Appendix B: RFDS

Uinta National Forest Oil and Gas Leasing Environmental Impact Statement Reasonably Foreseeable Development Scenario

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Uinta National Forest Oil and Gas Leasing Environmental Impact Statement

Reasonably Foreseeable Development Scenario

Prepared for Uinta National Forest

Developed by JBR, Inc.

July 12, 2007

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APD	application for permit to drill
AU	assessment units
EIS	Environmental Impact Statement
MMBO	million barrels of oil
mya	million years ago
RFDS	reasonably foreseeable development scenarios
RFOGD	reasonably foreseeable oil and gas development groups
TPS	total petroleum system
UDOGM	Utah Division of Oil, Gas, and Mining
UNF	Uinta National Forest
USGS	United States Geological Survey
WUB	Western Uinta Basin

1.0 INTRODUCTION

There has never been oil or gas production on the Uinta National Forest (UNF). Nevertheless, there are approximately 193,000 acres of active oil and gas leases on the Forest, another 56,775 acres of privately held mineral rights beneath the Strawberry Reservoir Lands, and approximately 38,800 acres of split estate (Federal mineral underlying private surface) lands scattered across the UNF. By contrast the UNF comprises approximately 897,400 acres. Information regarding the inferred oil and gas occurrence potential that leads to leasing is kept confidential by lessees. Given current and foreseeable economic demand for oil and gas nationally, interest by the oil and gas industry in acquiring additional Federal leases on the UNF is likely to be high through 2017. Whether or not exploration of these leases for oil and gas will occur during this time period is uncertain and dependent upon the assessment of the potential for discovery of new oil and gas fields as perceived by the oil and gas exploration industries. Even more uncertain is the potential for future oil and gas production on the UNF.

For the purpose of evaluating the potential for oil or gas occurrence and foreseeable exploration on the UNF through 2017, the Forest was divided into 9 analysis groups based upon surface geology, past exploration activities, and geography. These groups are called reasonably foreseeable oil and gas development groups (RFOGD) and have been named American Fork, Currant Creek, Deer Creek, Diamond Fork, Payson, Spanish Fork Canyon, Strawberry, Upper Provo, and Vernon (Figure 1). The following is a list of each group and associated management areas.

Group	**Management Areas**
American Fork	American Fork
Currant Creek	West Fork Duchesne, Currant Creek
Deer Creek	Deer Creek Reservoir, Lower Provo, Hobble Creek
Diamond Fork	Diamond Fork
Payson	Thistle, Payson, Mona, Nephi
Spanish Fork Canyon	Upper Spanish Fork Canyon
Strawberry	Strawberry Reservoir, Willow Creek, White River
Upper Provo	Upper Provo
Vernon	Vernon, West Sheeprock

The United States Bureau of Land Management (BLM), which is responsible for leasing all federally owned mineral rights for all oil and gas, requires that all potentially productive lands can be open with standard lease terms and conditions, except where made unavailable by law, regulation, executive order, or administratively (BLM, 2004).

The UNF has determined that this assessment of reasonably foreseeable development scenarios (RFDSs) should look ahead a period of 10 to 15 years. The rapid changes in the understanding of the petroleum geology of the region along with the new exploration occurring in the Central Utah Overthrust Belt to the south of the UNF make it likely that

advances in geologic understanding will render these RFDSs obsolete within that 10 to 15-year period.

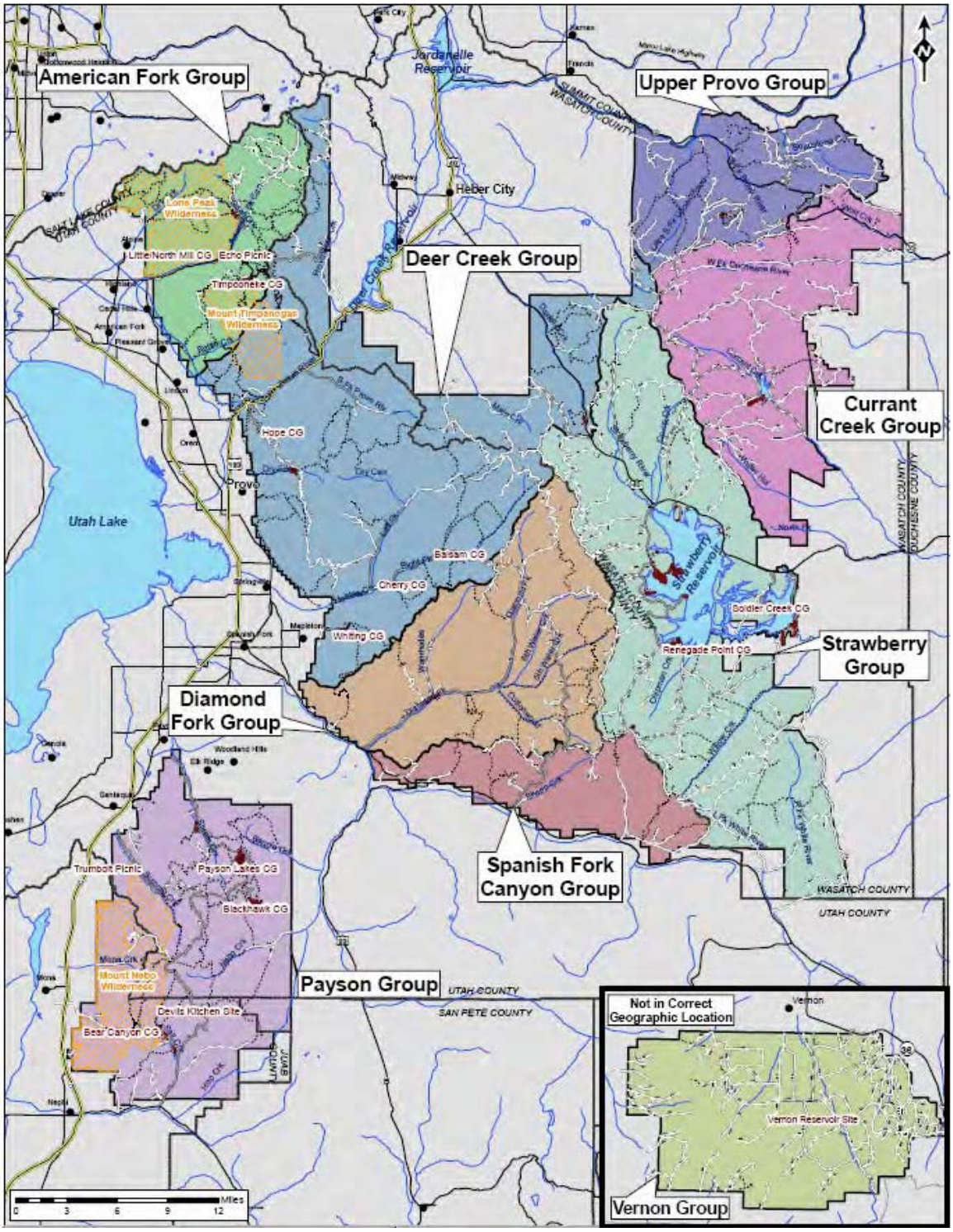

Figure 1. Reasonably Foreseeable Oil and Gas Development Groups.

2.0 GENERAL GEOLOGY

The UNF is underlain predominantly by rocks of two distinctly different ages: Tertiary formations that, in the Uinta Basin to the east, are known to contain oil and gas reservoirs; and older Paleozoic-age sedimentary rocks in highly structurally complex terrain that are part of the exposed northern segment of the Central Utah Overthrust Belt (Figure 2, inserted at end of document due to size).

The Paleozoic and younger rocks of the Overthrust Belt may conceal Mesozoic or even Paleozoic rocks that have the potential to contain oil and gas reservoirs. Oil and gas reservoirs have been found in both the southern part of the Central Utah Overthrust Belt in Sevier County, Utah, and the next segment of the Overthrust belt to the north of the UNF in southwestern Wyoming and to the southwest in Utah on the north flank of the Uinta uplift. The reservoir rocks in both of these areas are of Jurassic age.

The Overthrust Belt dominates the surficial structural geology in the entire UNF. The stratigraphy of the exposed Overthrust Belt rocks is disrupted by this complex structure and as a result, sedimentary rocks of early and late Paleozoic age, the Triassic, Jurassic, Cretaceous, and Tertiary periods are exposed on the UNF. In addition, Tertiary volcanic and intrusive igneous rocks occur in the northern UNF in the American Fork, Deer Creek, and Upper Provo Groups as well as in the Payson Group and the southern edge of the Diamond Fork Group.

The eastern limit of the Overthrust Belt in the UNF has been mapped as reaching Strawberry Reservoir on the Geologic Map of Utah (Hintze 1980) and to the east of Strawberry Reservoir by Willis (1999). Recent geologic mapping of the east part of the Provo 30’ x 60’ Quadrangle, issued as a Progress Report Geologic Map (Constenius and Coogan 2004) does not show the large, previously mapped thrust faults. Since this map is effectively an interim report, the absence of extensive mapped, through-going thrust faults may reflect the preliminary nature of the work. On the other hand, the lack of such major thrust faults may represent a revised interpretation of the geologic structure of this part of the Overthrust Belt.

The mountain-building process that formed what is today termed the Overthrust Belt in Utah has been named the Sevier Orogeny. This process began in late-Jurassic time, approximately 150 million years ago (mya) and was most active in the late Cretaceous Period (80 to 100 mya). This mountain-building event resulted from compressional forces driven by colliding crustal plates, which continued for more than 100 million years and is believed to have ended in the Eocene Epoch of the Tertiary Period approximately 40 to 50 mya. The plate collisions caused shortening of the earth’s crust by approximately 100 kilometers in Central Utah. In response to this deep crustal shortening, the overlying Paleozoic and Mesozoic rocks that now comprise the Overthrust Belt were folded and thrust over one another as the entire upper crustal section was compressed and pushed eastward. Thick shale formations within the

Jurassic and Paleozoic rocks provided the zones of weakness in which the thrust faults formed and along which the individual thrust sheets moved (Willis 1999).

The Sevier Orogeny not only produced the thrust faulting and related folding that is recognized today, but also resulted in extensive erosion of the resultant mountains. Re-deposition of the eroded sediments contributed to the large accumulations of coarse-grained sediments in the immediate vicinity of the eroding thrust-sheets that today have resulted in large, thick deposits of conglomerates along the Wasatch Front. To the east, these sediments contributed to the formation of late-Cretaceous fluvial sandstones and shales, coastal plain, deltaic and deeper water deposits that are widespread in eastern Utah, including at depth in the Uinta Basin (Willis 1999). The process of mountain-building and erosion progressed eastward throughout the time that the Sevier Orogeny was active. The late-Jurassic and older rocks that underlie all or parts of each of the individual management area groups were folded and faulted during this complex orogenic process. Late-Jurassic through early Tertiary rocks underlying the UNF were also folded and faulted by this mountain-building event. Many of these and younger sedimentary rocks formed in part from the erosion of the developing mountains and subsequent deposition of these eroded materials as sediments in fluvial and lacustrine deposits in the developing Uinta Basin.

As thrust faulting progressed eastward across Utah, the thrust sheets had less horizontal displacement and "…deformed into smaller amplitude folds between wider spaced thrust faults than the thick western plates" (Willis 1999).

Late Tertiary and Quaternary extensional tectonics began in the Miocene Period approximately 20 million years ago. This orogenic activity resulted in the predominantly normal faulting and resultant fault-block mountains and intervening basins that characterize the Basin and Range physiographic province whose eastern boundary overlaps the western parts of the American Fork, Deer Creek, Diamond Fork, and Payson Groups; the Vernon Group is located entirely within the Basin and Range province. Prior to and during the formation of the Basin and Range, intrusive igneous activity occurred in the American Fork Group and volcanic rocks were extruded and deposited in both the American Fork and Upper Payson Groups. These geologic processes combined with the effects of the Sevier Orogeny have resulted in the very complex geology that characterizes the entire UNF.

3.0 HISTORICAL EXPLORATION

There is currently no active oil and gas exploration on the UNF. However, a single application for permit to drill (APD) was filed in 2005. A total of 29 wells have been drilled on the Forest or within its boundaries in the past; all having been plugged and abandoned. Fourteen wells were drilled in the Diamond Fork Group, 12 in the Strawberry Group, and 3 in the Currant Creek Group. There is no recorded past oil and gas production from any wells on the UNF or within its boundaries. The closest producing conventional oil field is the Cedar Rim field located in Duchesne County approximately 18 miles to the east of the Currant Creek and Strawberry Groups. The Castlegate field, located in Carbon County approximately 12 miles southeast of the Strawberry Group produces gas (coal bed methane).

For each of the three groups described below Table 1, the relationship of historic drilling to geologic structures is derived from information regarding historic drilling activity provided in the Western Uinta Basin (WUB) Oil and Gas Leasing Environmental Impact Statement (EIS) (USFS and BLM 1997) and from geologic mapping by Constenius and Coogan (2004).

The well information referenced in the following subsections is compiled data that was derived from the Utah Division of Oil, Gas, and Mining (UDOGM) Online Oil and Gas Information System (UDOGM 2006). Compiled well information is presented in Table 1. This table provides information on the wells drilled on the UNF as well as within Strawberry Project Lands. Included in Table 1 are the well name, operator name, total depth, start and completion dates, and information on the strata penetrated by the well.

Table 1. Summary of Well Information for the UNF.

Well Name	API* Well Number	Formation	Formation Top	Thickness	Well Depth	Surface Elev.	Operator	Field Name	County Name	Location (T, R, Sec, 4/4)	Management Group
Federal 1-33	43-051-30006-00-00	Entrada	355'	Min. 355'	2,719'	8,915'	Terra Resources Inc	Wildcat	Wasatch	1n-11w, 33, Ne/Nw	Currant Creek Group
		Twin Creek	1,185'	830'							
		Nugget Sandstone	2,660'	Min. 59'							
Currant Creek Fed 1-26	43-051-30007-00-00	Curtis	0'	Min. 1,014'	9,290'	8,040'	Hamon Operating Co.	Wildcat	Wasatch	1s-11w,26, Ne/Nw	Currant Creek Group
		Twin Creek	1,014'	1,796'							
		Gye Springs	2,810'	310'							
		Morrison	3,120'	2,540'							
		Curtis	5,660'	205'							
		Entrada	5,865'	1,226'							
		Twin Creek	7,091'	1,141'							
		Nugget	8,232'	Min. 1,058'							
Doe Knoll Fee 1	43-051-11432-00-00	Uinta	0'	Min. 235'	235'	7,775.8'	Western Oil	Wildcat	Wasatch	2s-12w, 26, Sw/Nw	Strawberry Group
Strawberry Water Users Fee 1	43-051-10880-00-00	Green River	1,800'	5,560'	7,466'	7,795'	Pan American Petroleum Cor	Wildcat	Wasatch	3s-11w, 14, Se/Nw	Currant Creek Group
		Wasatch	7,360'	Min. 86'							
Strawberry Unit Union 1	43-051-11360-00-00	Uinta	0'	Min. 215'	7,015'	7,313.3'	Union Oil Co Of California	Wildcat	Wasatch	3s-11w, 35, Sw/Sw	Strawberry Group
		Green River	215'	5,515'							
		Wasatch	5,730'	Min. 1,285'							
West Portal U 1	43-049-11483-00-00	Uinta	0'	Min. 3,030'	4,200'	7,066'	Shell Oil Company	Wildcat	Utah	7s-6e, 19, Ne/Nw	Diamond Fork Group
		Colten	3,030'	105'							
		Flagstaff	3,135'	850'							
		North Horn	3,985'	Min. 215'							
Halls Fed 1-13-3c	43-049-30014-00-00	Wasatch	2,630'	546'	12,070'	7,778'	Chevron Usa Inc	Wildcat	Utah	7s-5e, 13, Se/Se	Diamond Fork Group
		Flagstaff	3,176'	1,370'							
		North Horn	4,546'	694'							

Well Name	API* Well Number	Formation	Formation Top	Thickness	Well Depth	Surface Elev.	Operator	Field Name	County Name	Location (T, R, Sec, 4/4)	Management Group
		Thaynes	5,240'	482'							
		Woodside Shale	5,722'	6,348'							
Diamond 1	43-049-10369-00-00	Ankareh	0'	Min. 1,045'	5,931'	Na	Feldman D D	Wildcat	Utah	8s-5e, 16, Sw/Se	Diamond Fork Group
		Thaynes	1,045'	1,600'							
		Woodside Shale	2,645'	310'							
		Thaynes	2,955'	661'							
		Woodside Shale	3,616'	874'							
		Park City	4,490'	1,441'							
Sun Unit 2	43-049-10370-00-00	Ankareh	0'	Min. 100'	5,778'	6,937'	Feldman D D	Wildcat	Utah	8s-5e, 16, Sw/Sw	Diamond Fork Group
		Thaynes	100'	1,405'							
		Woodside Shale	1,505'	879'							
		Park City	2,384'	3,302'							
		Diamond Creek	5,686'	Min. 92'							
Unnamed	43-049-20100-00-00	Pennsylvanian ?	?	?	3,980'	6,200'	?	Wildcat	Utah	8s-5e, 16, Se?Nw	Diamond Fork Group
Formally Diamond 2	43-049-20102-00-00	Park City?	?	?	3,990'	6,800'	?	Wildcat	Utah	8s-5e, 16, Se/Nw	Diamond Fork Group
Sun Unit 1	43-049-20104-00-00	Thaynes	580'	1,160'	3,821'	7,424'	Sun Oil Company	Wildcat	Utah	8s-5e, 17, Se/Ne	Diamond Fork Group
		Woodside Shale	1,740'	644'							
		Park City	2,384'	Min. 1,437'							
Unnamed	43-049-20106-00-00	?	?	?	10'	?	?	Wildcat	Utah	8s-5e, 29, Ne/Ne	
Unnamed	43-049-20108-00-00	?	?	?	1,691'	?	?	Wildcat	Utah	8s-5e, 29, Ne/Ne	Diamond Fork Group
Strawberry Ridge Fed 1	43-051-10452-00-00	Green River	780'	4,190'	5,300'	8,256'	Gulf Oil Corporation	Wildcat	Wasatch	4s-12w, 15, Ne/Ne	Strawberry Group
		Wasatch	4,970'	Min. 330'							

Well Name	API* Well Number	Formation	Formation Top	Thickness	Well Depth	Surface Elev.	Operator	Field Name	County Name	Location (T, R, Sec, 4/4)	Management Group
Strawberry River 1	43-051-30009-00-00	Green River	0'	Min. 4,360'	12,338'	7,987'	Amoco Production Company	Wildcat	Wasatch	4s-12w, 26, Ne/Ne	Strawberry Group
		Colten	4,360'	1,070'							
		Flagstaff	5,430'	90'							
		North Horn	5,520'	800'							
		Oquirrh	6,320'	Min. 6,018'							
Strawberry River U 2	43-051-30013-00-00	Green River	0'	Min. 4,690'	5,010'	7,989'	Amoco Production Company	Wildcat	Wasatch	4s-12w, 26, Ne/Ne	Strawberry Group
		Wasatch	4,690'	Min. 320'							
Burnett 1	43-051-20157-00-00	Colten	6,120'	1,740'	10,017'	8,788'	Carter Oil Co	Wildcat	Wasatch	4s-11w, 34, Sw/Sw	Strawberry Group
		Flagstaff	7,860'	530'							
		North Horn	8,390'	Min. 1,627'							
Duhrkop 1	43-051-20155-00-00	Green River	0'		2,758'	8,258'	Carter Oil Co	Wildcat	Wasatch	4s-11w, 33, Nw/Se	Strawberry Group
Strawberry Reservoir 1	43-051-30008-00-00	Uinta	0'	Min. 980	19,993'	7,904'	Exxon Corporation	Wildcat	Wasatch	4s-11w, 30, Ne/Sw	Strawberry Group
		Green River	980'	4,120'							
		Wasatch	5,100'	2,220'							
		Permian	7,320'	6,731'							
		Park City	14,051'	Min. 5,942							
Willow Creek Tribal 1	43-051-30001-00-00	Green River	1,700'	6,022'	9,196'	7,436'	Gulf Oil Corporation	Wildcat	Wasatch	4s-10w, 16, Sw/Sw	Strawberry Group
		Wasatch	7,722'	Min. 1,474'							
Strawberry Ridge U 1	43-051-20103-00-00	Green River	3,475'	2,425'	6,066'	8,850'	Gulf Oil Corporation	Wildcat	Wasatch	5s-11w, 18 Ne/Ne	Strawberry Group
		Wasatch	5,900'	Min. 166'							
Strawberry U 1	43-051-30005-00-00	Green River	0'	Min. 7,920'	17,002'	9,398'	Chevron Usa Inc	Wildcat	Wasatch	5s-11w, 10, Sw/Ne	Strawberry Group
		Wasatch	7,920'	7,068'							
		Mesaverede	14,988'	Min. 2,014'							
Buffalo Canyon U 1	43-051-30012-	Green River	0'	Min. 5,490'	14,201'	8,816'	Exxon	Wildcat	Wasatch	5s-12w, 13,	Strawberry

Well Name	API* Well Number	Formation	Formation Top	Thickness	Well Depth	Surface Elev.	Operator	Field Name	County Name	Location (T, R, Sec, 4/4)	Management Group
	00-00						Corporation			Ne/Se	Group
		Wasatch	5,490'	8,515'							
		Kirtland	14,005'	196'	14,201'	8,816'					
Thistle Dome U 1	43-049-20089-00-00	North Horn	0'	Min. 1,970'	8,207'	6,829'	Mountain Fuel Supply Co	Wildcat	Utah	9s-6e, 7 Sw/Nw	Diamond Fork Group
		Ankareh	1,970'	4'255'							
		Thaynes	6,225'	1,885'							
		Woodside Shale	8,110'	Min. 97'							
Cottonwood Cyn 1	43-049-30007-00-00	Nugget Sandstone	2,850'	1,250'	15,000'	6,790'	Amoco Production Company	Wildcat	Utah	9s-6e, 7, Sw/Nw	Diamond Fork Group
		Ankareh	4,100'	1,855'							
		Thaynes	5,955'	2,089'							
		Woodside Shale	8,044'	771'							
		Park City	8,815'	985'							
		Oquirrh	9,800'	Min. 5,200							
Fee 2	43-049-20110-00-00	Price River ?	?	?	2,151'	5,500'	Diamond Oil Co.	Wildcat	Utah	9s-4e, 3, Nw/Sw	Diamond Fork
Fee 1	43-049-20112-00-00	Price River ?	?	?	941'	5,500'	Diamond Oil Co.	Wildcat	Utah	9s-4e, 10, Sw/Ne	Diamond Fork
Gremo Hill Fee 1	43-051-30002-00-00	Green River	0'	Min. 2,480'			Mountain Fuel Supply Co	Wildcat	Wasatch	10s-8e, 16, Ne/Se	Strawberry Group
		Colten	2,480'	1,020'							
		Flagstaff	3,500'	1,310'							
		North Horn	4,810'	1,165'							
		Price River	5,975'	Min. 225'	6,200'	7,622					

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3.1 Currant Creek Group

The two wells in the Currant Creek Group were drilled between 1961 and 1980. A third well was permitted; however, the location was abandoned in 1981 without the well being drilled. According to UDOGM records, these wells were drilled to 2,719 feet, and 9,290 feet and both were dry holes that were plugged and abandoned. The two wells were drilled north and west of the Currant Creek Reservoir near the axis of an unnamed anticline with a northwest-trending axis. This fold is located in the upper plate of what the WUB EIS termed the Strawberry Thrust Fault The stratigraphic targets here are not known; however, the deeper well may have been drilled through a thrust fault, as discussed in more detail below.

3.2 Strawberry Group

Including wells drilled within the Strawberry Lands, 13 wells were drilled in the Strawberry Group between 1952 and 1982, although completion dates for two of the wells are not available in the UDOGM database. These wells ranged in depth from 2,758 feet to 19,993 feet and all are recorded as having been dry holes that have been plugged and abandoned. Surficial structural geology, or perhaps remote geophysical data (e.g., gravimetric or magnetic surveys), were probably used to site the wells. Seismic lines in the southern part of the Strawberry Group were shot in 1984 and 1985, apparently after the exploration wells in the area had been drilled.

One APD was filed for a location in the southeast corner of the Strawberry Group near Tabbyune Creek in 2005; it has not been approved. There are no other approved or pending APDs on the UNF.

3.3 Diamond Fork Group

Thirteen wells were drilled in the Diamond Fork Group but completion dates are unavailable for several of them. However, the 8 wells for which completion dates are available were drilled between 1945 and 1995. The 13 wells ranged in depth from 941 feet to 12,061 feet and all are recorded as dry holes that were plugged and abandoned. Ten of the 12 wells are located near the axis of the Diamond Fork Anticline or other unnamed structures in the area. The two wells in the southeastern part of the Diamond Fork Group are drilled in the vicinity of several inferred faults and what may be a plunging anticline.

It is probable that past exploration on UNF leases was directed at geologic structures, chiefly anticlines, identified by surficial geologic mapping. These structures occur in Cretaceous and early Tertiary sedimentary rocks deposited in the western edge of the Uinta Basin that were subsequently folded and probably thrust-faulted in the latter stages of the Sevier Orogeny. Some of the wells, based on their relatively shallow depth, may have targeted the folded early Tertiary Green River and Wasatch Formations in the upper plate. Other, deeper wells almost assuredly were drilled through the upper plate, through one or more thrust faults and completed in lower plate rocks, as discussed below.

3.4 Other

The Browns Peak Unit 1-G24 well located approximately 10 miles south of the south boundary of the Spanish Fork Group on the Manti LaSal National Forest encountered what is described on a summary log on the UDOGM well information data base (UDOGM 2006) as the following formations and top depths: Arapien at a measured depth of 2050 feet, “Entrada” at 4920 feet and Carmel at 6815 feet. This stratigraphic interpretation must be considered tentative at best, since the information is derived from the plugging report for the well. Quotations marks around “Entrada’ suggests that the formation name is tentative but that the section in question may have been sandstone dominant. A thickness for the Entrada of nearly 1900 feet is unlikely. It is possible that the 1900 foot section included Entrada and Navajo Sandstone as well as intervening units such as the Twin Creeks Formation or its equivalent. A drill stem test over a 24-foot interval (5788 – 5812) in what was called Entrada found 47° gravity oil under relatively little pressure; the hole was plugged and abandoned in August 1981. Lillis, et. al., 2003, in a chapter of the United States Geological Survey (USGS) report on the Uinta-Piceance Oil and Gas Assessment, described the age and source rock affiliation of a large number of oil samples from wells and other localities throughout the Uinta Basin using a variety of laboratory tests. The oil sample from the Browns Peak Unit 1-G24 was determined to be derived from the Permian Phosphoria Formation.

4.0 OIL AND GAS POTENTIAL

The potential for exploration for oil and gas resources on Federal oil and gas leases within the UNF is dependent upon economics, applied science, and the existence of favorable subsurface geology. Economic incentives drive risk-taking through "wildcat" exploration (an exploration well that is drilled outside of a known oil or gas field or reservoir in an area from which no oil or gas has been produced); however, success is dependent upon technology, good science, and, most importantly, whether or not commercial oil and gas reservoirs are present. That there are a large number of acres under lease in and of itself is not a gauge of the potential for new discoveries since most of the current leases are probably being held speculatively. There is currently only one APD.

Since the most recent exploration drilling on the Diamond Fork Group in 1995 (a single well drilled to a depth of 3,824 feet) and the Strawberry and Currant Creek Groups in the early 1980s, the understanding of both petroleum source and reservoir rocks and the economics of oil and gas production have changed substantially. New fields have been discovered in the Uinta Basin and new reservoir targets have been recognized there.

Wolverine Gas and Oil's discovery of the Covenant field approximately 80 miles south-southwest of the UNF on the Central Utah Overthrust Belt in northern Sevier County, Utah in 2004 demonstrated the potential for undiscovered oil and gas fields in the Utah Overthrust Belt south of the Uinta uplift (Figure 2). The oil in the Covenant field has been determined to be Mississippian in age (323 to 354 mya) and the source rocks are presumably shales that were deposited in western Utah. The source beds for the oil are presumed to be Mississippian-aged shales located in what is now the Great Basin of western Utah (Jansma, 2005; Chidsey and Sprinkel, 2007). Recognition of this previously suspected, but undocumented, source of petroleum fluids suggests that these shales may represent an abundant source of hydrocarbons for undiscovered reservoirs in the Central Utah Thrust Belt.

Prior to the Wolverine discovery and before a number of new Uinta Basin discoveries, the USGS prepared two reports as part of its National Petroleum Assessment that assess the potential for new petroleum resources in areas underlying the UNF. These reports examined the geology and petroleum systems of the Uinta-Piceance Basin (USGS, 2003) and the Eastern Great Basin (Peterson and Grow, 1995) and were prepared using the "total petroleum system (TPS) approach." Each report describes a number of assessment units or potential "plays" (focused exploration targets), some of which may occur beneath the UNF.

In the absence of past production on or adjacent to the UNF or new discoveries nearby, recognition of the potential for new discoveries beneath the UNF will be determined by the expertise and creative thinking of individual geologists and exploration companies.

Explorationists might begin with considering potential for discovery of analogs to known or potential oil and gas deposits in the Uinta Basin east of the UNF.

The following factors are anticipated to negatively affect leasing and exploration drilling over the next 10 to 15 years for conventional oil and gas reservoirs for multiple Management Areas in the UNF:

- Restrictions on access (no surface occupancy, etc.) may result in reluctance to lease within the UNF;
- Lack of past oil and gas production within or adjacent to the UNF;
- Recent successful exploration within USGS-identified TPSs in the Uinta Basin and Central Utah Overthrust Belt outside the UNF provide no direct encouragement for leasing and exploration drilling on the UNF. Recent exploration success in the Uinta Basin has taken place in the southern part of the basin. The Covenant Field discovery has not been followed by any further discoveries in the Utah Overthrust Belt to the north.

Crude oil and natural gas demand and prices cannot be predicted over the next 15 years; however, demand is likely to be relatively strong for the shorter to intermediate-term foreseeable future. For the immediate future, production of both crude oil and natural gas in the Uinta Basin is likely to remain constrained. The waxy crude produced in most of the Uinta Basin oil fields is less desirable to refineries than crude from other fields in nearby states and also the Covenant field crude oil. This has placed downward pressure on the price refineries in the Salt Lake Valley are willing to pay for Uinta Basin Crude. Although a number of new oil refineries have been discussed, including those that would be built expressly to refine Uinta Basin waxy crude, there are currently no plans for new refinery construction.

Similarly, the natural gas transport pipeline capacity from the Uinta Basin is currently not sufficient to transport all of the gas that the current wells in the Basin can produce. In particular, the lack of a pipeline from the Basin to the east prevents access to markets that would pay a higher price for Uinta Basin gas. As a result, an over supply of natural gas exists, which results in downward pressure on Uinta Basin natural gas prices. The Kinder-Morgan's Rockies Express Pipeline that will carry gas from the northern Rocky Mountains to Missouri and points east is under construction and is scheduled to be completed in large part by early 2008 (Kinder-Morgan 2007). Although a connection to the Uinta Basin is not currently planned, this pipeline will provide a market for natural gas produced in Wyoming and Colorado and may contribute to demand for northern Rocky Mountain natural gas and result in increased natural gas prices for Uinta Basin Crude which is now primarily sold in Utah and points south by the Kern River Pipeline.

These constraints may have the effect of suppressing interest in exploration in the Uinta Basin over the short term. However, assuming these constraints would be limiting factors over the entire 15-year assessment horizon is considered to be overly conservative. Therefore, the current transportation and refining issues have not been considered for the purpose of estimating future potential exploration drilling activities.

4.1 Uinta Basin

The USGS has identified four TPSs in the Uinta-Piceance Province: the Green River, Mesaverde, Mancos/Mowry, and Phosphoria TPSs. A fifth TPS, the Ferron/Wasatch Plateau TPS, is located south of the UNF and does not represent a potential hydrocarbon resource in the UNF. The general characteristics of each of the four systems are described below.

Green River TPS. Reservoirs are fluvial and lacustrine sandstone and lacustrine reservoirs ranging in age from mid-Tertiary to late Cretaceous with most production from the Green River and Wasatch Formations. The system is divided into two assessment units (AUs), one having conventional reservoirs (mobilized hydrocarbon reservoirs that are normally pressurized) and the other unconventional reservoirs (deeper, over-pressurized with near-continuous hydrocarbon saturation throughout the stratigraphic section). Only the more shallow, conventional part of the system is located beneath part of the UNF. Source rocks are the shales within the Green River Formation, where both oil and gas are produced.

Mesaverde TPS. Structural and stratigraphic traps form gas reservoirs in sandstones of the Mesa Verde Group and the overlying formations up to the lacustrine shales in the lowermost Green River Formation, with most reservoirs occurring in the Wasatch Formation. The source of the natural gas is the organic shale and coal beds that occur in the lower Mesaverde. The conventional and more shallow gas AU and the transitional gas AU, located margin-ward of the deep-basin continuous AU, underlie part of the UNF.

Mancos/Mowry TPS. Hydrocarbons in the Mancos/Mowry TPS are generated from the Mowry or Mancos Shales. Reservoir units are located below, within, and above the main source-rock interval in stratigraphic and structural traps. Reservoirs occur in shale and sandstone in the Mancos, and in sandstones in the Dakota and Morrison Formations. Two of the AUs within the Mancos/Mowry TPS, the Uinta Basin Continuous Gas AU and the Uinta-Piceance Transitional and Migrated Gas AU, extend to near the western margin of the Uinta Basin and underlie a portion of the eastern UNF.

Phosphoria TPS. Source rocks are presumed to be the Permian Phosphoria and Park City Formations for oil, and these formations as well as Cretaceous shales and coals for gas. Two AUs are identified, the Hanging Wall and Paleozoic/Mesozoic AU. The Hanging Wall AU contains conventional oil and gas in 18 separate units in anticlines associated with the north-bounding thrust fault of the Uinta Basin. Paleozoic/Mesozoic AU Reservoirs are structural and structural-stratigraphic traps in sandstone and carbonate aquifers associated with regional-scale uplifts and their associated faults and folds. Formations hosting reservoir rocks in the Uinta Basin include the Dakota, Morrison, Entrada and Park City/Morrison Formations.

Since the USGS publication of its Uinta-Piceance Basin study in 2003, the discoveries of new reservoirs and fields and resultant major increases in natural gas production in the Uinta Basin have resulted in an even greater understanding of reservoir occurrence there.

A recent natural gas discovery in Carbon County, Utah near Nine Mile Canyon on the West Tavaputs Plateau by Bill Barrett Corporation (Stone Cabin Field on Figure 2) encountered commercial quantities of natural gas in the Cretaceous Dakota and Jurassic Navajo and Entrada Formations in a reservoir associated with an anticlinal structure (PRNewswire, 2006). Formations above and below these sandstone formations are also considered by the discoverer to be potential reservoir hosts.

Eckels, et. al., (2006) describe a three-dimensional (3-D) seismic survey and subsequent drilling results on the North Hill Creek Extension of the Uintah-Ouray Ute Indian Reservation in the southern Uinta Basin. Drilling subsequent to the seismic survey reportedly resulted in more than 16 drilled and completed wells with production established in 11 formations ranging in depth from 3500 feet to 12,000 feet. The seismic and drilling activity lead to the understanding that the reservoirs in one of the oil fields in the area (Flat Rock Field) were not structurally controlled as had previously been thought but were controlled primarily by the depositional environment of the sandstone.

Source rocks for the foregoing discoveries have not been determined with certainty; however, the Bill Barrett discovery in the southern Uinta Basin may best fit the Phosphoria TPS model. The improved understanding of the nature of reservoirs in the Flat Rock Field suggests that the gas occurrences there may be part of a continuous petroleum system; although the source beds have not been determined with certainty.

These recent southern Uinta Basin discoveries, although 60 miles southeast of the UNF, are located on the southwest flank of the Uinta Basin, in a location relative to the basin margin that is somewhat analogous to parts of the Strawberry and Diamond Fork Group lands on the UNF. Both the Federal 1-33 and Currant Creek Federal 1-26 wells drilled on the Currant Creek Group encountered the Entrada and Nugget Formations (Table 1). The discovery of commercial natural gas reservoirs in these Jurassic sandstones in the southern Uinta Basin combined with the apparent occurrence of these formations at depth in the eastern UNF may suggest the potential for similar reservoirs there. However, such deep exploration would almost assuredly be preceded by seismic surveys.

The potential for exploration drilling in the Uinta Basin portion of the UNF within each of the USGS TPSs during the next 10 to 15 years is evaluated below.

4.1.1 Green River TPS

A single assessment unit in the Green River TPS, the Uinta Green River Conventional Oil and Gas AU (Figure 3, inserted at end of document due to size) is postulated to extend beneath the UNF. Mapping in the USGS assessment (Dubiel, 2003) indicates

that this AU would underlie the Strawberry and Spanish Fork Groups and portions of the Diamond Fork, and Currant Creek Groups. This AU is approximately coincident with mapped surficial exposures of the Wasatch and Green River Formations. This assessment unit "…is defined by the distribution of normally pressured conventional oil and associated gas accumulations in reservoir rocks of the Green River Formation at depths less than about 8,500 ft in the Uinta Basin" (Dubiel, 2003). The USGS assessment report further states that "the Uinta Green River Conventional Oil and Gas Assessment Unit includes strata that produce oil and associated gas from normally pressured reservoirs in primarily marginal-lacustrine rocks of the Green River Formation, and in alluvial rocks of the Wasatch Formation and correlative units." This same report states that "…significant untested areas lie in the western and northern parts of the…" area underlain by marginal-lacustrine rocks. The USGS (2003) has mapped these rock types in the subsurface beneath the UNF, although their distribution is less certain due to lesser well control in the western part of the Basin.

The USGS (2003) estimates that the maximum number of undiscovered fields in this AU to be 12, the median number to be 6, and the minimum number of fields to be discovered to be 1. The estimated size of the fields range from a maximum of 25 million barrels of oil (MMBO) to a minimum of 0.5 million MMBO with a median estimated of 1 MMBO.

Potential for Exploration Drilling in the UNF

The following factors, specific to the Green River Conventional AU are expected to influence leasing and exploration drilling decisions in the four management groups under which the AU has been recognized:

- Extensive existing leasing of private oil and gas rights in the Strawberry Lands, which are wholly contained within the Strawberry Group, may result in a focus on exploration in this area;
- Of 29 wells drilled to date on the UNF, 15 penetrated the Green River/Wasatch or equivalent units; 12 wells were drilled in the Strawberry Group, 2 in the Diamond Fork Group and 1 in the Currant Creek Group. All wells were plugged and abandoned;
- Available stratigraphic data (Table 1) suggest that the Green River Conventional reservoir beds do not occur beneath much of the Diamond Fork Group;
- The single well drilled in the Currant Creek Group that penetrated the Green River/Wasatch was located adjacent to the Strawberry Group at the south end of the Currant Creek Group.

For the reasons discussed above, exploration for targets within the Green Conventional Oil and Gas AU over the next 10 to 15 years is forecasted to occur only in the Strawberry and Currant Creek Groups. Neither trends in past drilling nor recent discoveries in the Uinta Basin provide any quantitative basis for estimating future drilling on the UNF. Both the potential for occurrence and certainty of occurrence of Green River Conventional Oil and Gas reservoirs are considered low. **Two exploration wells are estimated to be drilled on the Strawberry Group, and one well on the Currant**

Creek Group during the next 10 to 15 years. This number is approximately 25 percent of the previously drilled wells in these groups that penetrated Green River/Wasatch beds in the past. It has been nearly 25 years since a well was last drilled in search of Green River/Wasatch reservoirs on the UNF and the 13 wells that were drilled in the Strawberry and Currant Creek Groups were drilled between 1952 and 1983. Since 1952, the average rate of drilling for these reservoirs has been 0.23 wells per year. Given the advanced capabilities of seismic exploration methods available today, attempting to estimate future drilling activity by the average rate of the unsuccessful past exploration drilling is difficult and has accuracy constraints. However, information about past drilling activity was used to estimate a rate of 0.23 wells per year. At this rate, approximately 3 wells may be drilled in the 15-year forecast horizon of this evaluation.

4.1.2 Mesaverde TPS

Two of the AUs in the Mesaverde TPS, the Uinta-Piceance Basin Conventional Gas AU and the Uinta Basin Transitional Gas AU extend beneath parts of the Strawberry Group and the eastern part of the Spanish Fork Group. The conventional gas AU is characterized predominantly by fluvial channel reservoirs in the Wasatch Formation and "…a small potential for conventional-type accumulations in Mesaverde Group fluvial channel sandstones in basin margin areas. Reservoirs contain migrated gas in structural and stratigraphic traps with "…discrete gas water contacts (Johnson and Roberts, 2003). The presence of lacustrine shales in the overlying Green River Formation provides reservoir seals. According to the USGS (Johnson and Roberts, 2003) assessment report, transitional gas assessment units occur basin-margin-ward from "continuous gas assessment units [that] are considered to be basin-centered gas accumulations…" with continuous gas saturation. Transitional gas AUs have less complete gas saturation "…because underlying source rocks are less mature." Potential for discovery new transitional gas reservoirs would be enhanced by the presence of faulting as is the case at the Stone Cabin Field.

The USGS (Johnson and Roberts, 2003) has estimated the mean volume of undiscovered natural gas resources in the Uintah-Piceance Basin Conventional Gas AU as 0.066TCF of gas, 0.5 percent of the estimated resources in the entire Mesaverde TPS and the lowest resource estimate by far of any of the AUs in the TPS. The USGS (2005) also estimates that more than 99 percent of the undiscovered gas resources in the entire TPS occur in continuous-type accumulations," The estimate of undiscovered resources in the transitional gas AU is 1.5 TCF or 11.3 percent of the resources estimated to remain to be discovered in the TPS.

Potential for Exploration Drilling in the UNF

Of the 29 wells drilled in the UNF, 2, both in the Strawberry Group, intercepted Mesaverde or equivalent rocks overlain by Wasatch and Green River Formation rocks. The closest reservoir analog for either AU is the Stone Cabin field located 40 miles to

the southeast. However, wells forecasted for drilling in the Strawberry or Currant Creek Group could target both the Uinta Green River Conventional AU of the Green River TPS and the Uintah-Piceance Basin Conventional Gas AU of the Mesaverde TPS because of the overlap of those AUs in that area. Both the potential for occurrence and certainty of occurrence of Uinta-Piceance Basin Conventional or Transitional Gas reservoirs are considered low. **No wells directed at these AUs alone are forecasted over the next 10 to 15 years.**

4.1.3 Mancos/Mowry TPS

Hydrocarbons in the Mancos/Mowry TPS are generated from the Mowry or Mancos Shales. Reservoir units are located below, within, and above the main source-rock interval. Two of the AUs within the Mancos/Mowry TPS, the Uinta Basin Continuous Gas AU and the Uinta-Piceance Transitional and Migrated Gas AU, extend to near the western margin of the Uinta Basin and underlie a portion of the Strawberry and Spanish Fork Canyon Groups and possibly the extreme southeastern edge of the Currant Creek Group. Potential reservoir rocks in the continuous gas AU occur in the Dakota, Cedar Mountain, Mancos sandstones, and Morrison Formations. Reservoirs in these formations elsewhere in the Uinta Basin "…are classified as tight, a criterion of continuous accumulation" (Kirschbaum, 2003). None of the 29 wells drilled on the UNF recorded intersecting any of the reservoir rocks or the Mancos Formation (the Mowry Formation occurs predominantly in the Piceance Basin) that comprise the Mancos/Mowry TPS. Structure contour maps of the top of the Dakota Formation indicate that the elevation of the top of the Dakota is roughly 8,000 to 12,000 feet below sea level beneath the eastern UNF. Drilling depths to the upper-most potential reservoir bed, the Dakota Formation, would then exceed 13,000 feet throughout. Fields producing from the TPS are entirely within the Piceance Basin or the eastern Uinta Basin, with the closest field to the UNF being roughly 70 miles southeast of the eastern Forest boundary. All of the Uinta Basin fields producing gas from this TPS are located on the flanks of the Douglas Creek Arch and are associated with anticlinal structures. The 2003 Kirschbaum study based its location of the potential extent of the continuous and transitional gas AUs in the Mancos/Mowry TPS in the western Uinta Basin largely upon projected thermal maturity of the source rocks due to depth of burial.

Potential for Exploration Drilling in the UNF

There are no appropriate quantitative means of estimating the likelihood of exploration drilling for these AUs beneath the UNF. Both the potential for occurrence and certainty of occurrence of Uinta Basin Continuous Gas AU and the Uinta-Piceance Transitional and Migrated Gas AU reservoirs are considered low. **No wells directed at these AUs are forecasted over the next 10 to 15 years.**

4.1.4 Phosphoria TPS

The primary source of hydrocarbons for the Phosphoria TPS is the carbonaceous black shale deposited primarily in western Wyoming and southeastern Idaho and is estimated to have yielded up 225 billion barrels to a large number of oil fields in the Northern

Rocky Mountains, including several oil fields the Uinta-Piceance Basin (Johnson, 2003). Although the Phosphoria Formation occurs in the Uinta Basin, the member that contains carbonaceous shale in Wyoming and Idaho is low in organic carbon in northeastern Utah, which "…excludes it from being a major source of hydrocarbons for that area. Reservoir rocks in the Uinta Basin include the Pennsylvanian Weber Sandstone, the Permian Park City Formation (Phosphoria time-equivalent), the middle Jurassic Entrada Formation, the upper Jurassic Morrison Formation, the Dakota Sandstone, and the Mancos Formation. Major oil and gas fields in the Piceance Basin and the eastern Uinta Basin typify the Hanging Wall and Paleozoic/Mesozoic AUs described by the USGS (Johnson, 2003). The Ashley Valley field in eastern Utah and the Rangely field in western Colorado are representative of the Hanging Wall AU. Oil in these fields is believed to be sourced by both Phosphoria, perhaps other Paleozoic formations and younger Cretaceous shales (USGS, 2003). These fields are 75 and 100 miles east of the eastern edge of the UNF, respectively. The fields that represent the Paleozoic/Mesozoic AU in Utah are the Grassy Trail Creek, Cisco Dome and San Arroyo fields (Johnson, 2003). These fields are approximately 50 miles south-southeast, 100 miles southeast, and 150 miles east-southeast, respectively, of the eastern edge of the UNF.

The Phosphoria-sourced oil (Lillis, et. al., 2003) recovered from the Browns Peak Unit 1-G24 well drilled in 1981 on the Manti La Sal NF 10 miles south of the UNF Spanish Fork Group southern boundary was reported to UDOGM (UDOGM 2006) as having been derived from a drill stem test in the Entrada Formation. Although described by both Lillis, et. al. (2003) and the Johnson (2003) as being from oil within the Uinta Basin, the well is actually located within the Utah Overthrust Belt. Johnson (2003) states that the Paleozoic/Mesozoic AU is considered to be high risk; however, Phosphoria-sourced oil located in the vicinity of the UNF may suggest undiscovered, Phosphoria-sourced reservoirs in the UNF.

Of the 29 wells drilled on the UNF, 8 encountered formations that have been identified by the USGS (2003) as Phosphoria TPS reservoirs. Two wells the Fed 1-33 and the Currant Creek Fed 1-26 were drilled on the Currant Creek Group and encountered both the Entrada and Morrison Formations (Table 1). Evidence of thrust faulting is exhibited in the stratigraphy reported for the Currant Creek Fed 1-26 well (Table 1). This thrust faulting may be related to the Uinta uplift south-bounding thrust fault, which could suggest that the Hanging Wall AU extends to the northwestern Uinta Basin. It is also possible that this thrust faulting is related to the thrusting associated with the Sevier Frontal Zone and therefore part of the Overthrust Belt. The other 6 wells penetrated what was described as the Park City formation and in one case, simply "Permian" rocks. Only one well (Currant Creek Fed 1-26) encountered Morrison Formation and none of the wells encountered the Weber Formation.

The Hanging Wall AU was "…established to include all conventional hydrocarbon accumulations contained in structural and stratigraphic-structural traps associated with or assumed to be associated with, thrusted anticlines that, when considered in a group, form a trend of such structures marginal to the northern and northeastern boundary of

the Uinta-Piceance Province (Johnson, 2003)." Similarly, the Paleozoic/Mesozoic AU reservoirs are structural traps in anticlines associated with the Douglas Creek Arch at the eastern margin of the Uinta Basin and the northwest-plunging Uncompahgre Uplift. Additional structural traps are also associated with faulting in the vicinity of both the Douglas Creek Arch and the Uncompahgre Uplift (Johnson, 2003). The USGS (Johnson, 2003) postulates that hidden anticlines may exist to the northwest of the Uncompahgre Uplift where they would be hidden by younger rocks and not recognizable from the surface.

Potential for Exploration Drilling in the UNF

The absence of any evidence of either of the Phosphoria TPS AUs between the Ashley Valley and Cisco fields in the eastern Uinta Basin and the western edge of the Basin makes the speculative hidden, sediment-covered anticlines or other structures unlikely targets in the Uinta Basin in the near future. In addition, depth to the second youngest Phosphoria TPS reservoir rock, the Dakota Formation, beneath the Currant Creek, Strawberry, Diamond Fork, and Spanish Fork Groups is , as stated above, in excess of 13,000 feet —based on USGS (Kirschbaum, 2003) structure contour mapping of the top of the Dakota Formation. It is likely that exploration for hidden Paleozoic/Mesozoic AU structures in the Uinta Basin would take place first in those parts of the Basin closer to known fields and the major uplifts with which their trapping structures are located. Accordingly, both the potential for occurrence and certainty of occurrence of reservoirs in the Paleozoic/Mesozoic AU in the UNF is considered low. **No wells directed at the Paleozoic/Mesozoic AU alone are forecasted over the next 10 to 15 years.**

The occurrence of Phosphoria oil in the Browns Peak Unit 1-G24 well and the extensive thrust faulting associated with both the north margin of the Uinta Basin beneath the Currant Creek Group and the Sevier Thrust Belt elsewhere in the UNF suggest that sub-thrust reservoirs either in the Hanging Wall AU or the Overthrust Belt, discussed below, may contain Phosphoria Oil. **A single well targeting the Hanging Wall AU is forecast to be drilled on the Currant Creek Group during the next 10 to 15 years**. Both the potential for occurrence and certainty of occurrence of Hanging Wall AU reservoirs are considered low.

4.1.5 Other Hydrocarbon Accumulations

Coalbed gas is produced from Cretaceous coals in the Book Cliffs coal fields on the southern flank of the basin (Figure 4, inserted at end of document due to size). The Uinta Basin Blackhawk Coalbed Gas AU "…encompasses areas where the Blackhawk Formation or equivalent coal-bearing units in the Mesaverde Formation contain significant coal beds at depths of 6,000 ft or less" (USGS, 2003) These coal beds undoubtedly underlie the eastern and central parts of the UNF; however, with the possible exception of the Tabby Mountain Coal Field they are likely to occur at depths greater than economic production of coal bed gas can be achieved.

Coal production has not occurred in the Tabby Mountain coal field since the mid-20th century. The coal beds are located at the margin of the basin adjacent to the Uinta Uplift, and form part of the steeply dipping hanging wall of the Uinta Thrust Fault (USGS, 2003). As a result, the coal beds and surrounding rocks dip steeply to the south making mining of these beds uneconomic at current or projected coal prices. If these coal beds are ground water-saturated at depth and the faulting and fracturing associated with uplift have not provided conduits for coal bed methane to escape to the atmosphere, it is possible that coal bed gas reservoirs exist at depth. "The entire estimated extent of Mesaverde Formation coal on the hanging wall was assumed to be at depths less than 6,000 ft, and hence all of that area was included in the assessment unit, although there are no subsurface data to confirm this" (USGS, 2003).

Potential for Exploration Drilling in the UNF

Although the western part of the Tabby Mountain coal field extends beneath the Currant Creek Group, the lack of subsurface data regarding the presence of coal gas and the relatively complex structural geology make it very unlikely that coal bed methane exploration will occur in the Tabby Mountain Coal Field during the next 10 to 15 years. Both the potential for occurrence and certainty of occurrence of coal bed gas at economical production depths and the Uinta-Piceance Transitional and Migrated Gas AU reservoirs are considered low. **No exploration wells are projected for the Uinta Basin Blackhawk Coalbed Gas AU.**

4.1.6 Tar Sand and Oil Shale Deposits

In addition to natural gas and petroleum liquids, tar sand and oil shale deposits occur in the Uinta Basin. Minor tar sand occurrences have been recognized within and near the UNF boundaries (Blackett 1996); however, the large deposits that have attracted the interest of potential commercial developers are located well outside the UNF boundaries in the central and eastern Uinta Basin. The locations of these tar sand deposits and occurrences are shown on Figure 4. Tar sand deposits in the Uinta Basin occur in sandstone deposits ranging from mid-Jurassic to lower Tertiary in age. The presence of the small tar sand occurrences in and near the UNF demonstrates that migration of hydrocarbons has occurred within the units in which the tar sands occur. **Their presence provides no indication or suggestion that commercial quantities of tar sands or liquid hydrocarbons are present in their vicinity.**

Oil shales in the Uinta Basin occur in the Parachute Creek Member of the Tertiary Green River Formation. The highest-grade oil shale horizon has been named the Mahogany bed or zone. A thickness of 25 feet or more of oil shale in the Mahogany zone is considered potentially economic. In preparing its Programmatic EIS for Oil Shale and Tar Sands Leasing, the BLM has identified a region underlain by 25-foot-plus-thick Mahogany zone near the center of the Uintah Basin, the western edge of which lies 50 miles east of the UNF. This bed has been assessed by core drilling near

the western end of the Uintah-Ouray Indian Reservation in Duchesne County, approximately five miles east of the Strawberry Group. Though encountered by drilling at a depth of just over 200 feet, the thickness of the Mahogany zone was found to be much less than 25 feet and was considered sub-economic (Cashion 1992). Oil shales are certainly present beneath the Forest; however, the greatest quantities and more well-defined deposits are located in eastern Uintah County. Figure 4 shows the distribution of sub-economic oil shale beneath the UNF.

4.1.7 Eastern Great Basin - Paleozoic-Tertiary Composite TPS

The USGS has recognized the Paleozoic-Tertiary Composite TPS in the Eastern Great Basin (USGS, 2005). Three AUs, the Neogene Basins AU, the Ranges and Other Structures AU, and the Sevier Thrust System AU have been recognized. The Neogene Period represents Miocene (23.0 mya) through Recent geologic time. In 1995 Peterson and Grow (1995) described six plays in the Eastern Great Basin as part of the USGS's initial work on the National Petroleum Assessment. The most recent work by the USGS (2005) is a fact sheet that has put forth a further refinement of the Eastern Great Basin petroleum potential assessment by continuing to place the Eastern Great Basin in a total petroleum system context.

The USGS (2005) summarized its assessment of the quantities of potential hydrocarbon resources as follows:

> estimated a mean of 1.6 billion barrels of oil (BBO), a mean of 1.8 trillion cubic feet of gas (TCFG), and a mean of 85 million barrels of total natural gas liquids (MMBNGL) in the Paleozoic-Tertiary Composite TPS. All of the assessed undiscovered oil and gas resources are conventional. Of the total mean 1.6 billion barrels of oil (BBO), a mean of 827 million barrels of oil (MMBO) is estimated to be in the Neogene Basins AU, a mean of 470 MMBO in the Ranges and Other Structures AU, and a mean of 301 MMBO in the Sevier Thrust System AU. Of the 1.8 TCFG, about 0.1 TCFG is estimated to be in the Neogene Basins AU, 1.2 TCFG in the Ranges and Other Structures AU, and 0.5 TCFG in the Sevier Thrust System AU.

The following is derived from both the work of Peterson and Grow (1995) and the USGS (2005). For the purposes of this document, the plays conceived by Peterson and Grow (1995) relevant to the UNF have been incorporated into the AUs of the USGS (2005) that have the potential to occur on the UNF.

Potential for Exploration Drilling in the UNF

Neogene Basins AU. This AU would presumably occur throughout the eastern Great Basin wherever late Tertiary basins occur. The Unconformity "A" Play of Peterson and Grow (1995) appears to the only non-hypothetical play that would occur in this AU. Reservoirs include "…fractured and porous Paleozoic carbonate beds; lacustrine sandstone, siltstone and carbonate beds …and Middle Tertiary volcanic rocks

(ignimbrites), all of highly variable thickness" (Peterson and Grow, 1995). Source rocks are late Devonian and Mississippian shales with the Great Basin and "… lacustrine oil shale and bituminous shale and shaly carbonates of Early Tertiary- Late Cretaceous age" (Peterson and Grow, 1995). The best examples of this play are the Railroad Valley field south of Ely, Nevada and the Pine Valley field north of Eureka, Nevada; however, eight smaller fields, all located in Nevada, have also produced oil. This play has the potential to occur on the western edge of the Payson Group and in the Vernon Group.

The Younger Tertiary Basins Play of Peterson and Grow (1995), although described as hypothetical, includes the Rozell Point oil seep and reservoirs beneath the Great Salt Lake; however, the occurrence of another field like Rozell Point is considered a "remote possibility." **This play is not a realistic target for exploration on the UNF.**

Ranges and Other Structures AU. According to the USGS (2005) the "…Ranges and Other Structures AU is hypothetical with no current production." The hypothetical plays of Peterson and Grow (1995) that probably fit into this AU would be the Late Paleozoic, Early Tertiary-Late Cretaceous Sheep Pass and Equivalents Play, and the Late Paleozoic-Mesozoic (Central Nevada) Thrust Belt Play. Although with the exception of the latter play, all of these hypothetical plays may occur in the Utah portion of the eastern Great Basin, **exploration drilling related to any of these hypothetical plays is not anticipated in the next 10 to 15 years**. The potential exists for seismic surveys on the Vernon and Payson Groups that would search for this or related sub-thrust targets during the next 10 to 15 years.

Sevier Thrust System AU. The USGS (2005) provides no information for this or any of the other AUs beyond the oil and gas resource assessments described above. The work of Peterson and Grow described the Sevier Frontal Zone Play as hypothetical; however, the discovery of the Covenant Field in Sevier County, Utah has demonstrated that this play is proven, at least for that portion of the play to the south of the UNF in Sevier County. In the northern-most part of the play in Utah and Wasatch Counties, the play area covers essentially all of the UNF with the exception of the Vernon Group. In the northern part of the play, Peterson and Grow (1995) report that oil and gas shows "…have been encountered in several reservoir horizons from Mississippian, Permian, Triassic, Jurassic, and Cretaceous strata…" and consider formations of these ages to be potential reservoirs. Peterson and Grow (1995) report the following with regard to source rocks, timing, and migration:

> Potential source rocks include marine shales and mudstones of Upper Mississippian, Lower Pennsylvanian, and Permian, Triassic, and Upper Cretaceous age. Coaly beds are present in the Cretaceous. The Upper Cretaceous rocks become more fluvial and nonmarine to south and west, and probably are gas prone. Thrusting in the area is Cretaceous to early Tertiary in age, part of the Sevier Orogeny. Most of the hydrocarbon generation and migration probably occurred during this Period. However, some hydrocarbon generation and migration probably began as early as Permian or Triassic time in

the older rocks and as late Tertiary time in Mesozoic rocks. Late Tertiary extension in this area may have disrupted the traps more than in the Wyoming Thrust Belt to the north.

4.2 North End Central Utah Overthrust Belt

The following discussion, entitled, North End Central Utah Overthrust Belt, describes the potential for exploration in those management areas on the UNF where Paleozoic or younger sedimentary rocks have been thrust over younger formations. Accordingly, it includes the Vernon Group, which, though not part of the Sevier Frontal Zone of Peterson and Grow (1995), is located within the broader Sevier Orogenic Belt in the eastern Great Basin.

The conventional understanding of the Sevier Orogenic Belt, which is based largely on geologic mapping of surficial geology and limited subsurface data, it is possible that multiple thrust sheets occur at depth beneath this part of the UNF. One or more of these sheets or the formations underlying the thrust complex could contain favorable reservoir rocks and lithologic seals that could have enabled development of oil and/or gas reservoirs.

The Sevier Orogeny, a mountain-building event that began in the mid-Jurassic Period and ended in the early Tertiary Period, caused rocks deposited in western and central Utah to be pushed eastward and thrust over younger rocks, creating what, at its eastward leading edge, has been called the Overthrust Belt. In some better-understood parts of the Overthrust Belt, these rocks have been “piled” in a series of stacked individual thrust sheets or plates. The rocks in each plate were typically folded and faulted by the compressional forces that moved the plates eastward. The structure and lithology of the rocks covered by the thrust sheet or sheets of the Overthrust Belt in the vicinity of the UNF have not been described in the literature and there is relatively little information available on the subsurface geology in general. The rocks that comprise much of the exposed Overthrust sheet in the western part of the UNF are Mississippian-age and older Paleozoic rocks. By contrast, the surficial rocks in central Utah and Southwest Wyoming are younger: Tertiary and Cretaceous, respectively.

Overthrust Belt-related reservoirs of the type found in Southwestern Wyoming/Utah and in central Utah are formed as the result of thrust faulting and related folding; the folding creates the potential structural traps and the thrust faulting enables the lateral dislocation of formations and potential for stacking of reservoirs. While thrust faults and folds are mapped on a number of geologic maps that cover the UNF and vicinity, information on correlation of these faults with those that might be recognizable in the subsurface has not been published.

4.3 Past Exploration Drilling

No subsurface geologic investigations or compilations have been published for the stratigraphy encountered in the various oil and gas exploration wells on the UNF. However, well information for these wells have been reported to the UDOGM and were

recorded in that agency's records; these records provide some useful information. These data have been compiled and are presented in Table 1, and is summarized below.

Of the 29 wells drilled on the UNF, stratigraphic information is recorded for 26 of them. Of those 26 wells, many were shallow and may not have been located in areas where shallow thrust faults occur. Two of them, Currant Creek Fed 1-26 in the Currant Creek Group and Diamond 1 in the Diamond Fork Group, show evidence of thrust or reverse faulting in the summary stratigraphic records on file at UDOGM. Thrust faulting is recognized when a well encounters older rocks overlying younger rocks. The Currant Creek Fed 1-26 well stratigraphic summary shows a repeat of part of the middle Jurassic section, with Jurassic Twin Creeks Formation present in both the upper and lower plates. The Diamond 1 well stratigraphic summary shows a repeat of the Triassic section with the upper Triassic Ankareh Formation being absent in the sub-thrust plate. The deepest well drilled on the UNF, Strawberry Reservoir 1, appears to have incorrect stratigraphic data; therefore, although the recorded information does not indicate that thrust faulting was encountered, the possibility that thrust-faulting was encountered by that well cannot be ruled out.

The Strawberry Reservoir 1 well was the deepest well drilled on the UNF with a total depth of 19,993 feet. This well is located approximately three miles south of Strawberry Reservoir. The formations below the base of what is called the Wasatch Formation in the UDOGM well log database (UDOGM 2006) beginning at a depth of 7,320 feet and continuing to the bottom of the hole (an interval thickness of 12,673 feet) are simply called "Permian" and "Park City." A plugging report in the same file shows very different well stratigraphy. However neither document indicates the presence of the Cretaceous and Jurassic sections, including the Twin Creeks, Navajo/Nugget and Entrada Formations, which are possible reservoir rocks.

The stratigraphic "picks" in each well were certainly made by different geologists with individual understandings of the expected lithologies of the subsurface rocks. The understanding of the lateral extent, thickness, and depositional environments for the individual formations also changed over the 30-plus years over which the wells were drilled. These factors could have resulted in inconsistent interpretations of the stratigraphy encountered by each well. Of course it is also possible that mistakes in either interpreting the stratigraphy or in reporting it to UDOGM were made. Nevertheless, the subsurface data appear to reflect the presence of thrust faults in the subsurface, but leave open the question of whether or not the Jurassic sandstones and limestone postulated to be potential reservoir hosts in the area were encountered in the single deep well (Strawberry Reservoir 1) drilled in the eastern part of the UNF.

4.4 Oil and Gas Reservoirs in the Vicinity of UNF

The oil and gas reservoirs in the Southwestern Wyoming/Utah segment of the Overthrust belt occur predominantly in the Early Jurassic/latest Triassic Nugget and

Twin Creeks Formations. The reservoirs of the Covenant Field in central Utah are located in the Jurassic Navajo Sandstone, which is stratigraphically and depositionally equivalent to the Nugget Sandstone in northern Utah; the Twin Creeks Formation overlies the Navajo Sandstone at the Covenant Field. The Nugget and Navajo Formations represent sand dune deposits that are believed to have covered much of what is now the State of Utah and southwestern Wyoming during late Jurassic time. The Twin Creeks Formation is a limestone-dominant unit in which reservoirs have been created by fracturing resulting in secondary porosity and permeability. The reservoirs in both the Covenant field and in Southwestern Wyoming/Utah occur predominantly in anticlinal traps that formed during the Sevier Orogeny. Other, older formations of Paleozoic age may also have the characteristics necessary to have become reservoir rocks or sealing formations if the appropriate traps have formed. It is probable that these thick sandstone deposits also underlie much of the UNF.

The oil in the reservoirs may have accumulated either before the thrust sheets were formed, during the Sevier Orogeny, or post-orogenically. The presence of the Arapien Shale above the Navajo reportedly provides the reservoir seal for the Covenant Field (Jansma 2005).

Nothing in the available geologic information for the UNF suggests that oil fields or reservoirs similar to those found in central Utah or Southwestern Wyoming/Utah are present beneath the UNF. However, the available subsurface data certainly does not rule out the possibility that such analogs may exist. In the eastern part of the UNF, where Tertiary and Cretaceous rocks occur on the surface as they do in the Southwestern Wyoming/Utah fields, recent work by the Utah Geological Survey has resulted in a postulated trend or fairway in the Navajo/Nugget and/or Twin Creeks Formations in the subsurface east of the Charleston-Nebo thrust system in Utah and Wasatch Counties (National Energy Technology Laboratory 2006 and Chidsey and Sprinkel 2005). This postulated trend is shown on Figure 2 and is aligned with the surface trace of major thrust faults that have been mapped in the region. The Strawberry Reservoir 1 well discussed above is located on this trend in the Strawberry Group. Unfortunately, the well stratigraphy reported to UDOGM for this well is not useful in subsurface interpretation and characterization of the Overthrust Belt.

Petroleum source rocks for the Southwest Wyoming/Utah reservoirs are the Cretaceous shales of the Mowry Formation in the Green River Basin of Wyoming. The shales in the Cretaceous Mancos Formation in the Uinta Basin, which are of approximately the same age within the Cretaceous and were formed in a similar depositional environment as were the shales in the Mowry Formation, are the source, possibly along with the Permian Phosphoria Formation, of petroleum liquids and some of the natural gas in the Uinta Basin (Chidsey 2003). The recognition of Phosphoria oil in the Browns Peak Unit 1-G24 well and Mississippian age of the petroleum in the reservoirs of the Covenant Field indicates that with known Cretaceous source rocks at least three distinct potential sources for oil in potential undiscovered Overthrust Belt reservoirs beneath the UNF may exist.

Reservoirs in the Nugget Sandstone in the Southwestern Wyoming/Utah oil fields are sealed by the overlying Twin Creeks Limestone, which has low primary porosity and permeability. Reservoirs in the Twin Creeks are sealed by overlying shaly beds or less-fractured horizons within the unit itself. In contrast, the reservoir seals in the Covenant Field are provided by the overlying middle Jurassic Arapien Shale. There are a number of formations, including a number of shale formations, ranging in age from upper Mississippian through Cretaceous that could, depending upon the effects of thrust faulting, act as seals to undiscovered reservoirs beneath the UNF.

4.5 Potential Reservoir Rocks within the UNF

Within the UNF, Nugget Sandstone has been mapped on the surface in relatively small exposures at the northern edge of the Payson Group and in the south-central part of the Diamond Fork Group. A larger exposure has been mapped in the northern part of the Currant Creek Group; the Twin Creeks Formation has also been mapped in this area. No other surface exposures of the Nugget Sandstone are mapped on the State Geology Map within the UNF or by the more recent mapping of Constenius and Coogan (2004). In the Deer Creek Group, geologic mapping shows the lower Tertiary or uppermost Cretaceous North Horn Formation directly overlying the Pennsylvanian Oquirrh Group. In these relatively extensive outcrop areas, all of the underling Mesozoic section is absent. Some or all of the Mesozoic section is described as being absent between lower Tertiary or uppermost Cretaceous formations and either the Triassic or Permian beds below in three of the well records maintained by UDOGM: the Halls Federal 1-13-3-C well in the Diamond Fork Group, the Strawberry River 1 well in the western side of the Strawberry Group, and the Thistle Dome U 1 well in the southeastern part of the Diamond Fork Group.

Whether the absence of these Mesozoic beds is the result of lack of deposition in the first place, complete erosion during the Sevier Orogeny, thrust faulting or a combination of these factors has not been described in the literature. The potential for sub-thrust occurrences of the Nugget Formation such as was recognized in the Currant Creek Federal 1-26 well may exist elsewhere in the subsurface. Its apparent absence in most of the wells drilled in the past in the Strawberry and Diamond Fork Groups might suggest that the other groups would offer better potential for the presence of the Nugget Formation in a favorable structural setting. Alternatively, deeper drilling may be all that is needed to reach this formation. The Deer Creek Group, Payson, and Vernon Groups, where Paleozoic rocks that are part of an upper thrust plate and drilling has not been carried out in the past may offer potential for the presence of both favorable structure and sub-thrust reservoir rocks. The Currant Creek and adjoining parts of the Strawberry and Upper Provo Groups may offer similar potential for sub-thrust targets. The bulk of the Strawberry Group and the Diamond Fork Group may offer the potential for sub-thrust discoveries; however, the presence of favorable beds has not been identified in them.

The subsurface geology of the western margin of the Uinta Basin is not well-described. Surficially, at least the early Tertiary formations that underlie the central and eastern parts of the UNF have apparently been affected by the thrust faulting and folding that occurred during the Sevier Orogeny. The geology of the Tertiary and pre-Tertiary rocks beneath these deformed Tertiary formations has not been described in any published report. To the east of the UNF, the formations in the Uinta Basin were apparently largely unaffected by the Sevier Orogeny. The potential for sub-thrust Tertiary or Mesozoic Reservoirs in the Currant Creek and Strawberry Groups may exist.

4.5.1 Sevier Overthrust Belt

The geology of the Covenant Field and the fields in Southwestern Wyoming/Utah provide considerable insight into what oil and gas explorationists might search for in the Overthrust Belt section over which the UNF is located. If undiscovered sub-thrust oil fields occur in this area, the geologic setting would almost certainly be substantially different from that of either of these areas. Nevertheless, because of the discovery of the Covenant Field, Navajo/Nugget Sandstone or perhaps Twin Creeks Formation limestones are likely to be the initially targeted potential reservoir formations. While it is probable that Navajo/Nugget Sandstone is present at depth beneath parts of the UNF, the relationship of this or other potential reservoir hosts to necessary reservoir seals or the connectivity to source-rocks during migration of oil or gas from source-beds located either east or west of the UNF is completely unknown. Unless these components came together in the proper geometry and timing sequence that would allow an oil or gas reservoir to be created and then preserved, oil fields similar to those elsewhere in the Overthrust Belt will not have formed.

Potential for Exploration Drilling in the UNF

Based upon the foregoing discussion, both the potential for occurrence and certainty of occurrence of oil and gas reservoirs in the north end of the Central Utah Overthrust Belt are considered low. However, because of the heightened interest in the Overthrust Belt with the discovery of the Covenant field and the many untested exploration targets that may be found through future subsurface investigations, **a single exploration well on each of the Deer Creek, Diamond Fork, Payson, Spanish Fork, and Strawberry Groups is estimated.**

5.0 OIL AND GAS DEVELOPMENT SCENARIO

The lack of past oil and gas production, the limited available subsurface data and the uncertainties regarding the surficial geologic evidence for thrust faulting create a great deal of uncertainty regarding the assessment of future oil and gas development on the UNF. Nevertheless, nearly all of the UNF is considered to be prospective for oil and gas exploration with both the potential for occurrence and certainty of occurrence for all areas recognized as prospective.

Future exploration is likely to begin with seismic surveys since past exploration, apparently based in large part on observed surface-exposed geologic structures, failed to result in a discovery. The UNF has determined that this evaluation should not include estimation of the location, type, or extent of future seismic surveys.

Exploration drilling is not anticipated in three of the nine management groups, American Fork, Upper Provo and Vernon, during the 10 to 15-year analysis period. For reasons discussed elsewhere in this report, complex geologic structures, the presence of intrusive and extrusive igneous rocks and related hydrothermal activity, exploration drilling is not anticipated to occur on the American Fork and Upper Provo Groups. The lack of known oil or gas reservoirs in the eastern Great Basin of Utah and the perception of better prospects to the east along the Sevier Frontal Zone is anticipated to limit interest in the Vernon Group to, at most, seismic exploration.

In 1997 the WUB Oil and Gas Leasing EIS projected a maximum of one well to be drilled on the Uinta Basin portion of the UNF in the succeeding 15 years. No wells have been drilled on the UNF since 1997 and a single unapproved APD currently on file for the Strawberry Group is the only APD on file for the entire UNF. Neither the current status of permitting activity nor the lack of the limited drilling estimated by the WUB EIS can be considered indicators of the likelihood of exploration drilling for the entire 10 to 15-year evaluation period undertaken by this report. However, these factors combined with the lack of any recent or proposed seismic surveys, and the current market constraints on the sale of oil and gas produced in the Uinta Basin (discussed above) suggest that exploration may not begin in the early stages of the 10 to 15-year evaluation period.

If seismic results or geologic evaluations are favorable, then drilling of exploration wells could be anticipated. Assuming favorable seismic survey results or other successful target development, it is possible to forecast up to nine exploration wells in six RFOGDs: Currant Creek, Deer Creek, Diamond Fork, Payson, Spanish Fork, and Strawberry. Of course, a single discovery well, a change in crude oil or gas demand or market access, restrictions imposed on oil and gas exploration by future statutory or regulatory actions, or perhaps other factors that cannot be anticipated at this time could easily result in a greater or lesser number of new wells on the UNF. Directional drilling capabilities allow multiple wells to be drilled from a single location. A discovery may or

may not lead to construction of additional well pads as an immediate result. For example, the Covenant Field has production from multiple wells at a single well location.

The forecasted number of wells is presented in Table 2. The reasoning for the number of wells forecasted has been described in previous sections of this document. Please see the sections titled "Potential of Exploration Drilling" under each of the probable targeted units listed in the table. The bold text under these sections highlights the probability of exploration drilling.

Table 2. Forecasted APDs and Exploration Wells by RFOGD

RFOGD	Probable Targeted Assessment Units	Projected Number of Wells
Currant Creek	Uinta Green River Conventional Oil and Gas AU	1 well
	Phosphoria Hanging Wall AU	1 well
	Currant Creek Total	**2 wells**
Deer Creek	Sevier Overthrust Belt	1 well
Diamond Fork	Sevier Overthrust Belt	1 well
Payson	Sevier Overthrust Belt	1 well
Spanish Fork	Sevier Overthrust Belt /Phosphoria Paleozoic/Mesozoic AU	1 well
Strawberry	Sevier Frontal Zone of Sevier Overthrust Belt	1 well
	Uinta Green River Conventional Oil and Gas AU;	2 wells
	Strawberry Total	**3 wells**
UNF Total		**9 Wells**

The disturbance associated with the construction of each well pad is estimated at 2 acres. Well pad facilities would include the well head, drill rig, mud tanks, pipe racks for drill stem and casing, crew facilities (e.g., dog house, trailers, chemical toilets, etc.), water and fuel tanks, flare pit, mud logging trailer, space for support vehicle parking and turnaround. reserve pit for produced water. Additional facilities may be required for such post-well installation activities as formation fracturing depending on individual drilling results. When factoring in associated infrastructure, primarily access roads, it is assumed that disturbance would be approximately 5 acres. This assumption is based upon one mile of new road construction and one mile of road widening per well. Drill rig mobilization is estimated to involve road construction as well as well pad construction. Roads that are not of sufficient current width will need to be widened to a width of 20 feet to allow drilling and related equipment to pass. New roads would need to be 20-feet wide as well. All new or widened roads would be fitted with culverts at stream crossings, drainage ditches, water bars, and surfaced with gravel or a hardened surface to reduce or minimize erosion. The sites and access roads for wells that do not result in a discovery and on which the wells are plugged and abandoned will be reclaimed, resulting in net zero disturbance after reclamation has been completed.

After drilling is completed, producing well sites will be reclaimed in accordance to a lessee's surface use plan of operations and APD resulting in a reduction in the disturbed area during active production. All reclamation would be done according to USFS/BLM publication titled Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development (USFS/BLM 2006). This document can be found in the project record for this EIS. Following the guidelines set forth in that publication would ensure protection of sensitive resources during active production and would also ensure that final reclamation would occur on producing sites once they have been closed.

Discovery of commercial natural gas on the UNF would result in the need for installation of a gathering system and pipeline link to the nearest regional gas transmission line with available capacity. It has been assumed that even if a natural gas discovery is made, commercial production would require multiple producing wells prior to pipeline construction, and that this would not occur during the 10-15 year period for which this evaluation is to apply.

In the event that a commercial oil discovery was made, production could begin soon after completion and well testing. A discovery would require installation of such facilities as product tanks, produced water tanks, separators, and flare pits, if required. Site restoration would also begin by drying the reserve pit, disposing of any contaminated soils in the pit, backfilling the pit, replacing salvaged topsoil, and revegetation the pit site. Carrying out reclamation of other parts of the well pads would depend on the ongoing needs of the operation. Product would be stored in on-site tanks and oil would be hauled by truck to a refinery. In this case, access roads would have to be improved to enable heavier truck traffic. It has been assumed that heavy road construction, consisting of road bed improvements and widening the road to 30 feet excluding cut and fill, which would be reclaimed, would be required for each discovery. The two miles of access road estimated for each exploration well would be widened by 10 feet resulting in an additional disturbance of 1.2 acres of road disturbance per producing oil well. This additional disturbance might be offset to some degree by reclamation of reserve pits and other parts of the well pad.

In addition to crude oil, produced water would also be trucked from the producing well site and transported to a commercial produced water management facility. Crude oil and produced water truck traffic could result in multiple trips per day, round the clock or as few as several trips per week, depending on well production rates. Consideration for injection well disposal of produced water would only take place if well or field economics justified the investment cost compared to transportation costs to an offsite facility.

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7.0 FIGURES

[Hard Copy Insert]

Figure 2. Oil and Gas Fields and Oil Shale in Uinta National Forest and Surrounding Areas

Figure 3. Location of Uinta Green River Conventional Oil and Gas Assessment Unit in Relation to Uinta National Forest

Figure 4. Coal and Tar Sands in Uinta National Forest and Surrounding Areas

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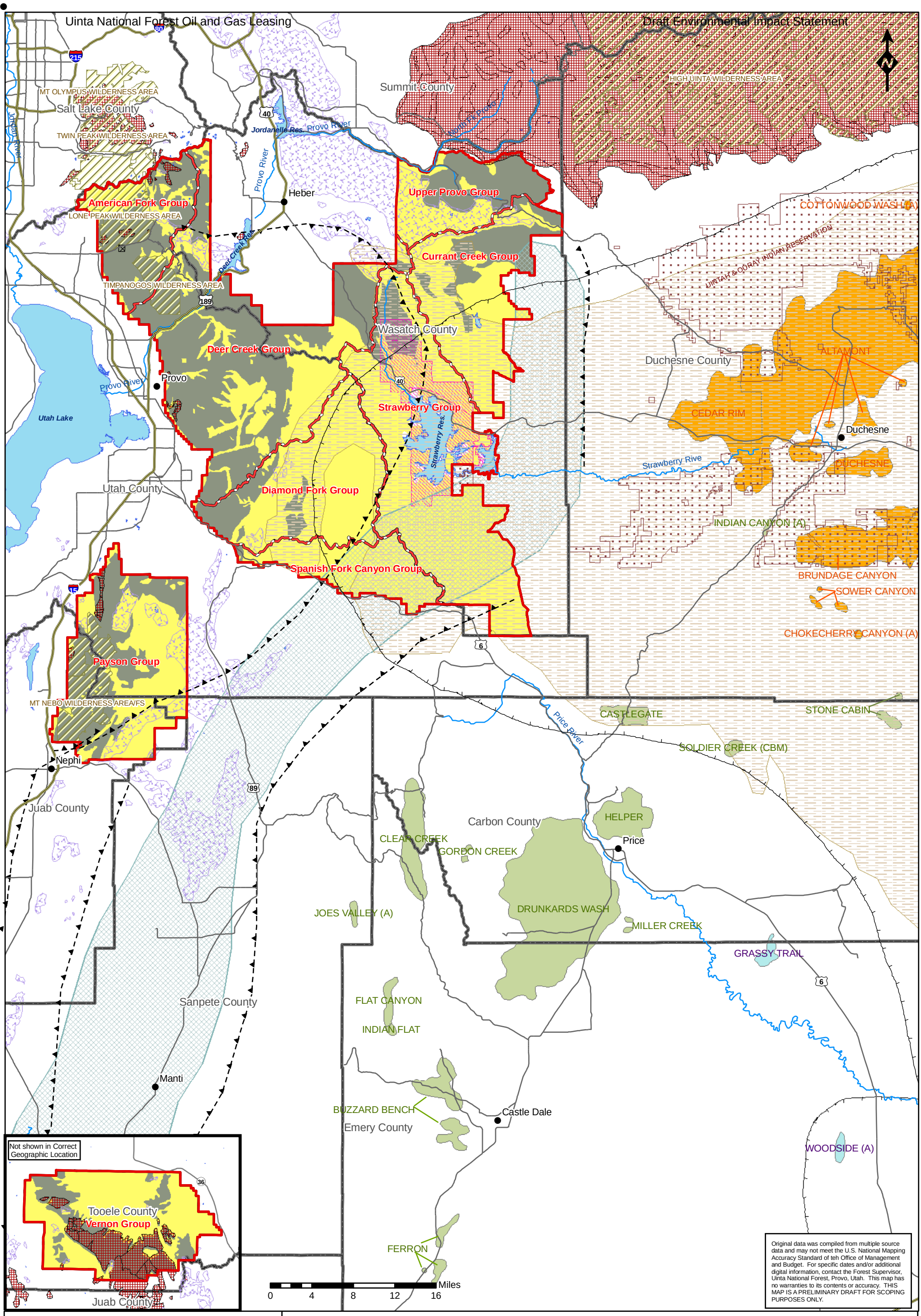


UINTA OIL & GAS EIS

Oil & Gas Fields and Oil Shale in Uinta National Forest and Surrounding Areas

Uinta National Forest

26 September 2006 | 1:530,000 | Horizontal Datum = NAD 1983 Coordinate System = Zone 12N

Legend

- County Seats
- Major Roads
- Freeways
- Major Utah Rivers
- Waterbodies
- County Boundaries
- National Parks
- Wilderness Areas
- Indian Reservations
- UNF Boundary
- RFOGD Groups*
- Strawberry Lands

*Reasonably Foreseeable Oil & Gas Development Groups (Comprised of UNF Management Areas)

Generalized UNF Formations (1)
- Tertiary-Cretaceous
- Dominant Paleozoic

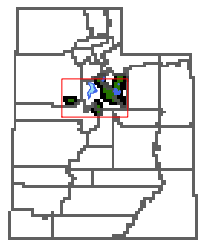
Fields (2)
- Generalized Oil Fields
- Generalized CO2 Fields
- Generalized Gas Fields
- Thrusts
- UGS-Speculated Potential Navajo Sandstone Play (3)
- Undifferentiated Precambrian rocks exposed on surface
- Tertiary/Quaternary volcanic rocks
- Oil Shale Potential (4)
- Major Sedimentary Basins

SOURCES
(1) Summarized from Utah Geological Survey Map 179DM (2000).
(2) Generalized from Utah Geological Survey Map 203 DM (2004).
(3) Utah Geological Survey (2005)
(4) Bar-S Corporation (2005)

UINTA OIL & GAS LEASING EIS

Uinta National Forest Reasonably Foreseeable Development Scenario

- Uinta Green River Conventional Oil and Gas Assessment Unit
- Main Rivers
- RFOGD Groups (1)
- Oil & Gas Potential (3)
- Interstate
- Main Water Bodies
- County Boundaries
- Municipalities



0 2.5 5 10 15 Miles

0 4.5 9 18 27 Kilometers

Projection: NAD 83 UTM Zone 12
Scale 1:365,000

Original data was compiled from multiple source data and may not meet the U.S. National Mapping Accuracy Standard of the Office of Management and Budget. For specific dates and/or additional digital information, contact the Forest Supervisor, Uinta National Forest, Provo, Utah. This map has no warranties to its contents or accuracy. THIS MAP IS A PRELIMINARY DRAFT.

(1) Reasonably Foreseeable Oil & Gas Development Groups
(2) Includes National Park Service, Wilderness, Private and State of Utah lands
(3) Geologic formations with known or recognized potential to contain oil and gas reservoirs in the Uinta Basin to the east.

Sandy
Alpine
American Fork
Heber City
Charleston
Wallsburg
Orem
Provo
Springville
Spanish Fork
Mapleton
Elk Ridge
Santaquin
Mona
Vernon
Utah Lake
SALT LAKE COUNTY
UTAH COUNTY
TOOELE COUNTY
SUMMIT COUNTY
JUAB COUNTY
SANPETE COUNTY
CARBON COUNTY
American Fork Group
Upper Provo Group
Currant Creek Group
Deer Creek Group
Strawberry Group
Strawberry Reservoir
Diamond Fork Group
Spanish Fork Canyon Group
Payson Group
Vernon Group
I15
U189
6

Coalville Coalfield
HIGH UINTA WILDERNESS AREA
MT OLYMPUS WILDERNESS AREA
Summit County
Salt Lake County
TWIN PEAK WILDERNESS AREA
Jordan River
Jordanelle Res.
Provo River
North Fk Provo
South Fk Provo
Heber
American Fork Group
Upper Provo Group
LONE PEAK WILDERNESS AREA
Deer Creek Res.
UINTAH & OURAY INDIAN RESERVATION
Currant Creek Group
TIMPANOGOS WILDERNESS AREA
Tabby Mountain Coalfield
Wasatch County
Deer Creek Group
Duchesne County
Provo
Provo River
Utah Lake
Strawberry Group
Strawberry Res.
Duchesne
Strawberry Rive
Utah County
Diamond Fork Group
Spanish Fork Canyon Group
Payson Group
MT NEBO WILDERNESS AREA/FS
Nephi
Juab County
Book Cliffs Coalfield
Price
Carbon County
Mount Pleasant Coalfield
Emery Coalfield
Wales Coalfield
Sanpete County
Manti
Wasatch Plateau Coalfield
Castle Dale
Emery County

Not shown in Correct Geographic Location
Tooele County
Vernon Group
Juab County

Original data was compiled from multiple source data and may not meet the U.S. National Mapping Accuracy Standard of teh Office of Management and Budget. For specific dates and/or additional digital information, contact the Forest Supervisor, Uinta National Forest, Provo, Utah. This map has no warranties to its contents or accuracy. THIS MAP IS A PRELIMINARY DRAFT FOR SCOPING PURPOSES ONLY.

Miles
0 4 8 12 16

UINTA OIL & GAS EIS
Coal and Tar-Sands in Uinta National Forest and Surrounding Areas
Uinta National Forest

23 September 2006 | 1:530,000 | Horizontal Datum = NAD 1983 Coordinate System = Zone 12N

Legend

- County Seats
- Major Roads
- Freeways
- Major Utah Rivers
- Waterbodies
- County Boundaries
- National Parks
- Wilderness Areas
- Indian Reservations
- UNF Boundary
- RFOGD Groups*
- Strawberry Lands
- **Generalized UNF Formations (1)**
- Tertiary-Cretaceous
- Dominant Paleozoic
- Uinta Basin
- Thrusts
- Secondary Tar-Sand Deposits** (2)
- Secondary Tar-Sand Deposits** (2)
- Coalfield Divider (2)
- **Coal Areas (3)**
- Coal Area with beds >4 ft thick and <3000 ft deep
- Areas underalin by coal-bearing rocks

* Reasonably Foreseeable Oil & Gas Development Groups (Comprised of UNF Management Groups)
** Deposit, known outcrop of bitumen-saturated rock or areas where bitumen can be projected from outcrop or core data.

SOURCES
(1) Summarized from Utah Geological Survey Map 179DM (2000).
(2) Utah Geological Survey Open-File Report 335, May 1996 Survey Map 203 DM (2004).
(3) Utah Geological Survey Map 226 DM (2006)

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