

Reasonable Foreseeable Development Scenario for Oil and Gas Activities in the Lewistown Planning Area, central Montana



Geologist at conglomerate outcrop in small coulee 1 mile west of Riceville, November 1930

**James F. Glover
and
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**United States Department of the Interior
Bureau of Land Management**

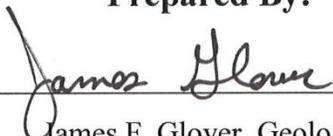
Final Report

June 13, 2014

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Oil and Gas Activities in the Lewistown Planning
Area, central Montana**

**Wyoming State Office
Reservoir Management Group**

Prepared By:

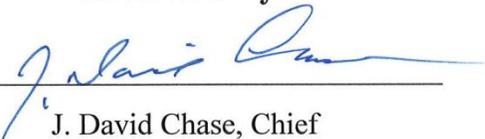


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Introduction

The purpose of this reasonable foreseeable development scenario (RFD) is to analyze the known and potential oil and gas resources of the Lewistown Planning Area in central Montana (**Figure 1**) and project the potential magnitude and trend of future oil, gas, and coalbed natural gas activity for the next twenty years (2014-2033). Historic and current oil and gas activity along with conventional oil and gas and coalbed natural gas occurrence potential within the planning area is also presented. We wish to emphasize that this RFD is a reasonable and scientific projection of the anticipated oil and gas activity that could potentially occur within the planning area based on logical and technical assumptions.

The Lewistown Planning Area contains approximately 12,907,058 surface acres of all mineral ownership types. Total federal oil and gas minerals in the area amounts to 3,461,030 acres. The Bureau of Land Management (BLM) manages 1,295,648 acres of federal oil and gas minerals – about 10% of total acres and about 37% of federal minerals within the planning area (acreages are based on geographic information systems (GIS) calculations and are therefore approximate). All BLM managed oil and gas mineral lands will be covered by decisions made in the Lewistown Field Office Resource Management Plan Environmental Impact Statement. The boundaries of the Lewistown Planning Area encompass all of Pondera, Teton, Cascade, Meagher, Judith Basin, and Petroleum Counties in central Montana. Lewis & Clark, Chouteau, and Fergus Counties are only partially within the planning area boundary (**Figure 1**).

We would like to thank Cathy Stilwell of the BLM Wyoming State Office Reservoir Management Group and Dale Manchester and John Wunder of the BLM Montana State Office for their contributions and comments in preparation of this document.

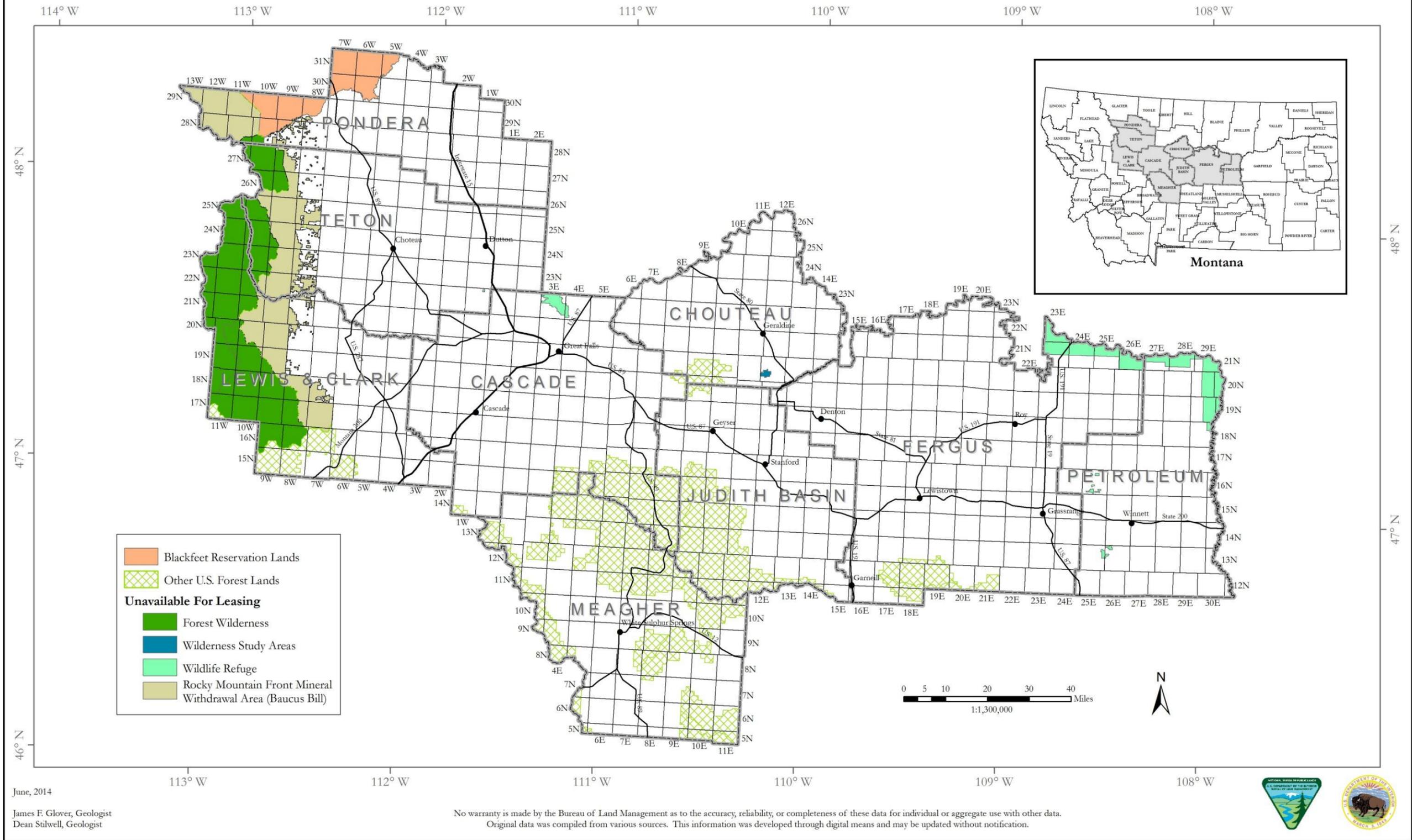
Operator Input

To aid our analysis of the reasonable foreseeable development scenario, we requested that operators in the Lewistown Planning Area provide their projections for the location and intensity of future oil, gas, and coalbed natural gas exploration and development activity for the 2014-2033 planning period. We provided each operator two maps of the planning area for their use. Operators were asked to mark townships with their projections of potential for conventional oil and gas drilling activity and coalbed natural gas drilling activity separately. Operators were asked only for information concerning their own anticipated drilling plans, not for their estimations of future activity of the industry as a whole in the planning area.

Although operator input was limited, their information was given priority for determining drilling potential for each township. No operator indicated an interest in coalbed natural gas exploration or development during the planning period. In areas where operator input was lacking, historic drilling and production trends combined with geologic assessments were given primary consideration when designating the development potential for each township.

Figure 1.

Lewistown Planning Area and its location within Montana.



Publications

Information from IHS Energy's well database was used to determine recent patterns in drilling activity in the Lewistown Planning Area. Electronic files of known oil and gas play and coal field boundaries were acquired from the U.S. Geological Survey and were used in determining where future activity would likely be concentrated.

Areas of drilling activity are foremost related to geology. Drilling will only occur where operators feel there is a likelihood of encountering hydrocarbons in the subsurface. The U.S. Geological Survey (USGS) has published surface and subsurface geologic maps and reports pertaining to regions throughout the United States. In addition, the USGS also publishes reports on their assessment of the oil and gas resources in major geologic provinces in the United States as part of the National Oil and Gas Assessment. Two of these provinces, the Montana Thrust Belt and the North-Central Montana Provinces, cover the Lewistown Planning Area (**Figure 2**). We used these quantitative assessments to better understand the potential for oil and gas occurrence and development. Likewise, we relied on the U.S. Geological Survey National Coal Resource Assessment and the Potential Gas Committee's 2012 report on the Potential Supply of Natural Gas in the United States to project coalbed natural gas occurrence and development potential.

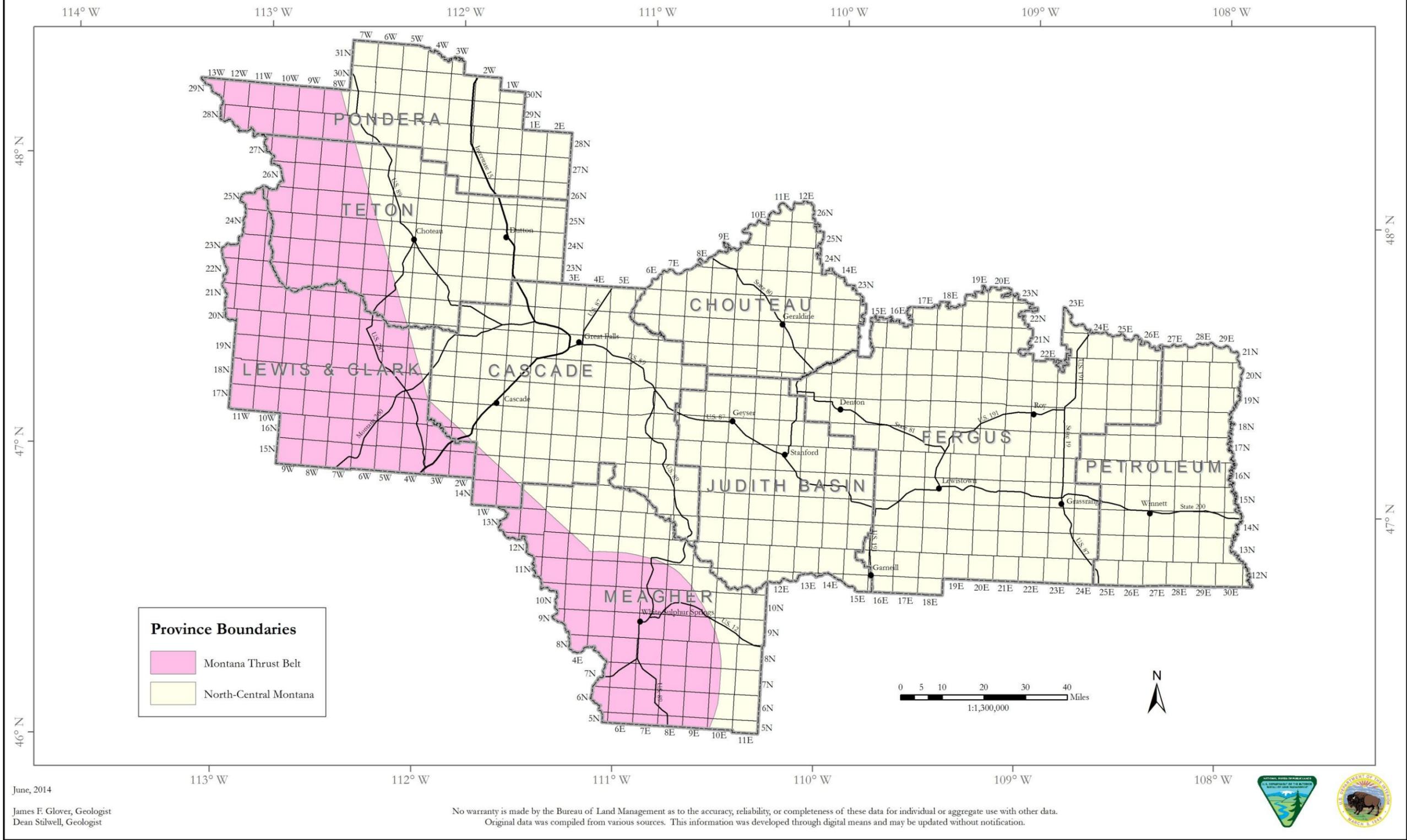
Historical Activity

Conventional Oil and Gas Activity

A total of 3,825 wells have been drilled in the Lewistown Planning Area through May 2014 (IHS Energy Group, 2014) as shown in **Figure 3**. For this map, wells were classified based on their original completion status of gas, oil, abandoned, injection, pilot, service, start, or at total depth. The total figure includes 247 gas wells, 1,100 oil wells, 45 injection wells, and 2,395 abandoned wells. About 29 percent of all wells were completed as oil producers, six percent as gas producers, and 63 percent as abandoned wells. The remaining two percent includes 45 injection wells and 38 wells completed as at total depth, pilot, service, or start. Historical oil activity has been concentrated mostly in Petroleum, Pondera, and Teton Counties whereas gas activity has occurred mostly in Pondera and Fergus Counties.

For purposes of analyzing and predicting future oil and gas activity in this RFD, we are interested mainly in the existing active wells, not the historical wells. Nevertheless, we wish to note that a discrepancy exists between the IHS Energy and the Montana Board of Oil and Gas Conservation databases for the total historical well count in the Lewistown Planning Area. A comparison of the well data reveals that although the IHS Energy database consistently counts more wells, the largest differences occur in well counts prior to 1970 while well counts after 1970 are similar for both databases. This discrepancy is mostly likely attributable to various standards in reporting and record keeping associated with the older drilling in the area. We wish to note this discrepancy and emphasize that only the existing active wells figure into the surface disturbance projections for the Lewistown Planning Area.

Figure 2.
Location of U.S. Geological Survey Montana Thrust Belt (2002) and North-Central Montana (1995 and 2008) Oil and Gas Assessment Provinces.

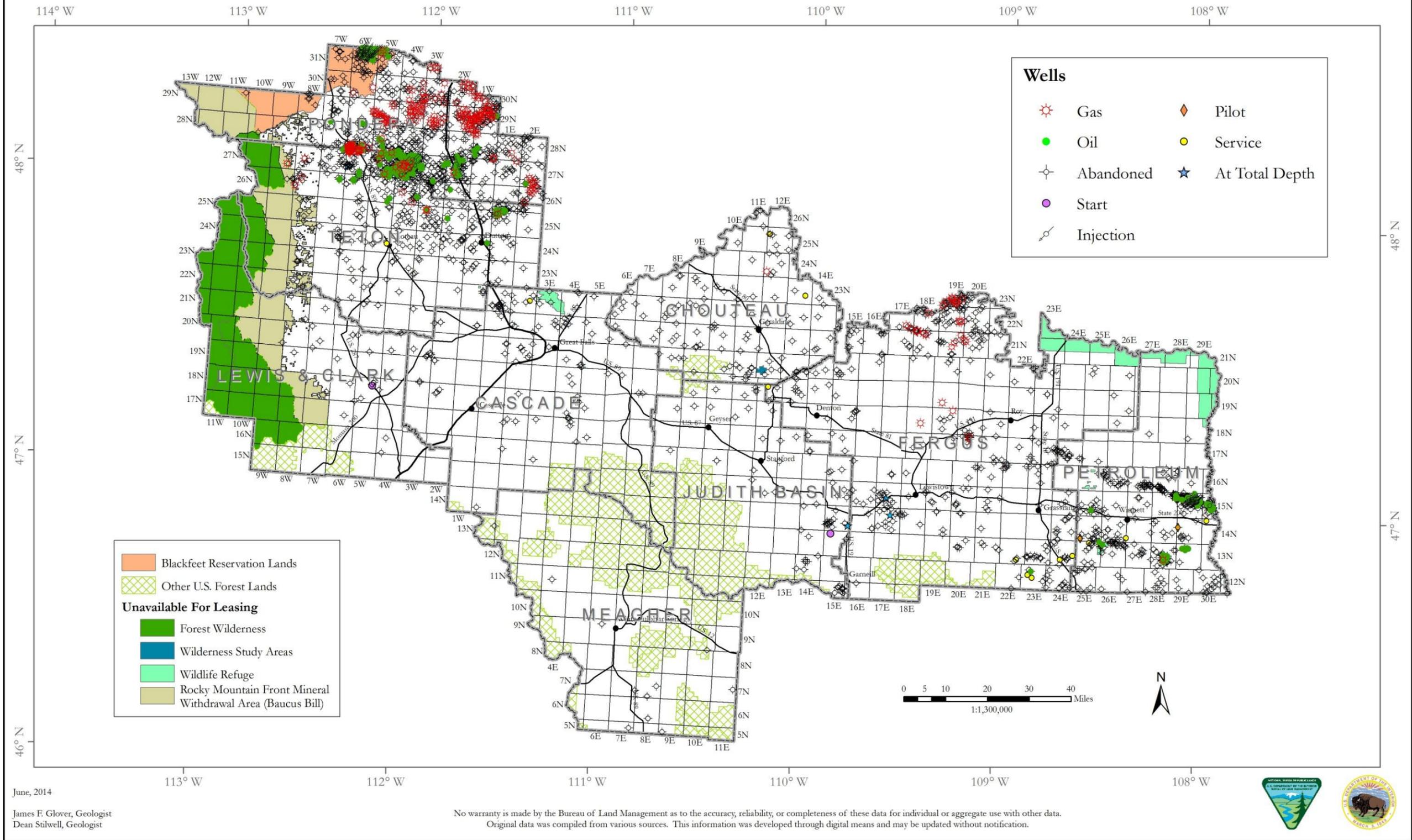


June, 2014

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Figure 3.
All wells within the Lewistown Planning Area (IHS Energy Group, 2014).



The Montana Board of Oil and Gas Conservation provided information about active wells as of May 2014 for the Lewistown Planning Area (**Figures 4a and 4b**). Wells were separated based on well type (oil, gas, or injection) and then subdivided based on well status. Wells with a status of producing, completed, domestic, spudded, active injection, permitted injection, shut-in, or temporarily abandoned were classified as active, for a total of 890 active wells. **Table 1** shows the status of these wells by county. Wells with a status of producing, completed, domestic, spudded, active injection, or permitted injection are considered operating wells and are shown on **Figure 4a**. Currently, 351 wells are operating oil wells, 110 wells are operating gas wells, and 53 wells are operating injection wells. Shut-in and temporarily abandoned wells were grouped separately by type and are shown on **Figure 4b**. There are 299 shut-in or temporarily abandoned oil wells, 75 shut-in or temporarily abandoned gas wells, and two shut-in or temporarily abandoned injection wells. For all active wells, about 73 percent are oil wells, 21 percent are gas wells, and six percent are injection wells. Current oil and gas activity is confined mostly to Pondera and Teton Counties in the northwest and Petroleum County in the southeast of the planning area. Other minor activity includes gas production in northern Fergus County, oil production in eastern Judith Basin/southwestern Fergus County, and one spudded well in Lewis & Clark County.

A total of 139 oil and gas wells have been drilled in the Lewistown Planning Area for the period January 2003-May 2014 (IHS Energy Group, 2014; **Table 2**). Wells were classified based on their original completion status. For this 10-year period, 45 gas wells, 29 oil wells, nine wells at total depth, two start wells, five pilot wells, and 49 abandoned wells were completed in the planning area (**Figure 5**). Recent oil activity has been concentrated in Teton, Pondera, and Petroleum Counties. Gas activity is confined to Fergus, Chouteau, and Pondera Counties with minor gas production in northern Teton County as well. Three oil wells drilled in the eastern Judith Basin/Southwestern Fergus County area are current oil producers with one additional well in that area at start status. Another well at start status is in Lewis & Clark County (**Figure 5 and Figure 4a**).

Producing Formations

Oil and gas occur in numerous formations within the Lewistown Planning Area, ranging in time from the Upper Devonian to the Upper Cretaceous. A generalized stratigraphic column for central, northwest, and northern Montana showing producing formations is presented in **Figure 6**. The stratigraphy is modified from the Montana Board of Oil and Gas Conservation Generalized Stratigraphic Correlation Chart and other stratigraphic charts found in the 1995 U.S. Geological Survey National Oil and Gas Assessment. Formations that are predominantly oil-producing are shown in green, predominantly gas-producing in red, and formations that have produced both oil and gas are shown in purple (IHS Energy Group, 2014). Oil-producing intervals include the Devonian Duperow, Birdbear (Nisku), and Three Forks Formations; the Mississippian Madison Group (Lodgepole Limestone) and Heath Formation; the Pennsylvanian Amsden Group; the Jurassic Sawtooth, Rierdon, Swift, and Morrison Formations; the Cretaceous 2nd Cat Creek, 3rd Cat Creek, Cut Bank, and Burwash sandstones; and the Cretaceous Mowry Shale. Gas is found in the Cretaceous Moulton, Eagle, and Virgelle sandstones; and the Cretaceous Blackleaf, Bow Island, Greenhorn, Telegraph Creek, and Judith River

Figure 4a.
Active wells (excluding shut-in and temporarily abandoned) within the Lewistown Planning Area (Montana Board of Oil and Gas Conservation, 2014).

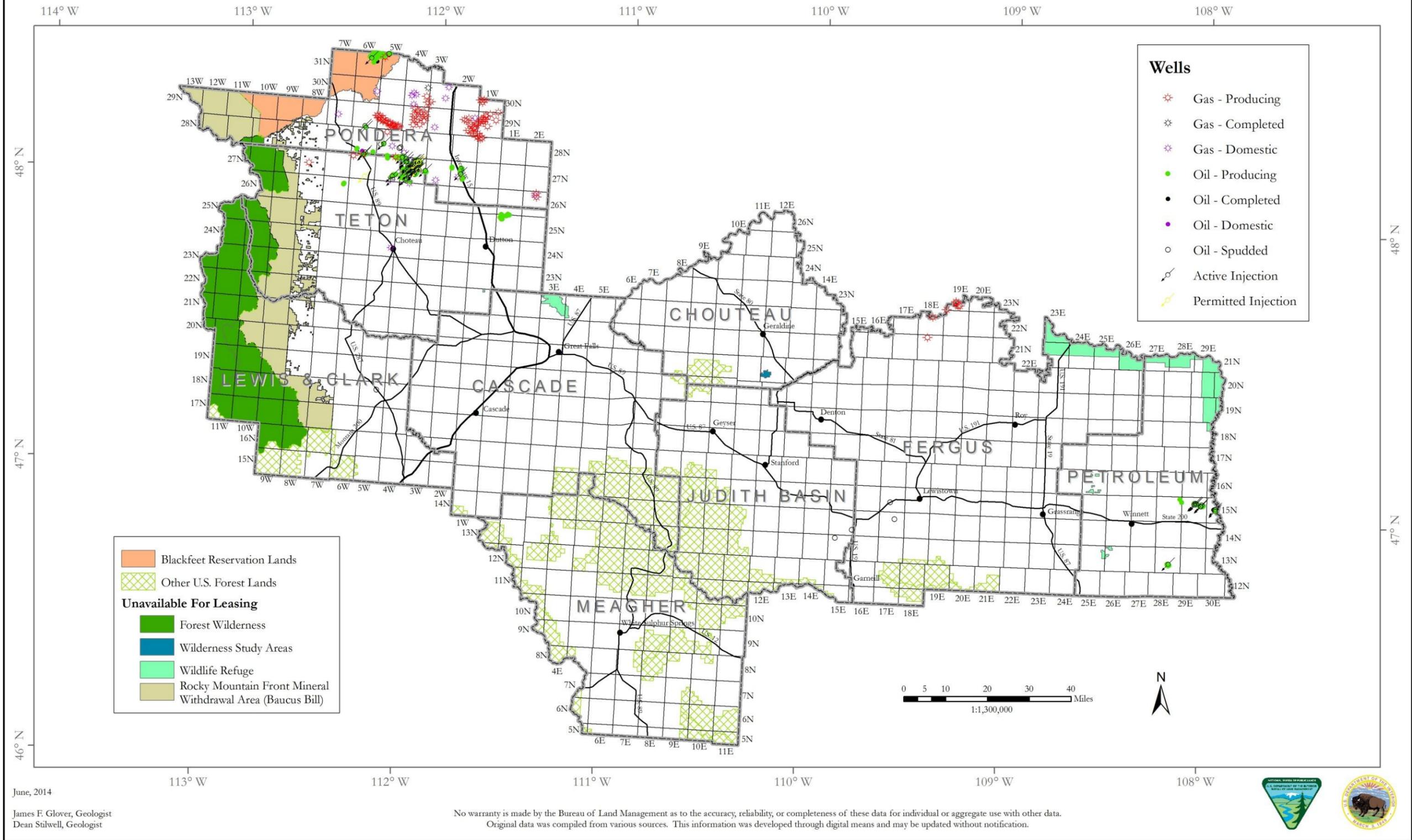
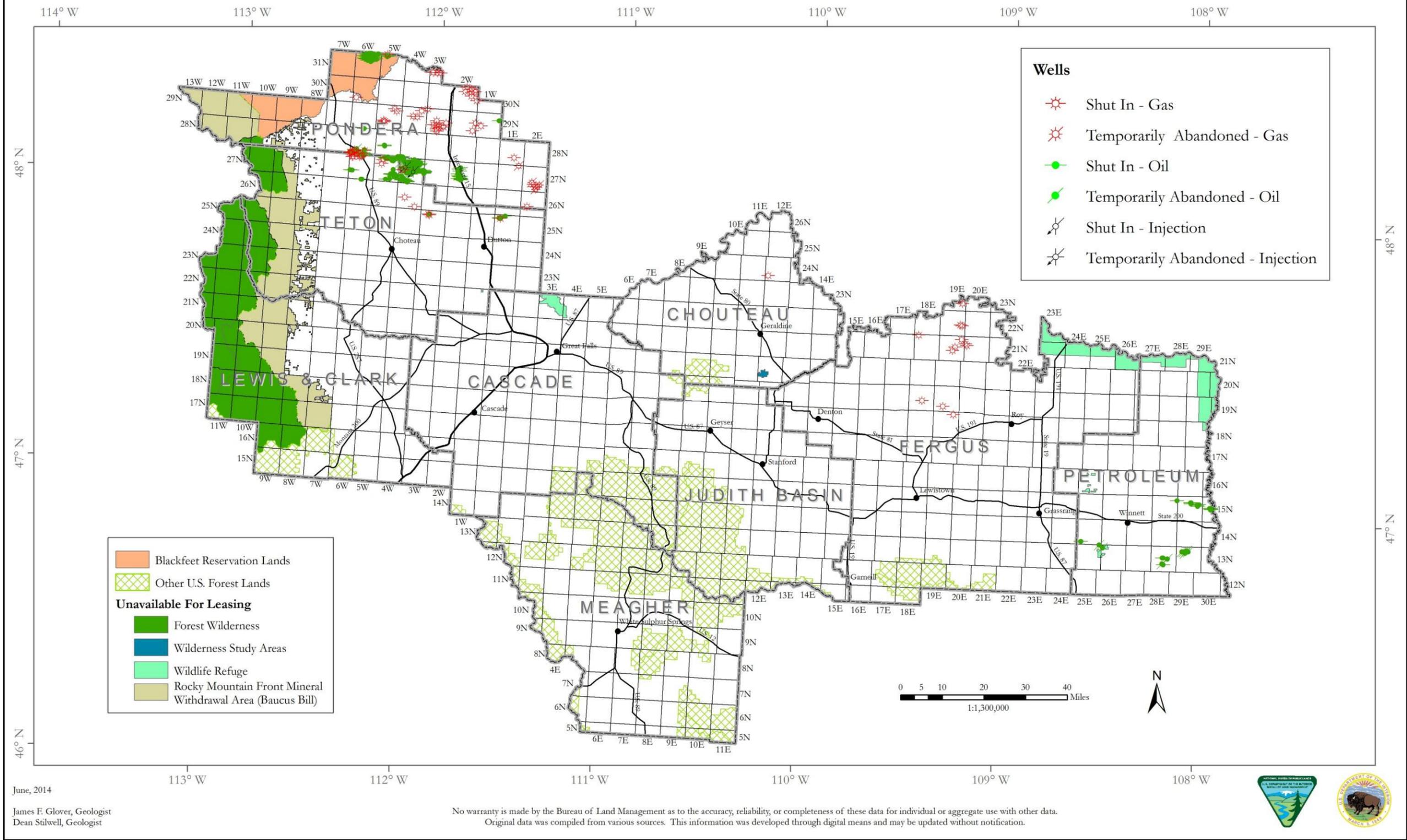


Figure 4b.
Active wells (only shut-in and temporarily abandoned) within the Lewistown Planning Area (Montana Board of Oil and Gas Conservation, 2014).



RFD Scenario for Oil and Gas Activities – Lewistown Planning Area, Montana

Table 1.

Type and status of active wells by county within the Lewistown Planning Area as of May 2014 (Montana Board of Oil and Gas Conservation).

Operating Wells											
Well Type	Status	Cascade	Chouteau	Fergus	Judith Basin	Lewis & Clark	Meagher	Petroleum	Pondera	Teton	Total Wells
Gas	Producing			7					77	4	88
Gas	Completed								1		1
Gas	Domestic								17	4	21
Oil	Producing							35	199	96	330
Oil	Completed							5	3	1	9
Oil	Domestic								1		1
Oil	Spudded			2	2	1			6		11
Oil	Active Injection							10	29	9	48
Oil	Permitted Injection								4	1	5
Total by County		0	0	9	2	1	0	50	337	115	514

Shut-in and Temporarily Abandoned Wells											
Well Type	Status	Cascade	Chouteau	Fergus	Judith Basin	Lewis & Clark	Meagher	Petroleum	Pondera	Teton	Total Wells
Gas	Shut In		1	12					45	12	70
Gas	Temporarily Abandoned								5		5
Oil	Shut In							17	184	82	283
Oil	Temporarily Abandoned							9	6	1	16
Injection	Shut In									1	1
Injection	Temporarily Abandoned								1		1
Total by County		0	1	12	0	0	0	26	241	96	376

RFD Scenario for Oil and Gas Activities – Lewistown Planning Area, Montana

Table 2.

Yearly summary by initial completion status of wells spud in the Lewistown Planning Area, January 2003-May 2014 (IHS Energy Group, 2014).

Year	Completion Status						Total Completions
	Gas	Oil	At TD	Start	Pilot	Abandoned	
2003	1					2	3
2004	6					3	9
2005	6					3	9
2006	6					1	7
2007	6	3				3	12
2008	14	7				11	32
2009	3	4	1			2	10
2010		1				9	10
2011	3	5			3	4	15
2012		6	3		2	7	18
2013		3	1	1		4	9
2014			4	1			5
Totals	45	29	9	2	5	49	139

Figure 5.
Wells within the Lewistown Planning Area spud between January 2003 and May 2014 (IHS Energy Group, 2014).

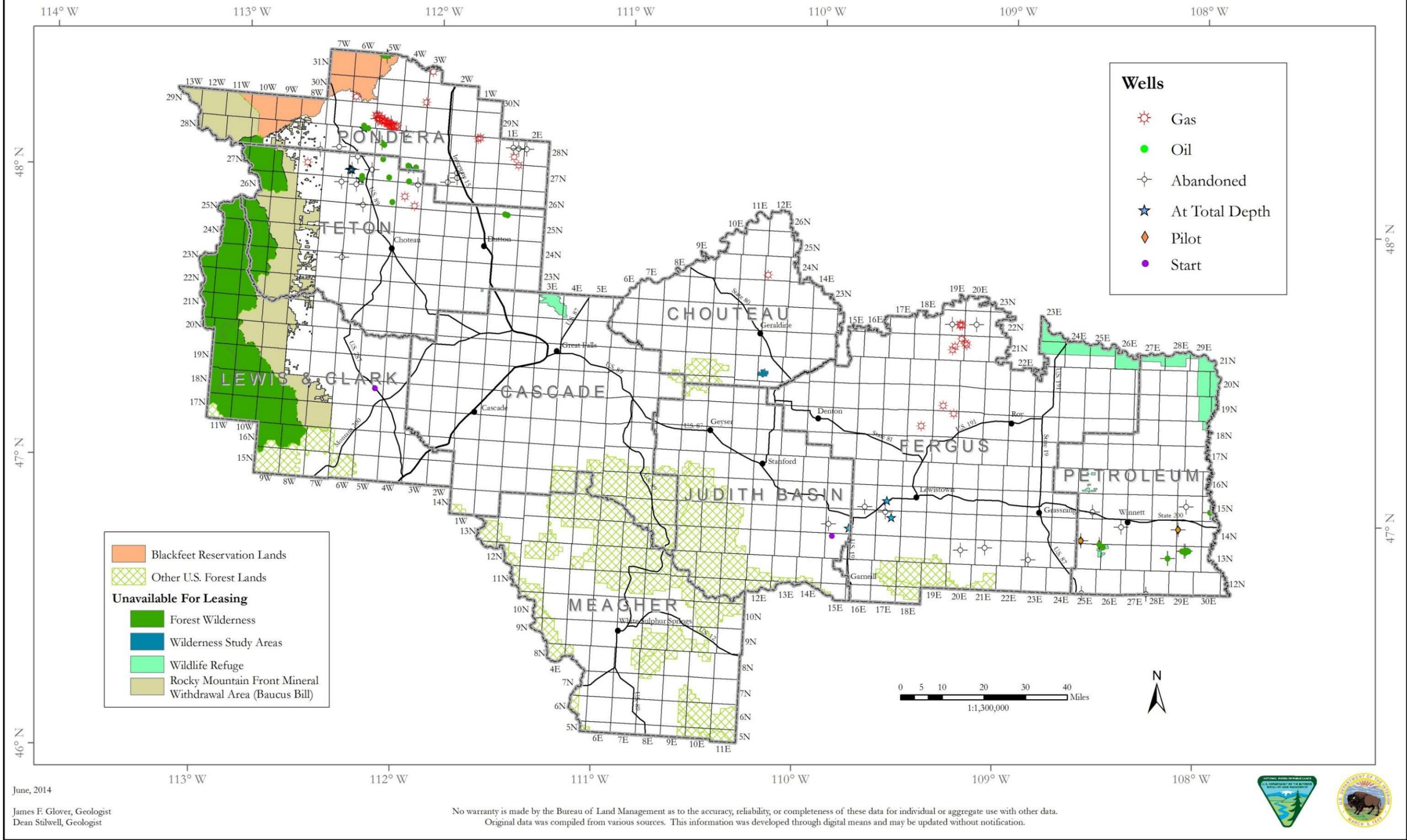
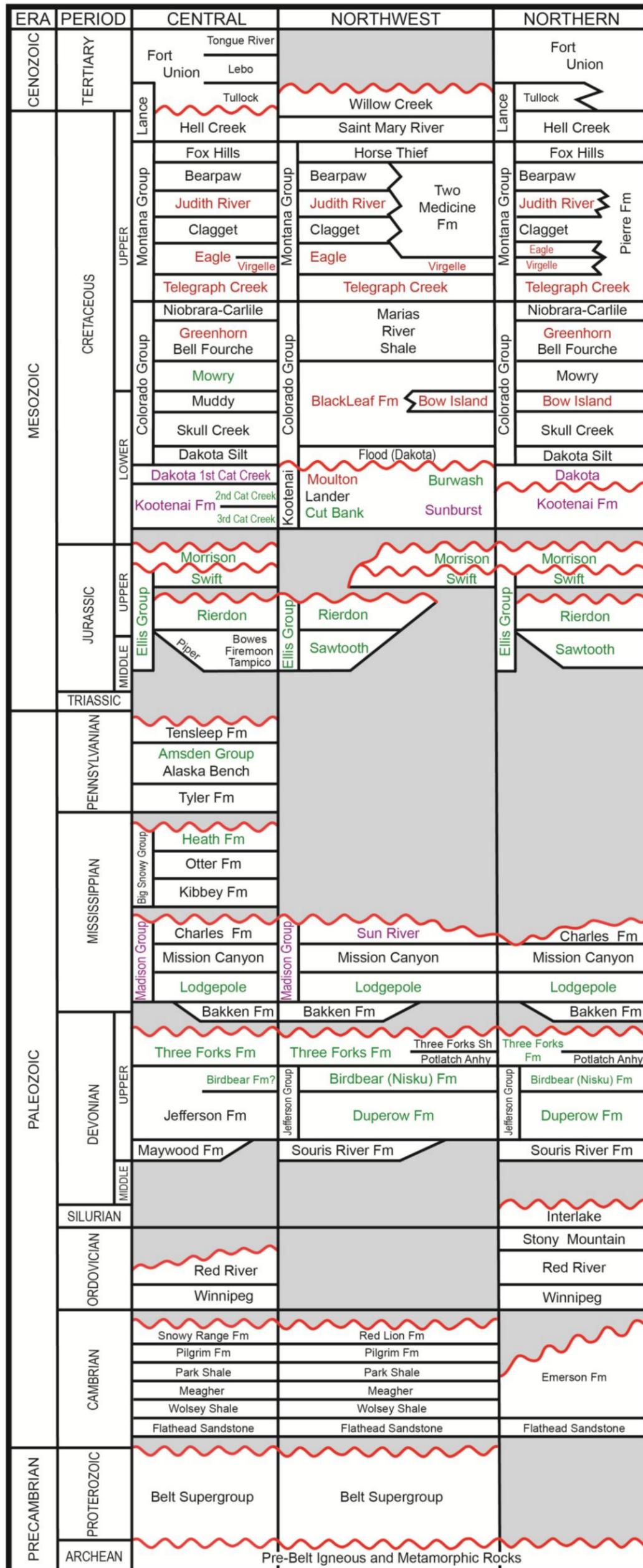


Figure 6. Stratigraphic column for central, northwest, and northern Montana showing formations that are predominantly oil-producing, gas-producing, or mixed oil/gas-producing formations. This chart is modified from the Montana Board of Oil and Gas Conservation Generalized Stratigraphic Correlation Chart and other stratigraphic charts taken from the 1995 U.S. Geological Survey National Oil and Gas Assessment. Production information is from IHS Energy Group, 2014.



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Formations. Formations that are known to produce both oil and gas include the Mississippian Madison Group and Sun River Formation; the Cretaceous Kootenai Formation and Dakota, 1st Cat Creek, and Sunburst sandstones. Further, The Cretaceous Greenhorn-Belle Fourche and Niobrara-Carlile Formations, Eagle sandstone, Clagget shale, and Judith River Formation are potential biogenic gas producers (North-Central Montana Province Assessment Team, 2008).

Coalbed Natural Gas Activity

The Lewistown Planning Area lies within the Northern Great Plains Coal Province and contains all or portions of the Blackfoot-Valier Coal Region, North Central Coal Region, Great Falls Coal Field, and Lewistown Coal Field (East, 2013; **Figure 7**). Most likely speculative assessments suggest as much as 1.2 trillion cubic feet of potential coalbed gas in the region (Potential Gas Committee, 2012), though quantitative assessments are not available. No coalbed gas activity has yet occurred within the planning area.

Conventional Oil and Gas Occurrence Potential

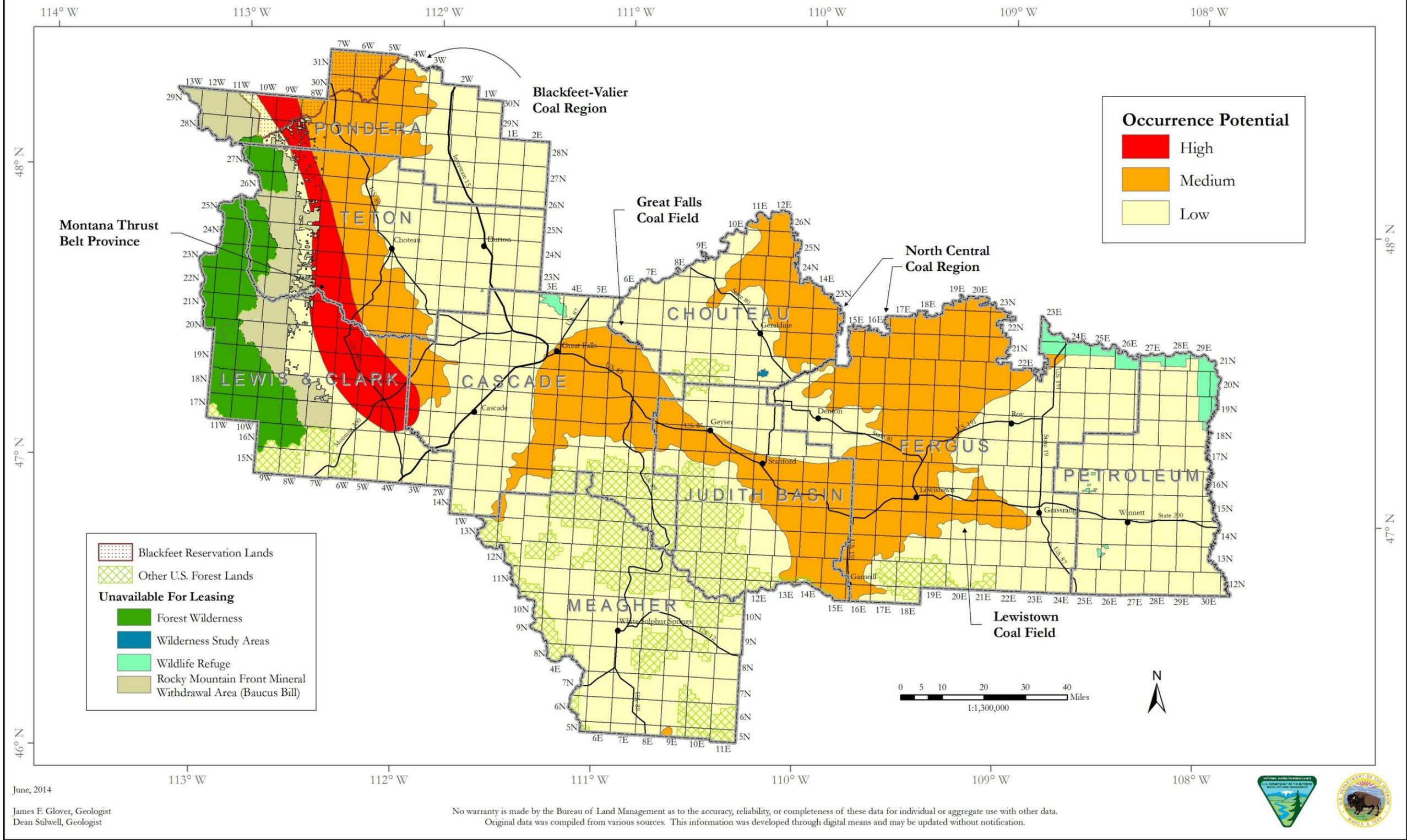
We consider the Lewistown Planning Area to have high potential for the occurrence of conventional oil and gas. The area falls within either the Montana Thrust Belt (2002) or the North-Central Montana Provinces (1995 and 2008), regions where the USGS has defined multiple assessment units with oil and/or gas potential (**Figure 2**). The BLM has established criteria for rating the oil and gas occurrence potential of lands studied for planning area documents such as the Resource Management Plan. This rating system is based on guidance outlined in the Bureau of Land Management Handbook H-1624-1. The assessment units within the Lewistown Planning Area were classified using a number of geologic characteristics that qualify them as having high occurrence potential:

- presence of hydrocarbon source rocks
- presence of reservoir rocks with adequate porosity/permeability
- potential for structural/stratigraphic traps to exist
- opportunity for migration from source to trap, and
- favorable temperature, depth of burial, and subsurface pressure conditions.

Coalbed Natural Gas Occurrence Potential

For coalbed natural gas occurrence potential, we delineated areas of high, medium, and low occurrence potential (**Figure 7**). The Montana Thrust Belt has a high occurrence potential since it lies within a U.S. Geological Survey assessment unit where potential undiscovered resources of Jurassic/Cretaceous coalbed gas were postulated; however, these resources were not quantitatively assessed (Montana Thrust Belt Team, 2002). Regions designated as medium occurrence potential are known coal-bearing regions, but have not been formally recognized or assessed by the U.S. Geological Survey for coalbed gas potential. Low occurrence potential areas are regions where coal-bearing strata and conditions for coalbed gas may exist, but are located outside of known coal regions or assessed oil and gas plays.

Figure 7. Known coal regions and occurrence potential for coalbed natural gas within the Lewistown Planning Area (U.S. Geological Survey National Coal Resource Assessment, 2013).



Oil and Gas Production

Figure 8 shows historical oil and natural gas production for the entire Lewistown Planning Area since 1973 (IHS Energy Group, 2014). **Table 3** summarizes this data as well, along with historical water production and water injection data. For the 40-year period, annual oil and gas production has been steadily declining from peak oil production of 771,110 barrels (bbls) in 1985 and peak gas production of 3,078,149 thousand cubic feet (Mcf) in 1983. Oil production has been relatively constant for 2003-2013, averaging 221,004 bbls per year. Natural gas production has been less consistent, with a low of 238,222 Mcf in 2012 and a high of 690,440 Mcf in 2006, averaging 387,648 Mcf for the same 10-year period. The majority of production within the Lewistown Planning Area has occurred and is occurring in the fields shown on **Figures 9a and 9b**. Notably, 33% of natural gas production for the peak gas-producing period 1980-1992 came from the Blackleaf Canyon Field in northwest Teton County. Currently, the westernmost portion of this field is now within the Rocky Mountain Front Mineral Withdrawal Area. Data shown are through year-end 2013.

Pipelines and Facilities

Figure 10 shows the existing pipelines and facilities by owner within the Lewistown Planning Area (IHS Energy Group, 2014). The U.S. Energy Information Administration defines intrastate pipelines as pipelines that operate totally within state borders and link producers to local markets or to the interstate pipeline network. Conversely, interstate pipelines cross one or more state borders, connecting regional networks. Intrastate oil pipelines exist in Pondera, Teton, Cascade, Chouteau, Judith Basin, and Fergus Counties. Intrastate natural gas pipelines exist in Pondera, Teton, Lewis & Clark, Cascade, and Fergus Counties. An interstate refined products pipeline crosses Cascade County from the southwest to Great Falls, Montana, where one refinery is operated by the Montana Refining Company (IHS Energy Group, 2014).

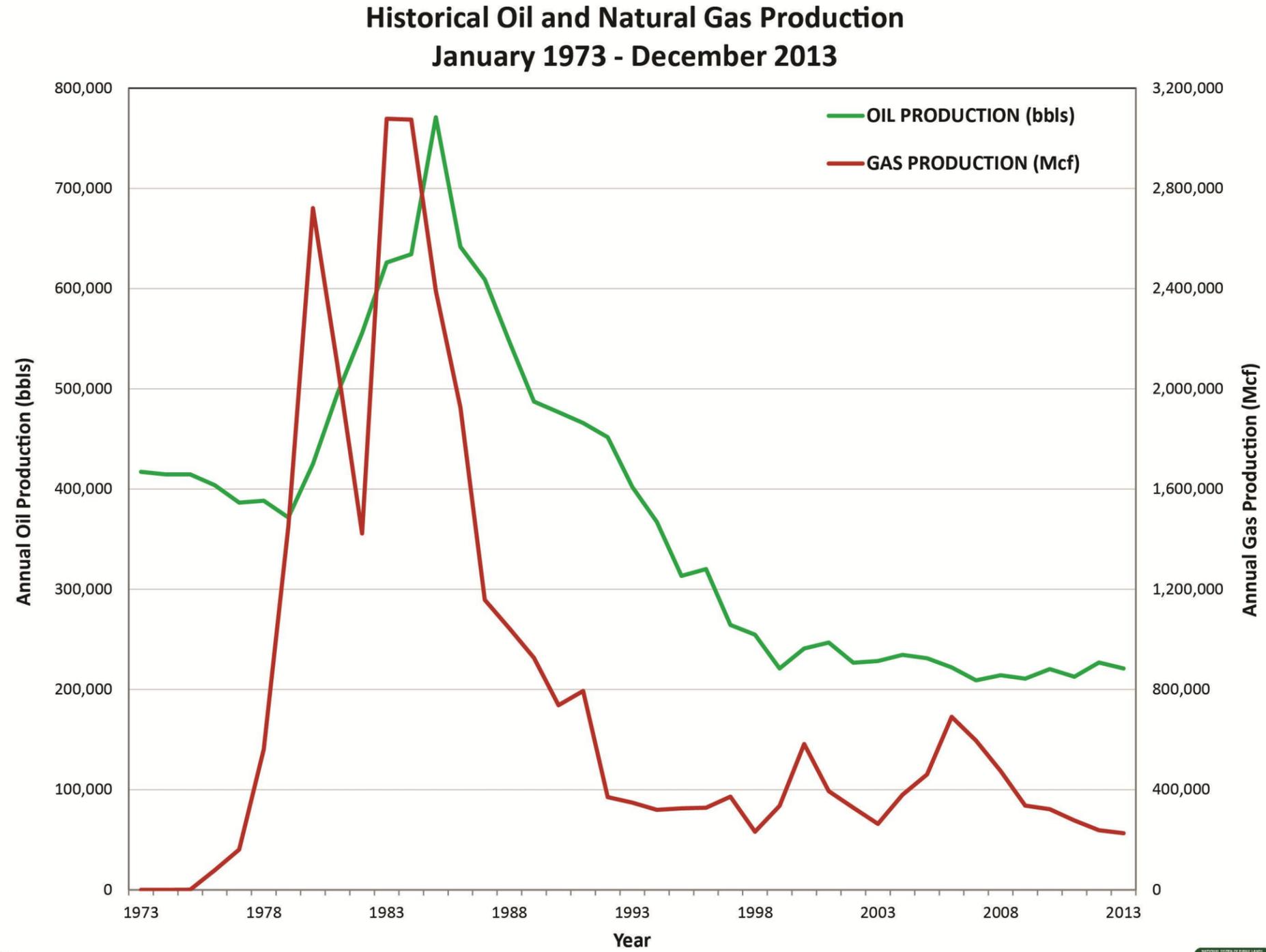
In producing gas fields (**Figure 9b**), gas compressors are a necessary part of the infrastructure to move natural gas to market. The BLM anticipates no additional gas compressors in producing fields since the current infrastructure is expected to handle present and future demand. Unless a significant oil or gas discovery is made, no new major pipelines or facilities are anticipated in the planning area (John Wunder, BLM Montana State Office, written communication, 2010).

Projections of Future Activity

To better predict future activity that may occur in the Lewistown Planning Area, major oil and gas companies operating in the area were contacted by letter and asked what development activity they anticipated during the next 20 years. Responses from operators were limited, so the received data were combined with the available technical data to project locations and amounts of future drilling activity within the planning area.

Two maps were prepared to show our assessment of the potential for conventional oil and gas and coalbed natural gas exploration and development activities for the planning period (**Figures 11 and 12**). For conventional development potential, future activity was

Figure 8.
Historical oil and natural gas production within the Lewistown Planning Area, January 1973-December 2013 (IHS Energy Group, 2014).



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Table 3.

Historical oil and natural gas production since 1973 for the Lewistown Planning Area (IHS Energy Group, 2014).

YEAR	OIL PRODUCTION (bbls)		GAS PRODUCTION (Mcf)		WATER PRODUCTION (bbls)		WATER INJECTION (bbls)	
	ANNUAL	CUM	ANNUAL	CUM	ANNUAL	CUM	ANNUAL	CUM
1973	417,181	28,112,199	0	139,178	1,637,237	1,637,237	0	0
1974	414,532	28,526,731	0	139,178	1,787,600	3,424,837	0	0
1975	414,627	28,941,358	347	139,525	2,769,510	6,194,347	0	0
1976	403,716	29,345,074	78,979	218,504	2,864,288	9,058,635	0	0
1977	386,484	29,731,558	160,822	379,326	2,997,683	12,056,318	0	0
1978	388,366	30,119,924	560,909	940,235	2,995,695	15,052,013	0	0
1979	371,532	30,491,456	1,450,290	2,390,525	3,155,970	18,207,983	0	0
1980	424,999	30,916,455	2,721,072	5,111,597	3,567,372	21,775,355	0	0
1981	495,258	31,411,713	2,093,513	7,205,110	4,053,211	25,828,566	0	0
1982	555,721	31,967,434	1,423,316	8,628,426	3,916,946	29,745,512	0	0
1983	625,979	32,593,413	3,078,149	11,706,575	4,345,380	34,090,892	0	0
1984	634,379	33,227,792	3,074,892	14,781,467	5,852,898	39,943,790	0	0
1985	771,110	33,998,902	2,390,823	17,172,290	6,782,341	46,726,131	0	0
1986	641,658	34,640,560	1,925,425	19,097,715	6,833,624	53,559,755	0	0
1987	609,162	35,249,722	1,158,012	20,255,727	6,932,899	60,492,654	0	0
1988	547,138	35,796,860	1,044,421	21,300,148	6,839,177	67,331,831	0	0
1989	487,338	36,284,198	926,401	22,226,549	6,691,930	74,023,761	0	0
1990	476,609	36,760,807	737,137	22,963,686	7,124,464	81,148,225	0	0
1991	465,888	37,226,695	794,289	23,757,975	7,588,437	88,736,662	0	0
1992	451,789	37,678,484	370,462	24,128,437	8,042,768	96,779,430	0	0
1993	402,058	38,080,542	348,124	24,476,561	7,997,821	104,777,251	0	0
1994	367,201	38,447,743	319,225	24,795,786	8,087,135	112,864,386	0	0
1995	313,360	38,761,103	325,428	25,121,214	6,461,117	119,325,503	0	0
1996	320,068	39,081,171	328,194	25,449,408	6,603,867	125,929,370	766,272	766,272
1997	264,401	39,345,572	371,988	25,821,396	6,030,535	131,959,905	5,204,505	5,970,777
1998	254,617	39,600,189	232,304	26,053,700	5,551,691	137,511,596	5,094,668	11,065,445
1999	220,973	39,821,162	335,153	26,388,853	4,264,782	141,776,378	3,641,340	14,706,785
2000	240,837	40,061,999	582,176	26,971,029	5,041,659	146,818,037	4,053,909	18,760,694
2001	246,913	40,308,912	393,962	27,364,991	5,827,261	152,645,298	4,747,440	23,508,134
2002	226,776	40,535,688	327,800	27,692,791	5,300,130	157,945,428	4,551,638	28,059,772
2003	228,450	40,764,138	263,133	27,955,924	5,865,137	163,810,565	4,985,413	33,045,185
2004	234,496	40,998,634	379,409	28,335,333	6,823,476	170,634,041	6,082,970	39,128,155
2005	231,156	41,229,790	461,020	28,796,353	7,108,955	177,742,996	6,256,361	45,384,516
2006	221,936	41,451,726	690,440	29,486,793	7,124,745	184,867,741	5,325,457	50,709,973
2007	209,065	41,660,791	595,588	30,082,381	6,534,617	191,402,358	3,143,322	53,853,295
2008	214,285	41,875,076	474,683	30,557,064	7,296,087	198,698,445	5,639,391	59,492,686
2009	210,808	42,085,884	336,765	30,893,829	6,959,689	205,658,134	6,370,324	65,863,010
2010	220,391	42,306,275	321,766	31,215,595	6,908,986	212,567,120	6,247,190	72,110,200
2011	212,616	42,518,891	276,834	31,492,429	6,320,450	218,887,570	6,261,238	78,371,438
2012	226,855	42,745,746	238,222	31,730,651	6,169,045	225,056,615	6,413,863	84,785,301
2013	220,983	42,966,729	226,266	31,956,917	5,969,985	231,026,600	6,294,626	91,079,927

Figure 9a.

Major oil fields within the Lewistown Planning Area. Field data from the Bureau of Land Management Montana/Dakotas State Office and IHS Energy Group (2014).

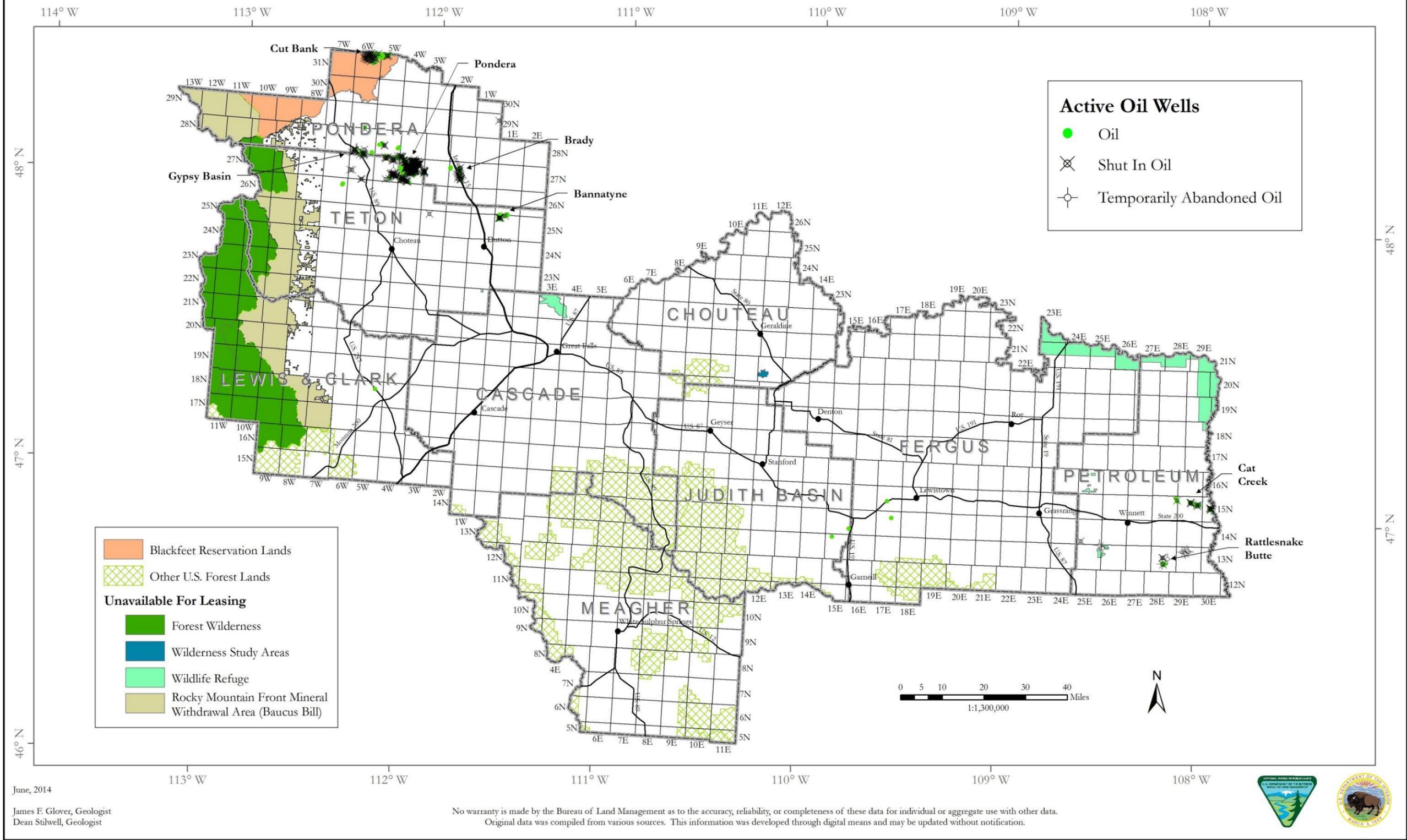


Figure 9b.

Major gas fields within the Lewistown Planning Area. Field data from the Bureau of Land Management Montana/Dakotas State Office and IHS Energy Group (2014).

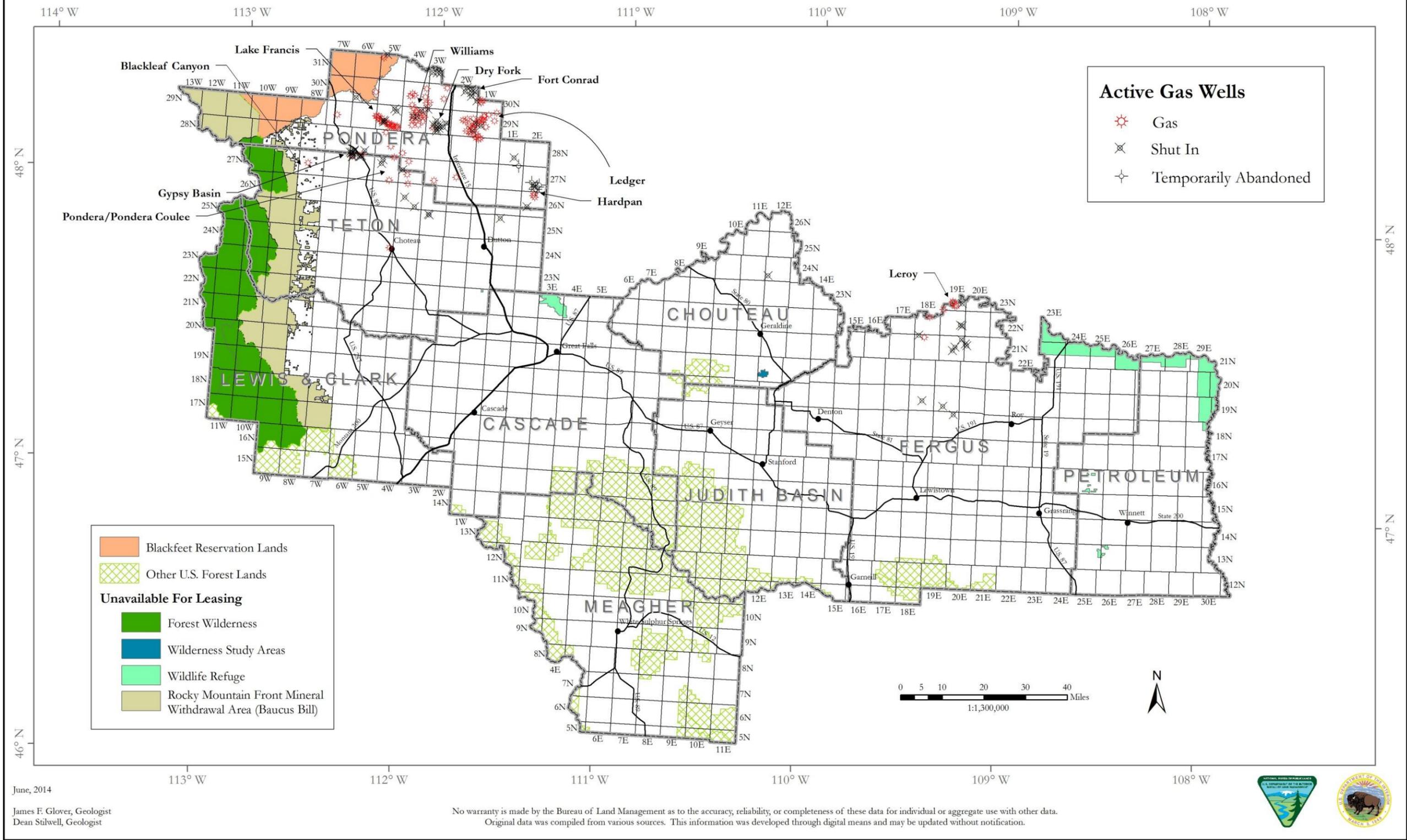


Figure 10.

Lewistown Planning Area pipelines and facilities by owner (IHS Energy Group, 2014).

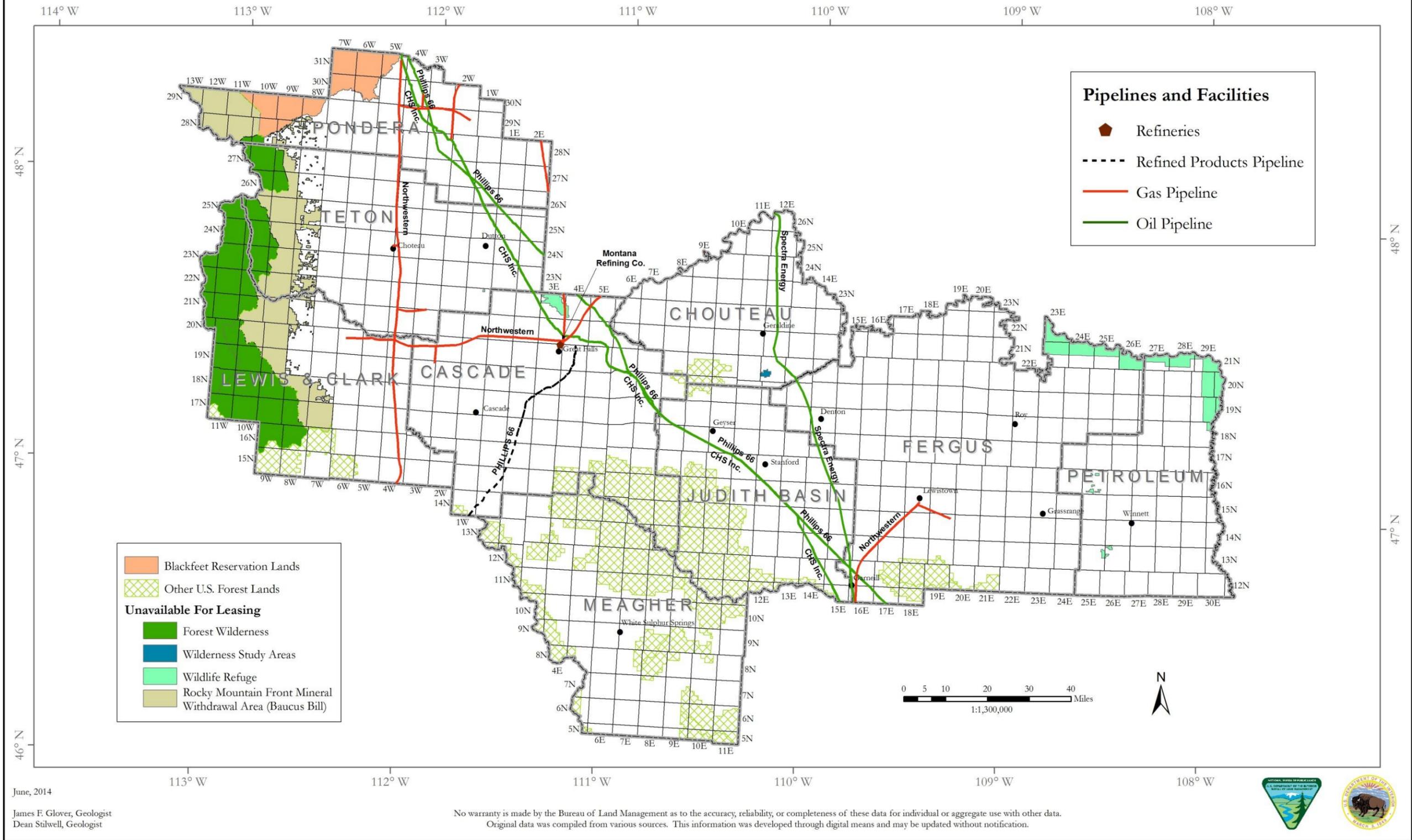


Figure 11.
Conventional oil and natural gas development potential within the Lewistown Planning Area, 2014-2033.

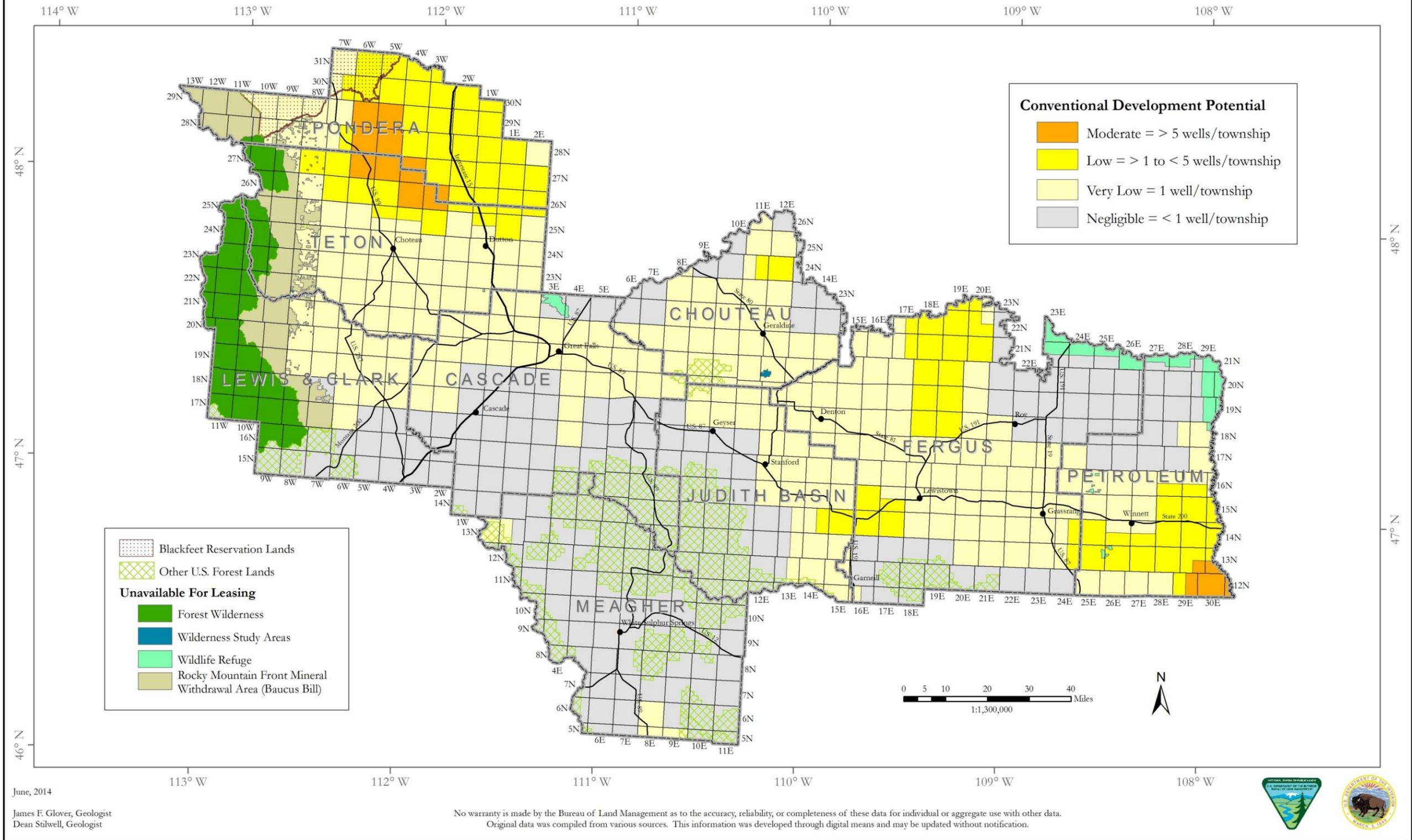
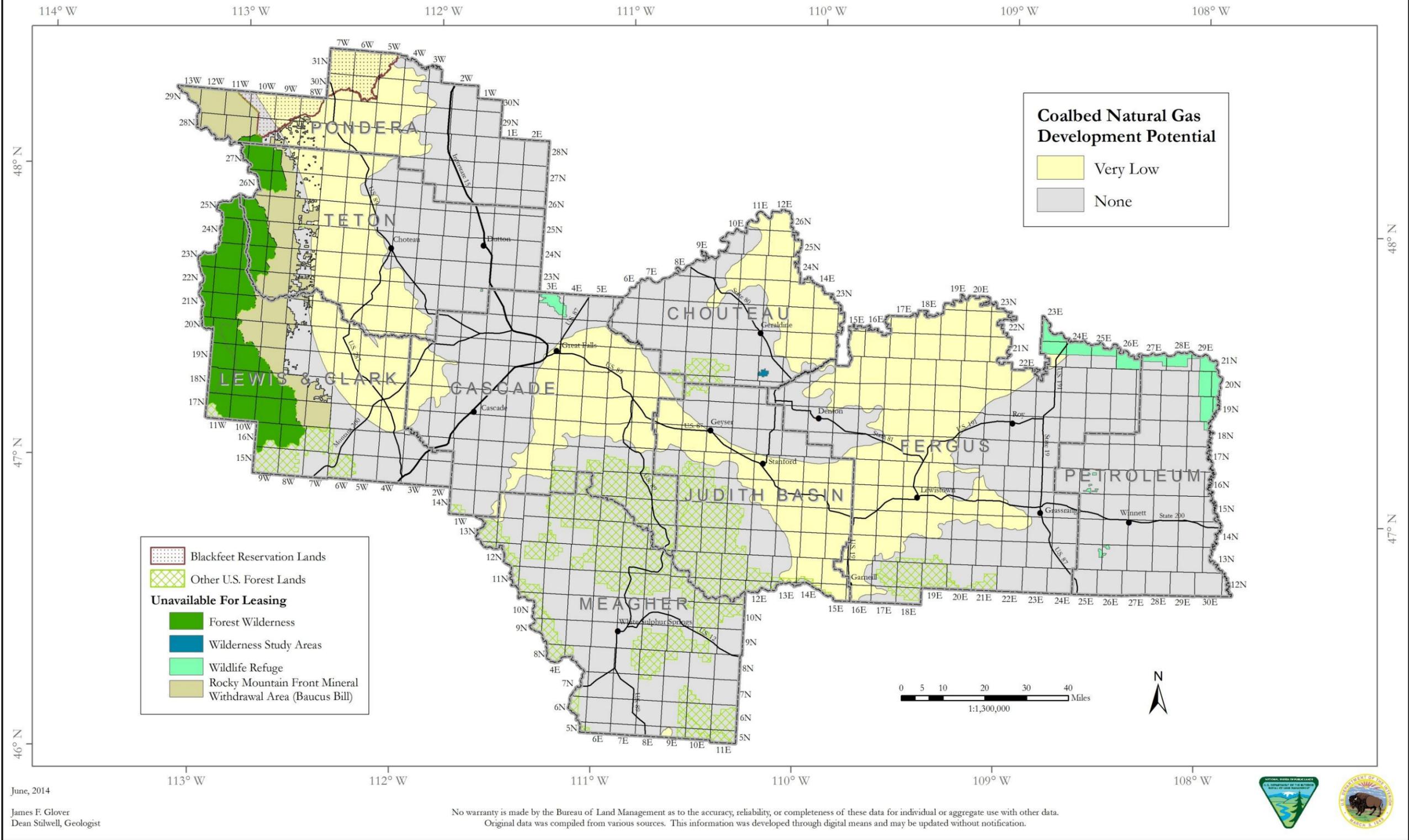


Figure 12.
Coalbed natural gas development potential within the Lewistown Planning Area, 2014-2033.



divided into four distinct categories based on the anticipated average number of wells to be drilled per township during the planning period:

- Moderate: 5 or more wells per township,
- Low: 1 to 5 wells per township,
- Very Low: 1 well per township, and
- Negligible: Less than 1 well per township.

With respect to coalbed natural gas activity in the area during the planning period, we used the following categories based on the anticipated average number of wells to be drilled per township during the planning period:

- Very Low: 1 well per township and
- None: No anticipated drilling activity during the planning period.

Each map also outlines areas that are unavailable for leasing (Forest Wilderness, Wilderness Study Areas, Wildlife Refuges, and the Rocky Mountain Front Mineral Withdrawal Area). Unavailable areas will see no drilling activity and are not assessed for development potential.

Projected Conventional Oil and Gas Drilling Activity

Operator input was considered first for determining potential for each township. In areas where operator input was limited, historic drilling and production trends combined with geologic assessments were given primary consideration when designating the development potential for each township. Locations of oil and gas fields, wells spud in the past 10-years, active wells, geology, production statistics, and knowledge of the region were all incorporated to determine where future activities would likely occur.

For a baseline reasonable foreseeable development projection (Rocky Mountain Federal Leadership Forum, 2002, page 13), we estimate that during the planning period as many as 658 wells will be drilled in the Lewistown Planning Area. This baseline activity scenario assumes all potentially productive areas can be open under standard lease terms and conditions, except those areas designated as closed to leasing by law, regulation, or executive order. Up to 25 of these wells could be coalbed natural gas wells, with the remainder being conventional oil and gas wells. Of these 633 conventional wells, the majority are projected to be drilled in and around existing fields in the northwestern and eastern portions of the planning area. These areas are marked as moderate or low development potential on **Figure 11**. Estimated acres, number of townships, average well densities, and total new wells within these classifications are summarized in **Table 4**. The remaining wells (those drilled in areas of very low or negligible potential) are projected to be drilled in areas generally not proven as productive by historical drilling, but which lie within the Montana Thrust Belt and North-Central Montana Provinces as defined by the U.S. Geological Survey National Oil and Gas Assessment and consequently have some potential for future exploration and development activity.

Drilling densities will vary by development area due to spacing limitations and pad

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Table 4.

Estimated acres, number of townships, wells per township, and total new wells within the four development potential categories (excluding coalbed gas) for the Lewistown Planning Area.

Development Potential	Acres (thousands)	Total Townships	Wells per Township	Total New Wells
Moderate	260.90	11.32	15.00	169.86
Low	1,612.89	70.00	3.00	210.01
Very Low	5,106.16	221.62	1.00	221.62
Negligible	4,779.28	207.43	0.15	31.12
Totals	11,759	510	-	633

drilling, and are expected to follow recent trends in densities seen in the planning area. As an approximation, the following shows the expected average density of fields in the four different development potential categories:

- Moderate and Low development potentials
 - developed principally with single well pads
 - up to 4 pads per square mile
 - variable downhole spacing depending on target
- Very Low development potential:
 - developed with single well pads
 - up to 2 pads per square mile
 - variable downhole spacing depending on target

In townships with moderate or low development potential, most of the development is expected to be expansion of the existing oil and gas fields in northwestern and eastern portions of the planning area (**Figure 9a and 9b**). Additionally, low development potential is projected for activity in eastern Judith Basin/southwestern Fergus County and northern Fergus County.

Any wells that occur within townships marked with very low and negligible potential will likely be drilled as wildcat wells looking to discover entirely new fields. The variable well spacing in areas of very low and negligible potential is likely to depend on the play(s) driving development. In these areas, very few new wells will be drilled and well densities will remain similar to what they are at present, with isolated townships having a small potential for an increase in drilling density, most likely around the fringes of townships marked with low or moderate potential. Anticipated activity will be tied to exploration for new field discoveries, and most of these townships will not receive any drilling at all. If a new field discovery is made in any of these areas of very low or negligible development potential, subsequent drilling density could increase moderately around that discovery. Based on previous exploration efforts in the planning area, the probability of successful discovery of one or more new fields in areas of very low and negligible development potential is unlikely (though possible) during the planning period.

Drilling Depths

We anticipate that drilling depths (true vertical depth) will not change significantly during the planning period and will be between 1,000 and 4,000 feet. Historically, about six wells have been drilled deeper than 10,000 feet, with the deepest being 13,225 feet. The majority of wells have been drilled to a depth between 1,000 and 4,000 feet, with an average depth of 2,300 feet. There could be some minor increases in depth if deeper reservoirs are locally encountered. Few, if any, wells are expected to be drilled to depths exceeding 10,000 feet, as the productive formations within the planning area are generally found at shallower depths. We anticipate most future wells to be vertical, though some future wells may be horizontally drilled to minimize surface impacts, comply with surface restrictions, or to recover hydrocarbons that would not otherwise be economically feasible to recover with a vertical well (John Wunder, BLM Montana State Office, written communication, 2010).

Projected Coalbed Natural Gas Drilling Activity

Coalbed gas production in Montana is presently only occurring in the Powder River Basin in the southeast part of the state. The potential for coalbed gas development in the Lewistown Planning Area appears to be very low. The U.S. Geological Survey identified an area of potential undiscovered resources of Jurassic/Cretaceous coalbed gas in the Montana Thrust Belt Province, but made no quantitative assessment of the potential resource (Montana Thrust Belt Team, 2002).

Several notable coal regions are present within the planning area (East, 2013; **Figure 7**). These are the Blackfoot-Valier and North-Central Regions, and the Great Falls and Lewistown Fields. The Potential Gas Committee (2003) estimated as much as 1.2 trillion cubic feet of potentially recoverable coalbed gas resources which includes the coal bearing strata of the Blackfoot-Valier and North-Central Regions as well as the central Montana coal fields. No drilling for coalbed gas has yet occurred in any part of these coal regions within the planning area.

About 25 coalbed gas wells are projected to be drilled in the Lewistown Planning Area between 2014 and 2033. The estimated development area for these new wells is shown on **Figure 12**. Only areas of very low and no potential were outlined. Areas of very low development potential are defined as averaging one well per township. Areas of known coal strata were assigned a very low development potential. The rest of the planning area was assigned a development potential of none.

Since no drilling has yet occurred within the Lewistown Planning Area to explore for coalbed gas, we consider plays in the area as being only hypothetical at present. No coalbed gas activities have been proposed by industry, and operators did not submit projections of future activity or interest in future activity.

To assess potential impacts of some exploration and potential development of the coalbed gas resource in the Lewistown Planning Area, we are assuming that up to 25 new wells could be drilled. Results from coalbed gas pilot projects in Wyoming suggest often that too few wells have been drilled to adequately evaluate the economic viability of a particular area. History indicates that pilots should contain 16 (four interior wells) to 25 (nine interior) wells to properly evaluate an area (Stilwell and Chase, 2012). History suggests that fewer than 16-25 wells may not adequately reduce pressure over a sufficient area and allow gas production or compensate for heterogeneity in the coal. A projection of 25 new coalbed gas wells assumes that minimum exploration and development activity will occur and will probably be limited to only one or a few townships in the planning area.

Estimated Future Oil and Gas Production

Table 5 represents our yearly baseline estimates for future newly producing oil and gas wells and production within the Lewistown Planning Area. The estimated well counts are based on our projection of 633 new oil and gas wells that could be drilled in the planning area (**Table 4**) and are computed from a best-fit curve based on the historical cumulative

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Table 5.

Baseline projections for future newly producing oil and gas wells and production in the Lewistown Planning Area.

Year	Total Wells Spud	New Producing Oil Wells	New Producing Gas Wells	Total New Producing Wells	Oil Produced (bbls)	Gas Produced (Mcf)
2014	18	4	2	6	9,000	70,000
2015	17	3	2	5	15,000	122,000
2016	27	5	3	8	25,000	199,000
2017	17	3	2	5	29,700	224,000
2018	33	6	3	9	40,800	282,000
2019	41	8	4	12	55,600	364,000
2020	34	6	3	9	64,800	395,000
2021	48	9	5	14	80,100	493,000
2022	44	8	4	12	92,000	537,000
2023	39	7	4	11	100,900	576,000
2024	44	8	4	12	111,600	610,000
2025	43	8	4	12	121,600	641,000
2026	40	7	4	11	128,800	669,000
2027	36	7	3	10	135,700	660,000
2028	31	6	3	9	140,000	657,000
2029	39	7	4	11	146,600	693,000
2030	25	5	3	8	148,300	687,000
2031	12	3	2	5	145,600	651,000
2032	20	4	2	6	145,700	625,000
2033	25	5	3	8	148,300	642,000
Totals	633	119	64	183	1,885,100	9,797,000

spud well counts and the future projection of 633 wells. Numbers for newly producing wells are generated using a least-square fit curve computed from a crossplot of the number of producing wells versus the number of wells historically spud by year. This methodology was used to generate separate curves and projections for newly producing oil wells and newly producing gas wells. We calculate that 119 newly producing oil wells and 64 newly producing gas wells will be completed for the 2014-2033 planning period.

We estimated the future yearly oil and gas production values by generating an oil production decline curve and a gas production decline curve from historical production data in the planning area and then convolving those production curves with the forecasted oil and gas well counts, respectively. The resulting projected production values are shown in **Table 5**. For 2014-2033, we project a potential total of 1,885,100 bbls of produced oil and 9,797,000 Mcf of produced gas. We estimate 94,255 bbls per year for average annual oil production and 489,850 Mcf per year for average annual gas production.

We did not project gas production that could come from successful coalbed natural gas wells. If any producible coalbed natural gas wells are drilled, we expect production rates to be relatively low and contribute minimally to overall production.

Surface Disturbance

Table 6 presents our estimates of short-term and long-term disturbance associated with the baseline projection of wells that could be drilled for the period 2014-2033. The upper portion of the table shows our projection of 633 conventional and 25 coalbed natural gas wells (with 75 of those wells managed by BLM) that could be drilled. An additional 890 existing unplugged wells (47 unplugged wells on BLM lands) lie within the Lewistown Planning Area. This portion of **Table 6** also calculates associated acres of total short-term surface disturbance directly associated with those wells. Approximately 3,914 acres of *new* short-term surface disturbance (conventional and coalbed gas disturbance combined) with 446 acres of BLM-managed new surface disturbance could occur if all projected wells are drilled. Including existing wells, total short-term surface disturbance is projected to be about 4,831 acres (494 acres of BLM-managed disturbance).

The lower portion of **Table 6** calculates the estimated numbers of wells remaining after dry holes are abandoned and reclaimed and producing wells cease to be productive and are also abandoned and reclaimed. To calculate the total numbers for new and existing wells in the long term, we used the following long-term abandonment rates:

- eight percent for coalbed gas wells
- 26 percent for new exploratory and development wells
- 25 percent for existing wells.

After accounting for abandonments, we project 468 new conventional wells and 23 new coalbed gas wells will remain in the planning area for the long term with 53 conventional and 3 coalbed gas wells managed by the BLM. We estimate that 668 existing wells will remain with 35 of those on BLM-managed lands. This portion of **Table 6** also calculates unreclaimed acres of total long-term surface disturbance. Approximately 505 acres of

Table 6.

Lewistown Planning Area surface disturbance associated with new wells projected for the development scenario for 2014 through 2033 and for existing active wells.

Disturbance Associated With All New Drilled Wells and Existing Active Wells (Short-Term Disturbance)						
Wells			Acres of Surface Disturbance			
Type	Total	BLM Managed	Access Roads/ Flow Lines	Well Pad	Total	BLM Managed
New Exploratory and Development Wells - Coalbed gas	25	3	3.64	1	116	14
New Exploratory and Development Wells - Conventional	633	72	3.9	2.1	3,798	432
Existing Wells	890	47	0.78	0.25	917	48
Total Wells/Disturbance	1,548	122			4,831	494

Disturbance Associated With All New Producing Wells and Existing Active Wells Less Abandonments (Long-Term Disturbance)						
Wells			Acres of Surface Disturbance			
Type	Total	BLM Managed	Access Roads/ Flow Lines	Well Pad	Total	BLM Managed
New Exploratory and Development Wells - Coalbed gas	23	3	0.5	0.5	23	3
New Exploratory and Development Wells - Conventional	468	53	0.78	0.25	482	55
Existing Wells	668	35	0.78	0.25	688	36
Total Wells/Disturbance	1,159	91			1,193	94

new unreclaimed surface disturbance (conventional and coalbed gas disturbance combined) with 58 acres of BLM-managed unreclaimed surface disturbance could remain in the long term. Including existing wells, long-term unreclaimed surface disturbance is projected to be about 1,193 acres with 94 acres of BLM-managed unreclaimed surface disturbance.

Assumptions used in **Table 6** to calculate short- and long-term surface disturbance for access roads/flow lines and well pads are based on estimates used in the BLM Montana/Dakotas HiLine Draft Resource Management Plan and modified for use in the Lewistown Planning Area (Dale Manchester, written communication, 2013). **Table 7** summarizes the percentages of the planning area that are managed by the BLM. These percentages were used to calculate the numbers of new conventional and coalbed gas wells that could be managed by the BLM for both the short-term and long-term scenarios shown in **Table 6**.

Summary

We examined the available information on the Lewistown Planning Area (operator input, environmental documents, unit agreement activity, publications, historical drilling data, and professional knowledge of the area) and used that data to prepare two maps that indicate areas of potential conventional oil and gas and coalbed natural gas development for 2014-2033 (**Figures 11 and 12**). We also estimated a range of wells (and their associated short- and long-term disturbance) that could be drilled during this period for both categories of wells (**Table 6**). We estimated that up to 633 conventional wells and 25 coalbed natural gas wells may be reasonably assumed to be drilled, with up to 4,831 acres of short-term disturbance (494 BLM-managed acres) and up to 1,193 acres of long-term disturbance (94 BLM-managed acres) in the planning area during the 2014-2033 period.

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Table 7.

Percentages of BLM-managed lands and projected numbers of BLM-managed wells within the four development potential categories (excluding coalbed gas) for the Lewistown Planning Area.

Development Potential	Percent of Planning Area Managed by BLM	Short-Term New Wells Managed by BLM	Long-Term New Wells Managed by BLM
Moderate	6.10	10.36	7.67
Low	19.05	40.00	29.60
Very Low	8.31	18.41	13.62
Negligible	9.59	2.98	2.21
Totals	-	72	53

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