

**DESCRIPTION OF MAP UNITS**

**GENERAL DESCRIPTION**

**Qal** ALLUVIAL AQUIFER (5-130 ft). Includes lake-basin deposits, unconsolidated flood plain deposits, and adjacent terrace deposits less than 50 feet above current stream level. Largely unconsolidated sand, silt, and clay with local lenses of gravel. Coarse well rounded gravel interbedded with finer material is common in local alluvial deposits along the Yellowstone and Missouri Rivers, probably derived from reworked terrace gravels. Along smaller streams, gravel consists of clinker and sandstone fragments; in the northeast part of the study area, gravels contain igneous pebbles deposited by glaciers. Thickness of unit is as much as 130 feet along the Missouri River, 50 feet along the Yellowstone River, and 40 feet along smaller streams.

**QTI** TERRACE GRAVEL AQUIFER (5-100 ft). Comprises terraces of Crane Creek, Cartwright, Flaville, and Rimmed Gravel as described by Howard (1960). Mostly gravel and sand with some silt and clay. Well rounded to 12-inch diameter boulders and bowlders and sand size particles of quartz, chert, and igneous rocks are common. Deposits are largely distributed along upland areas and benches of the Yellowstone River. Many of the higher terraces are covered by loess.

**Tca** CHADRON-ARKAREE AQUIFER (0-380 ft). Consists of Chadron Formation unconformably overlain by Arkaree Formation—Upper part of unit is massive light-gray to white calcareous sandstone, capped by thin, green, resistant quartzite; lower part of unit is light-green to light-pink calcareous shale and volcanic ash interbedded with pink to cream-colored siliceous limestone. Conglomerates are common at the base of both upper and lower parts. Contact is unconformable with underlying units.

**Tr** TONGUE AQUIFER (0-2,900 ft). Consists mostly of Tongue River Member of Fort Union Formation but locally includes overlying basal beds of Sentinel Butte Member of Fort Union Formation and of Washatch Formation—Light-gray to brownish-gray fine to medium-grained thick-bedded to massive and locally crossbedded lenticular sandstone and siltstone. Commonly weathers from light yellow to buff. Contains light-buff to dark-gray shaly siltstone and shale, brown to black carbonaceous shale, and coal beds as thick as 80 feet. Burning of coal beds along outcrops has baked overlying sandstone and shale to form thick to thin, lavender clinker. Base of system is mapped as the change from predominantly siltstone and sandstone to predominantly shale of underlying unit. Contact is conformable with underlying unit.

**Tru** TULLOCK AQUIFER (0-600 ft). Includes Lebo Shale Member of Fort Union Formation—Predominantly dark shale interbedded with light-gray and brown to black carbonaceous shale, siltstone, and locally thin coal beds. Shales contain altered and detritified volcanic ash and reddish-brown ferruginous concretions. White to light-gray argillaceous crossbedded and lenticular sandstones occur locally. Base of unit is mapped as the change from predominantly shale to predominantly fine-grained sandstone and shale of underlying unit. Contact is conformable with underlying unit.

**Trtu** TULLOCK AQUIFER (0-600 ft). Includes Lebo Shale Member of Fort Union Formation and locally includes upper 10 to 80 feet of Hell Creek Formation—Interbedded medium-gray to light-gray shale, light-gray fine-grained sandstone and siltstone, and thin but persistent coal beds. A red-brown sandstone commonly forms a streak at the top of the unit. Locally, sandstones and siltstone weather yellow to brown. Base of unit is mapped as change from fine-grained thin-bedded sandstone, siltstone, shale, and coal beds to predominantly thick dark shale of underlying unit. Contact is conformable with underlying unit.

**Ttr** LOWER FORT UNION AQUIFER (0-550 ft). Includes rocks in eastern part of study area equivalent to Lebo and Tullock Members of Fort Union Formation and may include uppermost part of Hell Creek Formation—Mostly interbedded light-gray to dark-gray shale, siltstone, and shaly sandstone. Upper part of unit is massive shale, locally interbedded with lenticular siltstone and sandstone that commonly weathers yellow to tan color. Lower part contains a few thin lignite coal beds. Overall appearance is darker than overlying and lighter than underlying unit. Contact is conformable and generally transitional with underlying unit.

**Khc** UPPER HELL CREEK CONFINING LAYER (0-500 ft). Comprises upper part of Hell Creek Formation—Gray to yellowish-gray silty clayey carbonaceous and bentonitic shale and siltstone; locally contains yellowish-gray to tan fine- to medium-grained silty sandstone, thin coal beds, and brown ferruginous concretions. Base of unit is mapped as the change from predominantly shale and silty shale to predominantly sandstone of underlying unit. Contact is conformable with underlying unit.

**Kh** FOX HILLS LOWER HELL CREEK AQUIFER (0-750 ft). Includes lower part of Hell Creek Formation and Fox Hills (Lempe) Sandstone—Gray to yellowish-gray to tan fine- to medium-grained sandstone; contains gray to olive-gray shale and shaly siltstone. Locally has massive or crossbedded sandstone layers and thin coal beds near top of unit. Lower contact considered to be the middle of the transitional siltstone located between sandstone above and shale of underlying unit. Contact is conformable with underlying unit.

**Kb** BEARPAW CONFINING LAYER (0-1,100 ft) AND OLDER ROCKS, UNDIFFERENTIATED. Bearpaw confining layer consists of Bearpaw Shale and equivalent upper part of Pierre Shale; forms the base of the overlying shallow aquifer system—Bearpaw is gray to black marine shaly claystone and shale; thin beds of siltstone, silty sandstone, and bentonite occur locally.

— Contact—Dashed where approximately located or transitional  
- - - Fault—Dashed where approximately located. Bar and half on downthrown side  
- - - Approximate boundary between Lebo confining layer and Tullock aquifer to the west and equivalent lower Fort Union aquifer to the east  
- - - Approximate maximum extent of glacial advance—Area north of this line is mantled by thin glacial drift; map shows occurrence of underlying hydrogeologic units only  
- - - Structure contour—Shows altitude of top of Bearpaw confining layer. Contour intervals 200 and 1,000 feet. National Geodetic Vertical Datum of 1929  
- - - Trace of hydrogeologic section (sheet 2)  
- - - Strike and dip of beds  
- - - Well or test hole. Number corresponds to hydrogeologic section

**WATER-YIELDING CHARACTERISTICS**

Coarse gravels along the Missouri River are reported to yield as much as 500 gal/min to large-diameter wells; along smaller streams and adjacent low-lying terraces, yields of 100 gal/min might be possible. Yields average about 15 gal/min to stock and domestic wells.

Most wells are shallow and probably yield less than 15 gal/min. Higher yields could be expected where wells penetrate saturated conglomerates. Lower part of unit (Chadron Formation) may not yield water to wells. Unit has limited occurrence in the study area.

Sandstone and coal beds are the major water-yielding units in the study area; shales do not yield water. Yields are as much as 150 gal/min to wells penetrating thick saturated sections. However, average yields to most stock and domestic wells are less than 20 gal/min. Where saturated, fractured clinker beds may yield as much as 65 gal/min to wells.

Relatively large percentages of lowly permeable shale in this unit retard vertical movement of water. However, in local areas where saturated, medium-grained channel sandstones may yield as much as 25 gal/min to wells.

Fine-grained sandstones and coal beds are the water-yielding units. Well yields may be as much as 40 gal/min, but generally average about 15 gal/min. Flowing wells tapping confined aquifers generally yield less than 10 gal/min.

Shaly sandstones and coal beds are the water-yielding units. Typical well yields are 12 gal/min. Locally, because of low permeability, the entire aquifer can retard vertical movement of water.

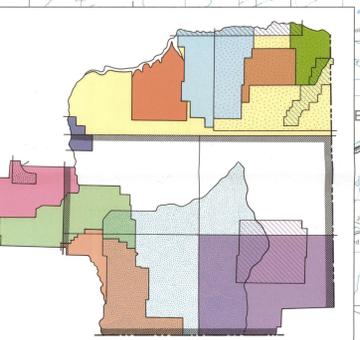
Limited as a water supply in the study area; a few flowing wells yield about 5 gal/min. Generally a low permeability unit.

Significant source of water in the study area. Yields 20 gal/min to flowing wells along major stream valleys, where conditions permit. Yields as much as 70 gal/min to domestic and stock wells and 200 gal/min to municipal or industrial wells.

Very low permeability; generally does not yield water to wells in the study area.

**CORRELATION OF MAP UNITS**

Qal	Holocene	QUATERNARY
QTI	Pleistocene, Pliocene or Miocene	
Tca	Miocene and Oligocene	
Tr	Eocene	TERTIARY
Tru	Palaeocene	
Ttr		
Khc	Upper Cretaceous	CRETACEOUS
Kh		
Kb		



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

**MAP SHOWING HYDROGEOLOGY AND CONFIGURATION OF TOP OF BEARPAW CONFINING LAYER**

**HYDROGEOLOGY OF THE FORT UNION COAL REGION, EASTERN MONTANA**

By  
**Jeffrey D. Stoner and Barney D. Lewis**  
1980

Hydrogeology reviewed, modified and where necessary, remapped by J. D. Stoner and B. D. Lewis, 1978. Structure in part modified from Lewis and Roberts (1978) and Taylor (1965).