U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
U.S. DEPARTMENT OF ENERGY

WATER-RESOURCES INVESTIGATIONS REPORT 96-4042
O'Hagan and Laczniak, 1996, Ground-water levels beneath eastern Pahute Mesa and vicinity Nevada Test Site, Nye County, Nevada

INTRODUCTION

The Nevada Test Site (NTS) is operated by the U.S. Department of Energy and has been the primary location for the continental testing of nuclear devices since the early 1950's. In 1963, the northwest boundary of the NTS was extended westward to incorporate the eastern part of the physiographic area known as Pahute Mesa. Since that time, more than 80 nuclear devices have been tested underground in this area, most of the detonations were at or below the water table. The regional distribution of the water table and the combined effect of the many nuclear tests on regional and local water levels are not yet fully known.

Purpose and Scope

This report presents water-level and basic construction data for drill holes in and around the primary area of underground testing on eastern Pahute Mesa, and water-level contours based on the most recent water-level measurement made in each drill hole. Measurements are presented for 72 wells and span about 30 years. The map complements an earlier publication by Blankennagel and Weir (1973, pl. 1) and later modified by Blankennagel for Byers and Hawkins (1981, pl. 1). Information is intended to benefit those involved in (1) the siting, drilling, and design of drill holes to house nuclear devices, (2) the study of ground-water hydrology and radionuclide transport beneath the Pahute Mesa area, and (3) investigations of regional ground-water flow at and near the NTS.

Location and Setting

The area of study is within Nye County, Nev., about 130 mi northwest of Las Vegas, Nev., and about 30 mi northeast of Beatty, Nev. (see index map). It includes the northwestern part of the NTS and extends across eastern Pahute Mesa. The map area covers about 375 mi², primarily Areas 19 and 20 and part of Area 18 of the NTS and adjacent parts of the Nellis Air Force Range.

The topography of the area is dominated by the extensive east-west trending plateau that constitutes Pahute Mesa. Altitudes range from about 5,000 to 8,000 ft above sea level, with the highest areas along the eastern-most part of the study area.

Pahute Mesa lies within the geologic region known as the southwest Nevada volcanic field (Carr and others, 1986). This region is underlain by a thick section of Tertiary volcanic rocks, primarily ash-flow and ash-fall tuff and rhyolite lava. The subsurface distribution of volcanic units is highly variable and depends on location relative to eruptive centers, the land-surface topography prior to deposition, and post-depositional faulting. The eastern part of Pahute Mesa is underlain by rocks erupted from two calderas, the Area 20 and Grouse Canyon calderas, which together form the Silent Canyon caldera complex (see map). These rocks generally are covered by younger ash-flow and ash-fall tuff erupted from calderas to the west and south. Younger calderas of the Timber Mountain caldera complex cut across the Silent Canyon caldera complex to the south and bound the mesa along its southern limit (see map). Volcanic units commonly are altered by argillization, zeolitization, and devitrification, generally with a concomitant decrease in permeability. The more areally extensive units commonly are cut by a series of basin-and-range faults that generally trend north-south across the map area. The total aggregate thickness of the volcanic section is not certain, but exceeds 13,000 ft at drill hole UE-20f (western Area 20, see map; any reader interested in additional information on the drill-hole naming convention is referred to Wood, 1992, p. 2).

The saturated subsurface within the northeastern part of the map area (northern and eastern Area 19) is dominated by thick, extensive rhyolite lava flows. Thick sequences of ash-flow and ash-fall tuff become more common and separate the thinning and less extensive rhyolite lava flows in areas to the west and south (Blankennagel and Weir, 1973). Fractures are prevalent, especially in the denser rock units such as rhyolite lava and welded ash-flow tuff. Ground water moves primarily through interconnected fractures because of the low interstitial permeability. In general, zeolitized and nonwelded tuff are the least permeable rocks and form confining units; and welded ash-flow tuffs and rhyolite lava flows, including vitrophyre and breccia, are the most permeable and form the principal aquifers (Blankennagel and Weir, 1973).

Recharge to the ground-water flow system, by the downward movement of precipitation, occurs over much of Pahute Mesa and the adjacent highlands. Its magnitude depends on the amount of precipitation. Typically, areas of highest altitude receive the most precipitation. On the basis of this premise, the eastern and northeastern parts of the map area are assumed to receive the greatest amount of local recharge (Blankennagel and Weir, 1973). This assumption is supported by the water-level distribution and vertical head gradients. Higher water-level altitudes in these areas may be a consequence of local mounding that results from greater recharge. Water levels decrease with depth in these areas indicating a downward component of flow; elsewhere, in contrast, water levels increase or are stable with depth, indicating an upward or lesser component of vertical flow. Semi-perched and perched ground water (water separated from the regional ground-water flow system by low-permeability rock of little or no water content) is common throughout the entire region (Blankennagel and Weir, 1973), but is especially prevalent at higher altitudes where greater recharge is more likely.

In general, ground water beneath Pahute Mesa flows away from local recharge areas in the eastern and northeastern parts of the map area toward major areas of surface discharge located to the south and southwest. A discontinuity in water-level altitudes, approximately coincident with the western boundary of the Silent Canyon caldera complex and the Purse and West Purse faults (see map), was first identified by Blankennagel and Weir (1973). They proposed that the discontinuity is caused by a contrast in permeability between rocks on the west and east sides of a feature they refer to as a hydraulic barrier. Their feature generally defines the trace of the contact between rocks of higher permeability on the east and of lower permeability on the west and is characterized by higher water levels in drill holes west of its location. In this report, the discontinuity is presented as a broad band to portray its uncertain location and cause. The presence of this feature diverts ground water flowing westward across the Silent Canyon caldera complex to the south. In addition, the discontinuity is supported by water-chemistry differences: sampled ground water from drill holes west of the feature contains higher concentrations of sulfate and chloride than that from holes east of the feature (Blankennagel and Weir, 1973).

GROUND-WATER LEVELS

Water levels have been measured throughout eastern Pahute Mesa beginning in the early 1960's. These measurements have been key in developing a conceptual understanding of the occurrence and movement of ground water in the region and in designing and engineering safe and effective underground nuclear tests on the mesa. Measurements have been made using several apparatus—including fluid-density probes, steel tapes, and electrical devices (Wood, 1992, p. 6).

Most measurements have been made in two distinctly different types of drill holes, locally referred to as emplacement and exploratory holes. Emplacement holes typically are large in diameter (96 to 120 in.), drilled to differing depths and open except for a short length of surface casing. Historically, eastern Pahute Mesa has been the primary location for detonating larger yield nuclear tests. The containment of radioactive gasses generated by larger yield tests commonly required hole depths greater than 4,000 ft. Many of these deeper holes penetrated thick sections of saturated rock. As the necessity for larger yield tests diminished, so too did the need to drill deep emplacement holes. Few of the more recently drilled emplacement holes exceed depths of 2,500 ft and penetrate more than 500 ft of saturated rock. Many of the more recent emplacement holes penetrate only saturated zeolitic tuffs, which are characterized by low permeability. Water levels measured in these holes may not be indicative of the regional water level, but instead may represent perched or semi-perched water. The limited thickness of saturated rock penetrated by recently drilled holes makes it difficult to determine if measured levels represent regional, perched, or semi-perched conditions.

Exploratory holes are smaller in diameter (usually less than 12 in.) and generally deeper than emplacement holes, commonly exceeding depths of 5,000 ft. Many exploratory holes are cased to depths below the water table with open sections penetrating several hundred to several thousand feet of saturated rock having differing permeability; thus, most measured water levels represent a composite value for the many rock units penetrated and not the level of water in an individual aquifer or confining unit. Historically, exploratory holes were drilled to characterize subsurface conditions prior to underground nuclear testing, but as the need for larger yield tests diminished and the geologic characterization of the testing area progressed, the drilling of exploratory holes became less frequent. Few recently drilled exploratory holes penetrate more than 500 ft of saturated rock.

Few drill holes, other than those constructed specifically for underground testing, have been available to measure water levels, primarily because of the great depth to water and the general inaccessibility of the area. Thus, measurements generally have been limited to those areas considered to be the most suitable for testing. Measurements are concentrated in the central parts of the major fault blocks (see map) because drill holes purposely were located away from major faults and other structural features to avoid any potential venting of radioactive gasses through structure-controlled openings (Nevada Test Site-Standard Operating Procedures, U.S. Department of Energy, written commun., 1992). Water levels measured beyond the limits of the actual testing areas, outside the areas of preferred testing media, near structural features, and beyond the boundary of the NTS are scarce. Within the map area, only one drill hole, Pahute Mesa #3, exists outside the boundary of the NTS.

The availability of emplacement and exploratory holes for water-level measurements developed upon operational needs of the testing program. Most emplacement holes are inevitably used for the placement of a nuclear device, whereas most exploratory holes are eventually stemmed (filled and sealed) to prevent any venting of radioactive gasses from nearby tests. The accessibility of the hole also may be affected by the installation of diagnostic instrumentation. The time a particular hole is available for measurement usually is limited, and generally is not sufficient to allow the water level in the drill hole to achieve equilibrium with the surrounding rock.

Water levels in the Pahute Mesa test area are known to have been affected by underground testing (Dudley and others, 1971; Gonzalez and Dudley, 1971). The effects of testing on water levels are caused by changes in properties of the rock/water media (such as the permeability and storage) and the dissipation of test-generated energy. Short-term water-level changes result from elastic (compressive and dilational) responses and energy effects, whereas longer term changes result from inelastic responses, such as the formation of rubble and fractures in the rock media (Garber, 1971). The magnitude and longevity of the changes and the combined effect of these changes on the distribution of water levels in and around the testing areas, particularly eastern Pahute Mesa, are not well known.

Water-Level Configuration

The water-level contours depicted on the map approximate the regional water-level configuration beneath eastern Pahute Mesa. The distribution presented is not intended to represent the water table or the potentiometric surface within a specific aquifer, but rather a coherent surface from which to generalize the regional occurrence and movement of ground water. Contours were constructed using water levels measured in 72 holes throughout the map area (see table 1, which includes two entries for U-20bb and UE-20f, each representing a different completion interval). Although contours are based on the most recent water level measured in each hole, measurements span about 30 years beginning in 1964.

The map updates contours presented on an earlier map by Blankennagel and Weir (1973, pl. 1) and later modified in the northern Timber Mountain area (Byers and Hawkins, 1981, pl. 1). Water levels used to construct this map include measurements from 45 drill holes not available to the earlier authors, and 19 of the remaining 27 drill holes had measurements made since the publication of their maps. Contours shown on earlier maps are interpolated from measurements made primarily in exploratory holes that were cased below the water table and penetrated thick sections (more than 2,000 ft) of saturated rock. Contours shown on this map are based on measurements from these same holes in addition to measurements made in emplacement holes, few of which penetrate more than 500 ft of saturated rock.

Contours are not extended beyond the northern boundary of the Silent Canyon caldera complex because no data are available from those areas. Contours extending south of the Silent Canyon caldera complex boundary are based on water levels measured in Water Well 8, UE-18r, and UE-18t. As constructed, these contours depict little or no hydrologic effect attributed to the structural boundary between the Silent Canyon and Timber Mountain caldera complexes and infer a west-southwestward flow direction. The addition of a few more measurements within the Timber Mountain caldera complex could alter this depiction of ground-water flow throughout the southern part of the map area.

The water-level discontinuity attributed to a permeability contrast and referred to as a hydraulic barrier by Blankennagel and Weir (1973) is preserved on the map, but is depicted as a broad regional feature to represent its uncertain position and areal extent. The high degree of uncertainty, especially pertaining to its southern extent, is a result of recent changes in the inferred location of the western boundary of the Silent Canyon caldera complex (Sawyer and others, 1995), of uncertainty as to the cause of the feature (caldera-boundary structures, the Purse and West Purse faults, or some combination), and of the limited availability of water-level data in the vicinity of the feature. Contours west of the feature are oriented east-west as compared with the northeast-southwest orientation of Blankennagel and Weir (1973). An east-west orientation implies a major southward (Savard, 1990) rather than southwestward component of flow west of the feature, and is more consistent with the concept of Oasis Valley (near Beatty) being the primary discharge for ground water within this area and of north-south trending structures influencing flow directions. This interpretation does not preclude, but likely limits, southwestward flow across the feature (see map).

Anomalous Water Levels

Anomalous water levels (elevated or depressed with respect to the water-level distribution presented on the map) occur throughout the map area. These levels were not used in constructing the regional contours depicted on the map because they are thought to represent local conditions, possibly resulting from the occurrence of perched or semi-perched water, of perturbations caused by underground nuclear testing, of differences attributed to varying water-level conditions within different aquifers, or of a combination thereof. Measured anomalies are shown on the map to identify areas where anomalous levels are common and to provide a basis from which to reason their occurrence. The specific cause of an anomaly is difficult to ascertain because of the limited information available in the area.

Anomalously high water levels found in the northeastern part of the map area are represented by measured altitudes of 4,885 and 4,904 ft in drill holes U-19ba and U-19ab, respectively. These and other drill holes in the general area in which anomalous measurements have been reported penetrate less than 250 ft of the saturated volcanic section (see table 1). Other nearby drill holes, specifically U-19c, UE-19c Water Well, UE-19e/Inst., and UE-19z/Inst., all penetrate much deeper into the volcanic section. Water levels in these deeper holes all measure about 200 ft lower. The higher (anomalous) levels in U-19ba and U-19ab may represent locally elevated conditions caused by low-permeability units obstructing and ponding downward moving recharge. This explanation is consistent with the area being one of local recharge and with the occurrence of bedded tuffs (a lower permeability rock) throughout the area.

Anomalously high water levels also are shown in the central map area near UE-19fS south of the southern extent of Almendro fault. Here, measured levels differ substantially in accordance with the saturated unit penetrated. Drill holes U-19aq, U-19az, and U-19bh are open to the same rhyolite lava flow, and all have relatively similar water-level altitudes (4,690, 4,674, and 4,667 ft, respectively) and penetrate less than 80 ft of the saturated section (see table 1). Drill holes UE-19fS and U-19ae penetrate deeper and are open to a stratigraphically lower rhyolite lava flow. Water-level altitudes (4,429 and 4,495 ft, respectively) are comparatively different from those measured in the younger, overlying rhyolite. Drill hole U-19x is open to a bedded tuff positioned between the two saturated lava flows mentioned above. Its water-level altitude is 4,567 ft and is intermediate with respect to levels measured in the two bounding rhyolite units. These data suggest that the bedded tuff acts as a confining unit, hydraulically separating the two rhyolite lava units and thus allowing differences in hydraulic heads to develop. The interpretation presented on the map accepts the measurements in UE-19fS and U-19ae as representative of the regional flow system, and considers the others as local anomalies.

Another area of anomalously high water levels is in the southern part of Area 20. Here, anomalous water-level altitudes are represented by measurements of 4,214 ft, 4,322 ft, 4,362 ft, 4,487 ft, and 4,275 ft in drill holes U-20at #1/Inst., U-20ao, U-20ax, U-20bb (shallow), and U-20bc, respectively. Each of these drill holes penetrated less than 200 ft of the saturated section at the time of the measurement (see table 1) and was either open to or expected to be underlain by a thick section of zeolitized bedded tuff. When first measured, U-20bb was drilled to a depth of 1,900 ft. Later, the hole was deepened to 2,200 ft and the water level dropped almost 300 ft to an altitude of about 4,200 ft. This lower value is similar to the level measured in the nearby drill hole U-20bb 1, which is less than 100 ft away and was drilled to a depth of 2,345 ft. The presence of low-permeability units, specifically thick zeolitic tuff, suggest that the higher levels may represent locally perched or semi-perched conditions. The origin of the water is uncertain, but could be one of the following: water that moved downward from the surface beneath nearby areas receiving recharge; water trapped since a past pluvial period when the area may have received sufficient precipitation to generate recharge; or water that was forced (injected) into these zones as a result of the underground nuclear testing in the area.

A single anomalously high water level is shown at UE-20f. As with other anomalies discussed, this level is high with respect to the regional distribution presented, but it represents a measurement made deeper within the flow system. The water-level altitude when first measured was 4,162 ft and represented a composite value for saturated rock above a depth of 4,543 ft (the total depth of the hole at that time). Soon thereafter, the drill hole was cased to a depth of 4,490 ft and deepened to a depth of 13,686 ft. The measured water-level altitude, representing the open interval between casing bottom and the new total depth, was 4,353 ft. Both water levels are shown on the map and given in table 1. These measurements, along with other measurements made at several discrete zones (Blankennagel and Weir, 1973), indicate a strong upward gradient between deep and shallow parts of the saturated section. A strong upward gradient is consistent with the area being a region of lesser local recharge and with the possible presence of a nearby barrier to westward flow. The lower water-level altitude was used in constructing regional contours because it is consistent with values from other nearby, similarly constructed drill holes.

Table 1. Hole-construction and water-level data from holes drilled in eastern Pahute Mesa.

[Depth measurements referenced to land surface. Altitude measurements referenced to sea level.]

Hole name[a]	Latitude (degrees, minutes, seconds)	Longitude (degrees, minutes, seconds)	Land-surface altitude (feet)	Depth drilled (feet)	Depth to open interval		Water-level measurement			Water above bottom opening (feet)
					Top (feet)	Bottom (feet)	Date	Depth (feet)	Altitude (feet)	
Area 18										
UE-18r	37 08 05	116 26 41	5,538	5,004	1,629	5,004	05/21/92	1,365	4,173	3,639
UE-18t	37 07 41	116 19 45	5,201	2,600	1,896	2,600	05/21/92	916	4,285	1,684
Water Well 8 (formerly USGS HTH-8 or TW-8)	37 09 56	116 17 41	5,695	5,499	1,250	2,170	02/17/82	1,076	4,619	1,094
Area 19										
U-19aS	37 16 30	37 16 30	6,761	3,584	12	2,813	07/27/64	2,192	4,569	621
U-19ab	37 15 12	37 15 12	6,928	2,250	58	2,250	02/11/81	2,024	4,904	226
U-19ae	37 14 10	37 14 10	6,775	2,730	40	2,730	02/23/82	2,280	4,495	450
U-19ai	37 19 29	37 19 29	6,742	2,075	77	2,075	10/11/80	2,054	4,688	21
U-19aq	37 13 41	37 13 41	6,799	2,175	50	2,175	06/17/87	2,109	4,690	66
U-19ar	37 16 43	116 21 20	6,706	2,200	77	2,200	03/28/86	2,119	4,587	81
U-19au	37 15 09	116 22 36	6,535	2,200	54	2,200	03/02/88	2,077	4,458	123
U-19av	37 15 19	116 22 33	6,512	2,145	52	2,145	04/17/89	2,022	4,490	123
U-19ay	37 16 32	116 21 13	6,713	2,156	59	2,156	01/09/89	2,129	4,584	27
U-19az	37 13 39	116 22 16	6,753	2,130	77	2,130	07/02/90	2,079	4,674	51
U-19ba	37 17 46	116 18 46	7,037	2,177	69	2,177	12/11/90	2,152	4,885	25
U-19bg 1	37 16 20	116 21 35	6,694	2,250	74	2,250	11/18/91	2,118	4,576	132
U-19bh	37 13 29	116 22 20	6,768	2,148	72	2,148	02/27/92	2,101	4,667	47
U-19c	37 15 54	116 18 53	7,032	4,520	12	2,656	11/09/64	2,320	4,712	336
U-19d #2 (formerly UE-19d)	37 20 54	116 19 19	6,861	7,689	2,560	6,561	01/13/65	2,177	4,684	4,384
U-19g	37 18 36	116 21 51	6,734	3,292	3,210	3,250	01/04/76	2,064	4,670	1,186
U-19v PS #1D[b]	37 14 53	116 20 57	6,842	3,625	3,604	3,613	05/17/83	2,297	4,545	1,316
U-19x	37 14 01	116 22 06	6,781	2,230	52	2,230	08/21/76	2,214	4,567	16
UE-19b #1	37 18 52	116 17 57	6,802	4,500	2,190	4,500	01/13/65	2,117	4,685	2,383
UE-19c Water Well	37 16 08	116 19 10	7,033	8,489	2,421	8,489	10/15/85	2,336	4,697	6,153
UE-19e/Inst.	37 17 50	116 19 59	6,919	6,005	2,475	6,005	--/--/65	2,240	4,679	3,765
UE-19fS	37 13 29	116 22 03	6,735	6,950	2,565	6,950	08/17/65	2,306	4,429	4,644
UE-19gS	37 18 30	116 21 53	6,719	7,500	2,650	7,500	05/06/65	2,045	4,674	5,455
UE-19h	37 20 34	116 22 25	6,780	3,705	2,321	3,456	08/09/65	2,112	4,668	1,344
UE-19i	37 15 00	116 20 49	6,839	8,000	2,896	7,960	09/01/65	2,258	4,581	5,702
UE-19z/Inst.	37 17 58	116 19 36	6,888	2,800	81	2,800	09/24/77	2,199	4,689	601
Area 20										
Pahute Mesa Ex. Hole #1 (formerly USGS HTH #9)	37 16 49	116 24 21	6,558	7,858	7,543	7,731	09/30/92	2,095	4,463	5,636
Pahute Mesa Ex. Hole #2	37 20 42	116 34 05	5,586	8,782	2,500	8,782	01/15/91	852	4,734	7,930
U-20 Water Well	3715 05	116 25 45	6,468	3,268	2,271	3,035	07/31/85	2,028	4,440	1,007
U-20a	37 14 34	116 25 51	6,520	2,177	14	2,177	02/13/64	2,161	4,359	16
U-20a #2	37 14 24	116 25 16	6,474	4,500	2,356	3,900	02/11/65	2,066	4,408	1,834
U-20ah	37 15 21	116 25 20	6,445	2,300	60	2,300	04/01/81	2,001	4,444	299
U-20ai	37 15 21	116 26 25	6,503	2,154	56	2,154	10/30/85	2,052	4,451	102
U-20ak	37 14 52	116 29 21	6,235	2,100	58	2,100	02/12/85	2,042	4,193	58
U-20am	37 16 04	116 24 38	6,593	2,200	55	2,200	02/01/84	2,142	4,451	58
U-20an	37 17 50	116 26 27	6,462	2,026	59	2,026	03/12/85	1,991	4,471	35
U-20ao	37 14 16	116 28 22	6,279	2,150	20	2,150	05/17/85	1,957	4,322	193
U-20ar #1/Inst.	37 18 52	116 28 17	6,319	2,285	109	2,285	05/08/87	1,841	4,478	444
U-20as	37 13 13	116 27 42	6,227	2,100	69	2,100	06/06/86	2,013	4,214	87
U-20at #1/Inst.	37 14 52	116 30 33	6,241	2,197	79	2,197	02/13/87	2,027	4,214	170
U-20av	37 13 59	116 25 23	6,464	2,100	77	2,100	12/08/86	2,075	4,389	25
U-20aw	37 16 58	116 24 44	6,585	2,100	53	2,100	11/04/88	2,086	4,499	14
U-20ax	37 13 50	116 26 47	6,535	2,200	63	2,200	03/31/92	2,173	4,362	27
U-20ay	37 15 36	116 26 28	6,520	2,100	58	2,100	01/11/88	2,046	4,474	54
U-20az	37 13 52	116 24 34	6,572	2,250	40	2,250	08/31/89	2,160	4,412	90
U-20bb (shallow)	37 14 52	116 29 39	6,226	1,900	36	1,900	12/18/89	1,739	4,487	161
U-20bb (deep)	37 14 52	116 29 39	6,226	2,200	36	2,200	03/22/90	2,034	4,192	166
U-20bb 1	37 14 52	116 29 39	6,230	2,345	60	2,345	070/9/90	2,028	4,202	317
U-20bc	37 15 47	116 29 26	6,146	2,000	40	2,000	08/02/89	1,871	4,275	129
U-20bd 1	37 15 42	116 25 13	6,486	2,402	114	2,402	03/14/90	2,038	4,448	364
U-20be	37 13 32	116 25 41	6,493	2,220	51	2,219	06/05/91	2,215	4,278	4
U-20bf	37 14 44	116 26 30	6,522	2,250	48	2,250	08/29/90	2,135	4,387	115
U-20bg	37 14 14	116 24 29	6,567	2,200	122	2,200	10/26/92	2,134	4,433	66
U-20c	37 13 53	116 28 25	6,281	4,800	4,540	4,800	02/25/65	2,097	4,184	2,703
U-20e	37 18 51	116 27 38	6,316	3,853	12	3,853	02/07/69	1,853	4,463	2,000
U-20g	37 18 07	116 24 30	6,470	4,200	3,990	4,200	10/30/64	2,017	4,453	2,183
U-20n PS #1 DD-H[b]	37 14 25	116 25 24	6,468	4,186	2,576	2,867	02/29/92	2,051	4,417	816
U-20y	37 13 15	116 28 29	6,257	2,602	52	2,602	02/18/75	2,067	4,190	535
UE-20ab	37 16 23	116 24 37	6,581	2,550	59	2,550	10/30/78	2,126	4,455	424
UE-20av	37 14 01	116 25 20	6,458	2,614	133	2,614	01/15/87	2,128	4,330	486
UE-20 bh 1	37 14 42	116 24 23	6,636	2,810	1,941	2,810	10/26/92	2,213	4,423	597
UE-20c	37 13 52	116 28 18	6,283	5,348	650	5,346	02/28/64	2,126	4,157	3,220
UE-20d	37 14 52	116 28 49	6,253	4,492	2,446	4,492	01/14/65	2,075	4,178	2,417
UE-20e #1	37 19 01	116 27 25	6,297	6,395	1,500	6,395	04/05/75	1,826	4,471	4,569
UE-20f (shallow)	37 16 17	116 29 17	6,116	4,543	734	4,543	04/07/64	1,954	4,162	2,589
UE-20f (deep)	37 16 17	116 29 17	6,116	13,686	4,490	13,686	11/24/74	1,763	4,353	11,923
UE-20h (formerly UE-20h	37 16 19	116 26 02	6,557	7,207	2,506	7,207	01/13/65	2,105	4,452	5,102
Ex. Hole)	37 18 01	116 32 03	5,903	5,690	1,740	5,690	10/23/64	1,270	4,633	4,420
UE-20j	37 14 25	116 25 19	6,461	3,300	2,282	2,834	02/29/92	2,040	4,421	794
UE-20n #1[c]	37 20 24	116 31 20	5,553	4,480	3,998	4,480	09/27/70	884	4,669	3,596
UE-20p										
Off Site										
Pahute Mesa #3[d]	37 14 21	116 33 37	5,823	3,019	93	3,019	09/30/91	1,458	4,365	1,561

[a] See Wood (1992, p. 2) for explanation of the hole naming convention.
[b] Slant hole--all depths have been corrected for deviation from vertical.
[c] Bridge plug set above reported drilled depth.
[d] Measurements reflect drill hole conditions prior to emplacement of dual piezometers.

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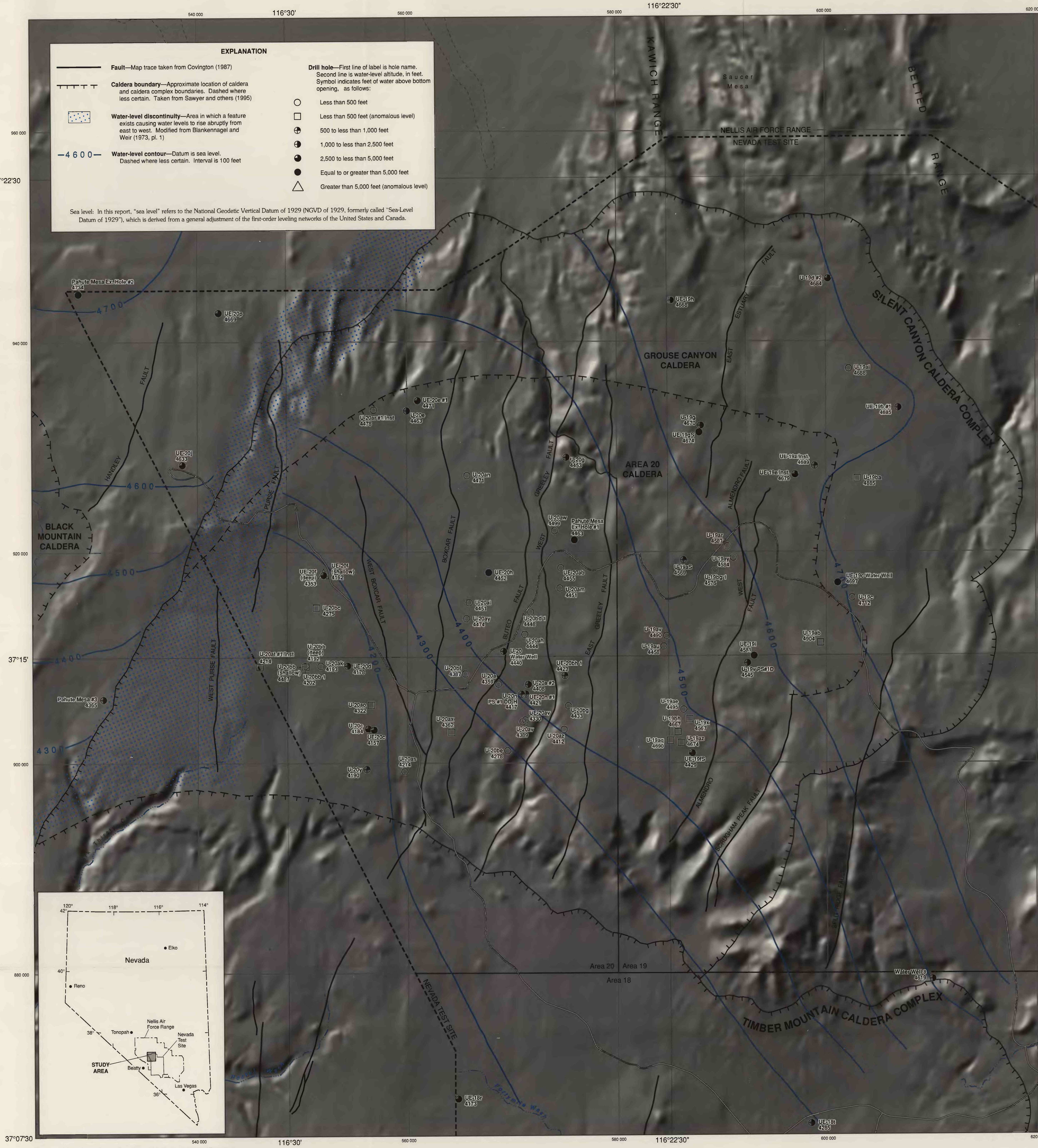
CONVERSION FACTORS AND ABBREVIATIONS

Multiply	By	To Obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi²)	2.59	square kilometer



Base from U.S. Geological Survey digital data, 1:100,000, 1981; Universal Transverse Mercator projection, Zone 11. Shaded-relief base from 1:100,000-scale Digital Elevation Model; sun illumination from northwest at 30 degrees above horizon
100,000-foot grid based on Nevada State Plane coordinate system, central zone

MILES 1 0 1 2 3 4
1 0 1 2 3 4 5 6 7 8 KILOMETERS

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1996

MAP SHOWING GROUND-WATER LEVELS BENEATH EASTERN PAHUTE MESA AND VICINITY, NEVADA TEST SITE, NYE COUNTY, NEVADA

by
Michael D. O'Hagan and Randell J. Laczniak

1996

ISBN 0-607-85551-7