ES322 Geomorphology
Fall 2012 Field Trip

DeVolder Science Center Construction Site
Western Oregon University

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VICINITY MAP

WESTERN OREGON UNIVERSITY
THE NEW SCIENCE CENTER
MONMOUTH, OREGON

SMD / AML		DSK/E0000

DATE October 2011	PROJECT NO. P1844 - 05 - 01	FIG. 1

Vicinity Map

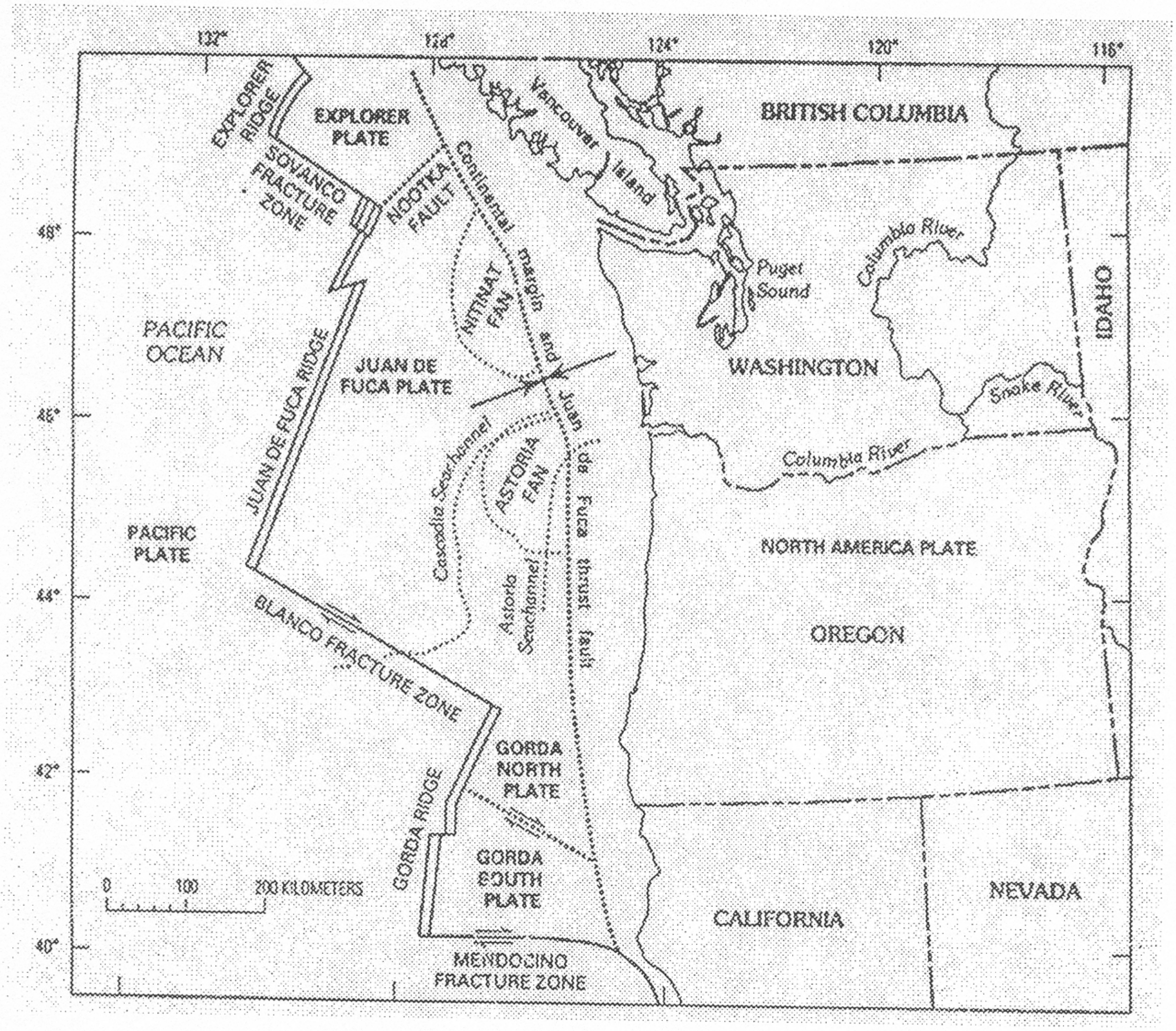
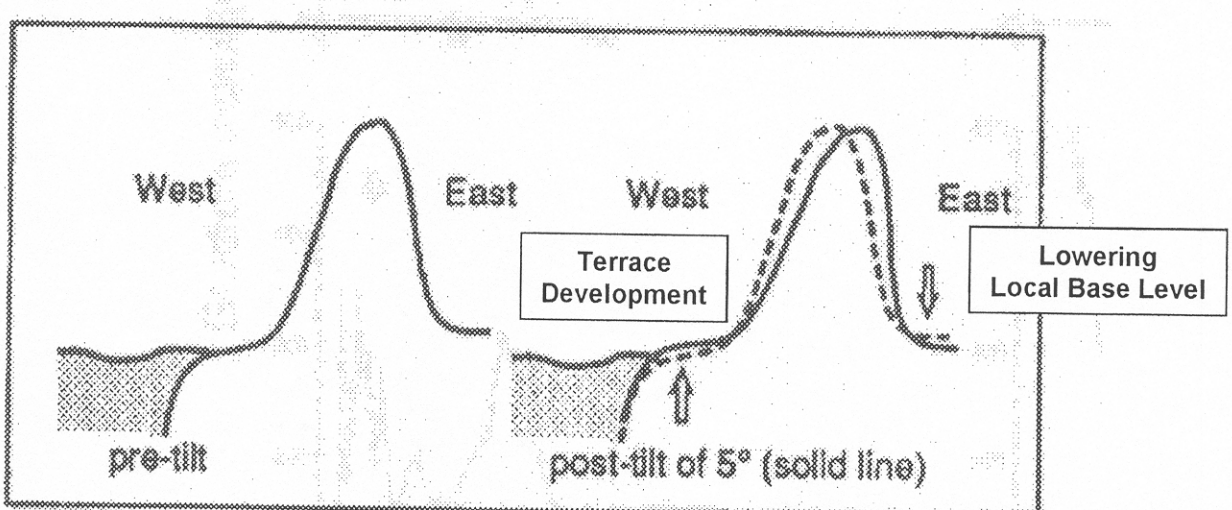


Plate tectonic configuration of the Pacific Northwest.



Cartoon showing effects of Coast Range tilting on watershed gradient (from Rhea, 1993)

57

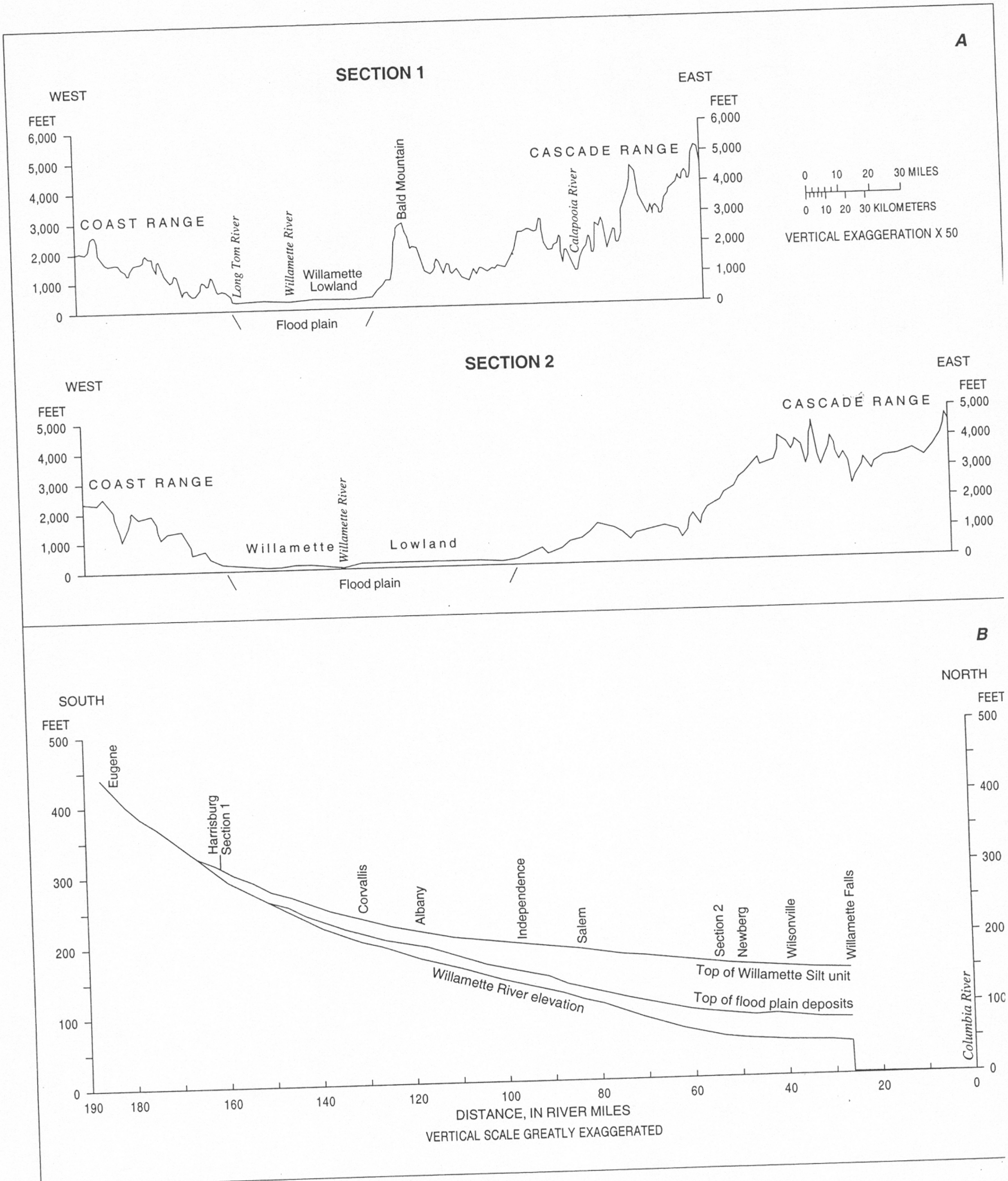
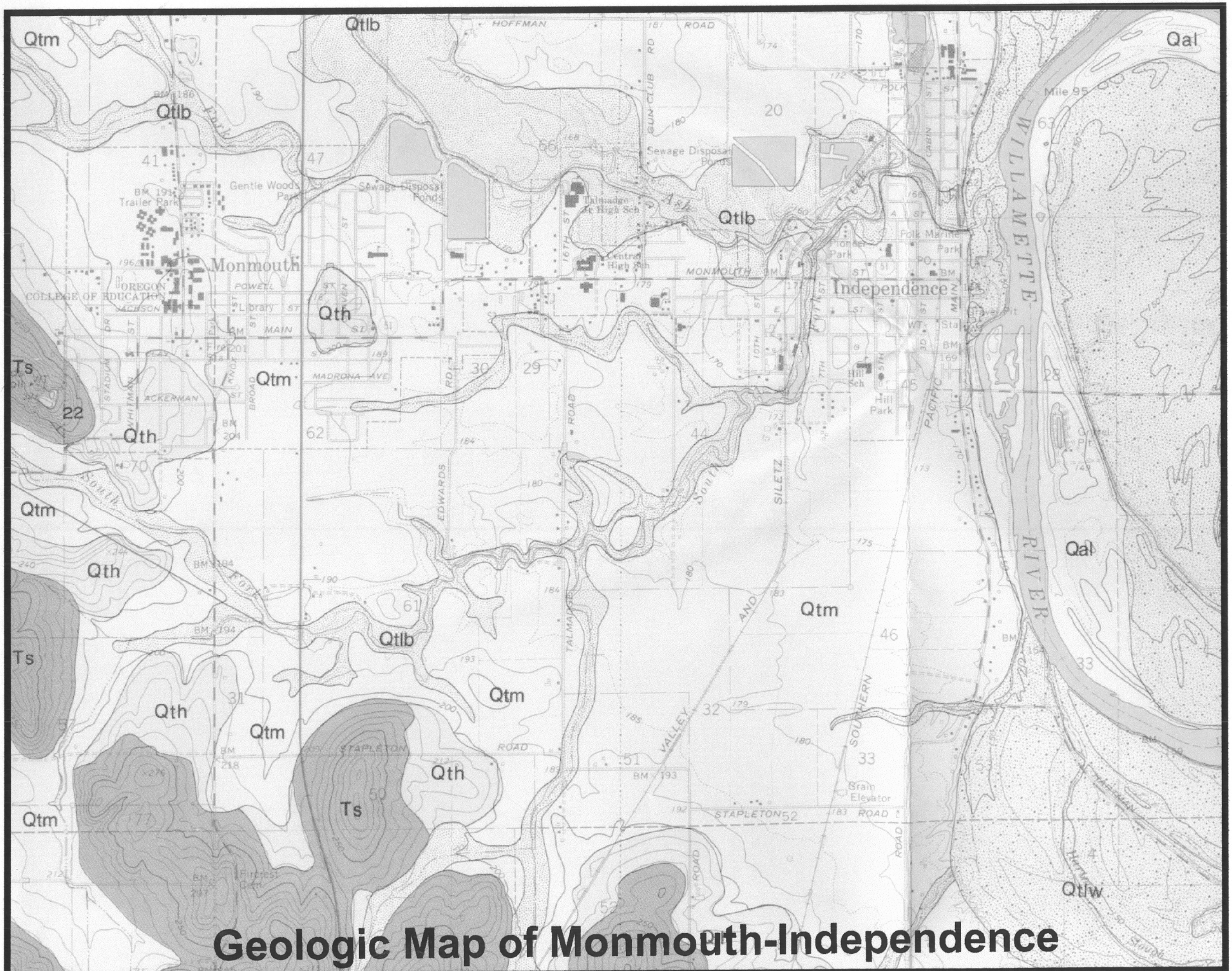


FIGURE 3. (A) Topographic sections west-east across study area and (B) Bank section along Willamette River. (Trace of topographic sections shown on figure 2.)

75



Geologic Map of Monmouth-Independence

MONMOUTH GEOLOGIC MAP

EXPLANATION

SURFICIAL GEOLOGIC UNITS

Qal — **Recent river alluvium:** *Unconsolidated cobbles, coarse gravel, sand, and some silt and clay within active channels of Willamette River. Generally 15-45 ft thick, consisting of stratified sands and well-rounded pebbles, gravels, and cobbles of primarily basaltic and andesitic composition; often overlain by 3-15 ft of light-brown sand and silt overburden. Characterized by low relief, point-bar and channel-bar deposits; many areas unvegetated, others support dense stands of brush and phreatophytes, such as willows and cottonwoods. Subject to major flooding, critical stream-bank erosion, and lateral channel migration; includes many areas located between 1852 meander line and present channel that illustrate possible extent of future changes*

Qtlw — **Lower terrace deposits of the Willamette River (Quaternary):** *Unconsolidated to semiconsolidated cobbles, gravel, sand, silt, clay, muck, and organic matter of variable thickness (30-50 ft) on the flood plain and lowland terraces immediately above the Recent river alluvium* (**Qal**)*; typically 5-20 ft of light-brown silt and clay or very fine sand overlying 10-45 ft of moderately well-sorted sand and locally cemented gravel. Surface topography characterized by a low, undulating, fluvial surface with abandoned channels, meander scrolls, oxbow lakes, and sloughs; subject to major and local flooding, some catastrophic channel migration of major scale, ponding, and high ground water. Flood-plain soils are predominantly well drained and somewhat excessively drained silty clay loams, silt loams, and sandy loams; good ground-water yields generally of 100-500 gallons per minute*

Qtlt — **Lower terrace deposits of tributary rivers and streams (Quaternary):** *Unconsolidated to semiconsolidated gravel, sand, silt, clay, and organic matter generally 15-30 ft thick on lowland terraces and flood plains immediately above major tributary rivers of the Willamette River. Gravel deposits are very thin to variable in thickness, according to tributary drainage source, generally limited to active stream beds or former meander channels, and located at or near bed rock beneath 20-30 ft of sand, silt, and clay. Somewhat tortuous meandering streams entrenched 15-45 ft, often flowing on Tertiary sedimentary bed rock or semiconsolidated older valley-fill alluvium. Surface topography characterized by a low, undulating fluvial surface of swell and swale relief, abandoned meander loops, and oxbow lakes; subject to high ground water and ponding and major and local flooding; flood-plain soils are predominantly well drained and somewhat excessively drained silty clay loams, silt loams, and sandy loams. Some soft, compressible organic soils of low shear strength may occur locally, particularly within abandoned channels and oxbows. Major stream-bank erosion commonly occurs at outer bends of meander loops by shallow earthflow and slump due to undercutting. Ground-water yields generally small*

Qtlb — **Lower terrace deposits of alluvial bottomlands (Quaternary):** *Flat, moderately to poorly drained areas with soft, organic compressible soils of low shear strength locally; characterized by low relief, ponding, and high ground water. Deposits typically consist of somewhat stratified very fine sands, silty sandy clays, silty clays, and silty clay loams, with slight to moderate plasticity (ML-CL); 4-12 ft thick along bottomlands of interior drainages of low, rolling sedimentary bedrock units. Deposits locally may represent somewhat thicker accumulations of silt and silty clay materials of fluviatile and/or loessal origin derived in part from Willamette Silts. Similar deposits along creeks are associated with deposits of units* **Qtm** *and* **Qth** *and are often modified by ditching and field drainage for agriculture; typical examples are deep (more than 60 in.) clay (CH), silty clay (CH), and silty clay loam (CL or ML) black Bashaw clay soils of Baskett Slough (Rickreall quadrangle). Similar thicknesses of reddish-brown sandy silty material (ML-CH) in basaltic terrain* (**Tcr**)

Qtm — **Middle terrace deposits (Quaternary):** *Semiconsolidated gravel, sand, silt, and clay forming very flat terraces of major extent along the Willamette River. Generally 10-30 ft of light-brown silty clay and interbedded very fine sand and silt (ML or CL-CH) surficial material; believed primarily related to Willamette Silts, including associated glacial erratics consisting of tiny fragments and pebbles up to boulders greater than 4 ft in diameter. Soils somewhat poorly drained and poorly drained silt loams and silty clay loams to moderately well-drained and well-drained silt loams subject to seasonal high ground water and ponding. Sand and gravel (GP, SM), where present, usually occur below 30 ft depth; locally more abundant near Monmouth-Independence and in the lower part of Ash Creek. Total thickness 0-85 ft, but often only 40-50 ft; within Rickreall 7½-minute quadrangle, 15-35 ft of brown clay or silt generally occurs above several to 30 ft of gravelly clay, black sands, and gravels. Generally small ground-water yields, except near Monmouth-Independence, where sand and gravel may yield up to 300 gallons per minute*

Qlg — **Linn gravel (Quaternary-upper Pleistocene):** *Stratified fine to coarse fluvial gravels deposited as an alluvial fan in the Stayton-Turner-Salem areas during an early stage of the Santiam River; of limited extent within the map area; uppermost few feet of gravels extensively oxidized and weathered, often chalky; thickness ranges from 30-40 ft to possibly as much as 300 ft. Regionally, the upper foot or so of gravel is cemented by an impermeable clay pan locally, which restricts drainage. Composition of gravels (mostly basalt, but also andesite, dacite, rhyolite, quartz, and diorite) essentially uniform. Within map area near Salem, soils are well drained and somewhat poorly drained gravelly silt loam and gravelly loam. Extensively utilized as source of sand and gravel. Good ground-water yields greater than 100 gallons per minute*

Qth — **Higher terrace deposits (Quaternary-middle Pleistocene):** *Generally semiconsolidated ligh and clay of variable thickness (3-15 ft) on higher terraces and remnants of old higher te sedimentary bedrock foothills; mantled by moderately well-drained and well-drained silt l colluvium, slope wash, and alluvial fan deposits near sedimentary bedrock foothills; d transitional with pediments. Material generally similar to unit* **Qtm**, *particularly in West glacial erratics related to Willamette Silt but also some gravelly alluvium. Some higher terra side of Salem Hills between Salem and Illahe Hill not shown due to scale. Also includes weath cobbles and gravels which extend beyond the study area west of Rickreall (8-10 ft thick) a margin of Sidney quadrangle (10-50? ft thick), where they are equivalent to the Leffler gravel. These deposits also mantled by 3-15 ft of light-brown silt loam and silty clay loam soils. Ge ground-water yield*

BEDROCK GEOLOGIC UNITS

Tcr — **Columbia River Basalt Group (Miocene):** *Medium-gray to black, fine-grained, even-textur phyritic basalt; unweathered flows generally dense, fairly crystalline, exhibiting massive colum base to diced or hackly jointing in entablature. Unit consists of weathered and unweathered b with interflow zones characterized by vesicular flow-top breccia, ash, and baked soils. Ma generally ranges 400-600 ft, with thickness greatly modified by erosion and weathering individual flows range from 40 ft to more than 100 ft in thickness.*

Formations recognized within the Yakima Basalt Subgroup (Beeson, 1980, personal commu (1) Grande Ronde Basalt: two to four "low Mg" N_2 flows, including one to two "Winter Wat (typical exposure at Dairy Queen, West Salem); one to two thick "low Mg" flow(s), 100-150 ft quarried throughout map area; one to two flow(s) of "high Mg" N_2 basalt, generally deeply wea above the "Winter Water" flow(s); and (2) a thinner layer of younger Wanapum Basalt, represent flow(s) of the Frenchman Springs Member, observed only in South Salem within the study area occurs outside the map area in the vicinity of Turner.

Weathered flows consist of reddish-brown to grayish-brown, crumbly to medium-dense basa variable and believed related to individual basalt flows; some exposures are altered to red clay (l of 30 ft, and occasionally as deep as 60-175 ft, while others are only slightly weathered at surface in Salem Hills (generally between 500-900 ft elevation within area bounded by Pringle Scho Jackson Hill) show extensive laterization which has resulted in deposits of bauxite (Corcoran an Soils are reddish-brown, well-drained silty clay loams and gravelly silty clay loams. Unit yiel quantities of ground water from permeable rubbly zones between flows

Ti — **Intrusive rocks (Oligocene):** *Dense basalt, andesite, and gabbro dikes and sills of very limited map area (Roby Hill, Sidney quadrangle); Roby Hill quarry geochemically not part of Colum Group (Beeson, 1980, personal communication). Another limited exposure of porphyritic intr flow rock, with vertical columns 1-2 ft in diameter in contact with claystone along east bank of L near Buena Vista Road (river mile 3.2). Presumed post-Eocene (Oligocene?) age (Helm and*

Toe — **Eocene-Oligocene sedimentary rock (middle and lower Oligocene and upper Eocene):** *Equival marine sedimentary rocks (Tts) of Baldwin and others (1955), Illahe tuffs (Tit) of Mundorf Formation (Ti) of Thayer (1939), Eocene-Oligocene marine sedimentary rocks (Tm) of Pr undifferentiated Tertiary rocks (Tu) of Gonthier (in press). Consists of two lithologic and faun Willamette River (Baldwin and others, 1955) but undifferentiated in this map due to poor expos light-gray to tan sandy tuffaceous siltstone equivalent in age to early Oligocene Keasey Form section near border of Amity-Rickreall 7½-minute quadrangles, where approximately 1,000 ft th Oligocene strata well exposed in Yamhill River near Yamhill locks, where steeply dipping and co Younger unit is fine- to coarse-grained tuffaceous sandstone equivalent in age to middle Olig Bluff Formation; basal stratum approximately 150 ft of dark-gray, coarse-grained, calcareous sandstone, chiefly composed of detrital igneous rock fragments. White, fine-grained, massively pumiceous volcanic glass approximately 250 ft thick exposed for 3 mi along hillside south of Fin quadrangle); good exposures of pebbly tuff, tuffaceous conglomerate, and fine-grained platy tu Hill Road in Sidney 7½-minute quadrangle.*

Tuffaceous marine sandstone and siltstone of Oligocene sedimentary rock correspond to Ol Formation described by Hickman (1969), which contains early to middle Oligocene molluscan foraminiferal analyses (McKeel, 1980) of oil and gas wells within the study area indicate unit 2,000 ft of upper Refugian and Refugian strata (Reichhold-Merrill #1, Sidney quadrangle) and basal siltstone, claystone, and shale of late Narizian (provincial West Coast late Eocene) age (Re and Reichhold-Merrill #1)

Ts — **Upper Eocene sandstone:** *Equivalent to Helmick beds (Thb) of Mundorff (1939) and Spencer ((in press); very fine- to medium-grained, thinly laminated (fissile) to thin-bedded, as well as pr massive, light-gray to yellowish-brown moderately well-sorted micaceous, calcareous, lithic (tuffaceous) sandstones; frequently interbedded with fine-grained marine tuffaceous siltstone, th clay shale, and claystone; comprised of almost equal proportions of quartz, feldspar, and cemented with calcite (in concretions); minor constituents include approximately 2% glauc (biotite, muscovite, and chlorite), and less than 1% authigenic pyrite; well compacted; carbona consisting of plant stems, leaves, and other organic fragments common; calcareous concretions, containing carbonaceous material, prominent along Willamette River south of Buena Vista (M rangle); pebbly lenses, abundant organic matter, and paleoecology indicate strandline environme from chiefly volcanic terrain. Weathered outcrops of massive, very fine- to medium-grained s friable, ranging in color from white to yellowish-brown, pale-brown, or yellowish-orange.*

According to McKeel (1980), this unit is bracketed by upper Narizian strata in the Reichhol (Amity quadrangle), by upper Narizian and Narizian strata in the Reserve-Bruer #1 well (Amit and by upper Narizian strata in the Reichhold-Merrill #1 well (Salem West quadrangle). Ave about 800 ft

Ty — **Yamhill Formation (middle and upper Eocene):** *Medium- to dark-gray, massive to faintly bedd tuffaceous shale and siltstone. Occasional beds of medium-gray to greenish-gray, fossilifero sandstone; minor limestone concretions.*

According to McKeel (1980), this unit contains 2,000-3,000 ft of Narizian and lower Narizia Reichhold-Finn #1 and Reserve-Bruer #1 wells, located in the Amity quadrangle. Shown only in th

OTHER SYMBOLS

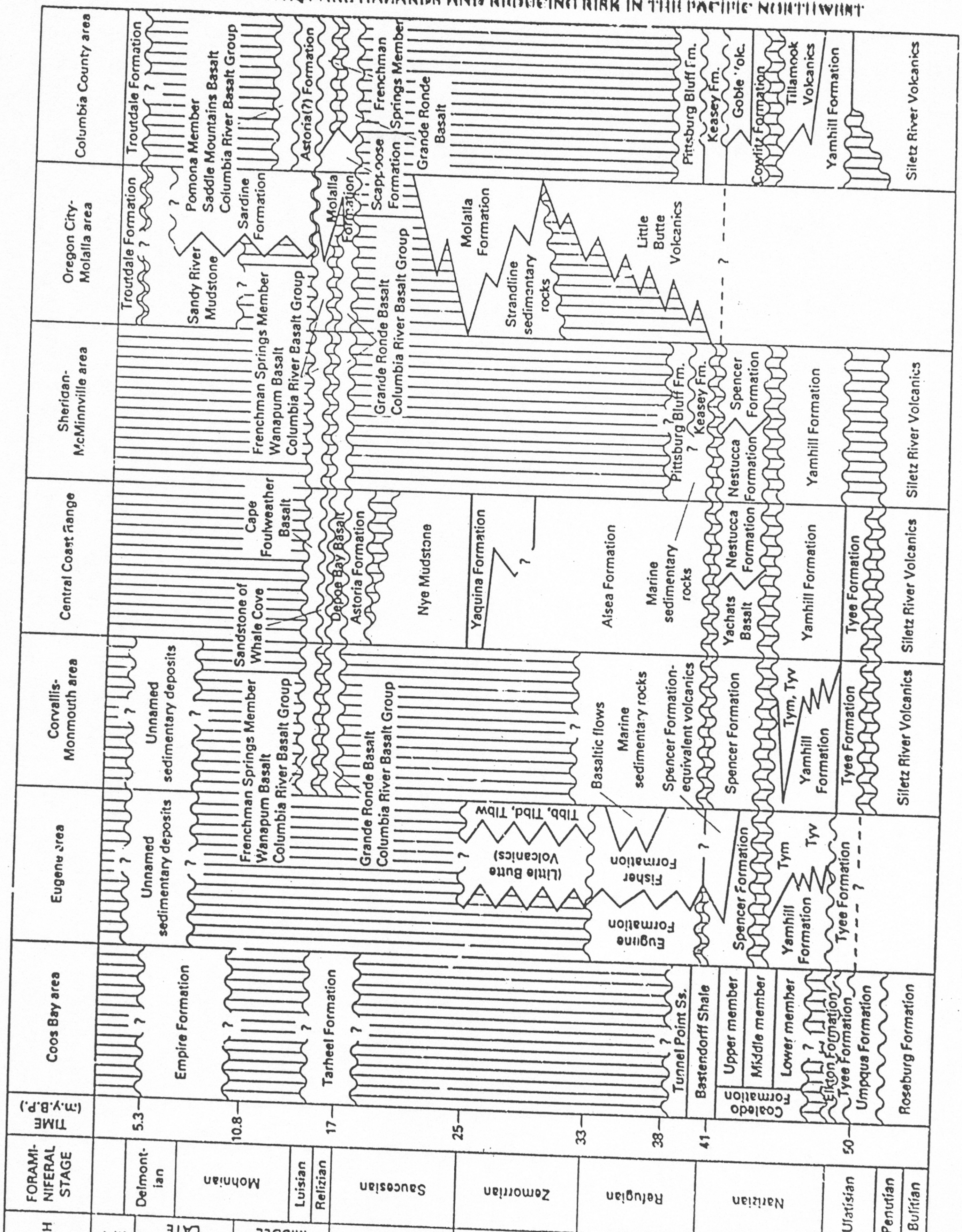
Lineament: *Selected major lineaments identified from 1:76,000 false-color infrared aerial phot Army Corps of Engineers, 1978), orthophotoquads, and topographic maps. Features include a major escarpments, concentric curvilinear drainages, aligned drainages across saddles, and par ted are short linear segments along drainages of less than 1 mi length; general trends NE and lineament features observed in western Oregon*

Landslide topography: *Large areas of deep bedrock failure characterized by irregular topogra stratigraphy, overall anomalous moderate to shallow slope, prominent arcuate headscarps, b blocks, springs, sag ponds, and disrupted drainage patterns. Most prominent along west side of S south and west side of Eola Hills, where undercutting of soft marine sediments (Eocene to Oligoce rock, unit* **Toe**) *has resulted in massive landsliding of blocks of more resistant unit* **Tcr**. *Subject debris avalanche along oversteepened escarpments and to slump in some areas (bowed and tip*

Deep bedrock slides within upper Eocene sedimentary rock (**Ts**) *within Monmouth quadra smaller than those associated with units* **Tcr/Toe**; *characterized by small knobby blocks of sea within general hummocky terrain*

Landslide scarp: *Characterized by steep cliff, often arcuate, and backward-tilted block below*

bc — **Basaltic colluvium and/or landslide debris:** *Generally reddish-yellow or reddish-brown bas and/or landslide debris, deeply weathered, overlying Oligocene sedimentary rock* (**Toe**), *ge landslide topography or beneath steep cliffs capped by Columbia River Basalt Group* (**Tcr**); *includ and some earthflow and debris-flow topography. Probably generally 6-35 ft thick but may include basalt of greater thickness. Soils well-drained silty clay loams and gravelly silty clay loams ove and clay*


EPOCH
FORAMINIFERAL STAGE
TIME (m.y.B.P.)
Coos Bay area
Eugene area
Corvallis-Monmouth area
Central Coast Range
Sheridan-McMinnville area
Oregon City-Molalla area
Columbia County area
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
LATE
MIDDLE
EARLY
Delmontian
Mohnian
Luisian
Relizian
Saucesian
Zemorrian
Refugian
Narizian
Ulatisian
Penutian
Bulitian
5.3
10.8
17
25
33
38
41
50
Empire Formation
Tarheel Formation
Tunnel Point Ss.
Bastendorff Shale
Coaledo Formation
Upper member
Middle member
Lower member
Elkton Formation
Tyee Formation
Umpqua Formation
Roseburg Formation
Unnamed sedimentary deposits
Frenchman Springs Member
Wanapum Basalt
Columbia River Basalt Group
Grande Ronde Basalt
Tibb, Tibd, Tibw
(Little Butte Volcanics)
Fisher Formation
Eugene Formation
Spencer Formation
Yamhill Formation
Tym
Tyv
Tym, Tyv
Basaltic flows
Marine sedimentary rocks
Spencer Formation-equivalent volcanics
Tyee Formation
Siletz River Volcanics
Sandstone of Whale Cove
Cape Foulweather Basalt
Depoe Bay Basalt
Astoria Formation
Nye Mudstone
Yaquina Formation
Alsea Formation
Yachats Basalt
Nestucca Formation
Pittsburg Bluff Fm.
Keasey Fm.
Troutdale Formation
Sandy River Mudstone
Sardine Formation
Molalla Formation
Strandline sedimentary rocks
Little Butte Volcanics
Pomona Member
Saddle Mountains Basalt
Astoria(?) Formation
Scappoose Formation
Goble Volc.
Cowlitz Formation
Tillamook Volcanics

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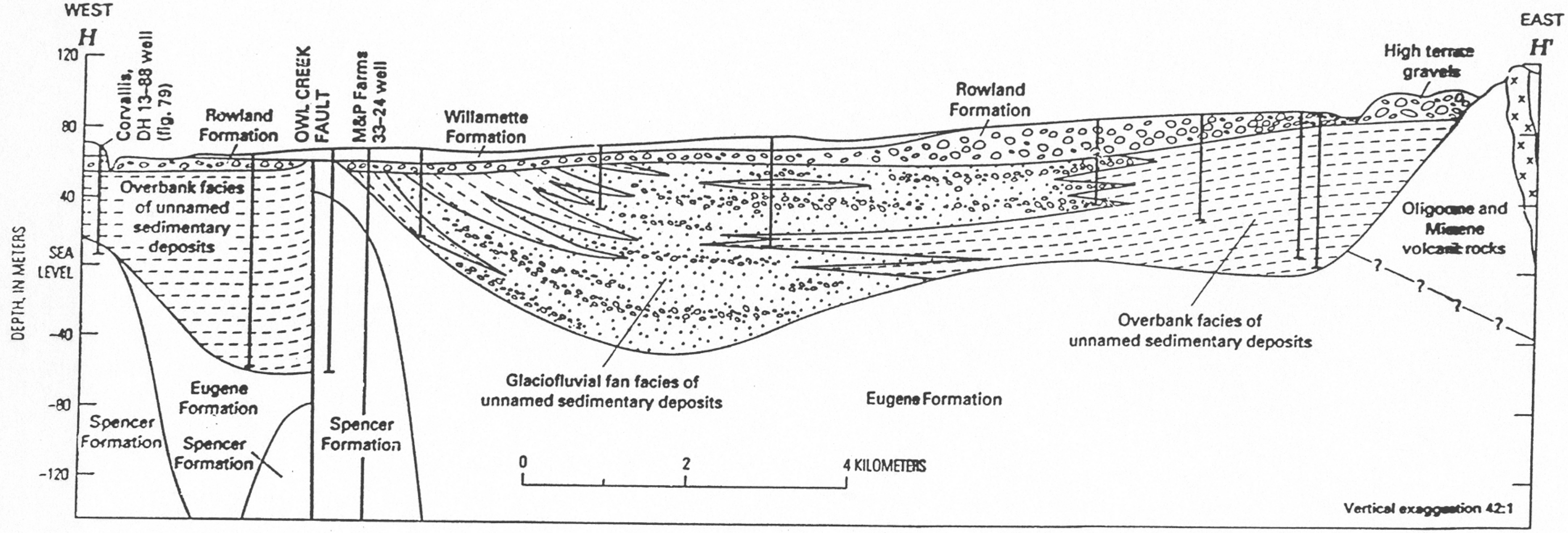

Figure 82. Structural cross section between Corvallis and Lebanon, Oreg., showing channel and overbank facies of unnamed fluvial sedimentary deposits, high-terrace gravels, late Pleistocene outwash deposits of the Rowland Formation, and catastrophic flood deposits of the Willamette Formation. Data are from water wells, engineering bore holes, and petroleum-exploration wells.

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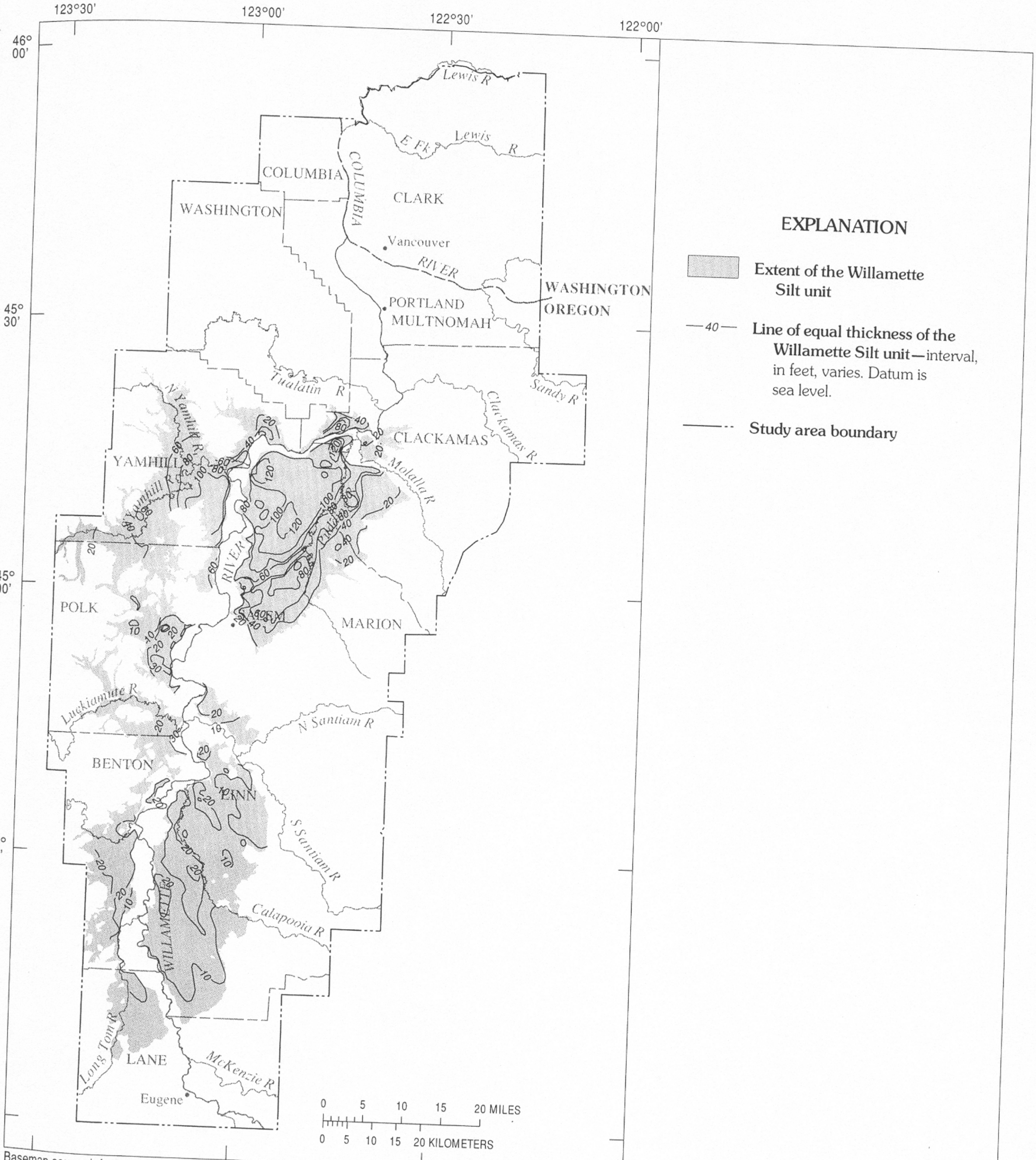

Basemap source information on page v.

nnett and Caldw
1424-A.

Geologic data modified from Gannett and Caldwell, 1998, USGS Professional Paper 1424-A.

FIGURE 14.—Extent and thickness of the Willamette Silt unit.

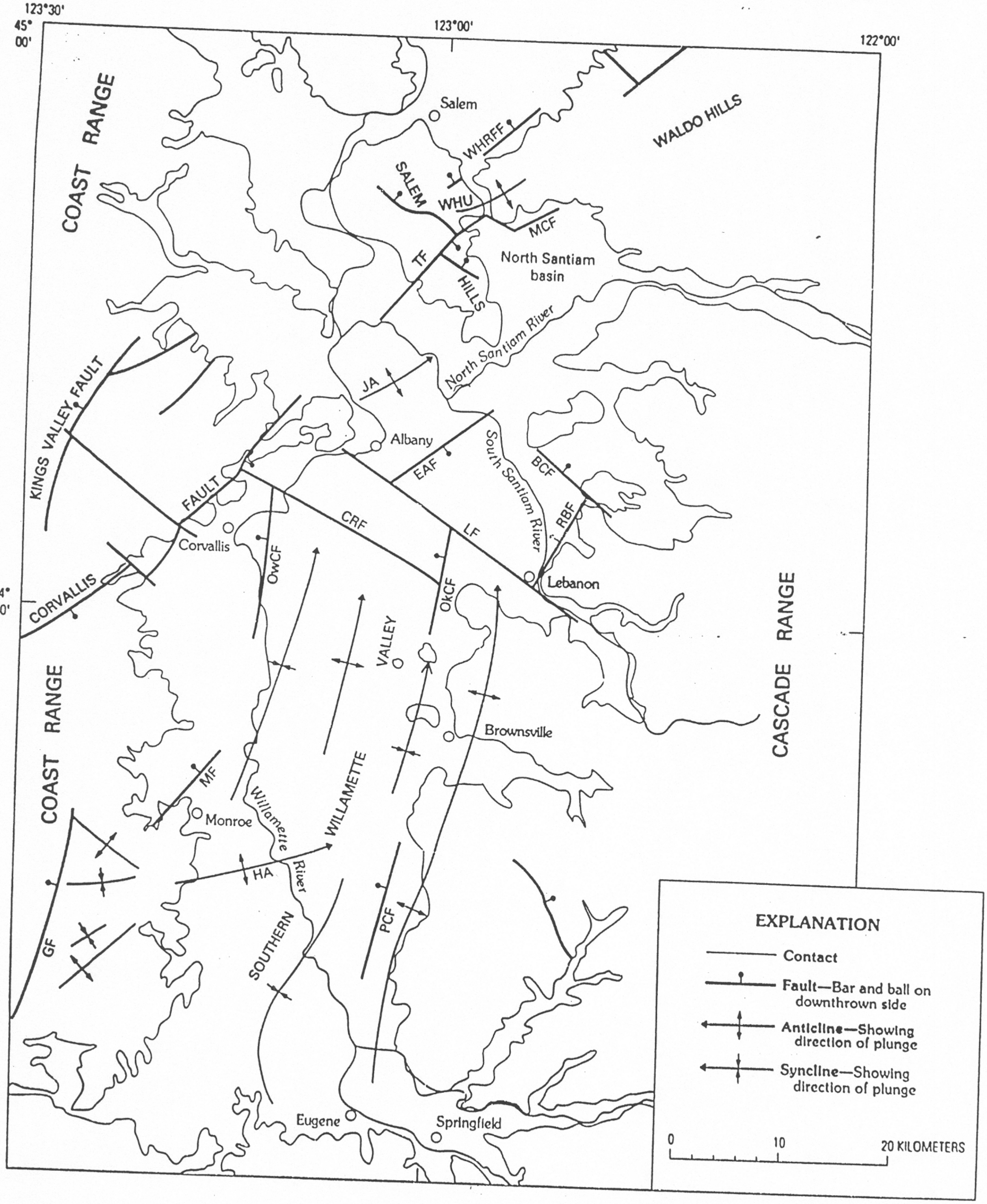

Figure 84. Tectonic map of the southern Willamette Valley, Oregon. Areas underlain by alluvial and fluvial deposits that postdate the Columbia River Basalt Group are unshaded; areas underlain directly by bedrock are shaded. BCF, Beaver Creek fault; CRF, Calapooia River fault; EAF, East Albany fault; GF, Glenbrook fault; HA, Harrisburg anticline; JA, Jefferson anticline; LF, Lebanon fault; MCF, Mill Creek fault; MF, Monroe fault; OwCF, Owl Creek fault; OkCF, Oak Creek fault; PCF, Pierce Creek fault; RBF, Ridgeway Butte fault; TF, Turner fault; WHRFF, Waldo Hills range-front fault; WHU, Waldo Hills uplift.

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2011

Table 1: Crustal Faults

Mapped Fault or Fault Zone	*Probability of Activity (Wong, 2000)*	*Fault Type (Geomatrix, 1995)*	*Maximum Moment Magnitude (Wong, 2000)*	*Approx. Horizontal Distance From Site to Surface Fault Trace (miles)*
Corvallis Fault	0.3	Reverse	6.5	11
Owl Creek Fault	0.3	Reverse	6.4	18
Mount Angel Fault	0.9	Strike-slip	6.6	27
Mill Creek Fault	0.3	Reverse	6.6	11
Waldo Hills Fault	0.3	Reverse	6.5	11

an estimated Richter Magnitude for those seismic events that do not have such a recording, the Gutenberg and Richter, 1965 relationship, M = (2/3) MMI +1, was applied to those earthquakes that only had a reported Modified Mercalli Intensity (MMI). The MMI scale is a means of estimating the size of an earthquake using human observations and reactions to the earthquake. The MMI scale ranges from I to XII, with XII representing the highest intensity. A search of the database was conducted to determine the number and estimated magnitude of earthquakes that have taken place within 50 kilometers of the site. The information derived from the Oregon earthquake catalog indicates that four M5.0 or greater earthquakes occurred within the search zone. M5.0 was the largest recorded magnitude within the 50-km search area.

5.2 Crustal Faults

Based on the literature review, there are no identified tectonic faults mapped within the boundaries of the site or within adjacent properties. Evidence was not encountered during the field investigation to suggest the presence of faults within the property. The potential for fault displacement and associated ground subsidence at the site is considered remote.

5.3 Ground Shaking Characteristics

The peak rock acceleration for the 2% chance of exceedance in 50-year event (2475-year return period) was evaluated using the 2008 United States Geological Survey's National Seismic Hazard Project. This probabilistic uniform hazard study incorporates the relative contributions of the Cascadia Subduction Zone, intraplate earthquakes within the Juan de Fuca plate, and crustal earthquakes from the North American Plate. Deaggregation of the uniform hazard data provides the relative contributions of the individual earthquake sources. The results of the probabilistic analysis indicate an estimated peak rock acceleration of 0.45g for a 2475-year return period. The deaggregation of the probabilistic uniform hazard indicates approximately 75% of the overall hazard is attributed to the Cascadia Subduction Zone with the remaining hazard contributed by shallow

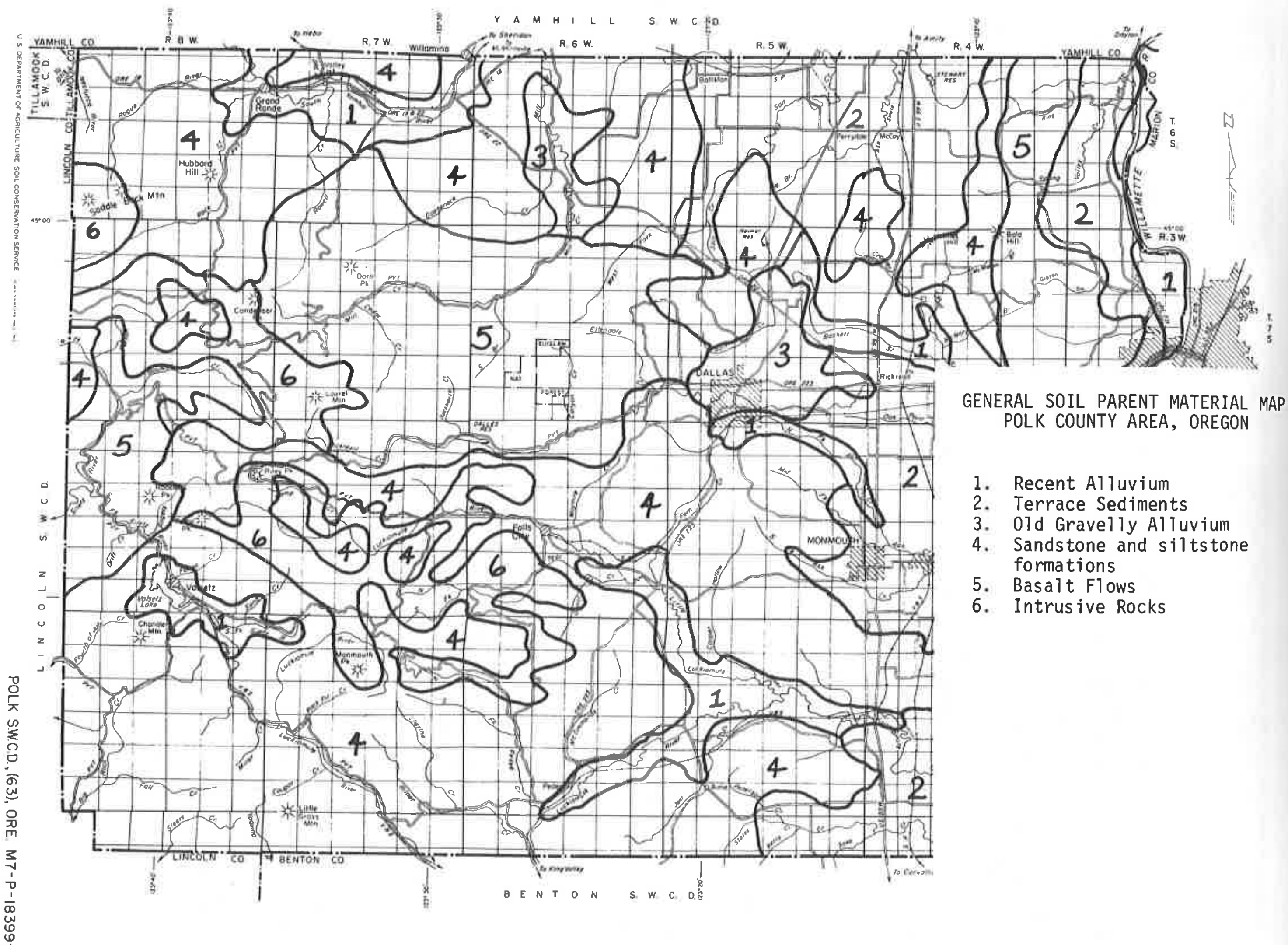
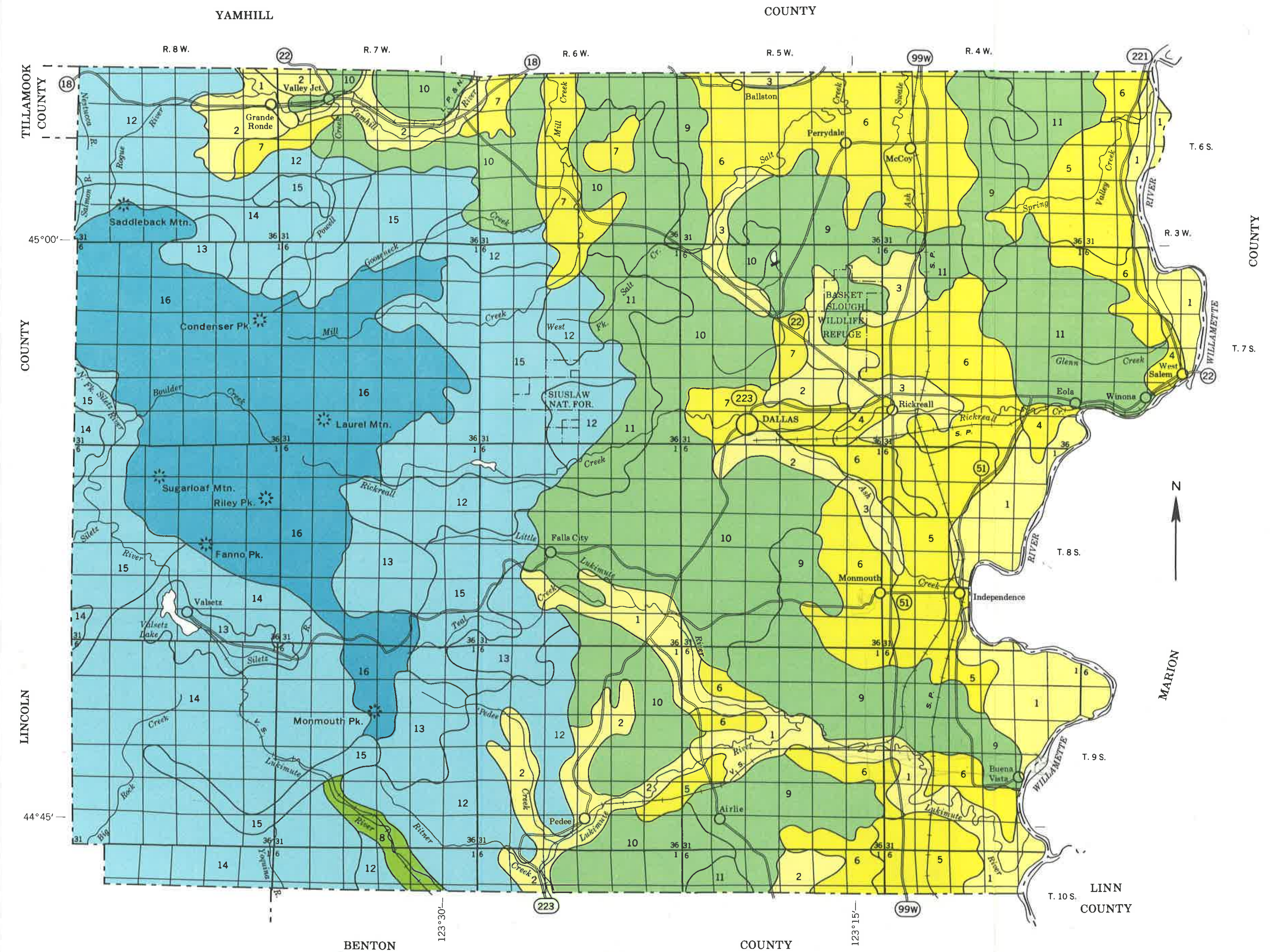


Figure 17.—General soil parent material, Polk County, Oregon.



Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

MAP UNIT

DOMINANTLY DEEP, SOMEWHAT EXCESSIVELY DRAINED TO POORLY DRAINED SOILS ON BOTTOM LANDS, TERRACES, AND FANS

1	Chehalis-Cloquato-Newberg: Well drained and somewhat excessively drained silty clay loams, silt loams, and sandy loams
2	Waldo-McAlpin: Poorly drained and moderately well drained silty clay loams
3	Cove-Bashaw: Poorly drained silty clay loams

DOMINANTLY DEEP, WELL DRAINED TO POORLY DRAINED SOILS ON TERRACES OF THE WILLAMETTE VALLEY

4	Malabon-Coburg: Well drained and moderately well drained silty clay loams
5	Dayton-Amity-Concord: Somewhat poorly drained and poorly drained silt loams
6	Woodburn-Willamette: Moderately well drained and well drained silt loams
7	Salkum-Briedwell: Well drained silty clay loams and silt loams

DOMINANTLY DEEP, POORLY DRAINED AND WELL DRAINED SOILS ON BOTTOM LANDS AND VALLEY TERRACES OF THE COAST RANGE

8	Brenner-Knappa: Poorly drained and well drained silt loams

DOMINANTLY SHALLOW TO DEEP, WELL DRAINED TO SOMEWHAT POORLY DRAINED SOILS ON FOOTHILLS AND UPLANDS

9	Helmick-Steiwer-Hazelair: Deep and moderately deep, well drained to somewhat poorly drained silt loams
10	Bellpine-Suver-Rickreall: Moderately deep, deep, and shallow, well drained to somewhat poorly drained silty clay loams
11	Jory-Nekia: Deep and moderately deep, well drained silty clay loams

DOMINANTLY DEEP AND MODERATELY DEEP, WELL DRAINED SOILS ON MOUNTAINOUS UPLANDS

12	Peavine-Honeygrove-McDuff: Deep and moderately deep, well drained silty clay loams
13	Blachly-Kilowan: Deep and moderately deep, well drained silty clay loams and gravelly silty clay loams
14	Bohannon-Astoria: Moderately deep and deep, well drained gravelly loams and silt loams
15	Kilchis-Klickitat: Shallow and deep, well drained stony loams and gravelly clay loams

DOMINANTLY MODERATELY DEEP AND SHALLOW, WELL DRAINED, COLD SOILS ON MOUNTAINOUS UPLANDS

16	Valsetz-Luckiamute: Moderately deep and shallow, well drained stony loams and very shaly loams

* Texture refers to the surface layer of the major soils unless otherwise noted.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
OREGON AGRICULTURAL EXPERIMENT STATION

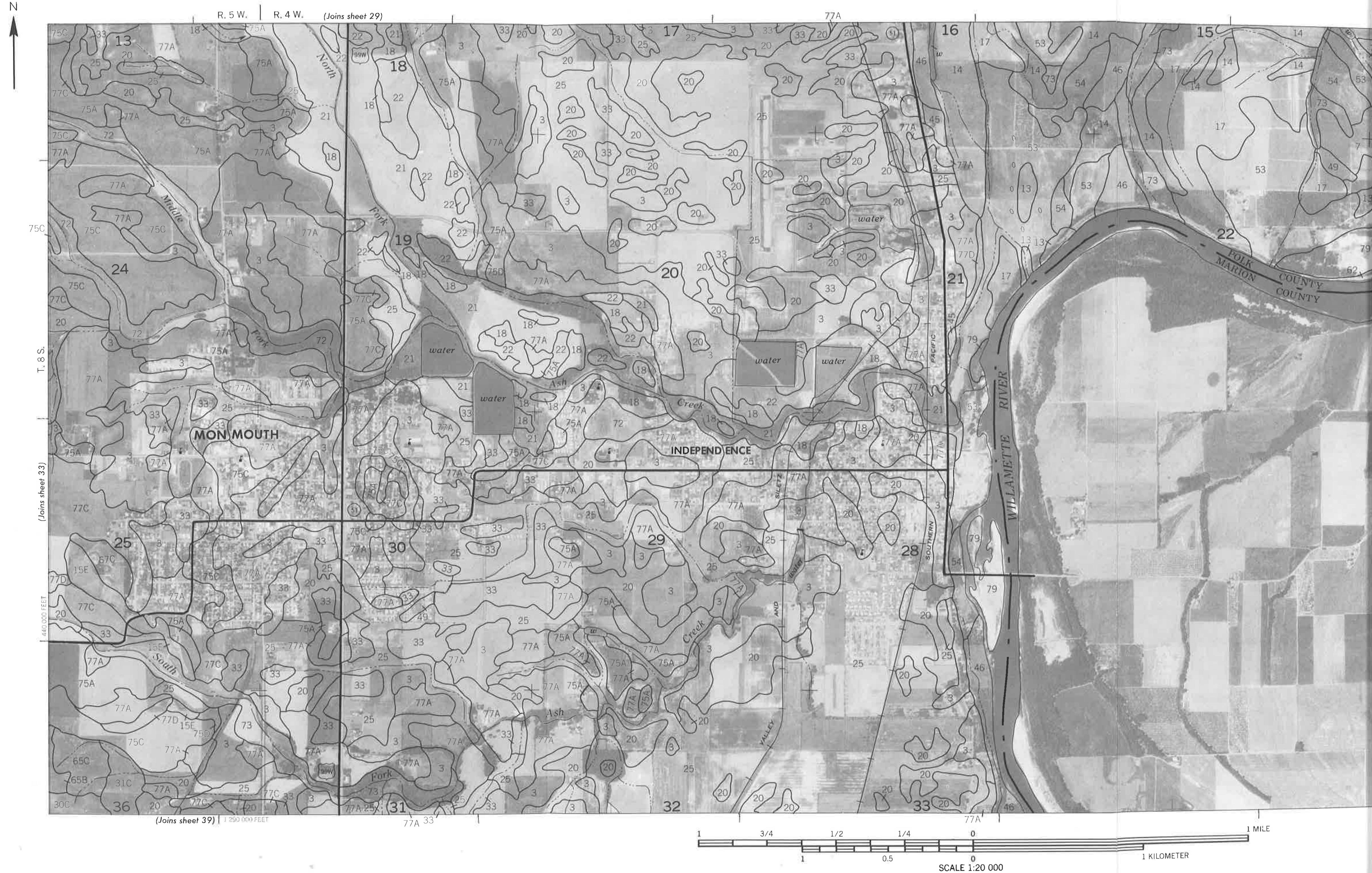
GENERAL SOIL MAP

POLK COUNTY, OREGON

SCALE 1:190,080

1 0 1 2 3 4 5 MILES

Compiled 1979


N
R. 5 W.
R. 4 W.
(Joins sheet 29)
(Joins sheet 33)
(Joins sheet 39)
T. 8 S.
MONMOUTH
INDEPENDENCE
WILLAMETTE RIVER
POLK COUNTY
MARION COUNTY
North Fork
Middle Fork
South Fork
Ash Creek
water
SOUTHERN PACIFIC
VALLEY AND SILETZ
440 000 FEET
1 290 000 FEET
1 MILE
1 KILOMETER
SCALE 1:20 000

SOIL LEGEND

Arabic numerals in the symbols indicate the soil name. The capital letters A, B, C, D, E, F, or G following the numeral or numerals indicate the slope class. Capital letters are omitted in symbols for nearly level soils and for other mapping units such as miscellaneous areas that may have a wide range in slope.

BOL	NAME
A	Abiqua silty clay loam, 0 to 3 percent slopes
B	Abiqua silty clay loam, 3 to 5 percent slopes
	Abiqua silty clay loam, occasionally flooded, 0 to 3 percent slopes
	Amity silt loam
D	Apt silty clay loam, 3 to 25 percent slopes
E	Apt silty clay loam, 25 to 50 percent slopes
D	Astoria silt loam, 5 to 30 percent slopes*
E	Astoria silt loam, 30 to 60 percent slopes*
A	Bashaw silty clay loam, 0 to 3 percent slopes
C	Bashaw silty clay, 3 to 12 percent slopes
	Bashaw clay, 0 to 3 percent slopes
C	Bellpine silty clay loam, 3 to 12 percent slopes
D	Bellpine silty clay loam, 12 to 20 percent slopes
E	Bellpine silty clay loam, 20 to 30 percent slopes
F	Bellpine silty clay loam, 30 to 50 percent slopes
G	Bellpine silty clay loam, 50 to 75 percent slopes
D	Blachly silty clay loam, 3 to 30 percent slopes*
E	Blachly silty clay loam, 30 to 50 percent slopes*
0D	Bohannon gravelly loam, 3 to 25 percent slopes*
0E	Bohannon gravelly loam, 25 to 50 percent slopes*
0F	Bohannon gravelly loam, 50 to 75 percent slopes*
1	Brenner silt loam
2A	Briedwell silt loam, 0 to 3 percent slopes
2C	Briedwell silt loam, 3 to 12 percent slopes
2D	Briedwell silt loam, 12 to 20 percent slopes
3	Camas gravelly sandy loam
4	Chehalis silty clay loam, occasionally flooded
5C	Chehulpum silt loam, 3 to 12 percent slopes
5E	Chehulpum silt loam, 12 to 40 percent slopes
6E	Chehulpum-Steiwer complex, 12 to 40 percent slopes
7	Cloquato silt loam
8	Coburg silty clay loam
9	Coburg silty clay loam, occasionally flooded
0	Concord silt loam
1	Cove silty clay loam
2	Cove silty clay loam, thick surface
3D	Cruiser gravelly loam, bedrock substratum, 3 to 25 percent slopes*
3E	Cruiser gravelly loam, bedrock substratum, 25 to 50 percent slopes*
3F	Cruiser gravelly loam, bedrock substratum, 50 to 70 percent slopes*
4D	Cumley silty clay loam, 2 to 20 percent slopes
5	Dayton silt loam
6C	Dixonville silty clay loam, 3 to 12 percent slopes
6D	Dixonville silty clay loam, 12 to 20 percent slopes
7C	Dupee silt loam, 3 to 12 percent slopes
7D	Dupee silt loam, 12 to 20 percent slopes
8	Grande Ronde silty clay loam
9C	Hazelair silt loam, 3 to 12 percent slopes
9D	Hazelair silt loam, 12 to 20 percent slopes
9E	Hazelair silt loam, 20 to 30 percent slopes
0C	Helmick silt loam, 3 to 12 percent slopes
0D	Helmick silt loam, 12 to 20 percent slopes
0E	Helmick silt loam, 20 to 50 percent slopes
1C	Helvetia silt loam, 0 to 12 percent slopes
1D	Helvetia silt loam, 12 to 20 percent slopes
2D	Hembre gravelly silt loam, 3 to 25 percent slopes
2E	Hembre gravelly silt loam, 25 to 50 percent slopes*
2F	Hembre gravelly silt loam, 50 to 75 percent slopes*
3	Holcomb silt loam
4D	Honeygrove silty clay loam, 3 to 25 percent slopes*
4E	Honeygrove silty clay loam, 25 to 50 percent slopes*
4F	Honeygrove silty clay loam, 50 to 75 percent slopes*
5C	Jory silt loam, 2 to 12 percent slopes
5D	Jory silt loam, 12 to 20 percent slopes
5E	Jory silt loam, 20 to 30 percent slopes
6C	Jory silty clay loam, 2 to 12 percent slopes
6D	Jory silty clay loam, 12 to 20 percent slopes
6E	Jory silty clay loam, 20 to 30 percent slopes
7D	Jory silty clay loam, 2 to 30 percent slopes*
7E	Jory silty clay loam, 30 to 50 percent slopes
8E	Kilchis stony loam, 3 to 30 percent slopes*
8F	Kilchis stony loam, 60 to 90 percent slopes*
9F	Kilchis-Klickitat complex, 60 to 90 percent slopes*
0D	Kilowan gravelly silty clay loam, 3 to 25 percent slopes*
0E	Kilowan gravelly silty clay loam, 25 to 50 percent slopes*
0F	Kilowan gravelly silty clay loam, 50 to 75 percent slopes*
1D	Klickitat gravelly clay loam, 3 to 30 percent slopes*
1E	Klickitat gravelly clay loam, 30 to 50 percent slopes*
1F	Klickitat gravelly clay loam, 50 to 75 percent slopes*
2B	Knappa silt loam, 0 to 7 percent slopes

SYMBOL	NAME
43D	Luckiamute very shaly loam, 3 to 30 percent slopes*
43F	Luckiamute very shaly loam, 30 to 75 percent slopes*
44D	Lurnick gravelly loam, 3 to 30 percent slopes*
44E	Lurnick gravelly loam, 30 to 50 percent slopes*
44F	Lurnick gravelly loam, 50 to 75 percent slopes*
45	Malabon silty clay loam
46	Malabon silty clay loam, occasionally flooded
47D	Marty gravelly loam, 3 to 25 percent slopes*
47E	Marty gravelly loam, 25 to 60 percent slopes*
48A	McAlpin silty clay loam, 0 to 3 percent slopes
48B	McAlpin silty clay loam, 3 to 6 percent slopes
49	McBee silty clay loam
50D	McDuff silty clay loam, 3 to 25 percent slopes*
50E	McDuff silty clay loam, 25 to 50 percent slopes*
50F	McDuff silty clay loam, 50 to 75 percent slopes*
51D	Mulkey loam, 5 to 25 percent slopes*
52C	Nekia silty clay loam, 2 to 12 percent slohes
52D	Nekia silty clay loam, 12 to 20 percent slopes
52E	Nekia silty clay loam, 20 to 30 percent slopes
52F	Nekia silty clay loam, 30 to 50 percent slopes
53	Newberg fine sandy loam
54	Newberg loam
55D	Peavine silty clay loam, 3 to 30 percent slopes*
55E	Peavine silty clay loam, 30 to 60 percent slopes*
55F	Peavine silty clay loam, 60 to 75 percent slopes*
56C	Philomath silty clay, 3 to 12 percent slopes
57E	Philomath silty clay, 12 to 45 percent slopes
58	Pilchuck fine sandy loam
59	Pits, quarries
60C	Rickreall silty clay loam, 3 to 12 percent slopes
60D	Rickreall silty clay loam, 12 to 20 percent slopes
60E	Rickreall silty clay loam, 20 to 50 percent slopes
60F	Rickreall silty clay loam, 50 to 75 percent slopes
61C	Ritner gravelly silty clay loam, 3 to 12 percent slopes
61D	Ritner gravelly silty clay loam, 12 to 30 percent slopes
61E	Ritner gravelly silty clay loam, 30 to 60 percent slopes
62	Riverwash
63	Rock outcrop
64B	Salkum silty clay loam, 2 to 6 percent slopes
64C	Salkum silty clay loam, 6 to 12 percent slopes
65B	Santiam silt loam, 3 to 6 percent slopes
65C	Santiam silt loam, 6 to 15 percent slopes
65D	Santiam silt loam, 15 to 20 percent slopes
66D	Slickrock gravelly loam, 3 to 25 percent slopes*
66E	Slickrock gravelly loam, 25 to 50 percent slopes*
67C	Steiwer silt loam, 3 to 12 percent slopes
67D	Steiwer silt loam, 12 to 20 percent slopes
67E	Steiwer silt loam, 20 to 50 percent slopes
68C	Suver silty clay loam, 3 to 12 percent slopes
68D	Suver silty clay loam, 12 to 20 percent slopes
68E	Suver silty clay loam, 20 to 30 percent slopes
69D	Trask shaly loam, 3 to 30 percent slopes*
69F	Trask shaly loam, 30 to 90 percent slopes*
70D	Valsetz stony loam, 3 to 30 percent slopes*
70E	Valsetz stony loam, 30 to 50 percent slopes*
70F	Valsetz stony loam, 50 to 75 percent slopes*
71F	Valsetz-Yellowstone complex, 50 to 90 percent slopes*
72	Waldo silty clay loam
73	Wapato silty clay loam
74C	Willakenzie silty clay loam, 2 to 12 percent slopes
74D	Willakenzie silty clay loam, 12 to 20 percent slopes
74E	Willakenzie silty clay loam, 20 to 30 percent slopes
$4F	Willakenzie silty clay loam, 30 to 45 percent slopes
75A	Willamette silt loam, 0 to 3 percent slopes
75C	Willamette silt loam, 3 to 12 percent slopes
75D	Willamette silt loam, 12 to 20 percent slopes
76C	Witzel very stony silt loam, 3 to 12 percent slopes
76E	Witzel very stony loam, 12 to 50 percent slopes
77A	Woodburn silt loam, 0 to 3 percent slopes
77C	Woodburn silt loam, 3 to 12 percent slopes
77D	Woodburn silt loam, 12 to 20 percent slopes
78	Xerochrepts and Haploxerolls, steep
79	Xerofluvents, loamy*
80D	Yellowstone stony loam, 3 to 30 percent slopes*
80F	Yellowstone stony loam, 30 to 90 percent slopes

* Broadly defined mapping units

PROJECT NO. P1667-05-01

BORING B 3

ELEV. (MSL.) ______ DATE COMPLETED **03-10-2009**

EQUIPMENT **B-57 MUD** BY: **S. DIXON**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0					2" ASPHALT over BASE ROCK			
3	B3-1			ML-CL	**NATIVE ALLUVIUM** Stiff, moist, brown, Clayey SILT to Silty CLAY	17		27.7
5.5	B3-2					8		42.7
10.5	B3-3					9		37.9
13				CL	Stiff, moist, brown and gray, CLAY			
15.5	B3-4					8		42.1
20.5	B3-5				-Becomes gray	15		43.7

BORING TERMINATED AT 21.5 FEET
Static groundwater not encountered

Figure A-3,
Log of Boring B 3, Page 1 of 1

P1667-05-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

PROJECT NO. P1844-05-01

BORING B 4

ELEV. (MSL.)_______ DATE COMPLETED **10-14-2011**

EQUIPMENT **TRAILER HSA** BY: **S. DIXON**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0					**3.5" ASPHALT OVER 8"BASE ROCK**			
				CH	**WILLAMETTE SILT** Medium stiff, moist, light brown, Silty CLAY			
2	B1-1					7		37.8
4	B1-2					6		40.4
6								
8	B1-3				-Becomes moist to wet	4		40.0
10	B1-5		▽		-Becomes soft, wet to saturated	3		38.8
12	B1-4				-Becomes medium stiff	4		43.7
14	B1-6					4		41.8
16								
18					Stiff to very stiff, wet to saturated, gray, CLAY			
20	B1-7					17		38.0

BORING TERMINATED AT 21.5 FEET
Groundwater encountered at 10 feet

Figure A-1,
Log of Boring B 4, Page 1 of 1

P1844-05-01.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	◧ ... STANDARD PENETRATION TEST	■ ... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	◣ ... CHUNK SAMPLE	▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

PROJECT NO. P1844-05-01

BORING B 5

ELEV. (MSL.)_______ DATE COMPLETED 10-14-2011

EQUIPMENT TRAILER HSA BY: S. DIXON

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0					3.5" ASPHALT OVER 1.5"BASE ROCK			
				ML/CL	**WILLAMETTE SILT** Medium stiff, moist, light brown, SILT with clay			
2								
	B2-1					7		36.6
4								
	B2-3					6		41.7
6								
8	B2-3				-Becomes soft	3		39.7
10	B2-4				-Becomes medium stiff, moist to wet	4		37.8
12								
14								
	B2-5					7		40.3
16								
18					Very stiff, wet, lighy gray, CLAY			
20	B2-6					20		51.5

BORING TERMINATED AT 21.5 FEET
Groundwater not encountered

Figure A-2,
Log of Boring B 5, Page 1 of 1

P1844-05-01.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM 10, OREGON within 30 days from the date of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)

POLK
3367

State Well No. 8/5W-24

State Permit No.

(1) OWNER:
Name HARRY A. BROWN
Address RT. 1 BOX 18 A.
MONMOUTH ORE.

(2) LOCATION OF WELL:
County POLK Driller's well number
¼ ¼ Section 24 T. 8S R. 5W W.M.
Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):
w Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
bandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 47 ft. Gage 1702
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(7) PERFORATIONS:
Perforated? ☐ Yes ☒ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS:
Well screen installed ☐ Yes ☒ No
Manufacturer's Name
e Model No.
n. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:
Well seal—Material used in seal BENTONITE
Depth of seal 45' ft. Was a packer used? yes
Diameter of well bore to bottom of seal 10" in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☒ Yes ☐ No
Type of water? SURFACE Depth of strata 16' TO 34'
Method of sealing strata off CASED

(10) WATER LEVELS:
Static level 21 ft. below land surface Date 6-30-64
Artesian pressure lbs. per square inch Date

(11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "
Bailer test 35 gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water 55 Was a chemical analysis made? ☐ Yes ☒ No

(12) WELL LOG:
Diameter of well below casing 6"
Depth drilled 85' ft. Depth of completed well 85' ft.

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
TOPSOIL	0	2
CLAY YELLOW COLOR	2	23
CLAY BLUE COLOR	23	34
CONGLOMERATE 1"	34	45
CLAYSTONE GRAY - HARD	45	75
CLAYSTONE WHITE HARD	75	85

Work started 6-27 19 64 Completed 6-30 19 64
Date well drilling machine moved off of well 6-30- 19 64

(13) PUMP:
Manufacturer's Name
Type: JET H.P. 1

Water Well Contractor's Certification:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME J.A. SNEED & SONS
(Person, firm or corporation) (Type or print)
Address 3910 SILVERTON RD. SALEM ORE.

Drilling Machine Operator's License No. 187

[Signed] J.A. Sneed
(Water Well Contractor)

Contractor's License No. 6 Date 6-30, 19 64

(USE ADDITIONAL SHEETS IF NECESSARY)