Table D5-1 Permit Area Stratigraphy (Page 1 of 3) *

Age	Formation	Thickness [1] (feet)	Aquifer [2]	Lithology
Quaternary	Alluvium (Qa)	0 to 20	Yes	Sands and clays derived chiefly from the Tertiary formations in the area.
Early Eocene	Battle Spring/ Wasatch Formation	6,200	Yes	Battle Spring Formation is a major fluvial system, consisting of alternating fine to coarse-grained sandstone, minor conglomerate, siltstones and mudstones. Host to mineralization. Minor carbonaceous matter. Color buff to tan in the oxidized areas and gray to dark-gray in unoxidized zones. Dips average of 3 degrees to the west. Mineralization in top portion in at least seven sand units separated by various siltstone and mudstones. Wasatch Formation interfingers with the Battle Spring Formation. It's source is to the south and southwest and consists of fine sandstones, mudstones, siltstones and lignites.
Unconformity [3]				
Paleocene	Fort Union Formation	4,650	Yes	Consists of alternating fine to coarse grained sandstone siltstone and mudstone. Contains various layers of lignitic coal beds.
Unconformity				

Table D5-1 Permit Area Stratigraphy (Page 2 of 3)

Age	Formation	Thickness (feet)	Aquifer	Lithology
Cretaceous	Lance Formation	2,950	Yes	Interbedded sandstone, siltstone and mudstone. Gray to brownish gray. Locally carbonaceous. Sandstone is white to grayish orange.
	Fox Hills Formation	550	No	Consists of coarsening upward shale and fine-grained sand with thin coal beds near the top. Represents a transition from marine to non-marine environment. Grades into Lewis Shale at the base.
	Lewis Shale	1,200	No	Interbedded dark-gray and olive-gray shale and olive-gray sandstone.
Unconformity				
Cretaceous	Mesa Verde Group	800	No	Gray to dark gray shales with interbedded buff to tan fine to medium grained sandstones.
	Steele and Niobrara Shales	2,000 to 2,500	No	Steele shale is soft gray marine, Niobrara shale is dark gray and contains calcareous zones.
	Frontier Formation	500 to 1,000	Yes	Gray sandstone and sandy shale.
	Dakota Formation	300 to 400	Yes	Marine sandstone, tan to buff, fine to medium grained may contain carbonaceous shale layer.
Jurassic	Nugget Sandstone	500	Yes	Grayish to dull red coarse grained cross-bedded quartz sandstone.
Triassic	Chugwater	1500	No	Red shale and siltstone contains gypsum partings near the base.

Table D5-1 Permit Area Stratigraphy (Page 3 of 3)

Age	Formation	Thickness (feet)	Aquifer	Lithology
Permian	Phosphoria	300	No	Black to dark gray shale, chert and phosphorite.
Permian-Pennsylvanian	Tensleep	500	No	White to gray sandstone containing thin limestone and dolomite partings.
Pennsylvanian-Mississippian	Amsden and Madison	250	No	Red and green shale and dolomite, sandstone near base.
Cambrian	Undifferentiated	1,000	No	Siltstone and quartzite, including Flathead sandstone.
Unconformity				
Precambrian	Basement		No	Granites and associated metamorphic and igneous rocks.

* (Love and Christiansen,1985; Wellborn and Wold, 1993)
[1] Thicknesses shown are approximate and apply only to the Permit Area and vicinity.
[2] Aquifer designation only applicable to the vicinity of the Permit Area.
[3] Only major unconformities are shown.