TABLE 2. HYROGEOLOGIC MAPPING UNITS[1] IN THE MESILLA BASIN REGION, DOÑA ANA COUNTY, NEW MEXICO, AND ADJACENT PARTS OF EL PASO COUNTY, TEXAS AND CHIHUAHUA, MEXICO (PLATES 1 TO 7)

[1]Divisions of Geologic Time and Cenozoic Units are defined, respectively, in **TABLES 2-1** and **2-2**

UPPER CENOZOIC (QUATERNARY-HOLOCENE/PLEISTOCENE AND UPPER TERTIARY (NEOGENE)-PLIOCENE/MIOCENE) HYDROSTRATIGRAPHIC UNITS (HSUs)

E Eolian sand—Late Quaternary; as much as 30 ft (10 m) thick and entirely in the vadose zone; stipple pattern or superposed symbols (e.g., **E/TA**, **E/PAU**, **E/Qb**) indicate HSUs or bedrock units with thin (<10 ft, 3 m) eolian cover

Rio Grande Valley-Fill HSUs (Post-Santa Fe Group—Holocene to Middle Pleistocene)

RA Channel and overbank-floodplain (fluvial) deposits of the Rio Grande—Late Quaternary (Holocene and Late Pleistocene); as much as 100 ft (30 m) thick and mostly in the saturated zone; primarily lithofacies assemblages (LFAs) a1 and a2

TA Channel and overbank (fluvial) deposits associated of the ancestral river terraces—Middle Quaternary (Holocene and Late Pleistocene); as much as 60 ft (20 m) thick and entirely in the vadose zone; primarily lithofacies assemblages (LFAs) a1

VA Undifferentiated alluvial deposits (**VAY** and **VAO**) of major ephemeral tributaries (arroyos) in areas bordering the inner valley of the Rio Grande—Late and Middle Quaternary; includes thin hillslope-colluvial and eolian sediments; as much as 120 ft (36 m) thick and mostly in vadose zone; primarily LFA b (like LFAs 5 and 6)

VAY Younger valley-border deposits (mostly alluvial fans and terraces) associated with entrenchment and partial backfilling of the inner valley of the Rio Grande—Late Quaternary; overlap and intertongue with **RA**; as much as 100 ft (30 m) thick and mostly in the vadose zone; primarily LFA b (like LFAs 5 and 6), with weak soil development

VAO Older valley-border deposits associated with at least two episodes of entrenchment and partial backfilling of the ancestral river valley—Middle Pleistocene; overlap and intertongue with **TA**; as much as 100 ft (30 m) thick and entirely in the vadose zone; primarily LFAs 5 to 8, with calcic paleosols

VAU Undifferentiated valley-border deposits (**VA**) and uppermost Santa Fe Gp basin fill (**USF1-2**)—Early to Middle Pleistocene; as much as 100 ft (30 m) thick and entirely in the vadose zone; primarily LFAs 5 to 8

VAR Undifferentiated valley-border deposits (**VAU**) and uppermost Santa Fe Gp basin fill (**USF1**) that form a thin alluvial cover on bedrock units—Early to Middle Pleistocene; as much as 30 ft (10 m) thick and entirely in the vadose zone; primarily LFAs 5 and 6

Basin-Floor HSUs (Post-Santa Fe Group—Holocene to Middle Pleistocene)

BF Undifferentiated deposits of ephemeral drainageways (alluvial-flats) on the floors of the Mesilla and southern Jornada structural basins (e.g., Jornada Draw)—Late and Middle Quaternary; as much as 30 ft (10 m) thick and entirely in vadose zone; primarily LFA c, with some intercalated gypsum (var. selenite) and weak to strong argillic and calcic soil-profile development; includes many small areas of HSU-**BFP**

BFP Playa-lake deposits in shallow depressions on basin-floor alluvial flats in the Mesilla and southern Jornada basins (e.g., e.g. Flat and Isaacks Lakes)—Late and Middle Quaternary; as much as 20 ft (6 m) thick and entirely in vadose zone; primarily LFA c, with some intercalated gypsum and local Vertisol development

Piedmont-Slope HSUs (Post-Santa Fe Group—Holocene to Middle Pleistocene)

PA Undifferentiated alluvial deposits (**PAY** and **PAO**) of major ephemeral streams (arroyos) with headwaters in mountain areas bordering the Mesilla and southern Jornada structural basins—Late and Middle Quaternary; includes thin hillslope-colluvial and eolian sediments; as much as 30 ft (10 m) thick and entirely in vadose zone; primarily LFAs 5 and 6

PAY Younger piedmont-slope deposits (mostly alluvial fans and terraces)—Late Quaternary; as much as 15 ft (5 m) thick and entirely in the vadose zone; primarily LFAs 5 and 6, with weak soil-profile development

PAO Older piedmont-slope deposits (mostly alluvial fans and terraces)—Middle Pleistocene; as much as 15 ft (5 m) thick and entirely in the vadose zone; primarily LFAs 5 and 6, with calcic and argillic paleosols)

PAU Undifferentiated piedmont-slope deposits (**PA**) and uppermost Santa Fe basin fill (**USF1**)—Middle and Early Pleistocene; as much as 50 ft (15 m) thick and entirely in the vadose zone; LFAs 5 to 8

PAUc Undifferentiated coarse-grained piedmont deposits (**PA**) and uppermost Santa Fe basin fill (**USF1** and **USFc**)—Middle and Early Pleistocene; as much as 50 ft (15 m) thick and entirely in the vadose zone; primarily LFAs 5 and 6

PAR Undifferentiated piedmont-slope deposits (**PAU and PAUc**) and uppermost Santa Fe Gp basin fill (**USF1** and **USFc**) that form a thin alluvial cover on bedrock units—Middle and Early Pleistocene; as much as 50 ft (15 m) thick and entirely in the vadose zone; primarily LFAs 5 to 8

Santa Fe Group Intermontane Basin-Fill HSUs—Uppermost Oligocene to Lower Pleistocene

SFGU Santa Fe Group HSUs-Undivided (used only on hydrogeologic cross sections)

USLM Upper Santa Fe HSU, surficial basin-floor facies: undivided sandy, fluvial and eolian sediments, and petrocalcic paleosols associated with the La Mesa geomorphic surface—mostly Early Pleistocene; as much as 20 ft (6 m) thick and entirely in vadose zone; primarily LFA 2; includes many small areas of unit **E**, and HSUs-**BF** and **BFP.** Correlative with uppermost Camp Rice Fm

USF2 Upper Santa Fe HSU, basin-floor facies: fluvial (channel and overbank) deposits of the ancestral Rio Grande—Pliocene to Middle Pleistocene; as much as 1000 ft (300 m) thick and partly in the vadose zone outside the inner river-valley corridor; primarily LFAs 1 to 3. Correlative with the Camp Rice Fm and upper part of Fort Hancock Fm

USF1 Upper Santa Fe HSU, piedmont-slope facies: mostly coalescent alluvial-fan deposits—Early to Middle Pleistocene; as much as 330 ft (100 m) thick and mostly in the vadose zone; primarily LFAs 5 to 7, with calcic and argillic paleosols. Correlative with Camp Rice Fm piedmont facies

USF **USF1** and **USF2**—Undivided

USFc Upper Santa Fe HSU, conglomeratic piedmont-slope facies: mostly proximal to medial alluvial-fan deposits—Late Pliocene to Early Pleistocene; as much as 200 ft (60 m) thick and mostly in the vadose zone; primarily LFAs 8, with petrocalcic and argillic paleosols associated with the Doña Ana geomorphic surface. Correlative with basal Camp Rice Fm piedmont facies

MSF2 Middle Santa Fe HSU, basin-floor facies: alluvial-flat and playa-lake deposits, and local eolian sediments predating development of the ancestral Rio Grande fluvial system—Middle to Late Miocene; as much as 2000 ft (600 m) thick and partly in the vadose zone outside the inner river-valley corridor; primarily LFAs 3, 4, 9, and 10. Unit is only exposed in parts of the Rincon Hills, San Diego Mountain (Tonuco) and Sierra de las Uvas uplifts. Correlative with main body of Rincon Valley Fm and lower part of Fort Hancock Fm

MSF1 Middle Santa Fe HSU, piedmont-slope facies: mostly coalescent alluvial-fan deposits— Middle to Late Miocene; as much as 1000 ft (300 m) thick and mostly in the saturated zone; primarily LFAs 5 to 7. Unit is only exposed in parts of the Rincon Hills, San Diego Mountain (Tonuco) and Sierra de las Uvas uplifts. Correlative with Rincon Valley Fm piedmont facies

MSF **MSF1** and **MSF2**—Undivided

LSF Lower Santa Fe HSU, undivided basin-floor and piedmont-slope facies including alluvial-fan, alluvial-flat, playa-lake and eolian deposits—Late Oligocene to Middle Miocene; as much as 1000 ft (300 m) thick and mostly in the saturated zone; primarily LFAs 4, and 7 to 10. Unit is only exposed in parts of the Rincon Hills, San Diego Mountain (Tonuco) and Sierra de las Uvas uplifts. Correlative with main body of Hayner Ranch Fm

MLS Middle and Lower Santa Fe Gp HSUs—Undivided (used primarily on hydrogeologic cross sections)

MAFIC VOLCANICS THAT CAP, PENETRATE, OR INTERTONGUE WITH SANTA FE GP

QTb Basaltic volcanics-undivided—Late Miocene to Late Pleistocene

<u>Mafic Volcanics That Cap, Penetrate, or Intertongue With Upper Santa Fe Gp HSUs</u>

Qba Alkali-olivine basalt flows associated with Aden shield volcano—Latest Pleistocene

Qbac Alkali-olivine basalt of Aden Crater "lava lake"—Latest Pleistocene

Qbm Basaltic volcanic rocks and younger basin fill associated with phreato-magmatic eruptive centers (Maar volcanoes). Complexes of Qb and Qt, PAY, BF, BFP, and USF2, at Kilbourne Hole, Hunt's Hole, and Potrillo Maar—Late Pleistocene

Qt Tephra-fall tuffs and breccias, including base-surge deposits, associated with Kilbourne Hole, Hunt's Hole, and Potrillo Maar volcanic centers—Late Pleistocene

Qb Alkali-olivine basalt flows and cinder cones associated with extrusive-volcanic centers in the southwestern Mesilla Basin-West Potrillo Mountains area (including the Black Mountain, Little Black Mountain volcanoes, and the Afton volcanic field—Middle and Late Pleistocene

<u>Mafic Volcanics That Cap, Penetrate, or Are Interbedded With Middle Santa Fe HSUs</u>

Tb Alkali-olivine basalt flows and plugs—Late Miocene

MIDDLE AND LOWER CENOZOIC (LOWER TERTIARY PALEOGENE)-OLIGOCENE/EOCENE) BEDROCK UNITS—PRE-SANTA FE GROUP

<u>Igneous and Sedimentary Rocks—Mostly Oligocene)</u>

Tmu Middle Cenozoic volcanic, plutonic (igneous-intrusive), and sedimentary rocks-Undivided (used only on hydrogeologic cross sections)

Tba Basaltic-andesite and other intermediate composition volcanic rocks (including Uvas Basalt)

Tmi Intermediate to silicic plutonic rocks, including monzodiorite to syenite stocks in the Organ and Doña Ana Mountains

Tmrs Silicic pyroclastic and volcaniclastic rocks—Oligocene; mainly rhyolite and latite ashflow tuffs and tuffaceous sandstones, with some basaltic-andesite flows

Tmrp Undifferentiated ash-flows, partly to densely welded, mostly rhyolitic--Oligocene; including tuffs of Cox Ranch, Achenback Park, and Cueva Tuff

Tmrv Silicic to intermediate composition lavas, mainly rhyolite, latite and dacite domes and flows; with some dacite breccias, silicic ash-flow tuffs and andesite flows—Oligocene; includes Soledad Rhyolite in Organ Mountains and flow-banded rhyolite dikes and domes in the Doña Ana Mountains and at Picacho Mountain

Tmsp Sedimentary rocks and tuffs

Tri Intrusive rhyolite and breccia

Igneous and Sedimentary Rocks—Mostly Eocene)

Tlu Lower Cenozoic volcanic, plutonic (igneous-intrusive), and sedimentary rocks-Undivided (used only on hydrogeologic cross sections)

Tli Intermediate volcanic rocks, including latite, dacite, and andesite intrusions, flows, and laharic breccia—Eocene; aphyric to moderately porphyritic, and generally fine grained; locally intercalated with clastic sedimentary rocks derived from **Tli**. Includes intrusions in the Vado Hill to Paso del Norte, and Mt. Riley-Cox areas, and correlative with **Tlvs**

Tlvs Volcaniclastic sedimentary rocks and some andesite flows and breccias, including Palm Park and Rubio Peak Formations—Eocene. Includes Orejon Andesite, and interbedded andesitic to dacitic flows, laharic breccia, and other volcaniclastic rocks in the Organ Mountains

Tls Mostly sedimentary rocks, sandstones, mudstones and conglomerates with minor or no volcaniclastic constituents—lower Eocene and Paleocene. Includes Eocene Love Ranch Fm and Paleocene to Upper Cretaceous Lobo Fm

Igneous and Sedimentary Rock Complexes of the Transboundary Area—Eocene to Cretaceous

TKu Igneous-intrusive and structurally deformed sedimentary-rock sequences of the El Paso-Smeltertown, Cerro de Muleros (Cristo Rey), and East Potrillo-Mt. Riley areas-undivided. Includes **Tli**, **Tlvs**, **Tls**, **K** and **Kl** (used only on hydrogeologic cross sections)

Sedimentary Rocks—Mesozoic and Paleozoic

K Cretaceous rocks, mostly Lower **K**-undivided. Primarily in the Paso del Norte area, including the Sierra de Muleros (Cerro del Cristo Rey uplift) and the southwestern Franklin Mountain piedmont

Ku Upper Cretaceous marine rocks-undivided. Soft sandstone, shale, and siltstone and massive, crossbedded, gray quartzite; with minor pelecypod coquina limestone; approximately 260 ft (80 m) thick in southern San Andres Mountains. Includes Dakota and Sarten sandstones

Kl Lower Cretaceous marine rocks-undivided: Sandy to shaly limestone, pelecypod coquina limestone, silty shale, calcareous sandstone, and limestone-pebble conglomerate, with local gypsite interbeds; approximately 1550 to 2200 ft (470-670m) thick, exposed in the Sierras Juárez and Sapello (Mezquité), Cerros de Muleros (Cristo Rey), and the East Potrillo Mountains. 1,050 ft (320 m) penetrated in a below msl sequence in the Grimm oil-test well located about 10 mi (16 km) southwest of Mesquite, NM (25S.01E.32.1411)

KPu Structurally deformed sedimentary-rock sequences of the southwestern Mesilla and East Potrillo uplift area. Includes **K**, **Kl**, and **P** (used only on hydrogeologic cross sections)

Pz Paleozoic rocks, **Pzu/Pzm/Pzl**-undivided

P Permian Rocks-undivided: primarily limestone, sandstone and red-bed mudstones

Pzu Upper Paleozoic (Pennsylvanian and Permian) rocks-undifferentiated: primarily limestone and redbed mudstones, with shale, sandstone and gypsite

Pzm Middle Paleozoic (Devonian and Mississippian) rocks-undivided: primarily limestone, with shale

Pzl Lower Paleozoic (Cambrian to Silurian) rocks, undivided: primarily limestone and dolomite, with thin basal (Cambro-Ordovician) sandstone

<u>Igneous and Metamorphic Rocks—Precambrian</u>

XY Proterozoic (Precambrian) Rocks, undivided: including coarse-grained granite cut by systems diabase-amphibolite dikes in Organ-southern San Andres Mountains; and metarhyolite and basaltic and metasedimentary rocks intruded by granite in the Franklin Mountains

PRIMARY MAPPING UNIT DATABASE SOURCES

(1a) Collins, E.W. and Raney, J.A., 2000, Geologic map of west Hueco Bolson, El Paso region, Texas: The University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map No. 40, scale 1:100,000.

(1b) Tremblay, T.A., 1999, ARCINFO data base for geologic data of the west Hueco Bolson, El Paso region, Texas: The University of Texas at Austin, Bureau of Economic Geology, open-file digital data base.

(2a) DGGTN, no date, Ciudad Juárez H13-1, Cartas Geologica, Escala de Geografia del Territoria Nacional, Escala 1:250,000.

(2b) INEGI, 1983b, Ciudad Juárez H13-1, Cartas Geologica: SPP Programación y Presupuesto. Coordinación General de los Servicios Nacionales de Estadistica, Geografía e Informática. Dirección General de Geografía del Territorio Nacional, Escala 1:250,000.

(3) Seager, W.R., Clemons, R.E., Hawley, J.W. and Kelley, R.E., 1982, Geology of northwest part of Las Cruces 1º x 2º sheet, New Mexico: New Mexico Bureau of Mines and Mineral Resources Geologic Map, GM-53, scale 1:125,000.

(4) Seager, W.R., Hawley, J.W., Kottlowski, F.E. and Kelley, S.A., 1987, Geologic map of east half of Las Cruces and northeast El Paso 1º x 2º sheets, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geologic Map 57, scale: 1:125,000.

(5) Seager, W.R., 1995, Geologic map of southwest part of Las Cruces and northwest part of El Paso 1º x 2º sheets, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geologic Map 60, scale: 1:125,000.