

Information Circular No. 23

IDAHO BUREAU OF MINES AND GEOLOGY

Moscow, Idaho

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***Guide for the Location of Water Wells
in Latah County, Idaho***

by
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INTRODUCTION

Purpose and Objectives

Ground water is a primary source of municipal and domestic water supplies for residents of Idaho. Successful wells range from single domestic supplies of only a few gallons per minute to major supply wells for urban areas yielding thousands of gallons per minute. The construction of a supply well is usually the end result of considerable thought and planning. It may replace an unsuitable or unreliable water supply or simply result from an initiation or expansion of water use. Whatever the motivation for the well, it is imperative that it be successful; the well should yield good quality water in usable quantities from reasonable depths. Knowledge of the general and local subsurface geology and the occurrence and movement of ground water is important in the completion of a successful well. The yield of a well is dependent upon the well construction and the ability of the saturated geologic material to store and transmit water.

Most of the residents of Latah County derive their domestic water supplies from ground water. The common water-yielding geologic materials include basalt, sedimentary materials, granite and metamorphic rocks. The subsurface geology is generally complex and large differences in water-yielding capabilities are found in short distances.

The purpose of this report is to summarize the knowledge of ground-water geology in Latah County in northern Idaho and to provide a guide for land owners and drillers for the construction of water wells. The specific objectives of the project are to 1) review the reports and papers pertinent to the geology and hydrology of the area, 2) compile information on existing wells in the study area, and 3) present analyses of groundwater potential for subareas or basins within Latah County.

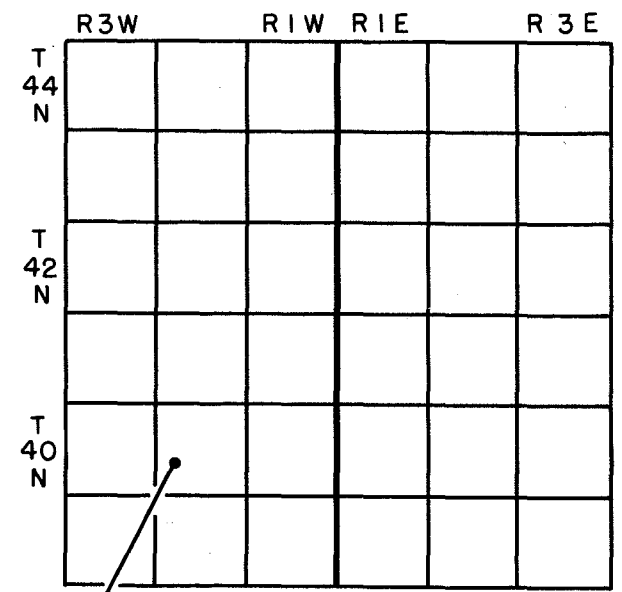
Previous Studies

Previous studies of the ground-water resource in Latah County have been centered in the Moscow Basin. Recent reports include those by Stevens (1960), Ross (1965), and Jones and Ross (1972). Short term studies to locate municipal water supplies for the towns of Genesee, Deary, Juliaetta and Potlatch have also been performed. The principal contributions to the geology of Latah County are reports by Tullis (1944) and Bond (1963). A report on the geology and ground-water occurrence in Whitman County, Washington by Walters and Glancy (1969) was useful in the analysis of the ground-water potential in the western portion of Latah County.

Richard Wyatt of Hoffman and Fiske Engineers is concurrently conducting a survey of municipal water and sewage works in Latah County. Data generated by that study are included in this report.

Well Numbering System

The well numbering system used in this study is the same as that used by the U.S. Geological Survey in Idaho (Fig. 1). This system indicates the locations of wells within the official rectangular subdivisions of the public lands, with reference to the Boise Base Line and Meridian. The first two segments of the number give the township and range, followed by the section number, and by two letters and a numeral, which indicate the quarter section, the forty-acre tract, and the serial number of the well within the tract. Quarter sections are



Well No. 40N-2W-30 ba 1

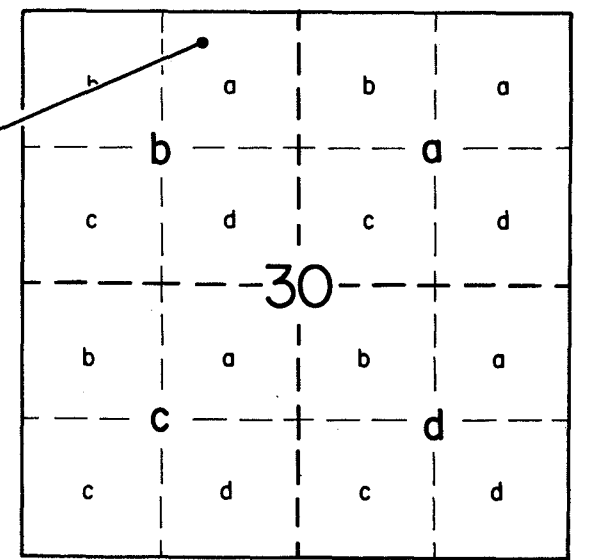
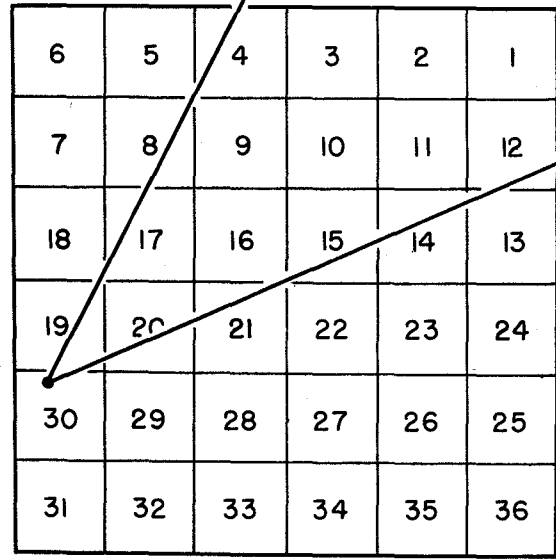


Figure 1-Well Numbering System

lettered a, b, c, and d in counter clockwise order from the northeast quarter of each section. Within the quarter sections forty-acre tracts are lettered in the same manner. As an example, well 40N 2W 30 bal is in the NE $\frac{1}{4}$ NW $\frac{1}{4}$ of Section 30, Township 40 North, Range 2 West, Boise Meridian and is the first well designated in that tract.

Acknowledgments

The author acknowledges the assistance of the following well-drilling firms in supplying information on wells in Latah County; Adcock Air Drilling, Burns and Witt Well Drilling, Detray Drilling, Ray McPherson Well Drilling, Phil Olson Well Drilling and A.E. Spray Well Drilling. The assistance of Carl Simons of the Electrical Shop and Ken Carter of the Farm and Logger Supply, pump dealers in the area, is appreciated. The information and access provided by well owners in the area is also appreciated.

GROUND-WATER GEOLOGY

Introduction

Four general ages of geologic material are present in Latah County: the Precambrian Belt Supergroup, the Cretaceous granitic rocks, the Tertiary Columbia River Group and the Quarternary Palouse Formation and alluvium. Belt and granitic rocks make up the topographic highs and underlie the basalt and sediments throughout the county.

A map of the generalized geology is presented as Figure 2. The map is based on the geology presented by Tullis (1944) with additional detail on the Columbia River Group in the southern portion of the county from Bond (1963) and in the Moscow Basin from Ross (1965).

Belt Supergroup

The Belt Supergroup in northern Idaho consists of sedimentary rocks which have been metamorphosed into quartzite, gneiss, schist and other related rock types. Belt rocks occur extensively in the northern and eastern parts of the county and at scattered locations in the southern and western portions (Figure 2). In general, the rocks make up the more mountainous areas. Exceptions occur at scattered locations in the southern portions of the county where Belt rocks are exposed on Fix and Big Bear Ridges. Wells south of Deary and in Potlatch have penetrated what is believed to be the Belt series underlying the Columbia River Group.

Quartzite, schist and gneiss, the primary rock types in the Belt Supergroup, generally yield only small quantities of water to wells. Davis and DeWiest (1966, p. 319) noted that solid pieces of metamorphic rocks commonly have porosity values of less than one percent and extremely low permeability values. The low porosity (ratio of the volume of voids in a rock to the total volume) indicates that only very small quantities of water may be stored in unaltered metamorphic rocks. The low permeability (ability of the rock to allow movement of water) indicates that little water, if any, can move through the solid rock. Both porosity and permeability may be developed through natural fracturing and weathering of the rock. It is the storage and movement of water in the fractured and weathered zones that provides the limited potential available for well development in the Belt rock in Latah County and northern Idaho.

Permeability produced by natural fracturing of unweathered rock may vary widely across short distances. Water-yielding zones produced by this weathering are thus often highly localized. Permeability because of natural fracturing generally decreases with depth. As a result, the water production per foot of well depth also decreased with depth (Davis and Turk, 1964, p. 11).

The effects of weathering on metamorphic rocks normally extends downward from 5 to 50 feet but may extend along fractures to as great as 300 feet from the surface of the ground. The hardness of the weathered material generally increases with depth down to the unweathered rock. Gear (1951, p. 252) noted that larger water supplies and greater permeability values are found from the medium hard rock just above the unweathered surface than either the very hard or soft rock. Permeabilities in the lower part of the weathered zone are generally ten times greater than in the underlying unaltered rock (Davis and DeWiest, 1966, p. 320).

Davis and Turk (1964, p. 8) presented several graphs showing the yield of wells in crystalline rock with depth. One graph, based on 814 wells in granite and 1,522 wells in schist in the eastern United States, is reproduced in Figure 3. The yield of water from crystalline rock is shown to decrease rapidly with depth. This may be attributed to the decreased openings of fractures and decreased weathering effects.

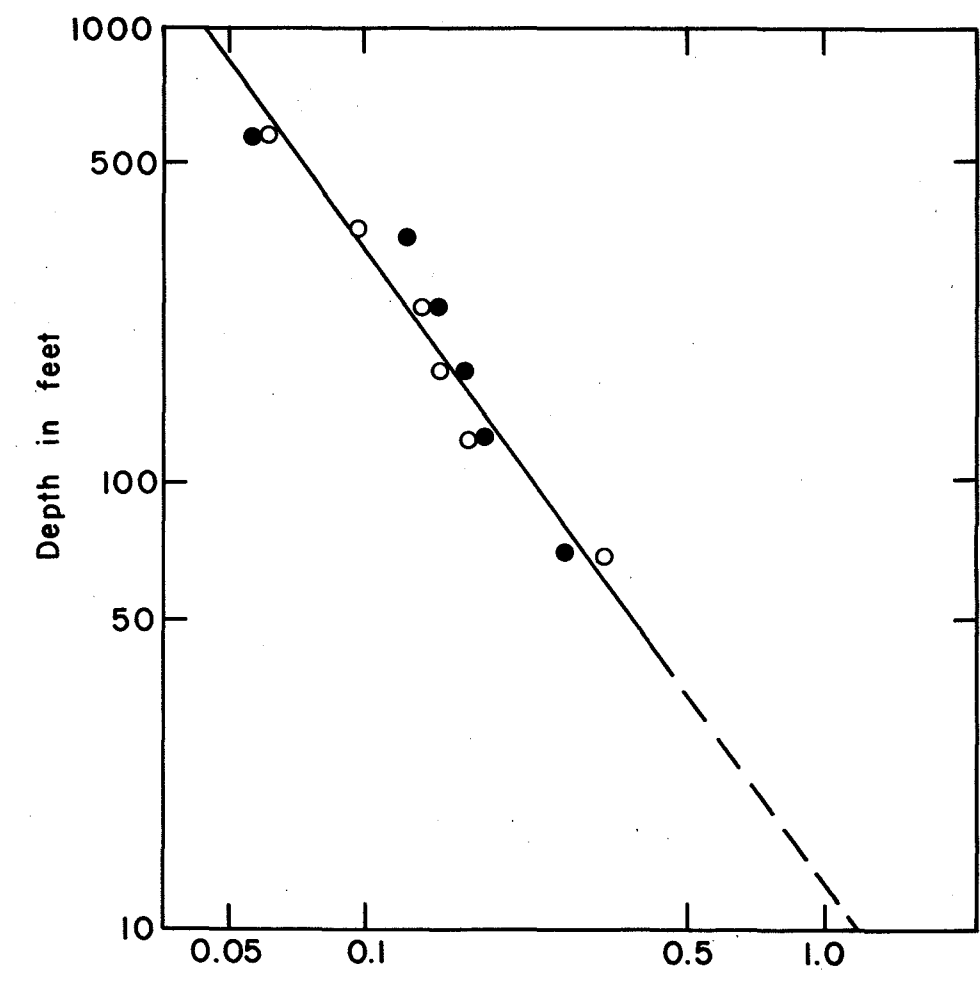
Reported well yields from the Belt rocks in Latah County are low and generally range from one to five gpm (gallons per minute). Data from wells in metamorphic and plutonic igneous rocks in other areas indicate a mean yield of 10 to 25 gpm (Davis and DeWiest, 1966, p. 323). The differences in well yields depend primarily on the degree of weathering and fracturing. The low well yields from the Belt rocks in Latah County may be partially the result of the existing type of well construction and use. Almost all the wells drilled in the metamorphic rocks in the county are for individual domestic supplies. Most wells are designed for small yields and drilling is stopped when the first usable supply of water is obtained. The maximum potential yields from the Belt Supergroup have thus not been obtained.

One of the primary conclusions of the study by Davis and Turk (1964, p. 11) is that "the water-bearing characteristics of most crystalline rocks are primarily controlled by weathering and structure. Rock type alone is commonly of secondary importance." Some characteristic differences in the density of fracturing and the resistance to weathering between rock types in the Belt Supergroup have been noted. Generally, however, these differences are of small magnitude.

Some porosity has been noted in the Belt rocks in Latah County from the original structure of the rock. Limited yields have been derived from a sandstone that was metamorphosed but not completely recrystallized. In general, however, the original structure has been altered extensively throughout the area. Data are not available to denote any characteristic hydrologic properties within the various Belt formations. Well yields appear to be in the same range from all of the formations within the Belt Supergroup throughout the county.

Granitic Rocks

The intrusive igneous rocks exposed in Latah County are primarily quartz, diorite, granodiorite, monzonite and granite (Ross, 1965, p. 14). For this study, no differentiation is made between the types of rocks and all are referred to as granitic rocks. The discussion of granitic rocks also includes the older igneous rocks exposed on Gold Hill.



Well yield in gallons per minute per foot of well depth

Figure 3—Well Yield vs. Depth in Crystalline Rock
(Davis and Turk, 1964)

The granitic rocks occur roughly in a northeast-southwest band across the center of Latah County (Figure 2). Generally, the granitic rocks appear on the surface as topographic highs, but at depths probably underlie all other rocks in the county.

Wells drilled in granitic rocks generally yield only small quantities of water. The occurrence of water in these rocks is similar to that described previously for the metamorphic rocks of the Belt Supergroup. Unfractured and unweathered granite has a very low permeability and may be considered impermeable for all practical purposes. The general water-yielding characteristics of the granitic material thus depends on the amount of fracturing and the depth and extent of weathering. In general, the permeability created by these actions is in the same order of magnitude as that described for the Belt rocks. Somewhat greater yields might be expected from the weathered granite than the weathered Belt rocks because the decomposed or weathered zones in the granite are probably slightly coarser grained than similar zones in the Belt rocks. This difference in yield is probably offset by the possibility of some original porosity and permeability in Belt rocks that have not been completely recrystallized. As a result, the potential well yields from Belt and granitic rocks are about the same.

Reported well yields from granitic rocks in Latah County are generally low. Most yields range from one-to-seven gallons per minute with an average of about three gallons per minute. Davis and DeWiest (1966, p. 326) report average yields of wells in granite from various areas range from 6 to 38 gpm. The yields reported from wells in granitic rock in Latah County are probably not maximum values because of the type of well construction. In general, no attempt has been made to produce large quantities of water from the granite in the county. There is no indication, however, that high sustained yields can hope to be obtained from granitic rock in Latah County.

Columbia River Group

The Columbia River Group in Latah County is composed of a number of basalt flows and associated sedimentary interbeds. The lava flows of the Columbia River Group spread eastward into northern Idaho covering the valleys and foothills to a probable minimum altitude of 2,800 feet, and to a depth in places of more than 3,700 feet (Bond, 1963, p. 1). Around its margins, the basalt lies in part upon older rocks and in part upon contemporaneous sedimentary deposits which in places interfinger with the basalt (Newcomb, 1959, p. 1).

The Columbia River Group occurs as three separate lobes in parts of Latah County (Figure 2). The flows in the southern portion of the county have been described by Bond (1963); Ross (1965) discussed the formation in the Moscow Basin and Tullis (1944) delineated the basalt in the Potlatch area. Basalt occurs in an area covering approximately 400 square miles of Latah County. The elevation of the top of the basalt ranges from about 2,900 feet in the eastern part of the county to about 2,600 feet near Potlatch. About 1,700 feet of the formation is exposed in the canyon near Juliaetta, including approximately 300 feet of sediments.

Ground water in the Columbia River Group occurs primarily in the contact zones between basalt layers, Newcomb (1961, p. A-2) described the basalt as follows: "The average flow consists of dense, almost flintlike, partially fractured rock at its base; grades vertically to dense, massive columnar-jointed rock at its center; and then to vesicular and some places rubbly-rock at its top." "The open-

ings in the interflow zones consist principally of cracks and crevices, produced mainly by the incomplete closure of one flow over another and by the unhealed fragmentation and the vesicular character of the basalt at the tops of some flows." (Newcomb, 1959, p. 4). The porosity of the dense, unfractured center of basalt flows commonly ranges from one to five percent. The porosity of the vesicular zones may range as high as 50 percent (Davis and DeWiest, 1966, p. 333). The permeability of the vesicular zones depends on both the percent of openings and the degree of interconnection of the openings.

The interbedded sedimentary deposits in the Columbia River Group do not generally yield large quantities of water to wells (Newcomb, 1959, p. 5). Bond (1963, p. 15) divided the interbedded sedimentary rocks into three types: marginal, deformational and composite. Most of the sedimentary rocks are the "marginal" type formed by ponding of ancestral rivers and creeks by basalt flows (Figure 4). These rocks are normally located near the basalt-basement contact and usually grade from medium to fine-grained material away from the basement rocks. Most of the material is silt and clay deposited in a lake environment.

One location where the sediments are believed to form a good aquifer is in the Moscow Basin. The deeper wells in the area obtain water from both the basalt and the sand interbeds. Jones and Ross (1972, p. 12) note that the upper, middle and lower artesian aquifers are made up of both basalt and sedimentary interbeds.

The yields from wells penetrating the Columbia River Group are extremely variable. Poor producing wells may be located within a few feet of good producing wells. Because of this extreme variability, a discussion of well yields must necessarily be based on averages. Newcomb (1959, p. 13) noted that two general types of wells have been drilled in the basalt: small 4, 6 and 8-inch wells which extend down to the first usable water for household or farmstead supply and 6 to 36 inch wells which commonly tap several aquifers and provide large yields of water for public supply, irrigation or industrial purposes. Wells of the former type predominate in Latah County. A compilation of several hundred wells penetrating 300 feet or more of the Columbia River basalt in Washington indicated that one gallon per minute per foot of well penetration below the regional water table is an overall average of the yield obtained by a 10 or 12 inch well when pumped at a common draw-down of 50 to 100 feet (Newcomb, 1959, p. 14). This estimate, noted to be on the conservative side, applies only to those wells drilled to provide large yields. Walters and Glancy (1969, p. 9) estimated that these types of wells yield 125 to 200 gpm for each 100 feet of basalt penetrated below the water table in Whitman County, Washington.

The yields of wells from the Columbia River Group in Latah County vary from nearly zero to greater than 1,000 gpm. This wide variation may be attributed to the type of well, the permeability of the formation and the location of the well with respect to the general ground-water flow system. The first two factors have been discussed previously; the latter, the general flow system, needs additional clarification. A number of the individual domestic wells in the county obtain water from local aquifers located above the more regional system. This is particularly common in the Ridges area south of Troy and Deary. The long-term yields of wells penetrating these aquifers are limited by the local areal extent of the saturated zones and the small rate of recharge.

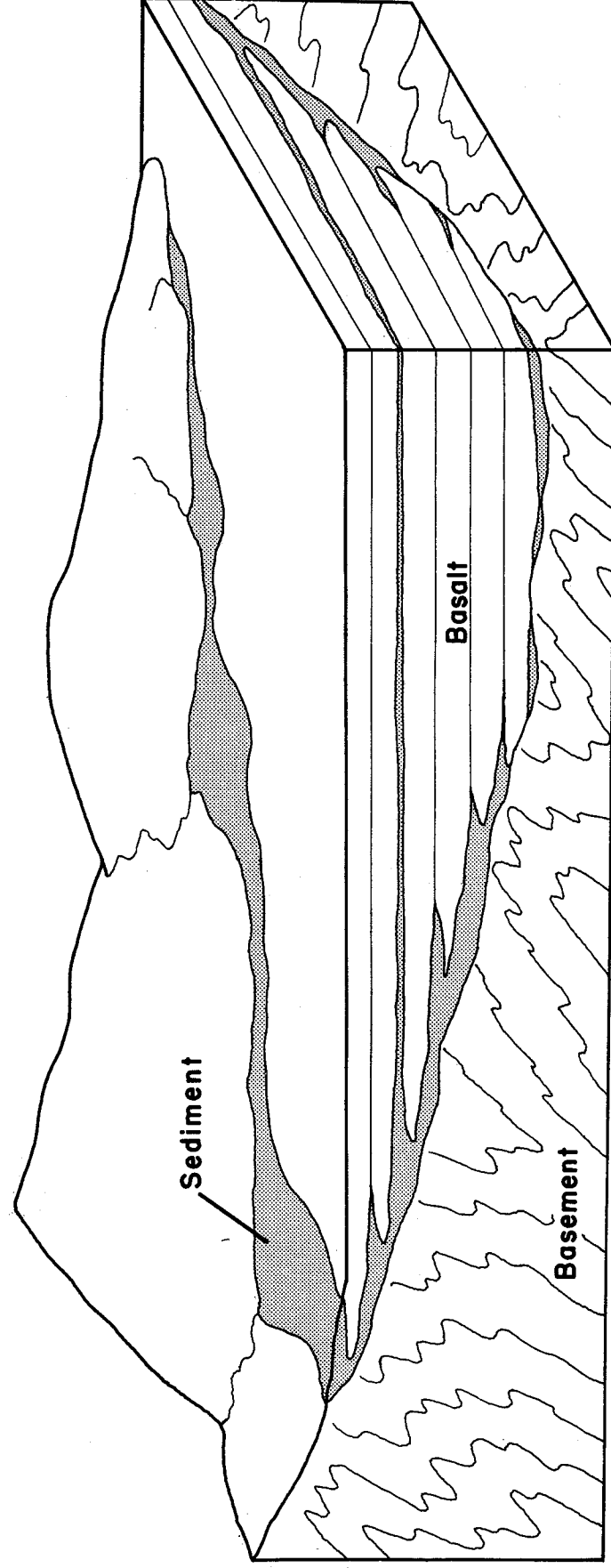


Figure 4 – Diagrammatic Basalt–Basement Interrelationship (Bond, 1962)

The general flow system in the Columbia River Group is very complex. Foxworthy and Washburn (1963, p. 16-18) note that recharge to the basalt aquifers occurs from both downward movement of water from the overlying Palouse Formation and from lateral movement of water from the basalt-basement contact. The general vertical movement of water results in the formation of many local ground-water flow systems. It is thus very difficult to define a regional water table in basalt. The ground-water potential, or head, is known to decrease with depth in the basalt throughout most of the study area and in eastern Washington. A downward component of ground-water flow exists in the area to fairly great depths. The depth to water thus increases with increasing well depth.

Tertiary volcanic rocks are exposed on Potato Hill north of Deary. The permeability and water yielding characteristics of these rocks is unknown.

Alluvium and Palouse Formation

The Palouse Formation and alluvium are the most recent geologic deposits in the county. The Palouse Formation is a mantle of loess that covers many square miles of the Palouse Hills in northern Idaho and eastern Washington. The formation is composed of tan or brown clayey silt and ranges from one foot to greater than 150 feet in thickness (Foxworthy and Washburn, 1963, p. 12). The alluvium found in the county is generally near and related to the present stream valleys. Many individual domestic water supplies are obtained from shallow dug wells in the alluvium and Palouse Formation. The yields of these wells are usually small and many wells go dry in the summer.

GROUND-WATER POTENTIAL IN SUBAREAS

Delineation of Subareas

The county is divided into five subareas for the discussion of the ground-water potential. The delineation of the subareas was based primarily on similarities in geologic and hydrologic conditions. The subareas, shown on Figure 5, are named as follows: Ridges Subarea, Troy-Deary-Bovill Subarea, Genesee Subarea, Moscow Subarea and Potlatch Subarea.

Ridges Subarea

The availability of ground water to wells in the Ridges subarea is presented in Figure 6. In general, the ground-water potential is poor because of the discontinuous nature of the aquifer systems. The most productive area is in the canyon of the Potlatch River near Kendrick and Juliaetta (area II on Figure 6).

The Ridges subarea is characterized by a series of north-south ridges separated by deep canyons. The ridges range in elevation from 2,300 feet to 2,800 feet and have a general gentle north-to-south slope. The streams are confined to canyons generally less than one-mile wide and ranging in depth from 200 to 1,200 feet. All of the streams are tributary to the Potlatch River.

Bond (1963) noted fault control of the locations of Little Potlatch Creek, Middle Potlatch Creek and the west fork of Little Bear Creek. These streams all trend in a northwest-southeast direction. Several of the other canyons trend in a north-south direction. This orientation may be the result of jointing or faulting or the regional dip in the area. The ridges are bounded on three sides by canyons and have only narrow highland connections with the mountains. Basalt of the Columbia River Group occurs over most of the subarea. Belt rocks crop out at several locations in the subarea (Figure 2). These rocks, plus granite, underlie the basalt throughout the area.

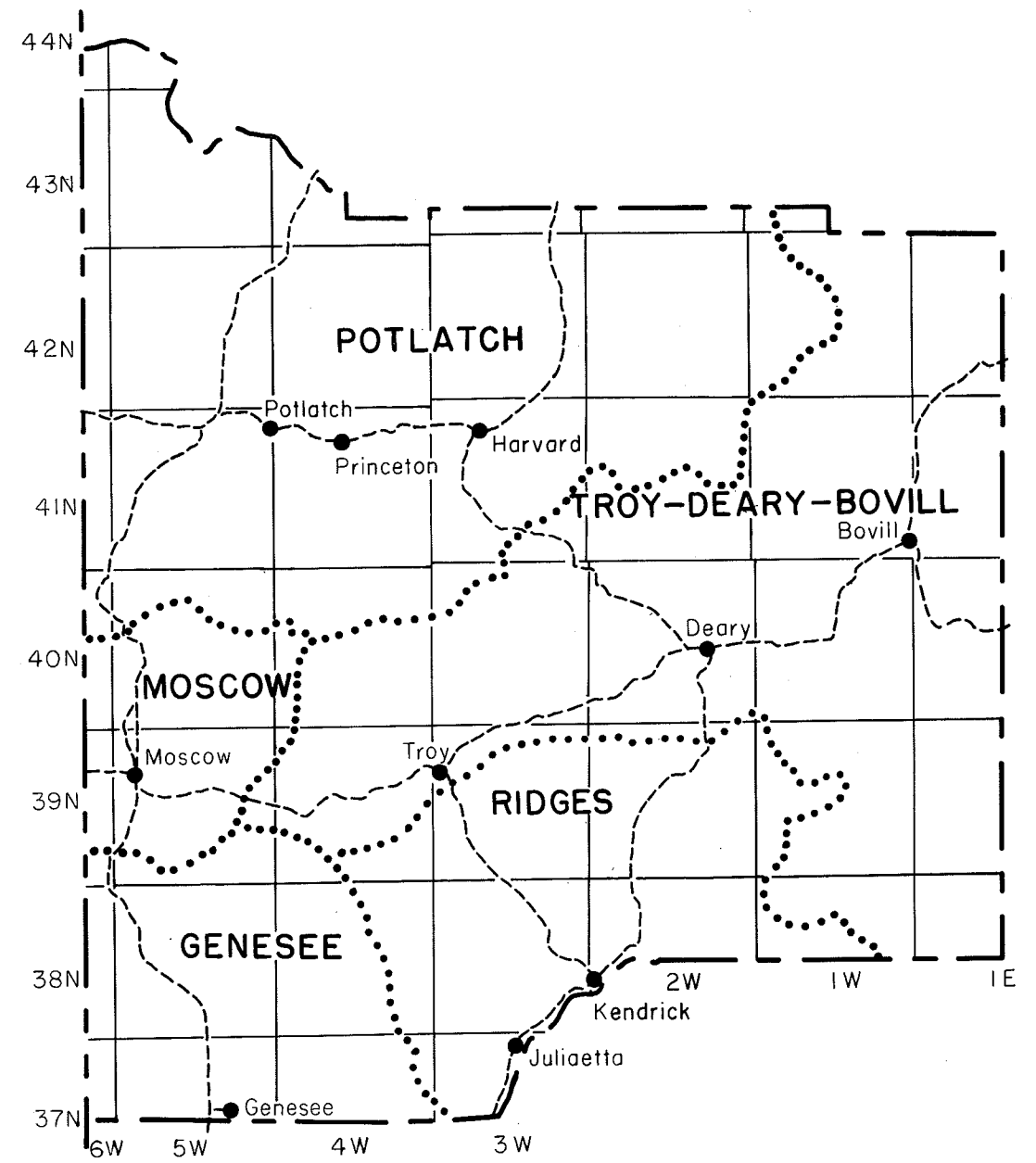


Figure 5—Delineation of Subareas

The Columbia River Group is the primary water bearing unit in the area. Wells penetrating the basalt yield water for domestic purposes on each of the ridges. The Belt rocks are penetrated by wells only on Fix and Big Bear Ridges. Water supplies are also derived from shallow dug wells in the alluvium and loess on each of the ridges.

The regional ground-water flow system in the Ridges Subarea is believed to be at or near the elevation of the streams because of the absence of ground-water discharge along the walls of the deep canyons in the area. A limited number of springs from local flow systems exist in the subarea, most of which flow only in the spring and early summer. The low flow measurements of stream discharge on Big Bear Creek at Kendrick indicate an average discharge of less than one cubic foot per second (cfs) and no flow during some periods (Decker and others, 1970, p. 307). Most of the other streams are reported to be dry during late summer periods. Newcomb (1959, p. 8) concurred with the above description, noting that "in and near the northern part of the Columbia River Plateau, the ground water tapped at depth rises to the approximate level of the floor of the deepest local ravine or coulee." Walters and Glancy (1969, p. 10) stated that most of the rocks at shallow depths along the canyons of the Snake and Palouse Rivers in Whitman County, Washington, "are drained of water". Wells must be drilled to or below the level of the rivers to obtain supplies for any use greater than domestic or stock.

Since most of the wells on the Ridges are less than 400 feet in depth, it is probable that the regional ground-water system has not been developed in the subarea and that the wells obtain water from local aquifers. Newcomb (1959, p. 7) stated that water often accumulated in local "perched" zones above the regional water table in the Columbia River Group. The downward flow of water is slowed or stopped by less permeable layers within the basalt or by fine-grained interbeds to form these saturated zones. The discontinuous "perched" zones on the ridges have originated from a limited rate of recharge over a very long period of time. The primary source of recharge for the local aquifers is precipitation. Only a very small percentage of the total precipitation on the Ridges is believed to infiltrate and recharge the shallow ground-water systems. The discharge from the local "perched" zones is probably directed both downward and horizontally towards the canyons. A considerable vegetative growth, including conifers, is present in each of the canyons. A large part of the natural discharge may thus be in the form of evapotranspiration by plants. Neither the mechanisms for recharge nor discharge indicate that the local flow systems on the ridges are of large magnitude.

Most of the wells in the Ridges subarea range in depth from 100 to 300 feet. The deepest well reported drilled in the subarea is 600 feet. Many of these wells were drilled in the period 1950 to 1960. Almost no record was kept of well depth, yield, and geologic material penetrated prior to 1960. Drillers logs are available on only eight wells in the subarea. The logs for wells on Little Bear Ridge indicate the following basalt-sediment sequence: 60 feet of soil and clay, 200 feet of basalt and a variable thickness of fine sediments (greater than 100 feet in one well). Data from one well on Texas Ridge indicates a similar basalt-sediment sequence: 100 feet of fine grained sediments, 80 feet of basalt, 110 feet of sediments and 125 feet of basalt. Water is obtained from either the basalt or the sediments.

A number of "dry" holes have reportedly been drilled in the Ridges area. Generally, these unproductive wells are found on the southern or "break" end of the Ridges. Texas Ridge appears to have the greatest number of non-producing wells. Several instances of wells "going dry" were also reported in the area. In general, the yield of what was believed to be a good well decreased in a few months to a year to a level deemed unusable. Because of the discontinuous nature of the local aquifers, the wells probably depleted the water from aquifers with very limited storage. Once the aquifer was dewatered, the well yield decreased to the annual rate of recharge.

Wells have been drilled in the canyons within the subarea at Kendrick and Juliaetta. The wells penetrate about 450 feet of basalt with medium to coarse sediments underlying the basalt. The yields to wells in the canyon are the highest in the subarea; one well reportedly yields greater than 300 gpm.

Troy-Deary-Bovill Subarea

The general availability of water to wells in the Troy-Deary-Bovill subarea is presented in Figure 7. The lowest yields in the area are expected from the granitic and Belt series rocks. Higher yields are expected from the basalt and some of the interbedded sediments. Thick sections of fine-grained sediments have very low permeability and yield only small quantities of water to wells.

The Troy-Deary-Bovill subarea is characterized by the transition in the topography from mountains on the north and east to a plateau on the south. The subarea includes the area in the Potlatch River drainage north and east of the Ridges subarea (Figure 7). The mountains in the northern part of the subarea are made up primarily of granitic rocks (Figure 2). The mountains along the eastern edge of the subarea are composed of Belt rocks. Basalt of the Columbia River Group has covered the older rocks in the central part of the subarea and formed a rolling plateau. "Marginal" sedimentary deposits are located between basalt flows and along the contact between the basalt and the older rocks. The Columbia River Group is the primary water-bearing unit in the area. Wells yield water for domestic supplies from both the basalt and the associated interbeds. The sediments range widely in grain size. The extensive clay deposits generally have very low permeability and yield only small quantities of water to wells. In several locations in the subarea, the interbeds range in grain size up to medium sands and yield moderate to large supplies of water. A Deary city well (40N 2W 24dbd), for example, penetrates a fine to medium sand from 259 to 272 feet and yields approximately 250 gpm. Individual domestic wells have also been drilled in granitic rocks in the subarea. The reported yields of these wells range from 1 to 15 gpm.

Ground-water flows from the mountains to the plateau. The existing well development indicates that several flow systems are present in the plateau part of the subarea. The upper system is comparable with the "perched" aquifers in the Ridges subarea.

Most of the wells in the subarea are between 50 and 250 feet in depth. The wells that obtain water from granite usually penetrate 0 to 40 feet of sediments overlying what is described as decomposed granite. The average penetration of the granite is 140 feet in the subarea. The depth of the wells depend on the thickness of the weathered zone and the degree of fracturing. The wells that obtain water from the basalt typically penetrate 10 to 50 feet of sedimentary material overlying the basalt. The drilling is continued until a permeable zone is found in

the basalt. Yields from the basalt vary from nearly "dry holes" to a reported 100 gpm. from the city well at Bovill.

Driller's logs are available on seven wells in the subarea that penetrated the basalt and derived water from the underlying interbedded sediments. The basalt ranged from 112 to 247 feet in thickness and averaged 160 feet. One well in Deary (40N 2W 23ba) penetrated 280 feet of fine grained sediments underlying the basalt. A well west of Troy (34N 4W 15cc) penetrated 15 feet of sediments and then a second sequence of basalt 110 feet thick underlain by a minimum of 27 feet of sediments. The deeper basalt flows were not penetrated in the eastern part of the subarea. Several wells west of Deary penetrated sediments to depths of 140 to 247 feet (40N 2W 15aa and 22 bc). The yields from these "marginal" sediments were low. The diagrammatic section presented in Figure 4 suggests that a greater thickness of sediments would be expected in the section near the basalt-basement contact than further south on the plateau.

Genesee Subarea

The general availability of ground water to wells in the Genesee subarea is presented in Figure 8. The most productive area for well development is in the flood plain of Cow Creek. The least productive area is on Paradise Ridge. The division between the Cow Creek area (II) and the southern portion of the county (III) is based on the geologic discontinuity believed present in the area.

The Genesee subarea includes the southwest portion of Latah County bounded on the north by Paradise Ridge and on the east by Little Potlatch Creek and Fix Ridge (Figure 5). Most of the subarea is underlain by the Columbia River Group (Figure 2). Paradise Ridge, in the northern portion of the subarea, is composed of Belt and granitic rocks. A narrow band of these Belt rocks is also exposed along Fix Ridge.

The subarea is notable in the general absence of the deep canyons found in the Ridges subarea to the east. Little Potlatch Creek on the eastern boundary of the subarea is in a canyon approximately 1,500 feet deep near its mouth. The Clearwater River is located approximately seven miles south of the county in a canyon about 1,700 feet below the plateau. The canyons of the northside tributaries to the river extend no more than four miles north of the river and are not present in the county.

The Columbia River Group is the primary aquifer in the area. Wells penetrate and obtain water from both the basalt and the sedimentary interbeds. A few wells have been drilled on Paradise Ridge and obtain water from the Belt and granitic rocks.

The general direction of ground-water movement in the subarea is approximately southward toward the general area of Genesee and then westward into Washington. The elevation of the water surface in wells is lowest in the lowlands near the streams such as the Cow Creek Valley and higher in the surrounding hills. A general discontinuity in the flow system is believed to be present in a general east-west direction about one mile south of Genesee. An abrupt change in water levels may be noted along this general line. The elevation of the ground-water is approximately 150 feet higher south of this discontinuity than in the Cow Creek Valley. The line also marks the location of a topographic high and is roughly the drainage divide between Cow Creek and the Clearwater River. Bond (1962) noted the possibility of an east-west fault south of Genesee of the basis of a discontinuity in the dip of the basalt.

Walters and Glancy (1969, p. 10), in their discussion of the ground-water occurrence in Whitman County, Washington, noted an interruption of the stratigraphic continuity of the basalt in the form of an eastward trending series of faults and folds in the area south of Uniontown. They mentioned that this deformation impedes the southward flow of ground-water in the south-eastern part of Whitman County. Bond (1963, p. 61) discussed the location of the Uniontown anticline in northern Nez Perce County. Secondary faults and folds in association with the anticline have been found in the area (Hollenbaugh, 1959, p. 39). The structural discontinuity in the basalt south of Genesee is believed to effectively prevent the movement of ground water toward the south and consequently diverts the flow toward the west.

An important hydrologic feature in the Genesee subarea is the occurrence of ground-water under confined conditions in shallow wells in the Cow Creek Valley. A number of domestic wells ranging from 70 to 100 feet in depth obtain large quantities of water from a shallow basalt aquifer. The wells normally have water levels from 20 to 30 feet below land surface and yield 25 to 50 gpm. One domestic well has a reported yield of 100 gpm. A Genesee city well, drilled to a depth of 160 feet, is reported to yield about 320 gpm.

The basalt aquifer overlies a 15 to 40 foot sedimentary interbed throughout the Cow Creek flood plain. This interbed is believed to be the Sweetwater Creek interbed mapped by Bond (1963, p. 24), an equivalent of which crops out as the sand pit on Coyote Creek grade. The top of the fine-grained sedimentary unit occurs at 2,550 to 2,640 feet elevation in the wells in the Genesee area. This interbed is important because it is believed to restrict the downward movement of ground water and effectively hold it close to land surface. Only two wells have been found that penetrate this sedimentary unit in the Genesee area. The newest municipal well for Genesee was deepened from 160 feet to approximately 320 feet in an attempt to obtain more water. The deepened section of the well was reported to penetrate basalt which yielded very little water. The well was backfilled to the original depth. A well drilled west of Genesee (37N 5W 9bb) did not penetrate the basalt aquifer overlying the sedimentary interbed, and was thus drilled to greater depths. The well penetrated 210 feet of basalt below the interbed from which no water was derived and an additional 40 feet of basalt which yielded only small quantities of water. The elevation of the water surface in this well is approximately 280 feet below those wells in the upper basalt aquifer on the Cow Creek flood plain. The elevation of the water surface thus decreased with depth indicating a tendency for downward movement of water.

The same general water-surface elevation is present in wells in the Union Flat Creek (Cow Creek) Valley in southern Whitman County, Washington (Walters and Glancy, 1969). The sedimentary interbed is present in the eastern portion of Whitman County but is missing to the west.

The elevation of the water surface in the aquifer system south of the postulated geologic discontinuity ranges from 2,800 feet in the north to 2,600 feet in the south and east. The yields of wells south of the possible fault system are smaller than yields from wells in the Cow Creek Valley and commonly range from 5 to 10 gpm. A corresponding aquifer system is believed present in the area south of Uniontown in Whitman County (Walters and Glancy, 1969).

The restriction of downward movement of ground water by the interbed is believed to partially account for the large number of perennial springs in the southern portion of the Genesee subarea and in northern Nez Perce County. Parts of the seeps and wet spots that have necessitated tile drainage in the fields near Genesee are

believed to be derived from local ground-water flow systems (Carrol Tyler, U.S. Soil Conservation Service, personal communication). However, some of the more major spring areas south of the postulated geologic discontinuity are believed to be ground-water discharge from the general aquifer system. Most of the springs in the Catholic Creek and Howard Gulch drainages discharge between elevations of 2,400 and 2,200 feet. The Sweetwater Creek interbed crops out in this area at about 2,200 feet. Only minor springs may be noted along the canyon of the Clearwater River and its tributaries below this elevation.

Moscow Subarea

The general availability of ground-water to wells in the Moscow subarea is presented in Figure 9. The largest yields are obtained from the artesian zones in the Columbia River basalt and associated sediments. The smallest yields are from the basement rocks.

The geology and hydrology of the Moscow subarea has been studied by many investigators. In particular, reports by Stevens (1960) and Ross (1965) present detailed information on the occurrence and movement of ground water in the basin. The discussion of the Moscow Basin in this report is based largely on the previous studies. Persons interested in greater detail should study the earlier reports.

The Moscow subarea includes approximately 60 square miles in the west-central part of the county. The basin is bounded on the north, east and south by mountains composed of Belt and granitic rocks. The basalt and sediments of the Columbia River Group occupy the center of the basin and are the primary aquifers in the subarea. Wells also obtain water from Belt and granitic rocks.

The ground water moves from the mountainous areas to the lowlands and then westward into Washington. Ross (1965, pp. 41-53) delineated unconfined aquifers in the basement rock, the Palouse Formation and the alluvium, and confined aquifers in the Columbia River Group. Large diameter dug wells obtain water for individual domestic supplies from the Palouse Formation and the weathered basement rock at various locations in the subarea. Alluvial aquifers yield small to moderate amounts of water to shallow wells in the basin.

At least three confined ground-water systems have been identified in the Columbia River Group in the basin. These are the upper, middle and lower artesian aquifers (Figure 10). The upper artesian zone has been developed extensively and was the primary source of municipal water in the basin up to the 1960's. Wells in this zone are generally less than 300 feet in depth and penetrate 175 to 210 feet of basalt. The depth to water is usually less than 100 feet. The City of Moscow presently obtains water from the lower artesian aquifer and the University of Idaho from the middle aquifer. All three zones are extremely permeable and well yields exceed 1,000 gpm. Water-level declines have occurred in all three zones, although a steady recovery has been noted in the upper zone with the utilization of the deeper aquifers. Basement rocks were penetrated by the deep city wells at about 1,500 ft.

Potlatch Subarea

The general availability of water to wells in the Potlatch subarea is presented in Figure 11. The Columbia River basalt flows and associated sediments provide the greatest potential for ground-water development. The yields from wells in the granitic and Belt series rocks are uniformly low.

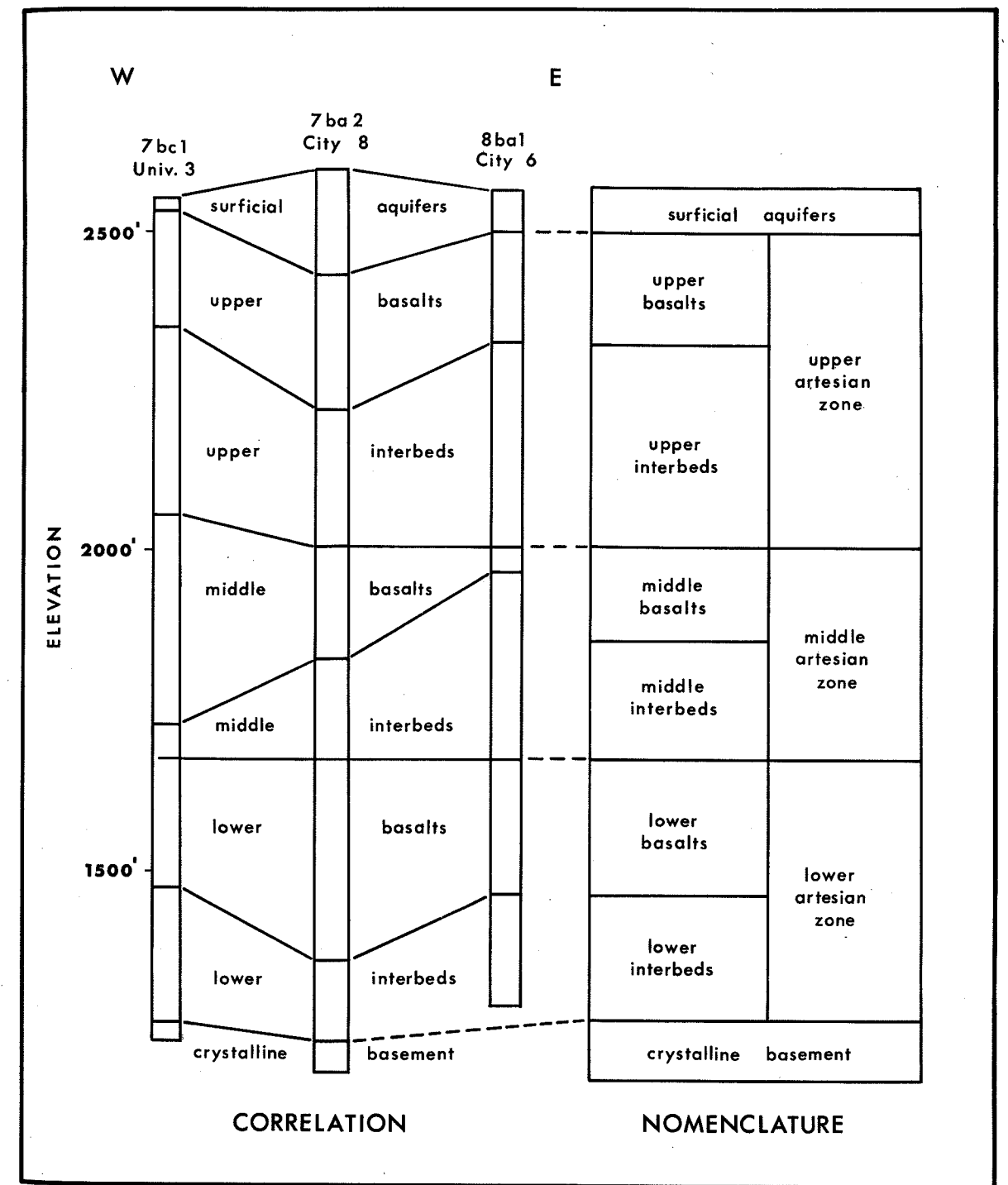


Figure 10. Confined aquifers in the Columbia River basalt in the Moscow subarea, (Jones and Ross, 1972)

The Potlatch subarea includes the northern one-third of Latah County. Most of the subarea is contained in the drainage of the Palouse River. The valley of the Palouse River is underlain by rocks of the Columbia River Group from Harvard west to the state line (Figure 2). The mountainous area in the northern part of the subarea is made up of Belt rocks. Granitic rocks form the mountains along the southern portion of the subarea. Belt or granitic rocks underlie the basalt throughout the area.

The basalt and sediments of the Columbia River Group are the primary aquifers in the area. Wells have also been drilled and obtain water from the Belt and granitic rocks.

The ground water moves from the mountainous areas to the lowlands and then westward into Washington. The gradient or slope of the ground-water surface is relatively steep in the Belt and granitic rocks and flat in the basalt and sediments. The water surface follows the major topographic features and is generally no more than 50 feet below land surface in the eastern two-thirds of the subarea. The elevation of the ground-water surface is between 2,475 and 2,525 feet over most of the lowland area. The ground-water potential does not decrease with depth in the eastern two-thirds of the subarea. Downward flow is believed to be limited by the relatively shallow low permeability basement rocks.

A downward vertical gradient is apparent in the western portion of the subarea. Three wells were drilled in 42N 6W 25ca to depths of 172, 245 and 367 feet. The depths to water in these wells are 80, 148, and 238 respectively. The water levels in the wells thus decrease with depth indicating a tendency for downward flow of water. A similar decrease in potential with increasing well depth is noted in Whitman County immediately to the west of the Potlatch subarea (Walters and Glancy, 1969).

Ground water occurs under confined conditions in most portions of the subarea. Generally, the water rises from 50 to 150 feet above the aquifer. Flowing artesian wells may be found in several parts of the subarea, particularly near Princeton.

The Columbia River Group yields the greatest quantity of water to wells in the subarea. Wells penetrating only the basalt generally yield from 5 to 40 gpm. The city well for Onaway (41N 4W 6bd) obtains about 100 gpm. from the basalt at a depth of about 500 feet. The yields from the basalt, however, are variable and poor wells are found short distances from producing wells. The largest production well in the subarea, a city well for Potlatch (42N 5W 35dd), obtains water from a gravel zone 770-775 feet below land surface. Some water is also obtained from the overlying basalt. The yield of this well is about 150 gpm. The sedimentary interbeds associated with the basalt vary widely in their ability to yield water. A well near the state line (42N 6W 24caa) penetrated 360 feet of fine grained sediments and yielded only a small quantity of water. A test hole drilled for the City of Potlatch (41N 5W 1dc) penetrated 254 feet of sediments and was abandoned because of low yield. The deepest well in the area was drilled at the Potlatch Forest Industries mill to a depth of 1,705 feet (Kirkham, 1927). Rocks identified as Belt material were encountered from about 550 feet to the bottom of the well.

A number of wells have been drilled in both the granite and Belt rocks in the subarea. In general, the yields from both units are low. Most wells penetrating the granite yield less than 3 gpm while most wells penetrating the Belt rocks yield less than 6 gpm. Several wells have reported yields of 10-20 gpm from either alluvium or the upper weathered portion of the Belt rocks.

RECOMMENDATIONS FOR WELL LOCATION

The location of a well within a 40-acre tract may have an important impact on the cost, usefulness and yield of that well. The primary factors that influence well location include ground-water geology, topography, potential pollution sources and accessibility.

The influence of ground-water geology on potential well yields has been discussed previously. It is important to know the type of material the well will penetrate in order to evaluate the possible depth and yield.

Topography can be an important factor in maximizing the possible yield of the well and minimizing the cost. As a general rule, it is better to drill in the valleys than on the ridges. This is particularly true in granitic or metamorphic rocks. Davis and DeWiest (1966, p. 327) presented a figure showing the influence of topographic position on well yield in granitic and metamorphic rocks in North Carolina. This figure (reproduced as Figure 12) shows that valleys and broad ravines yield the greatest quantity of water to wells and that crests of hills yield the lowest. The higher yields in valleys may be explained by greater thicknesses of weathered material than on slopes and crests and by the possibility of fault or joint control of the valleys. In addition, the depth-to-water is often less in the valleys than on the slopes. Care should be taken, however, not to drill close enough to valley bottom that flooding can contaminate the well or be harmful to pumping equipment.

It is important to consider the potential recharge area when choosing a well site in granitic and metamorphic rocks. The direction of ground-water flow is often similar to the surface water drainage. A well in a local valley will have a greater recharge area than a well on a ridge. As a general rule, if water is obtained in a well at shallow depths, the recharge area is reasonably close. The location with respect to the local topography is thus more important for a shallow well than a deep well.

Topography is also an important factor in the selection of a site for a well penetrating a basalt aquifer system. Generally, the regional ground-water surface is nearly flat in basalt. A large production well on a hill will thus have a greater well depth and depth-to-water than a well in a valley. This is not always the case for individual domestic wells in the Columbia River Group because of the downward movement of water and the development of local perched saturated zones.

It is important to locate the well away from potential sources of pollution. Common sources of pollution include septic tanks, cesspools, and barnyards. Health standards generally recommend locating the well at least 50 feet upgradient from such pollution hazards. The final criterion for well location is accessibility. This includes both accessibility for construction and maintenance and for connection with existing or planned water distribution facilities.

The construction of a well is much like the construction of a building. Careful planning is required along with good construction techniques. An investigation of the ground-water geology is an important step in well location and construction and often means the difference between a "dry" hole and a producing well.

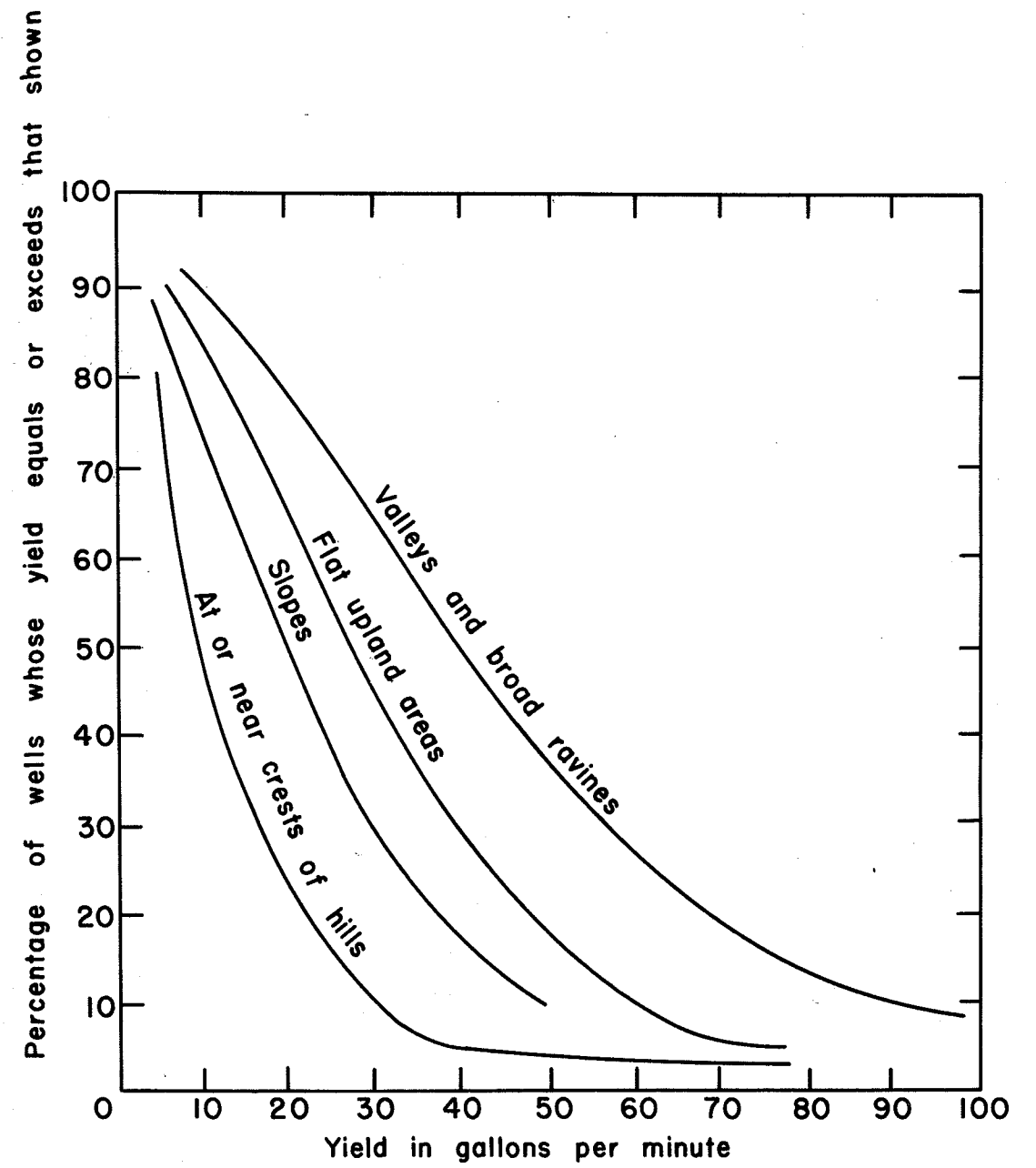


Figure 12—Well Yield vs. Topography in Crystalline Rock (Davis and DeWiest, 1966)

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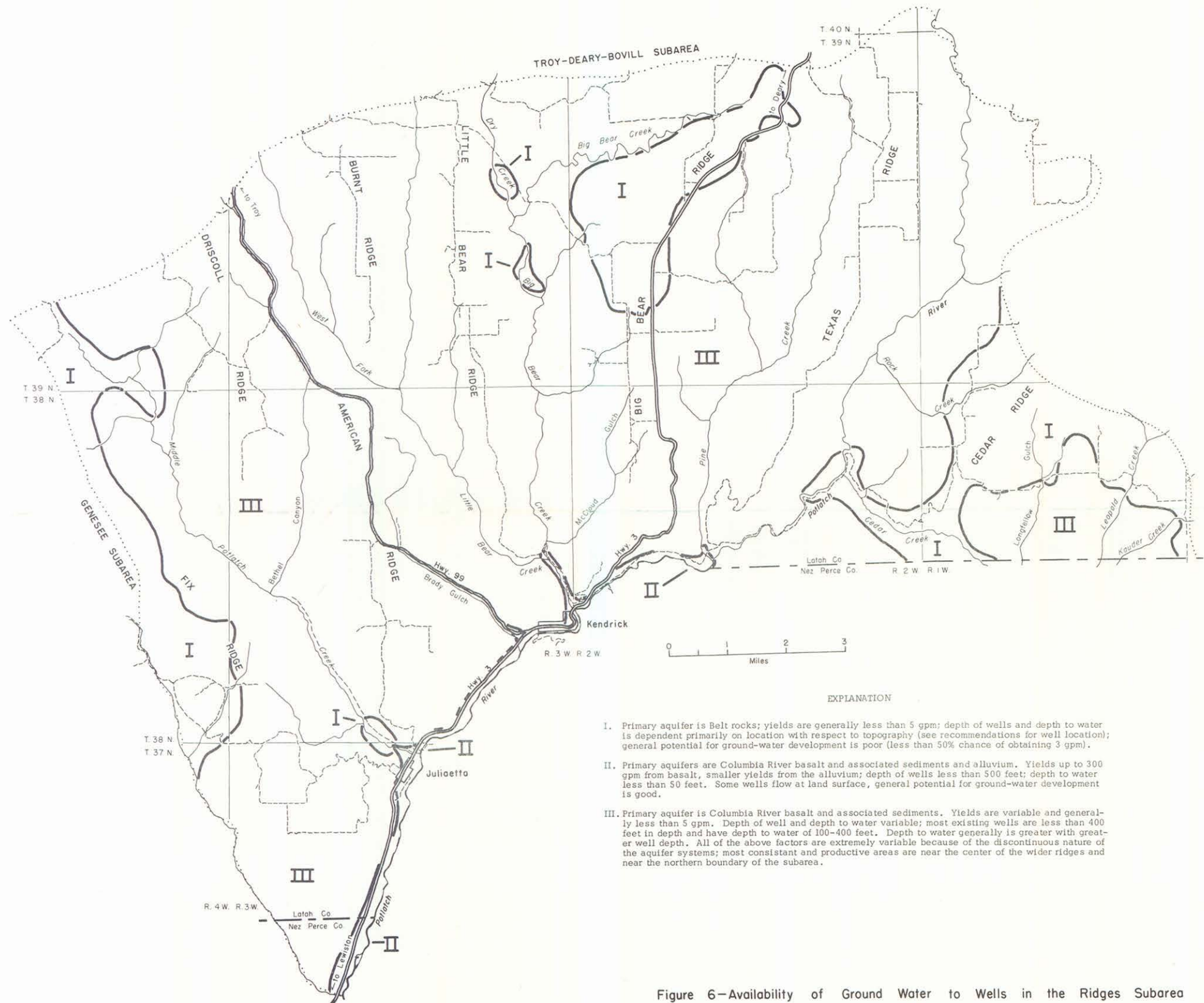


Figure 6—Availability of Ground Water to Wells in the Ridges Subarea

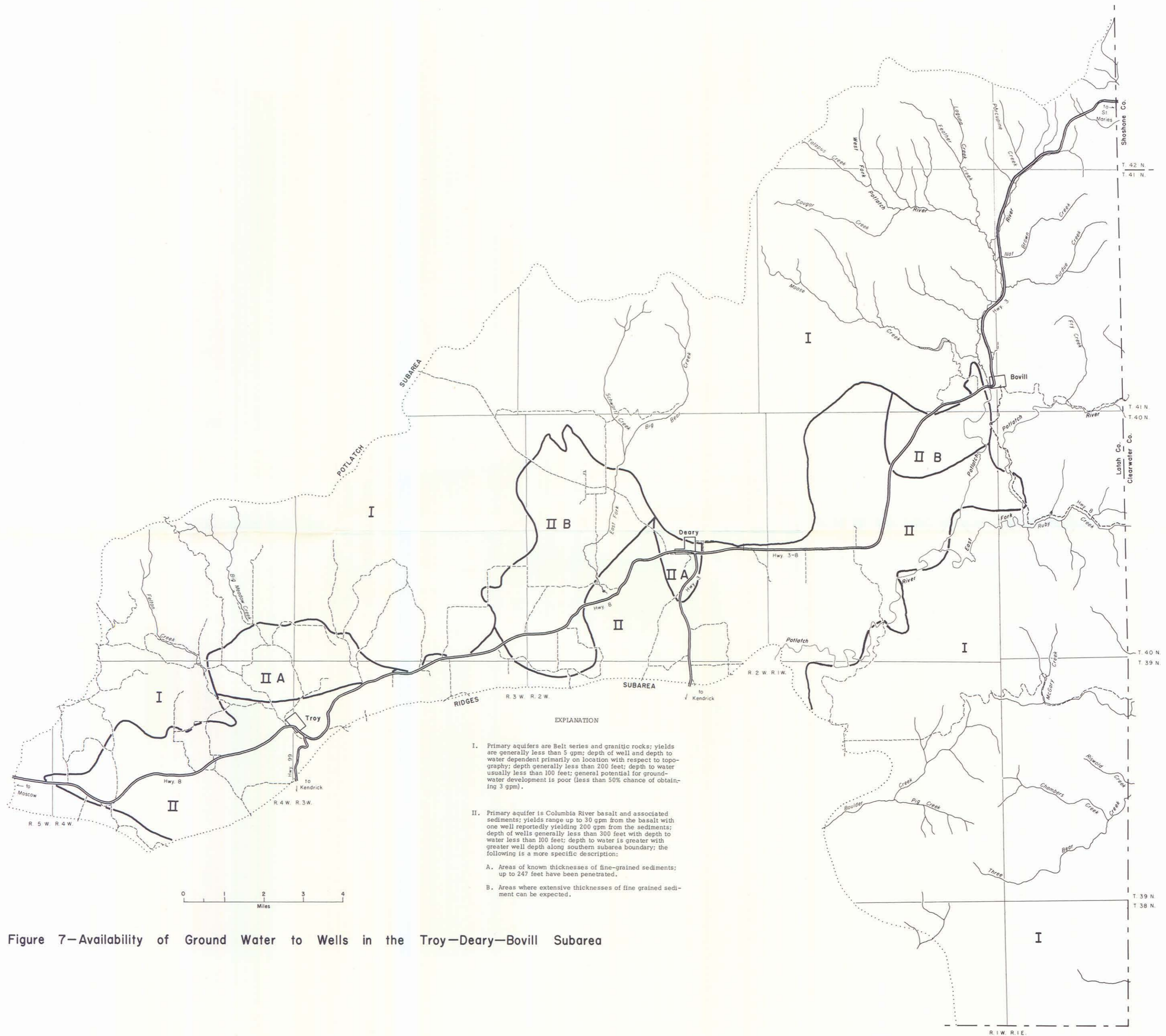
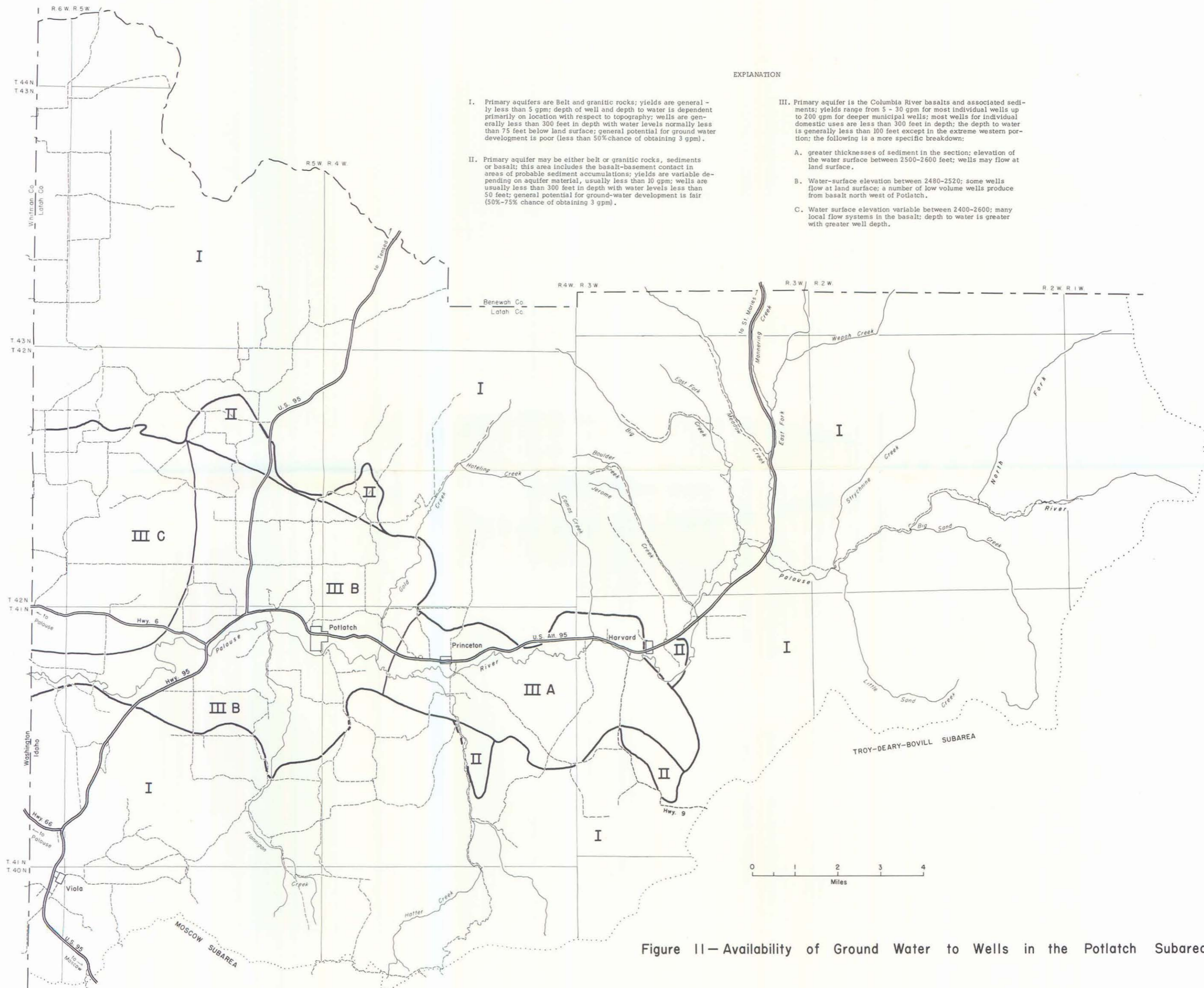


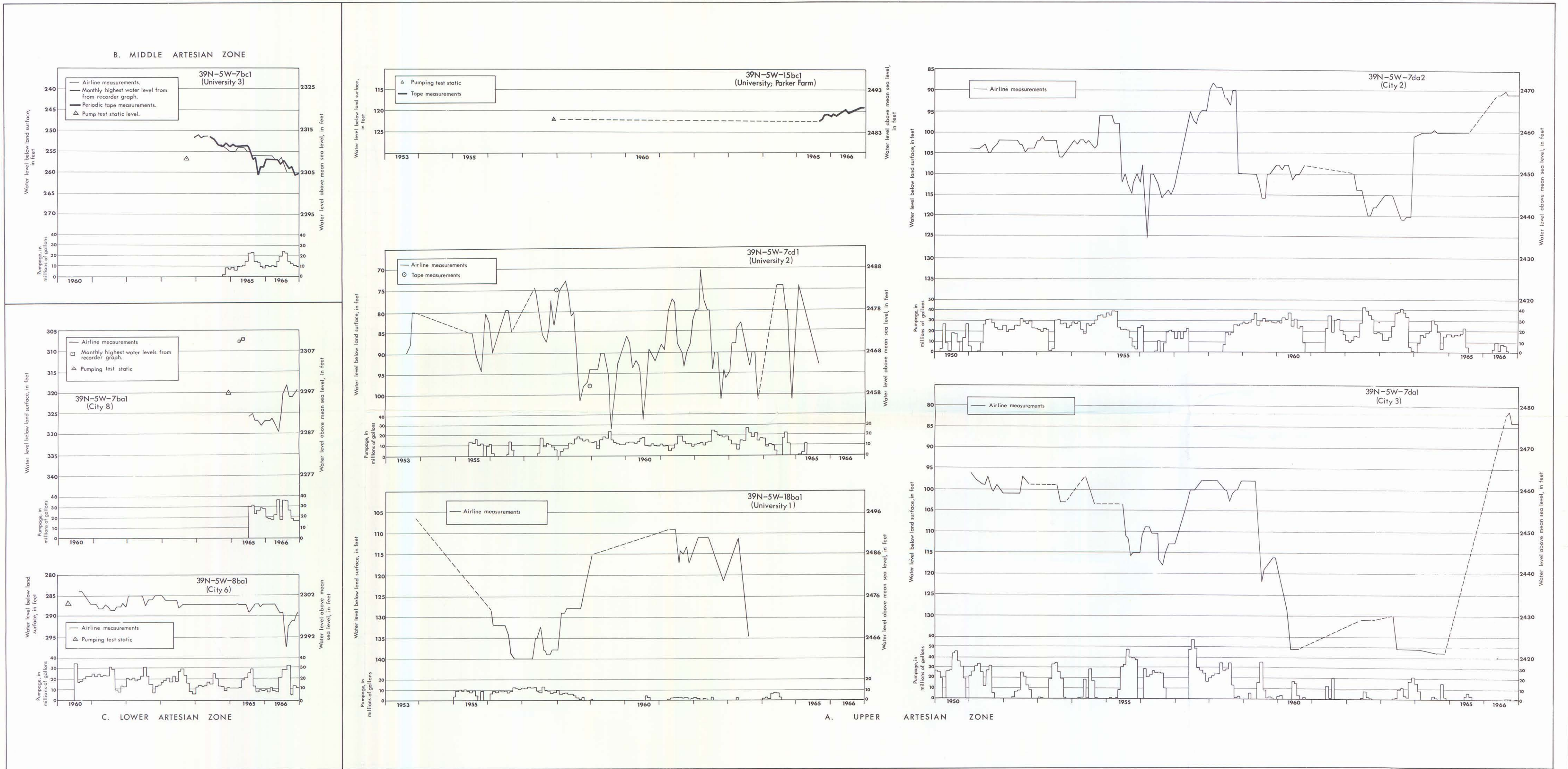
Figure 7—Availability of Ground Water to Wells in the Troy—Deary—Bovill Subarea



EXPLANATION

- I. Primary aquifers are Belt and granitic rocks; yields are generally less than 5 gpm; depth of well and depth to water is dependent primarily on location with respect to topography; wells are generally less than 300 feet in depth with water levels normally less than 75 feet below land surface; general potential for ground water development is poor (less than 50% chance of obtaining 3 gpm).
- II. Primary aquifer may be either belt or granitic rocks, sediments or basalt; this area includes the basalt-basement contact in areas of probable sediment accumulations; yields are variable depending on aquifer material, usually less than 10 gpm; wells are usually less than 300 feet in depth with water levels less than 50 feet; general potential for ground-water development is fair (50%-75% chance of obtaining 3 gpm).
- III. Primary aquifer is the Columbia River basalts and associated sediments; yields range from 5 - 30 gpm for most individual wells up to 200 gpm for deeper municipal wells; most wells for individual domestic uses are less than 300 feet in depth; the depth to water is generally less than 100 feet except in the extreme western portion; the following is a more specific breakdown:
 - A. greater thicknesses of sediment in the section; elevation of the water surface between 2500-2600 feet; wells may flow at land surface.
 - B. Water-surface elevation between 2480-2520; some wells flow at land surface; a number of low volume wells produce from basalt north west of Potlatch.
 - C. Water surface elevation variable between 2400-2600; many local flow systems in the basalt; depth to water is greater with greater well depth.

Figure 11—Availability of Ground Water to Wells in the Potlatch Subarea



WATER LEVEL FLUCTUATIONS IN PUBLIC SUPPLY WELLS, CITY OF MOSCOW AND UNIVERSITY OF IDAHO, 1951-1966; Moscow Basin, Idaho