamath basement rocks north and east of Redding. Generally only mildly deformed and gently dipping

Kgv **Great Valley sequence (Early Cretaceous)**—Dominantly marine, well-indurated shale, sandstone, and conglomerate. Shale locally contains calcareous beds and nodules. Main area of unit is at southern end of map area, but sedimentary outliers are found at several places within map area. Correlative strata (not shown), which are part of the Snow Camp terrane of Blake and others (1985), crop out on north side of Canyonville fault at northern end of map area. Onlap of Klamath basement terranes by the Great Valley sequence was generally from west to east. At southern end of map area, oldest overlap strata resting on Jurassic and older basement are nonmarine to marine Valanginian-age deposits (Jones and Irwin, 1971) of the Glade Creek and Big Bar outliers. Eastward, Hauterivian-age beds (Murphy and others, 1969) lie depositionally on basement rocks of Early Cretaceous (Shasta Bally batholith, 136 Ma; Lanphere and Jones, 1978) and older ages. In map area, unit is mainly Early Cretaceous but includes minor early Late Cretaceous rocks (see Blake and others, 1984)

CRETACEOUS METAMORPHIC ROCKS

Ksfm **South Fork Mountain Schist (Early Cretaceous)**—Mainly fine-grained quartz-albite-muscovite-chlorite schist and minor lawsonite; K-Ar isotopic age of metamorphism about 120 Ma (Lanphere and others, 1978). Widely exposed west of map area

POSTAMALGAMATION PLUTONIC ROCKS

[Includes some plutons of uncertain affiliation]

Ksb **Plutons of Shasta Bally belt (Early Cretaceous)**—Mostly quartz diorite, trondhjemite, and granodiorite in composition; 133 to 136 Ma in isotopic age; probably postaccretion (see Irwin, 1985a). Also includes several small Cretaceous plutons in easternmost part of the Redding subterrane (fig. 1)

KJgp **Plutons of Grants Pass belt (Early Cretaceous? and Jurassic)**—Mostly quartz diorite

Jgr **Granitoid rocks (Jurassic)**—Plutonic rocks ranging from quartz diorite to granite in composition

Jdi **Diorite (Jurassic)**—Mostly diorite, but locally includes gabbro and quartz diorite. Includes weakly foliated hornblende-diorite gneiss in Willow Creek quadrangle

Jgb **Gabbro (Jurassic)**—Includes minor pyroxenite

WESTERN KLAMATH TERRANE

[Consists of Smith River, Rogue Valley, Dry Butte, and Briggs Creek subterranes (see fig. 1; Blake and others, 1985)]

Js **Sedimentary rocks (Late Jurassic)**—Includes the Galice Formation; mildly slaty to phyllitic argillite, graywacke, and stretched-pebble conglomerate. Locally contains pyroclastic interlayers. Contains sparse pelecypods of Late Jurassic (Oxfordian to Kimmeridgian) age (Imlay and others, 1959) north of Smith River, but none found to south. Kink folds common. Unit locally metamorphosed to mica schist along tectonic boundaries of terrane. Isotopic age of metamorphic overprint is approximately 150 Ma (Lanphere and others, 1978). Locally contact metamorphosed to hornfels and chiastolite-bearing schist adjacent to plutons

Jv **Volcanic rocks (Late Jurassic)**—Includes the Rogue Formation. Consists of basaltic and andesitic volcanic and volcaniclastic rocks, interbedded shale and mudstone, and locally interbedded chert. Conformably underlies and locally interlayered with the Galice Formation in the Rogue Valley subterrane. Uncommon in the Smith River subterrane. Zircon from dacitic tuff breccia in the type Rogue Formation yielded a U-Pb age of approximately 157 Ma, and dacitic dikes that cut upper part of the Rogue are dated at approximately 150 Ma (Saleeby, 1984). Triassic radiolarian chert found (Roure and De Wever, 1983) at locality within general outline of unit is presumably of extraneous origin

Jsc **Shale and chert (Late Jurassic)**—Shale, siltstone, mudstone, and thin-bedded radiolarian chert associated with ophiolite of Onion Mountain area

Josephine ophiolite of Harper (1980) (Jurassic)—Divided into:

Jjsd **Sheeted dikes and (or) pillow basalt (Late or Middle Jurassic)**—Includes basalt in ophiolite of Onion Mountain area. Beds within and above volcanic part of unit contain latest Callovian or earliest Oxfordian radiolarians (E.A. Pessagno, Jr., and C.D. Blome, written commun., 1989)

Jjgb **Gabbro (Middle? Jurassic)**—Includes gabbro in ophiolite of Onion Mountain area

Jjpx **Pyroxenite (Jurassic)**

Jjum **Ultramafic rocks (Jurassic)**—Includes ultramafic rocks of Onion Mountain area and other ultramafic rocks of the Western Klamath terrane except units Jum and Jpd of the Dry Butte subterrane

Dry Butte subterrane

[Includes informally named Chetco River complex of Hotz (1971a)]

Jp **Plutons (Late Jurassic)**—Mainly tonalite and quartz diorite; also includes muscovite-bearing granodiorite plutons; K-Ar isotopic analyses indicate ages of approximately 153 Ma (Hotz, 1971a)

Jcg **Cumulate gabbro (Jurassic)**—Mainly cumulate two-pyroxene gabbro, locally metamorphosed, and minor hornblende-plagioclase metagabbro; locally includes diorite and quartz diorite

Jum **Ultramafic rocks (Jurassic)**—Cumulate peridotite, dunite, pyroxenite, and wehrlite

Jvr **Volcanic rocks (Jurassic?)**—Rhyodacite flows and porcelaneous tuff, with local andesite and basalt flows

Jpd **Peridotite (Jurassic?)**—Harzburgite and dunite; both tectonite and cumulate fabrics; locally completely serpentinized; separated from other units by faults (Smith and others, 1982)

am **Amphibolite (age uncertain)**—Amphibole schist and quartz-rich hornblende gneiss with local impure marble; exposed at places along Madstone Cabin fault and along province boundary near Chetco Peak; relation to the Dry Butte subterrane uncertain

Briggs Creek subterrane

bc **Briggs Creek amphibolite of Garcia (1979) (age uncertain)**—Informal unit of Garcia (1979). Mainly amphibolite but includes micaceous quartzite, quartz schist, and recrystallized manganiferous chert

CONDREY MOUNTAIN TERRANE

Condrey Mountain Schist (Late Jurassic)—Isotopic ages measured on various lithologies range from 118 to 170 Ma and are equivocal (see Helper, 1986a). May be correlative with the Galice Formation of the Western Klamath terrane and (or) with the South Fork Mountain Schist of Coast Ranges province (Helper, 1986b; Brown and Blake, 1987). Divided into:

Jcms **Metasedimentary rocks**—Graphitic quartz-albite-muscovite schist. Generally well foliated, fine to medium grained, and gray to blue black. Contains blueschist (bs) that is mostly flaggy and composed of alternating blue crossite-rich layers and green chlorite-epidote-rich layers. Unit locally includes ferruginous and manganiferous metachert and serpentinized ultramafic rocks (um)

Jcmv **Metavolcanic rocks**—Metavolcanic rocks of greenschist facies. Unit locally includes interlayers of fine-grained metasedimentary rocks (Jcms?)

MAY CREEK TERRANE

Jmc **May Creek Schist (Late Jurassic)**—Fine- to medium-grained quartzite, phyllite, micaceous quartzofeldspathic schist, impure calcareous schist, and rare marble. Grades to south into foliated volcanogenic metasedimentary rocks, including tuffaceous mafic metasandstone and metagraywacke. Unit was formerly considered a gradational metamorphic facies of the Applegate Group by previous workers (Wells and Peck, 1961); unit now shown to be in fault contact with undivided rocks of the Applegate Group (Smith and others, 1982; M.M. Donato, written commun., 1990). Protolith age is considered to be Jurassic or older

Jam **Amphibolite (Late Jurassic)**—Medium-grained hornblende-plagioclase amphibolite that may represent metamorphosed dikes, sills, and tholeiitic basalt. Metamorphic age is Late Jurassic on the basis of isotopic ages of 145 and 147 Ma measured on hornblende (M.M. Donato, oral commun., 1991). Protolith age is considered to be Jurassic or older

RATTLESNAKE CREEK TERRANE

[Includes type area in southern part of Klamath Mountains province (Irwin, 1972), questionably correlative rocks of Preston Peak area, melange of Takilma area, ophiolite of Sexton Mountain area, and metamorphosed melange of Marble Mountains, Seiad Valley, Condrey Mountain, and Dutchman Peak areas]

rcp **Plutonic rocks (Jurassic and Triassic?)**—Medium- to coarse-grained rock ranging from diorite to granite. Includes Star Mountain pluton that has a U-Pb isotopic age of approximately 200 Ma (Wright, 1981)

rcm **Melange (Jurassic and older)**—Consists of sheared and dislocated bodies of serpentinized peridotite, pillow basalt and other mafic volcanic flows and tuff, thin-bedded chert, argillite, intermediate-composition to silicic volcanic rocks, dikes and irregular intrusive bodies ranging from gabbro to granite, weakly slaty mudstone, sandstone, and conglomerate, and minor limestone (ls) and blocks of amphibolite (a). Chert contains Late Triassic to Middle Jurassic radiolarians; limestone contains Devonian(?) and younger corals, late Paleozoic fusulinids, and Late Triassic ammonites and conodonts (Irwin, 1985b; Irwin and others, 1985)

rcmm **Metamorphosed melange (Jurassic and older)**—Tectonically disrupted metasedimentary and metavolcanic rocks in Marble Mountains Wilderness area (Donato and others, 1982), in Condrey Mountain quadrangle (Hotz, 1967), and in Dutchmans Peak area (Smith and others, 1982). Consists of quartz-biotite-muscovite schist and other quartzose metasedimentary rocks that include metaquartzite (metachert?), lenses of micaceous and quartzitic marble (m), and of amphibolitic metavolcanic rocks, metadiabase, metagabbro, and metamorphosed ultramafic rocks. Probably metamorphosed equivalent of unit rcm

rcum **Serpentinized ultramafic rocks (age uncertain)**—Mainly sheared serpentinized peridotite. Locally is blocky tectonitic harzburgite and minor dunite. Includes metaperidotite (pattern), consisting mainly of olivine and variable amounts of actinolite, anthophyllite, and chlorite, in areas adjacent to unit rcmm (Coleman and others, 1988)

Sexton Mountain area

Ophiolite of Sexton Mountain area (Jurassic and (or) Triassic)—Included with the Rattlesnake Creek terrane on the basis of lithology and regional relations. Divided into:

sba **Basaltic volcanic rocks**—Mainly pillows and pillow breccia, basalt flows and flow breccia, and agglomerate. Includes diabasic and gabbroic dikes and sills

sgb **Gabbro**—Both layered and massive varieties

ssp **Serpentinite**—Serpentinized peridotite and dunite. Locally contains chromite deposits

HAYFORK TERRANE

[Consists of Eastern Hayfork and Western Hayfork subterranes in southern part of map area, probably correlative units ms, mv, and mvs in central part, and questionably correlative units formerly of Applegate Group in northern part]

Western Hayfork subterrane

Jhc **Chert, argillite, and meta-andesite (Middle Jurassic)**—Thin-bedded chert interlayered with argillite and meta-andesite. Overlies and interfingers with the Hayfork Bally Meta-andesite

Jhhb **Hayfork Bally Meta-andesite (Middle Jurassic)**—Mafic volcaniclastic rocks ranging from coarse agglomerate to crystal tuff. Commonly characterized by euhedral augite and plagioclase crystals in light- to dark-green groundmass. Locally includes thin-bedded chert and argillite. K-Ar isotopic ages measured on meta-andesite are 156 Ma (M.A. Lanphere, oral commun., 1977) and 168 to 177 Ma (Fahan, 1982). Unit represents volcanic-arc deposit. Intruded by the Ironside Mountain batholith (Jhim) and probably cogenetic. May be correlative with units mv and mvs in central part of map area and with units JTrpv, JTrh, JTra, JTrv, JTrp, and JTrpp

Jhim **Ironside Mountain batholith and related plutons (Middle Jurassic)**—Mostly medium-grained monzodiorite but includes diorite and minor gabbro and pyroxenite. Age is Middle Jurassic on the basis of isotopic ages of about 170 Ma (K-Ar analyses, revised constant, Lanphere and others, 1968; U-Pb analyses, Wright and Fahan, 1988). Intrudes the Hayfork Bally Meta-andesite (Jhhb). Related plutons include Forks of Salmon, Wildwood, and Walker Point plutons

Jhpx **Pyroxenite (Middle? Jurassic)**—Included in Wildwood and Walker Point plutons

Eastern Hayfork subterrane

Jehm **Melange (Middle? Jurassic)**—Includes mafic volcaniclastic rocks, thin-bedded chert, tuff, sandstone, limestone (ls), serpentinite, and minor mica schist and amphibolite (a). Chert contains Late Triassic and Jurassic radiolarians and Middle or Late Triassic conodonts. Limestone yielded a Late Permian ammonite and a Late Permian Tethyan fusulinid fauna. Upper age of unit is limited by unconformity at base of superjacent Lower Cretaceous strata of the Great Valley sequence

ehsp **Serpentinite (age uncertain)**

CORRELATIVE(?) ROCKS OF HAYFORK TERRANE

Northern Klamath Mountains

Correlative(?) rocks of the Hayfork terrane in northern Klamath Mountains (Jurassic and (or) Triassic)—Divided into:

JTrpv **Pyroxene volcanic rocks**—Mainly porphyritic augite andesite to andesitic basalt flows. Includes interbedded andesitic breccia and tuff breccia; dacitic to rhyodacitic breccia, tuff, and flows; and porphyritic basalt and basaltic intrusive rocks. May be equivalent to the Hayfork Bally Meta-andesite (Jhhb) of the Western Hayfork subterrane. Locally contains interlayers of metasedimentary rocks (JTrms)

JTrms **Metasedimentary rocks**—Mildly metamorphosed shale, mudstone, sandstone, conglomerate, cherty tuff, thin-bedded chert, and marble. Interlayered with pyroxene volcanic rocks (JTrpv). May include Upper Triassic limestone near Wilderville

JTrh **Hornblende volcanic rocks**—Mainly porphyritic hornblende andesite flows interlayered with argillite. Includes andesitic pyroclastic rocks interbedded with andesitic to dacitic and rhyodacitic flows and agglomerates. Dashed lines indicate local units of aphanitic bedded tuff, volcaniclastic mudstone, and rare marble

JTra **Andesitic and dacitic volcanic rocks**—Includes tuff, tuff breccia, and agglomerate

JTrv **Vesicular andesite and basalt**—Vesicular basaltic to porphyritic andesitic flows. Pillow breccia and pillow basalt found locally near top of unit. Marble containing volcaniclastic debris is locally present

JTrp **Porphyritic andesite**—Mostly flows and agglomerate, which contain plagioclase phenocrysts, clasts of porphyritic andesite, and local interbeds of crystal tuff

JTrpp **Porphyritic pyroxene andesite**

JTrs **Metasedimentary rocks**

Central Klamath Mountains

Correlative(?) rocks of the Hayfork terrane in central Klamath Mountains (Jurassic and (or) older)—Divided into:

ms **Metasedimentary rocks**—Includes slate, feldspathic metagraywacke, metachert, quartzite, and chert-argillite breccia. Locally contains pods (olistoliths?) of limestone (ls), chert, serpentinized peridotite (um), and rare amphibolite, which range in length from less than 1 m to more than 100 m. Boundary between unit and the Eastern Hayfork subterrane (Jehm) is unknown. Queried outcrops northeast of Yreka may be part of the North Fork terrane (Mortimer, 1984)

mv **Metavolcanic rocks**—Intermediate-composition to felsic, pillowed to massive, predominantly aphyric flows, tuff, and minor intrusive rocks. Locally resemble and may be genetically related to units mvs and Jhhb. Queried outcrops northeast of Yreka may be part of the North Fork terrane (Mortimer, 1984)

mvs **Volcanogenic metasedimentary rocks**—Mainly pale- to dark-greenish gray volcaniclastic rocks and rare flows of andesite and basalt. Locally interbedded with slate. Graded bedding locally abundant. Includes crystal tuff containing phenocrysts of pyroxene and (or) hornblende and, in some cases, plagioclase. Metamorphic assemblage is commonly actinolite-epidote-albite-biotite. Unit probably equivalent to the Hayfork Bally Meta-andesite (Jhhb)

NORTH FORK TERRANE

nfvs **Volcanic and sedimentary rocks (Jurassic to Permian)**—Basaltic volcanic and volcaniclastic rocks and interlayered argillite, thin-bedded chert, and limestone (ls). Chert and siliceous argillite contain radiolarians of Permian, Triassic, and Early Jurassic ages. Limestone is generally oolitic, and some lenses contain Permian fusulinids. Blocks (olistoliths?) of blueschist-facies metavolcanic rocks (bs) are present in Salmon River area

North Fork ophiolite (Triassic and (or) late Paleozoic)—Divided into:

nfd **Diabase and basalt**

nfgb **Gabbro**—Zircon from plagiogranite pod in gabbro of Salmon River area yielded late Paleozoic (265–310 Ma) isotopic age (Ando and others, 1983)

nfum **Ultramafic rocks**—Dominantly serpentinized harzburgite

FORT JONES TERRANE

fjm **Metasedimentary and metavolcanic rocks (age uncertain)**—Micaceous quartzite and phyllite (representing bedded chert, shale, and sandstone) and actinolitic schist and phyllonite (representing metavolcanic rocks). Contains blueschist-facies metamorphic minerals; near Yreka, contains blocks of blueschist (x) that yield K-Ar isotopic ages of about 220 Ma (Late Triassic) (Hotz and others, 1977). Also contains ultramafic rocks (um) of unknown affinity in outlier west of Yreka. Includes the Stuart Fork Formation

CENTRAL METAMORPHIC TERRANE

Da **Abrams Schist (Devonian)**—Predominantly metasedimentary rocks, including quartz-mica schist, calc schist, micaceous marble, and minor intercalated amphibolite schist. As mapped, includes the Grouse Ridge Formation of Davis and others (1965). In Scott Valley-Yreka area, unit as mapped also includes unnamed metasedimentary rocks (Potter and others, 1977) and, in undivided southernmost part of terrane, part of the underlying Salmon Schist. Rb-Sr age of approximately 380 Ma (Lanphere and others, 1968). Cometamorphic with the Salmon Schist

Ds **Salmon Schist (Devonian)**—Mostly fine- to medium-grained hornblende-epidote-albite schist. Locally phyllonitic and retrograded. Probably represents metamorphosed mafic volcanic rocks. As mapped, includes unnamed amphibolite in Scott Valley-Yreka area that has K-Ar isotopic age of 390 to 399 Ma (Hotz, 1977)

EASTERN KLAMATH TERRANE

[Consists of Yreka, Trinity, and Redding subterranes]

Yreka subterrane

DSg **Gazelle Formation (Early Devonian to Early? Silurian)**—Shale, mudstone, siltstone, sandstone, limestone, bedded chert, and siliceous mudstone; poorly to well bedded; total thickness may exceed 1,300 m. Divided into three informal units (Potter and others, 1977), but units not distinguished in map area

SOmc **Moffett Creek Formation (Silurian and Ordovician?)**—Tan-weathering shale and mudstone, calcareous siltstone, sandstone, and minor bedded chert, siliceous mudstone, and limestone; mostly massive and disrupted; generally unfossiliferous, but chert contains Ordovician or Silurian radiolarians; commonly in fault contact with adjacent units, but locally is depositionally overlain by the Gazelle Formation (Potter and others, 1977)

SOam **Antelope Mountain Quartzite (Silurian and (or) Ordovician)**—Well-bedded quartz sandstone. Beds commonly 0.5 to 1.5 m thick. Locally thin and rhythmically bedded. Includes beds and lenses of chert adjacent to the Duzel Phyllite. Thickness may be 1,500 to 1,700 m. Depositionally overlies the Duzel Phyllite (Hotz, 1977)

SOd **Duzel Phyllite (Silurian and (or) Ordovician)**—Phyllitic calcareous siltstone and calcareous sandstone (Potter and others, 1977). Locally resembles the Moffett Creek Formation. As mapped, includes the Schulmeyer Gulch sequence of Hotz (1977) west and north of the Antelope Mountain Quartzite

Osg **Schist of Skookum Gulch of Potter and others (1977) (Ordovician? and older)**—Mainly melange of albite-chlorite-epidote-actinolite schist and phyllite containing limestone lenses and tectonic blocks of glaucophane-lawsonite rock and plutonic rocks (Hotz, 1977). Plutonic rocks (p) range from quartz diorite to plagiogranite and yield U-Pb isotopic ages of about 565 to 570 Ma (Early Cambrian) (Wallin and others, 1988)

Trinity subterrane

Ov **Volcanic rocks and diabase (Ordovician?)**—Mafic volcanic rocks consisting of massive flows, breccias, and local volcaniclastic beds; unconformably overlain by Ordovician rocks in Lovers Leap area (Potter and others, 1977); relation to underlying ophiolitic rocks uncertain

Ogb **Gabbro and diorite (Ordovician)**—Cumulate and layered hornblende gabbro grading into hornblende diorite and quartz diorite. Includes younger pegmatitic gabbro. U-Pb isotopic ages measured on layered gabbro and diorite are as old as 455 to 480 Ma (Lindsley-Griffin, 1977; Wallin and others, 1988)

Oum **Trinity ultramafic sheet (Ordovician)**—Dominantly serpentinized tectonitic peridotite (harzburgite and lherzolite) and minor dunite; in part, may represent an ophiolite (Lindsley-Griffin, 1982). Intruded by Ordovician gabbro (Ogb)

Redding subterrane

Jpo **Potem Formation (Middle and Early Jurassic)**—Marine argillite, tuffaceous sandstone, and minor limestone and coarse pyroclastic deposits. Normally gray to black, but locally weathers red to reddish purple. Locally highly fossiliferous. Probably late Pliensbachian to early Bathonian in age (Sanborn, 1960)

Ja **Arvison Formation of Sanborn (1960) (Early Jurassic)**—Marine andesitic pyroclastic beds, flows, breccia, and conglomerate and interbedded tuff, tuffaceous sandstone, and minor limestone (ls). May be gradational upward into the Potem Formation. Probably Sinemurian and early Pliensbachian in age (Sanborn, 1960)

Trmb **Modin Formation of Sanborn (1960) and Brock Shale, undivided (Late Triassic)**—The Modin Formation consists of three members of Sanborn (1960): the basal Hawkins Creek Member, consisting of coarse pyroclastic and conglomeratic beds that contain limestone clasts that have fossils of ages similar to the Hosselkus Limestone; the medial Devils Canyon Member, consisting of tuffaceous limestone and sandstone; and the upper Kosk Creek Member, consisting of thin-bedded argillite; total thickness approximately 1,675 m; probably late Norian to Rhaetian in age; conformably(?) overlies the Brock Shale. The Brock Shale consists of argillite and interbeds of tuff and tuffaceous sandstone; approximately 120 m thick; probably Norian in age (Sanborn, 1960); conformably overlies the Hosselkus Limestone

Trh **Hosselkus Limestone (Late Triassic)**—Thin-bedded to massive, light-gray marine limestone. Locally pinches out, and ranges up to approximately 120 m thick. Conformable with the overlying Brock Shale and the underlying Pit Formation. Highly fossiliferous in basal part. Karnian and early Norian(?) in age (Sanborn, 1960)

TrPp **Pit Formation (Triassic and Permian?)**—Marine shale, mudstone, siltstone, and pyroclastic rocks. Includes minor lenses of limestone similar to the Hosselkus Limestone, and quartz keratophyre and metadacite tuff and flows. Thickness ranges from approximately 600 to 1,500 m. Conformably underlies the Hosselkus Limestone, and overlies and interfingers with the Bully Hill Rhyolite. Unit has generally been considered to be Middle and Late Triassic in age (Albers and Robertson, 1961), but tuffaceous chert that may possibly be in basal part of formation contains Permian radiolarians (Silberling and Jones, 1982)

Pbh **Bully Hill Rhyolite (Permian)**—Quartz keratophyre and metadacite tuff, tuff breccia, and shallow intrusive rocks; locally includes flows similar to the Dekkas Andesite. Thickness ranges from approximately 30 m to as much as 760 m. Unit locally intertongues with the overlying Pit Formation and the underlying Dekkas Andesite

Ppr **Pit River stock and related plutons (Permian)**—The Pit River stock is medium- to coarse-grained quartz diorite, granodiorite, and albite granite. Isotopic (U-Pb) age is 261 Ma (Fraticelli and others, 1985). Other small plutons of albite quartz diorite and mafic diorite (pattern) along general outcrop belt of the McCloud Limestone (unit Pm) are probably similar in age to and cogenetic with the Dekkas Andesite

Pdn **Dekkas Andesite and Nosoni Formation, undivided (Permian)**—Equivalent to the Bollibokka Group of Coogan (1960). The Dekkas Andesite is mostly volcanic breccia and pyroclastic rocks but includes interbedded mudstone, tuffaceous sandstone, and local limestone (ls); tuffaceous beds contain fusulinids of Guadalupian age (Albers and Robertson, 1961); interfingers with the underlying Nosoni Formation. The Nosoni is mostly tuffaceous mudstone and tuff and subordinate sandstone, conglomerate, and mafic flows; contains abundant fossils of Guadalupian and Leonardian(?) age (Albers and Robertson, 1961; Miller, 1986). In southern part of outcrop belt, thickness of the Dekkas is approximately 300 to 1,060 m and the Nosoni is as much as 610 m (Albers and Robertson, 1961). In northern part, thickness of the undivided Dekkas and Nosoni is nearly 6 km (Miller, 1986). Separated from the underlying McCloud Limestone by disconformity and, locally, by intrusive rocks

Pm **McCloud Limestone (Early Permian)**—Light-gray limestone and minor chert lenses and nodules. Thickness may be as much as 1,525 m. Contains abundant corals and fusulinids; mainly Wolfcampian and Leonardian(?) in age (Albers and Robertson, 1961). Separated at many places from the overlying Nosoni and the underlying Baird Formations by mafic quartz diorite intrusions and by faults

PMb **Baird Formation (Permian to Mississippian)**—Mostly mafic pyroclastic rocks and interbedded tuffaceous sandstone, mudstone, siliceous mudstone, tuff, flows, and minor limestone and chert. Thickness approximately 915 to 1,525 m. Contains abundant brachiopods, bryozoans, and corals that range in age from Late Mississippian to Late Pennsylvanian or Early Permian (Watkins, 1974). Unit is mainly Mississippian and Pennsylvanian in age but ranges into the Permian (Wolfcampian) at Hirz Mountain (Watkins, 1985)

Mb **Bragdon Formation (Mississippian)**—Interbedded dark shale, siltstone, sandstone, grit, and locally abundant pebble-conglomerate beds. May be as much as 1,828 m thick (Diller, 1906). Conformably underlies the Baird Formation. May rest unconformably on older rocks that consist of the Kennett Formation at some places and at other places the Balaklala Rhyolite or the Copley Greenstone. Generally unfossiliferous but locally contains fossiliferous limestone and siltstone near top of unit (Watkins, 1974). Metamorphosed to spotted slate and quartz-biotite schist in aureole of the Shasta Bally batholith (Irwin, 1963)

Dk **Kennett Formation (Middle and Early? Devonian)**—Interbedded dark siliceous shale, rhyolitic tuff, and limestone (ls). The limestone is rich in corals, conodonts, and brachiopods of late Eifelian age (Boucot and others, 1974). In Shasta Lake region, the Kennett is a maximum of 122 m thick and grades downward into the Balaklala Rhyolite (Kinkel and others, 1956). Unit shown along Spring Creek fault is highly contorted cherty shale, thin and discontinuous, and of questionable formational affiliation (Albers and others, 1964)

Dmm **Mule Mountain stock (Devonian)**—Mostly medium- to coarse-grained albite granite, trondhjemite, and quartz diorite. Isotopic (U-Pb) age is 400 Ma (Albers and others, 1981). Outcrop is generally highly weathered

Db **Balaklala Rhyolite (Middle and (or) Early Devonian)**—Consists of silicic flows, breccia, and tuff. Lower part is mostly pyroclastic, and upper part is mostly flows. May be as much as 1,067 m thick in southern part of the Redding subterrane, where it forms a volcanic pile that thins toward its edges (Kinkel and others, 1956); generally absent in northern part. Early Devonian age is based on probable cogenetic relation and intrusion by the Mule Mountain stock. Middle Devonian age is suggested by presence of a fossil marine fish (Boucot and others, 1974) and by gradational relation to the Kennett Formation

Dc **Copley Greenstone (Early Devonian)**—Mainly andesitic and basaltic volcanic breccia, tuff, and pillow lavas. Thickness is at least 1,128 m and may be as much as 1,829 m (Kinkel and others, 1956). Upper part contains interbeds of rhyolitic tuff and grades into the overlying Balaklala Rhyolite. Formation rests on the Trinity ultramafic sheet, but contact is not exposed and may be a fault. Unit is unfossiliferous. Age is Early Devonian on the basis of stratigraphic relation with the Balaklala Rhyolite and on intrusion by, and possible cogenetic relation with, the Mule Mountain stock. Metamorphosed to gneiss and amphibolite adjacent to the Shasta Bally batholith (Albers and others, 1964)

Contact—Dashed where approximately located; dotted where concealed; queried where uncertain

Fault—Dashed where approximately located; dotted where concealed

Thrust fault—Dashed where approximately located; dotted where concealed. Sawteeth on upper plate

Fold axis

Antiform—Showing direction of plunge

Overturned antiform

Synform

Volcanic cone

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225

ATTACHMENT 4:

Soil Exploration

Date: 06/19/2023

Report to: Burnt Ranch Estates Mutual Water
PO Box 102
Burnt Ranch, CA 95527

RE: APN: N/A

TP #: 1A, 1B, 1C Depth: 2', 5', 9' Sample Description: Soil

Sampled By: J. McKnight Date Tested: 06/16/2023 Date Sampled: 05/21/2023

SOILS EXAMINATION FOR SOIL PERCOLATION SUITABILITY

Textural Analysis	TP-1A	TP-1B	TP-1C
Sand:	74%	66%	62%
Clay:	14%	14%	17%
Silt:	12%	20%	21%
Zone Classification:	**2**	**2**	**2**

Bulk Density: N/A

Comments:

Zone 1 - Soils in this zone are very high in sand content. They readily accept effluent, but because of their low silt and clay content, they provide minimal filtration. These soils demand greater separation distances from ground water.

Zone 2 - Soils in this zone provide adequate percolation rates and filtration to effluent. They are suitable for use of a conventional system without further testing.

Zone 3 - Soils in this zone are expected to provide filtration of effluent, but their ability at a suitable rate is questionable. These soils require wet-weather percolation tests to verify their suitability for effluent disposal by conventional leachfield methods.

Zone 4 - Soils in this zone are unsuitable for a conventional leach field because of their severe limitations for accepting effluent.

Josh McKnight, P.E.

Soil Texture Analysis Worksheet

Job Name: BREMW - Drought Resilience

Job No.: 1754.04

Performed By: J. McKnight

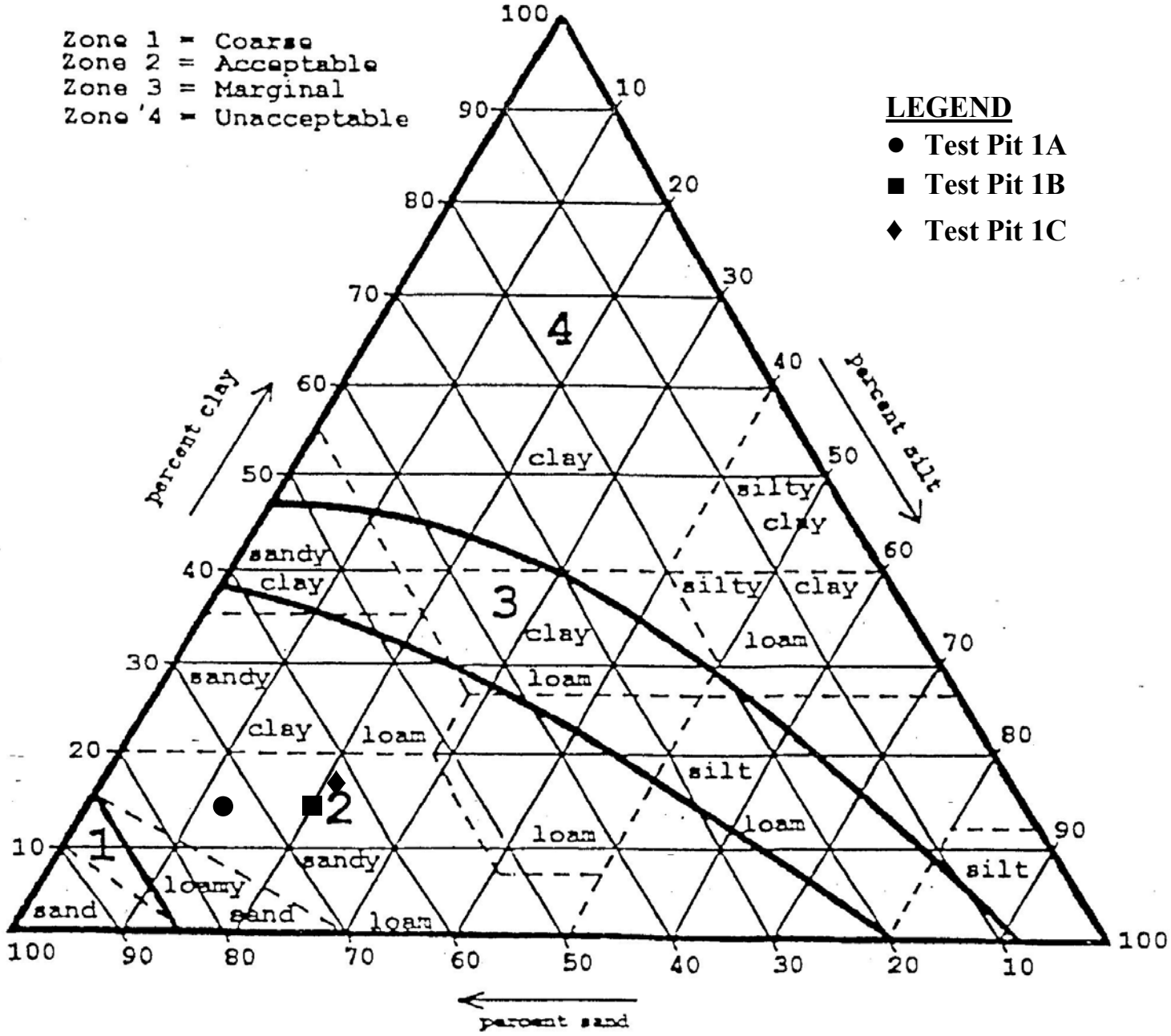
Hole #	TP-1A	TP-1B	TP-1C	
Depth (ft)	2	5	9	
Oven Dry Weight (g)	100	100	100	
Starting Time	1435	1430	1455	
Temp @ 40 Sec	62	62	64	
Hydrometer Reading @ 40 sec	34	42	45	
Composite Correction	7.7	7.7	7.3	
True Density @ 40 sec	26.3	34.3	37.7	
Temp @ 2 Hours	73	73	74	
Hydrometer Reading @ 2 Hours	19	19	22	
Composite Correction	5.5	5.5	5.3	
True Density @ 2 hours	13.5	13.5	16.7	
% Sand	74	66	62	
% Clay	14	14	17	
% Silt	12	20	21	
Soil Zone	**2**	**2**	**2**	
Classification	**Sandy Loam**	**Sandy Loam**	**Sandy Loam**	

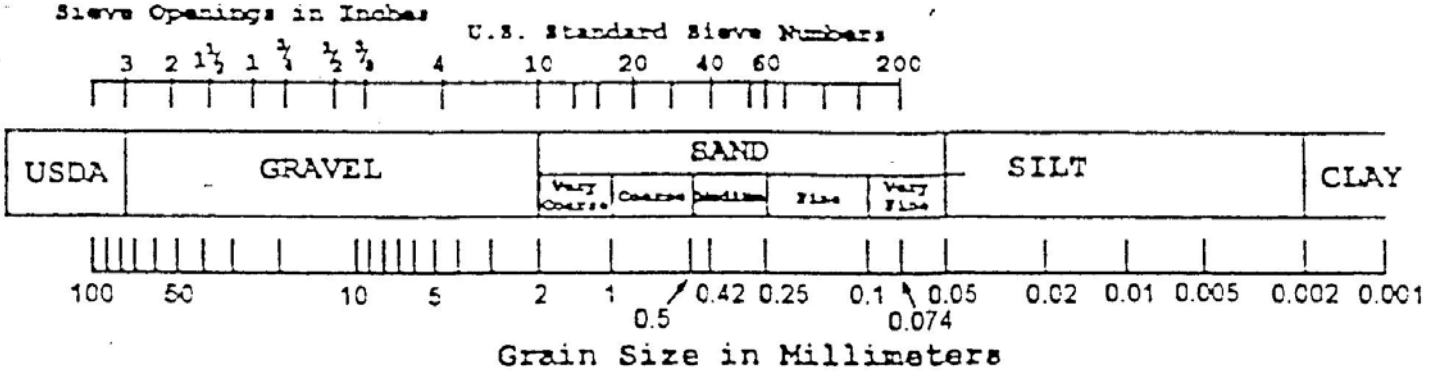
Job Name: BREMW - Drought Resilience
Job No.: 1754.04

Test Pit Number	TP-1A	TP-1B	TP-1C	
Percolation Rate (minutes per inch)	16	16	16	
Application Rate (gallons per day per square foot)	0.7	0.7	0.7	

Joshua T. McKnight CE 60687

BREMW – Drought Resilience Project
APN: N/A
Job No. 1754.04





Date: 06/19/2023

Report to: Burnt Ranch Estates Mutual Water
PO Box 102
Burnt Ranch, CA 95527

RE: APN: N/A

TP #: 2A, 2B, 2C Depth: 2', 5', 9' Sample Description: Soil

Sampled By: J. McKnight Date Tested: 06/16/2023 Date Sampled: 05/21/2023

SOILS EXAMINATION FOR SOIL PERCOLATION SUITABILITY

Textural Analysis	TP-2A	TP-2B	TP-2C
Sand:	69%	73%	69%
Clay:	12%	9%	11%
Silt:	19%	18%	20%
Zone Classification:	**2**	**2**	**2**

Bulk Density: N/A

Comments:

Zone 1 - Soils in this zone are very high in sand content. They readily accept effluent, but because of their low silt and clay content, they provide minimal filtration. These soils demand greater separation distances from ground water.

Zone 2 - Soils in this zone provide adequate percolation rates and filtration to effluent. They are suitable for use of a conventional system without further testing.

Zone 3 - Soils in this zone are expected to provide filtration of effluent, but their ability at a suitable rate is questionable. These soils require wet-weather percolation tests to verify their suitability for effluent disposal by conventional leachfield methods.

Zone 4 - Soils in this zone are unsuitable for a conventional leach field because of their severe limitations for accepting effluent.

Josh McKnight, P.E.

Soil Texture Analysis Worksheet

Job Name: BREMW - Drought Resilience

Job No.: 1754.04

Performed By: J. McKnight

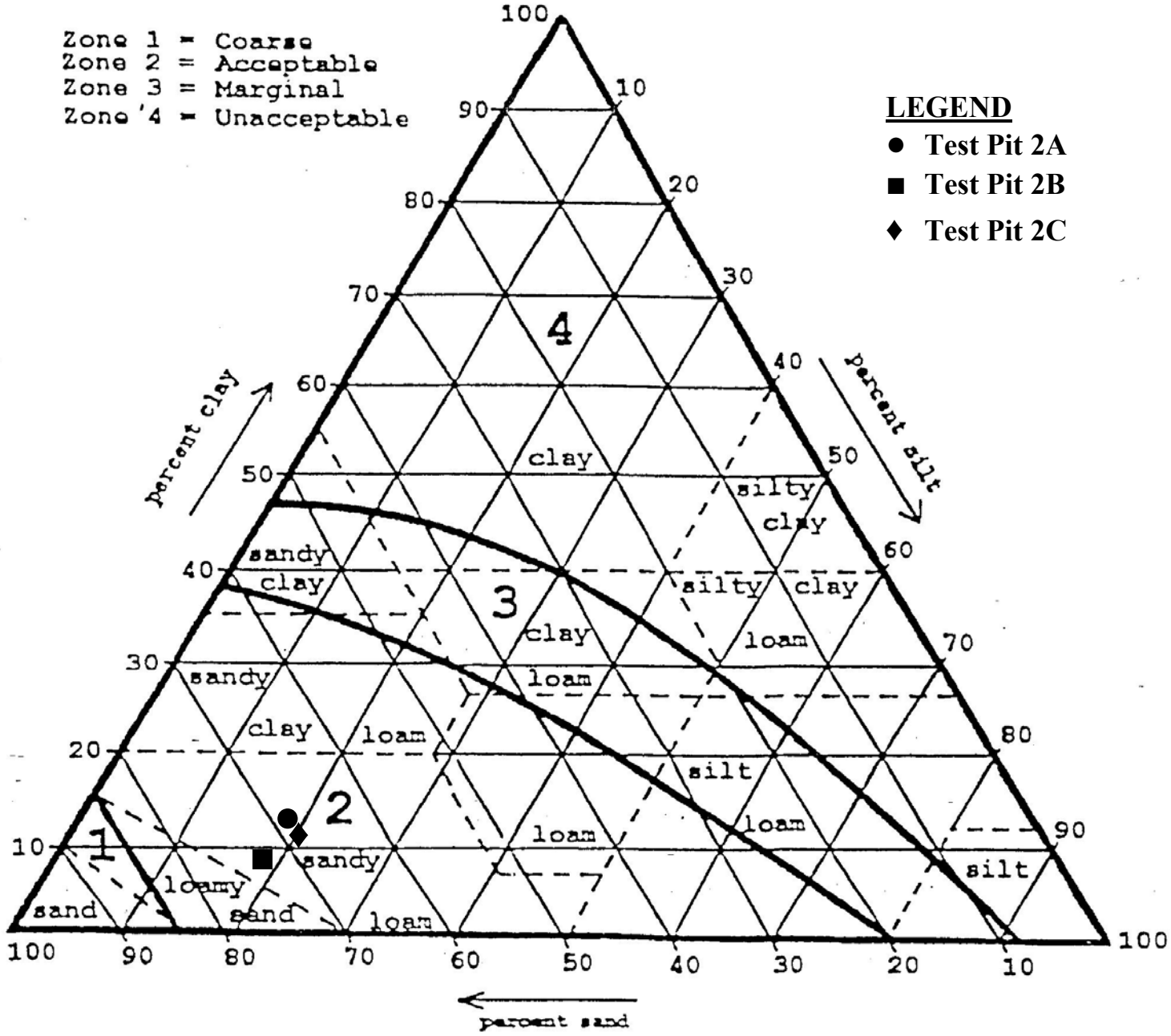
Hole #	TP-2A	TP-2B	TP-2C	
Depth (ft)	2	5	9	
Oven Dry Weight (g)	100	100	100	
Starting Time	1440	1445	1500	
Temp @ 40 Sec	65	66	64	
Hydrometer Reading @ 40 sec	38	34	38	
Composite Correction	7.1	6.9	7.3	
True Density @ 40 sec	30.9	27.1	30.7	
Temp @ 2 Hours	73	74	74	
Hydrometer Reading @ 2 Hours	17	14	16	
Composite Correction	5.5	5.3	5.3	
True Density @ 2 hours	11.5	8.7	10.7	
% Sand	69	73	69	
% Clay	12	9	11	
% Silt	19	18	20	
Soil Zone	**2**	**2**	**2**	
Classification	**Sandy Loam**	**Sandy Loam**	**Sandy Loam**	

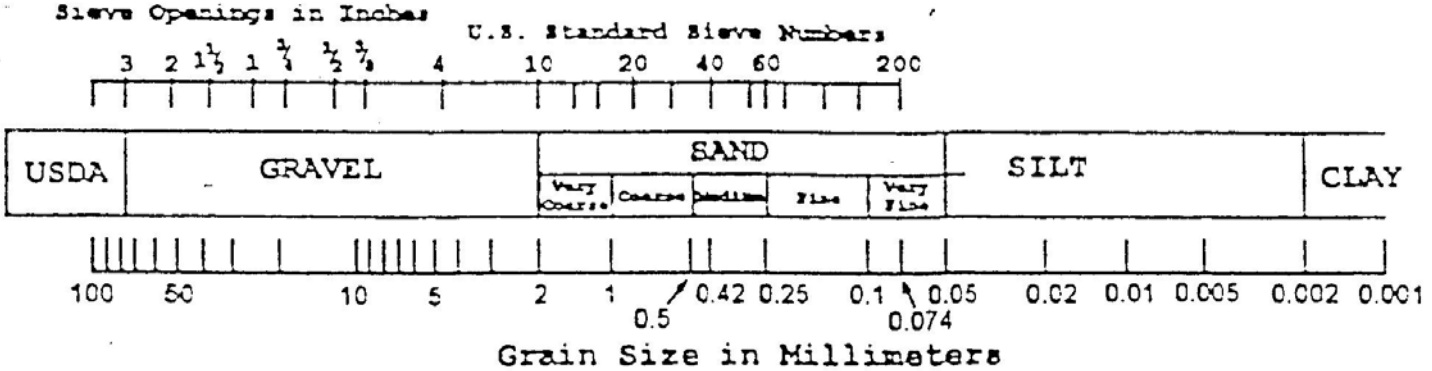
Job Name: BREMW - Drought Resilience
Job No.: 1754.04

Test Pit Number	TP-2A	TP-2B	TP-2C	
Percolation Rate (minutes per inch)	16	16	16	
Application Rate (gallons per day per square foot)	0.7	0.7	0.7	

Joshua T. McKnight CE 60687

BREMW – Drought Resilience Project
APN: N/A
Job No. 1754.04





Date: 06/19/2023

Report to: Burnt Ranch Estates Mutual Water
PO Box 102
Burnt Ranch, CA 95527

RE: APN: N/A

TP #: 3A, 3B, 3C Depth: 2', 5', 8' Sample Description: Soil

Sampled By: J. McKnight Date Tested: 06/12/2023 Date Sampled: 05/21/2023

SOILS EXAMINATION FOR SOIL PERCOLATION SUITABILITY

Textural Analysis	TP-3A	TP-3B	TP-3C
Sand:	79%	61%	62%
Clay:	9%	13%	13%
Silt:	12%	26%	25%
Zone Classification:	**2**	**2**	**2**

Bulk Density: N/A

Comments:

Zone 1 - Soils in this zone are very high in sand content. They readily accept effluent, but because of their low silt and clay content, they provide minimal filtration. These soils demand greater separation distances from ground water.

Zone 2 - Soils in this zone provide adequate percolation rates and filtration to effluent. They are suitable for use of a conventional system without further testing.

Zone 3 - Soils in this zone are expected to provide filtration of effluent, but their ability at a suitable rate is questionable. These soils require wet-weather percolation tests to verify their suitability for effluent disposal by conventional leachfield methods.

Zone 4 - Soils in this zone are unsuitable for a conventional leach field because of their severe limitations for accepting effluent.

Josh McKnight, P.E.

Soil Texture Analysis Worksheet

Job Name: BREMW - Drought Resilience

Job No.: 1754.04

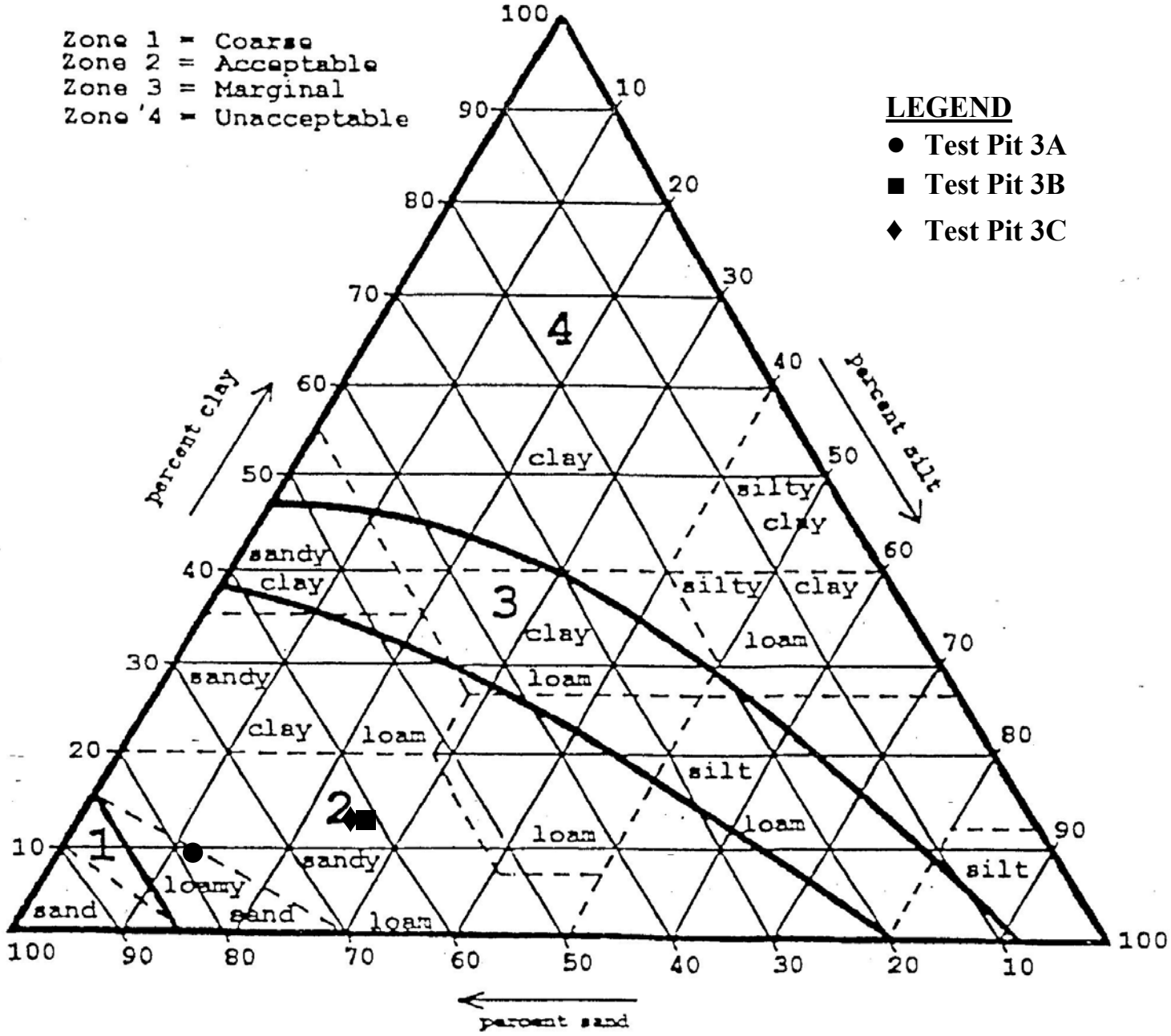
Performed By: J. McKnight

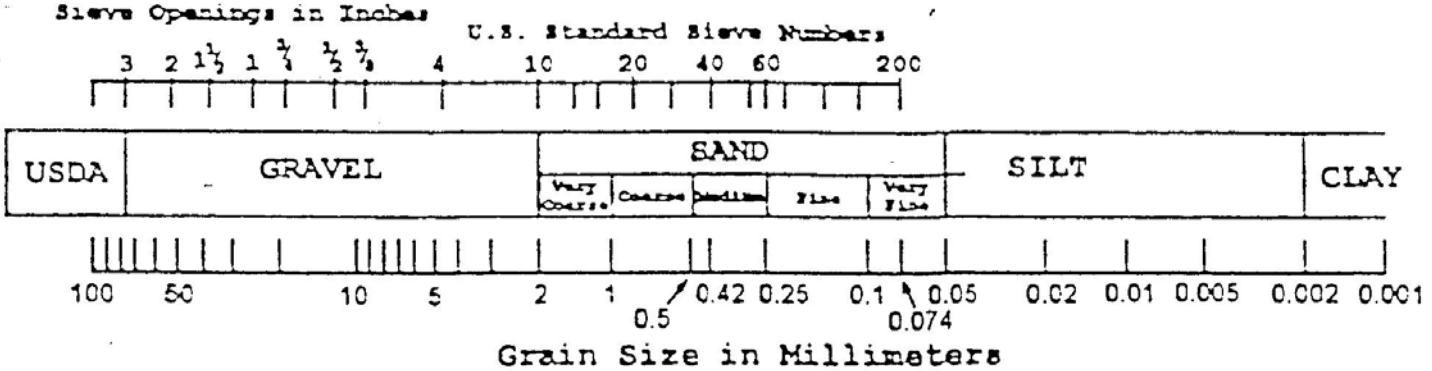
Hole #	TP-3A	TP-3B	TP-3C	
Depth (ft)	2	5	8	
Oven Dry Weight (g)	100	100	100	
Starting Time	0915	0925	0910	
Temp @ 40 Sec	65	66	65	
Hydrometer Reading @ 40 sec	28	46	45	
Composite Correction	7.1	6.9	7.1	
True Density @ 40 sec	20.9	39.1	37.9	
Temp @ 2 Hours	74	74	75	
Hydrometer Reading @ 2 Hours	14	18	18	
Composite Correction	5.3	5.3	5.1	
True Density @ 2 hours	8.7	12.7	12.9	
% Sand	79	61	62	
% Clay	9	13	13	
% Silt	12	26	25	
Soil Zone	**2**	**2**	**2**	
Classification	**Sandy Loam**	**Sandy Loam**	**Sandy Loam**	

Job Name: BREMW - Drought Resilience
Job No.: 1754.04

Test Pit Number	TP-3A	TP-3B	TP-3C	
Percolation Rate (minutes per inch)	16	16	16	
Application Rate (gallons per day per square foot)	0.7	0.7	0.7	

BREMW – Drought Resilience Project
APN: N/A
Job No. 1754.04





TRINITY VALLEY CONSULTING ENGINEERS, INC
Engineering – Surveying – Land Planning – Construction Management

Date: 06/19/2023

Report to: Burnt Ranch Estates Mutual Water
PO Box 102
Burnt Ranch, CA 95527

RE: APN: N/A

TP #: 4A, 4B, 5A, 5B Depth: 2', 5' Sample Description: Soil

Sampled By: J. McKnight Date Tested: 06/16/2023
06/12/2023 Date Sampled: 05/21/2023

SOILS EXAMINATION FOR SOIL PERCOLATION SUITABILITY

Textural Analysis	TP-4A	TP-4B	TP-5A	TP-5B
Sand:	58%	67%	42%	62%
Clay:	15%	12%	23%	16%
Silt:	27%	21%	35%	22%
Zone Classification:	**2**	**2**	**2**	**2**

Bulk Density: N/A

Comments:

Zone 1 - Soils in this zone are very high in sand content. They readily accept effluent, but because of their low silt and clay content, they provide minimal filtration. These soils demand greater separation distances from ground water.

Zone 2 - Soils in this zone provide adequate percolation rates and filtration to effluent. They are suitable for use of a conventional system without further testing.

Zone 3 - Soils in this zone are expected to provide filtration of effluent, but their ability at a suitable rate is questionable. These soils require wet-weather percolation tests to verify their suitability for effluent disposal by conventional leachfield methods.

Zone 4 - Soils in this zone are unsuitable for a conventional leach field because of their severe limitations for accepting effluent.

Josh McKnight, P.E.

Main Office
67 Walnut Way
Willow Creek CA 95573
(530) 629.3000

Weaverville Office
2200 Main Street
Weaverville CA 96093
(530) 623.4446

Soil Texture Analysis Worksheet

Job Name: BREMW - Drought Resilience

Job No.: 1754.04

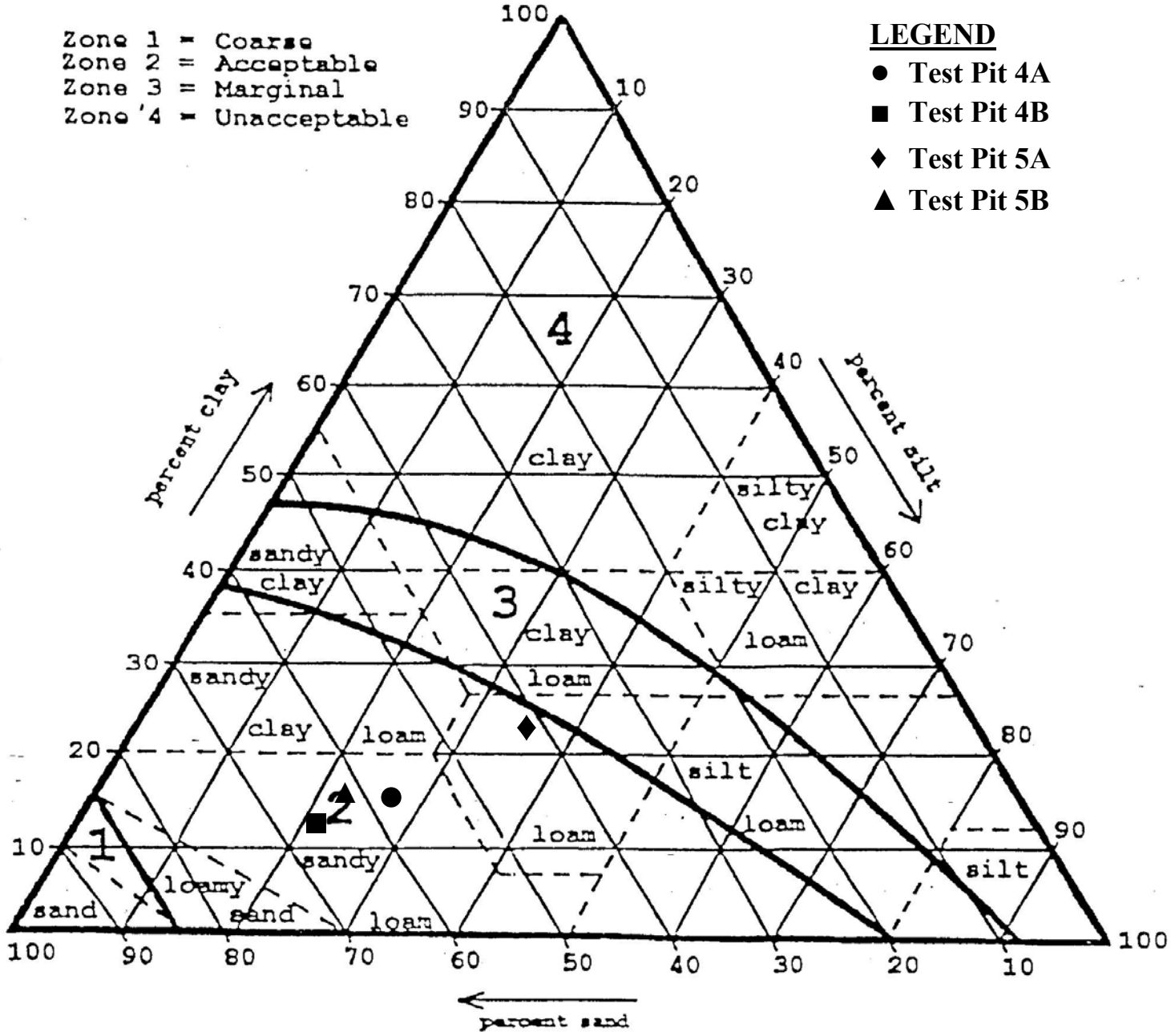
Performed By: J. McKnight

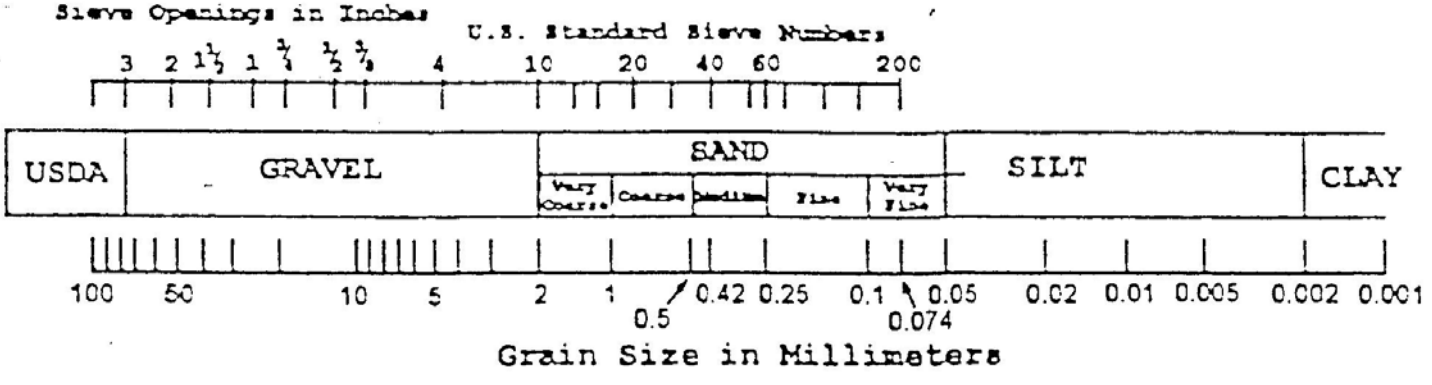
Hole #	TP-4A	TP-4B	TP-5A	TP-5B
Depth (ft)	2	5	2	5
Oven Dry Weight (g)	100	100	100	100
Starting Time	1450	1505	0935	0930
Temp @ 40 Sec	63	64	65	65
Hydrometer Reading @ 40 sec	50	40	65	45
Composite Correction	7.5	7.3	7.1	7.1
True Density @ 40 sec	42.5	32.7	57.9	37.9
Temp @ 2 Hours	72	73	74	74
Hydrometer Reading @ 2 Hours	21	17	28	21
Composite Correction	5.7	5.5	5.3	5.3
True Density @ 2 hours	15.3	11.5	22.7	15.7
% Sand	58	67	42	62
% Clay	15	12	23	16
% Silt	27	21	35	22
Soil Zone	**2**	**2**	**2**	**2**
Classification	**Sandy Loam**	**Sandy Loam**	**Loam**	**Sandy Loam**

Job Name: BREMW - Drought Resilience
Job No.: 1754.04

Test Pit Number	TP-4A	TP-4B	TP-5A	TP-5B
Percolation Rate (minutes per inch)	16	16	30	16
Application Rate (gallons per day per square foot)	0.7	0.7	0.6	0.7

BREMW – Drought Resilience Project
APN: N/A
Job No. 1754.04





ATTACHMENT 5:

Soil Log

SOIL EXPLORATION LOG

Project Name:
BREMWC

Project No: 1754

Date: 5/21/23

Test Pit #: TP-1

Hole Depths: 3' x 6' x 9'

Excavation Method: Backhoe

Burnt Ranch, CA 95527

Groundwater Elevation: N/A

Logged by: E. Keyes

DESCRIPTION & REMARKS	COLOR	MOISTURE	CONSIST.	SOIL TYPE - USCS	DEPTH	PROFILE	SAMPLE TYPE / NUMBER	BLOWS / FT	WATER CONTENT %	UNIT DRY WEIGHT, PSF
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-1 -2 -3		TP-1A			
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-4 -5 -6 -7		TP-1B			
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-8 -9		TP-1C			
Maximum depth of Test Pit (9ft)/ No Bedrock/Groundwater Encountered					-10					

SOIL EXPLORATION LOG

Project Name:
BREMWC

Project No: 1754

Date: 5/21/23

Test Pit #: TP-2

Hole Depths: 3' x 6' x 9'

Excavation Method: Backhoe

Burnt Ranch, CA 95527

Groundwater Elevation: N/A

Logged by: E. Keyes

DESCRIPTION & REMARKS	COLOR	MOISTURE	CONSIST.	SOIL TYPE - USCS	DEPTH	PROFILE	SAMPLE TYPE / NUMBER	BLOWS / FT	WATER CONTENT %	UNIT DRY WEIGHT, PSF
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-1 -2 -3		TP-2A			
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-4 -5 -6 -7		TP-2B			
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-8 -9		TP-2C			
Maximum depth of Test Pit (9ft)/ No Bedrock/Groundwater Encountered					-10					

SOIL EXPLORATION LOG

Project Name:
BREMWC

Project No: 1754

Date: 5/21/23

Test Pit #: TP-3

Hole Depths: 3' x 6' x 8'

Excavation Method: Backhoe

Burnt Ranch, CA 95527

Groundwater Elevation: N/A

Logged by: E. Keyes

DESCRIPTION & REMARKS	COLOR	MOISTURE	CONSIST.	SOIL TYPE - USCS	DEPTH	PROFILE	SAMPLE TYPE / NUMBER	BLOWS / FT	WATER CONTENT %	UNIT DRY WEIGHT, PSF
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-1 -2 -3		TP-3A			
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-4 -5 -6 -7		TP-3B			
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-8 -9		TP-3C			
Maximum depth of Test Pit (8ft)/ No Bedrock/Groundwater Encountered					-10					

SOIL EXPLORATION LOG

Project Name:
BREMWC

Project No: 1754

Date: 5/21/23

Test Pit #: TP-4 & 5

Hole Depths: 3' x 6' x 5'

Excavation Method: Backhoe

Burnt Ranch, CA 95527

Groundwater Elevation: N/A

Logged by: E. Keyes

DESCRIPTION & REMARKS	COLOR	MOISTURE	CONSIST.	SOIL TYPE - USCS	DEPTH	PROFILE	SAMPLE TYPE / NUMBER	BLOWS / FT	WATER CONTENT %	UNIT DRY WEIGHT, PSF
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-1 -2 -3		**TP-4A TP-5A**			
Light Brown with small amounts of clay pockets; medium plasticity; mixture of sand, silt, and clay (USDA Classification - Sandy Loam)	BRN	Damp	FIRM	SC	-4 -5 -6 -7 -8 -9 -10		**TP-4B TP-5B**			
Maximum depth of Test Pit (5ft)/ No Bedrock/Groundwater Encountered										

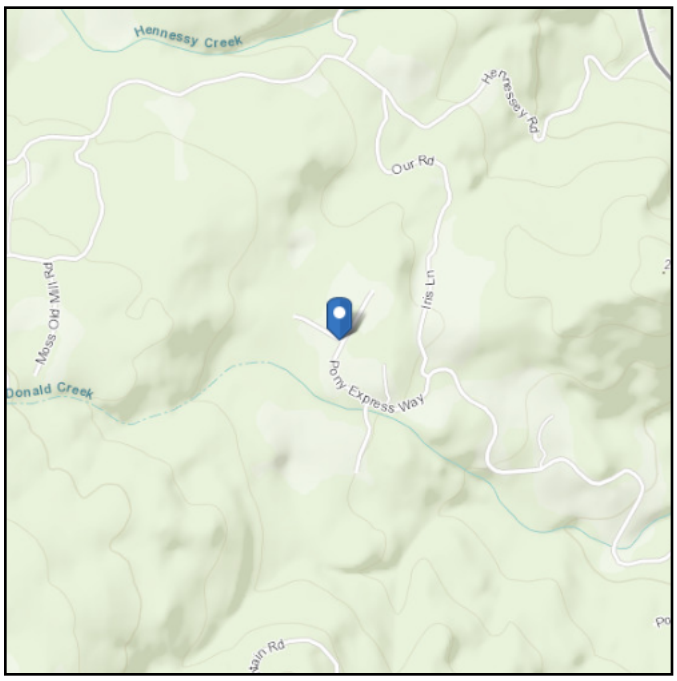
ATTACHMENT 6:

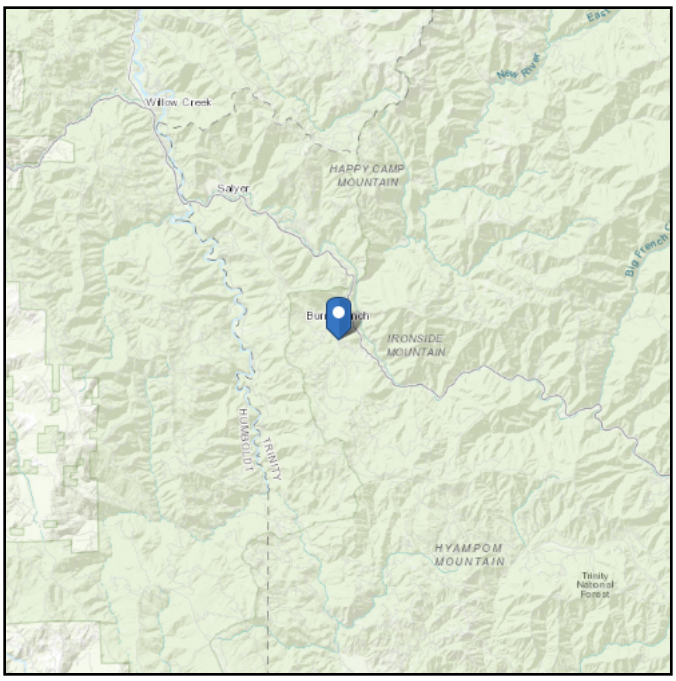
ASCE Seismic Hazards

ASCE Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-22	**Latitude:**	40.814244
Risk Category:	IV	**Longitude:**	-123.494544
Soil Class:	Default	**Elevation:**	1975.6349810319973 ft (NAVD 88)





Seismic

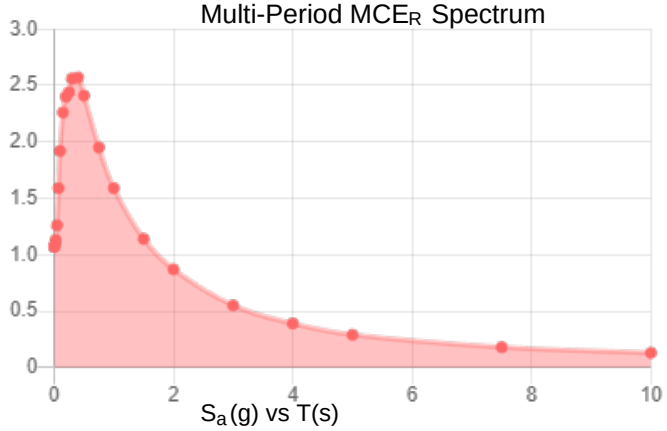
Site Soil Class: Default

Results:

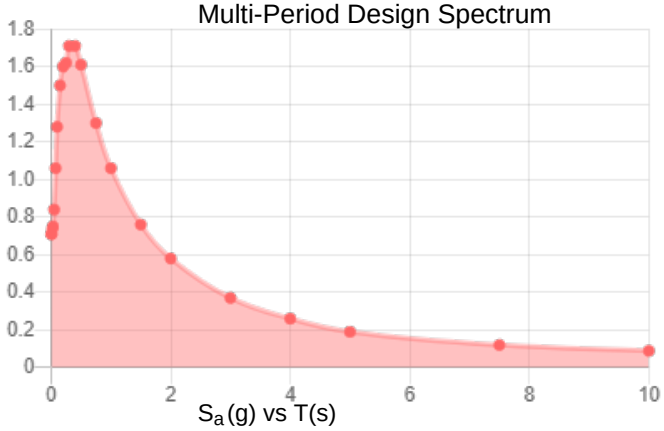
PGA_M :	0.99	T_L :	16
S_{MS} :	2.31	S_S :	1.94
S_{M1} :	1.59	S_1 :	0.73
S_{DS} :	1.54	V_{S30} :	260
S_{D1} :	1.06		

Seismic Design Category: D

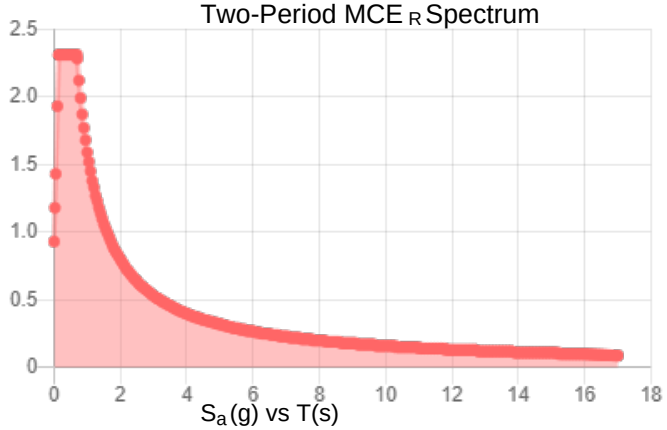
Multi-Period MCE_R Spectrum



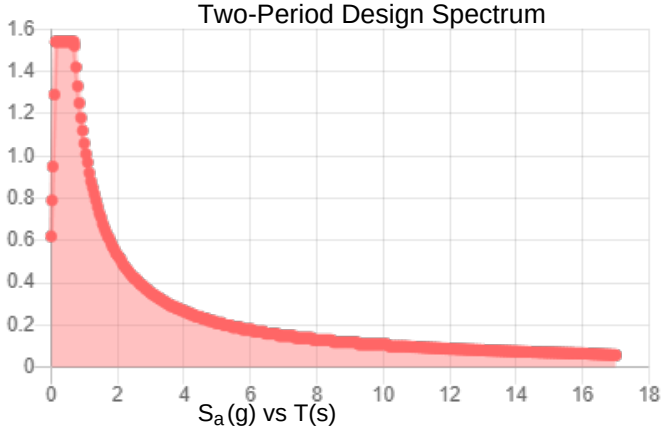
Multi-Period Design Spectrum



Two-Period MCE_R Spectrum



Two-Period Design Spectrum



MCE_R Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Data Accessed: Tue Apr 09 2024

Date Source:
USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.

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