Appendix Q
Energy and Minerals

This appendix provides detailed background on mineral and energy developments.

In this appendix:

Reasonably Foreseeable Mineral and Energy Developments Summary

Table Q-1. Fluid Mineral Development Potential

	Salem	Eugene	Roseburg	Coos Bay	Medford	Klamath Falls
Conventional Oil/Gas	68 wells associated with the Mist Gas Field	N/A	Zero to 114 wells	3 exploration wells	N/A	N/A
Seismic notices of intent	Expected to be confined to existing road systems; negligible effects.		Expected to be confined to existing road systems; negligible effects.	Expected to be confined to existing road systems; negligible effects.		
Road construction	0.25 mile per well @ 40 feet = 82 acres disturbance.		7 miles new road = 39 acres.	0.25 mile per well @ 40 feet = 4 acres disturbance		
Well pad	2 acres per well.= 136 acres		Nested wells and services = 114 acres.	2 acres per well = 6 acres		
Collection pipe:	Assume 25% well success; 2 miles per well; 30 feet wide = 124 acres.		Collection piping will utilize road prism.	No discoveries; no pipe; no disturbance.		
Plug & abandon wells	No additional effect.		No additional effect.	No additional effect.		
Coal bed natural gas	Exploration only	N/A	N/A	37 to 77 wells	N/A	N/A
Seismic notices of intent	Expected to be confined to existing road systems; negligible effects			Expected to be confined to existing road systems; negligible effects		
Road construction				¼ mile per well @ 40 feet = 45 to 90 acres disturbance		
Well pad				Assume 4 wells per pad; 2 acres per pad =19 to 38 acres disturbance		
Collection pipe:				Assume 50% well success; Assume most collection pipe along existing transportation system; new disturbance = 5 to 10 linear miles at 30 feet wide = 18 to 36 acres.		
Plug & abandon wells				No additional effect		
Geothermal	N/A	N/A	N/A	N/A	N/A	See below.

For Klamath Falls Resource Area:

Geophysical Exploration (includes seismic reflection and gravity/magnetic field surveys):

- Notices of Intent: 2; Very small acres disturbed
- Exploratory Wells: 1-2: 0.1 acre per site; .25 acre per well for roads. 0.35-0.7 acres total disturbance

Geothermal Operations:

-Notices of Intent:

Surface Geophysical Surveys: 6: very limited surface disturbance

Temperature Gradient Holes: 5: 0.1 acre per site; .25 acre per well for roads. 2.25 acres total disturbance

Exploration wells: 5 wells; One acre per well pad; 40 ft. wide ROW @ 0.5 mile per well = 17 acres total disturbance

Geothermal Power Plant Development:

1 possible in the life of the plan; if proposed, evaluate separately in cooperation with the State.

Direct Use of Geothermal Energy for space heat:

2 possible; evaluate separately if proposed

Table Q-2. Salable Mineral Development Scenario Summary For 2008-2018

	Roseburg	Salem	Eugene	Coos Bay	Medford	Klamath Falls
New quarries	1	5	2	5	3	1 to 2
Acres disturbed	2 acres per quarry, plus ½ acre for access.					2 to 3 acres per quarry, plus ½ acre for access.
Existing quarries	60	38	71	32	188	18 quarry & cinder sites used Intermittently.
	6 quarries expanded @ 2 acres per quarry	8 quarries expanded. Less than 2 acres per quarry.	4 quarries expanded at approximately 1 acre each.	6 quarries expanded. Less than 2 acres each quarry.	10% of quarries expanded at less than1 acre per quarry, plus 1/10 acre per quarry for new access.	
Depletions	10 quarries	2 quarries	2 quarries	1 quarry	5 quarries	Up to 4 quarries
Decorative stone		3 to 6 sales per year	1 to 2 sales per year		750 sales over the 10-year period	1 to 2 sales per year

Table Q-3. Locatable Mineral Development Scenario

	Roseburg	Salem	Eugene[a]	Coos Bay	Medford	Klamath Falls
Bench Placer notices	2	10	6	6	80	0
Roads	0.3 acres per	0.3 acres per	0.3 acres per	0.3 acres per	Of 80 estimated, 10 would have roads at ½ acre per notice.	0
Test pits, support facility	1 acre per notice	1 acre per notice	1 acre per notice	1 acre per notice	1 acre per notice on average.	
Notice to plan	1	1	0	1	0	0
Vein notices	2	4	4	one	100 notices; surface disturbance 1 to 5 acres per notice.	4
Roads	3 per notice 40x200 = ½ acre per notice	3 per notice 40X200=1/2 acre per notice	3 per notice 40x200= ½ acre per notice	3 per notice 40x200= ½ acre per notice	Mostly existing roads; minimal temporary roads; estimate 0.50-acre for half of the notices; and zero acres for the other half of the notices.	Mostly existing roads; minimal temporary roads.
Support facilities	1 acre per notice	1 acre per notice	1 acre per notice	1 acre per notice	1 acre for half of the notices (many current notices take ore off-site for processing).	
Sample sites	½ acre per notice	0.50-acre per notice	0.50-acre per notice	0.50-acre per notice	Ten holes per notice; 0.1 acre per hole; estimate 1/5 of the notices will drill a hole.	Ten holes per notice; 0.1 acre per hole.
Plans of Operation	1	1	1	1	15 (lode & placer)	0
Exploratory holes	5; 0.1 acre per hole; roads 40x300= 0.75 acre	Ten; 0.1 acre per hole; roads 40x300= 0.75 acre	Ten; 0.1 acre per hole; roads 40x300= 0.75 acre	Ten; 0.1 acre per hole; roads 40x300= 0.75 acre	Ten; 0.1 acre per hole; roads 40x300= 0.75 acre. Estimate ½ of the plans will be lodes and have exploratory holes.	
Support facility	1 acre	1 acre	1 acre	1 acre	1 acre per plan	
Second Phase Exploration						
Roads	5 (standard as above)= 2.5 acres	10 (standard as above)= 2.5 acres	10 (standard as above)= 2.5 acres	10 (standard as above)= 2.5 acres	Mostly existing roads; minimal temporary roads; estimate ½ acre for ½ of the plans;zero acres for the other half of the plans.	
Drill pads	5 holes, 0.1 acre per hole	10 holes, 0.1 acre per hole	10 holes, 0.1 acre per hole	10 holes, 0.1 acre per hole	10 holes, 0.1 acre per hole; on ¼ of the plans.	
Mine Development						
Bench placer	One; 1 acre	One, 7.5 acres	one; 7.5 acres		Eight of the plans are estimated to be bench placers at five acres per plan.	

	Roseburg	Salem	Eugene[a]	Coos Bay	Medford	Klamath Falls
Lode	One	one	None		Seven of the plans are estimated to be lodes with one requiring a 25 acre heap leach.	
Surface excavation	1 acre	10 acres			5 acres per plan.	
Stockpile topsoil	1 acre	2acres			1 acre per plan.	
Support facility	1 acre	2acres			1 acre per plan.	
Roads	1 acre	2 acres			Less than 1 acre per plan.	
Mineral Processing	Done offsite	Done offsite			One acre for half of the plans.	
Silica sand deposit		One	[a] See Footnote	one		0
Mine site		21 acres		20 acres		
Stockpile heavy minerals		One acre		2 acres		
vegetation stockpile		One acre		½ acre		
Office & magnetic separation		One acre		One acre		
Laterite placer plan of operation				One plan		0
Exploratory Holes drilled				10 @ 0.1 acre per hole		
New temporary Roads				0.75 acres total		
Support facility				One acre		
Second Phase Expansion						
Temporary roads				2.5 acres total		
Ten additional drill holes				One acre total		
Recreational mining	5 notices; 2 Acres total	30 notices; 7.5 acres total	30 notices; 7.5 acres total	30 notices; 7.5 acres total	800 Estimate 300 acres, this is disturbance only under the water level.	See suction dredging above.

[a] Eugene footnote: Locatable minerals with silica sand potential withdrawn from mineral entry in the Florence area. However, sand is excavated and removed from BLM property near Florence, Oregon, on an easement granted to the adjacent landowner.

Ten-Year Reasonably Foreseeable Development Of Oil And Gas Resources Scenario For The Salem And Coos Bay Districts

Summary

Salem District

The Salem District is located in northwest Oregon, bound by the Pacific Ocean to the west, the Columbia River to the north, the crest of the Cascade Mountain Range to the east, and the Salem District/Eugene District boundary to the south. It encompasses lands in 13 different counties (Clatsop, Columbia, Multnomah, Tillamook, Washington, Clackamas, Yamhill, Marion, Polk, Lincoln, Benton, Linn and Lane). Most Public Domain and O&C railroad lands within the district will be available for oil and gas leasing, subject to guiding stipulations.

Estimating how much oil and gas exploration and development will occur on Federal lands managed by the Salem District during the next 10 years is based on an existing gas field designation and historical oil and gas investigations. The first exploration well was drilled near Newberg, Oregon in 1902. Conventional petroleum resources in the district have been the focus of numerous studies. Two periods of intense search occurred from 1920 to 1940, and again from 1940 to 1960. These investigations resulted in development of the Mist Gas Field, with a discovery well in 1979. Small amounts of gas, however, have been found throughout the District within projected sedimentary basins.

Review of Oil and Gas Occurrence Potential, Oil and Gas System and Play Analysis, Oil and Gas Production Activities, Potential for Resource Occurrence and Development, and Leasing are needed to understand the District's oil and gas potential. This information was used to project activity through 2018. Given the current incipient nature of petroleum development in Oregon (i.e., current Coalbed Natural Gas development, new exploration of the Mist Gas Field), completely new assumptions and information that impact Reasonably Foreseeable Development (RFD) scenarios may be applicable during the next 10 years and beyond.

Identified potential petroleum source sedimentary basins within the district include:

- Astoria Basin
- Nehalem Basin (or Arch)
- Tualatin Basin
- Willamette Valley
- Yaquina Basin
- Tillamook Basin

Both the Yaquina Basin and the Tillamook Basin are part of the off-shore Newport Basin. The BLM manages approximately 19,400 acres of surface estate within these basins. The amount of subsurface estate is unknown. These basins exist within the Western Tertiary Basins Geologic Province. The Mist Gas Field lies within the Nehalem Basin/Arch.

As of 1985, the estimated in-place gas reserves for the Mist Gas Field were 28.4 billion cubic feet (bcf), with total production through 1984 of 19.2 bcf. The total estimated resource in 1985 was 47.6 bcf. As of 2007, the State of Oregon Department of Geology and Mineral Industries (DOGAMI) reported that approximately 65 bcf of gas had been produced from the Mist Gas Field, with 2.7 bcf produced between 2002 and 2006. This exceeds the 1985 estimate by 17.4 bcf, indicating continued discoveries of resource.

Current non-federal lease holdings within the Salem District are focused within the Mist Gas Field. There are currently no BLM-administered surface holdings within the Mist Gas Field. However, there appears to be one BLM-administered subsurface estate within the field. The BLM-administered surface estate is located to the southeast of the current field description. Previous Mist Gas Field boundaries include approximately 980 acres of BLM-administered surface estate. Similar geology and structure exists under at least 9,000 acres of BLM-administered surface estate southeast of the Mist Gas Field, indicating that foreseeable development of the high potential area could result in approximately 10,800 acres of BLM lease offerings.

The spacing plan for the Mist Gas Field is 160 acres. The size of the pools ranges from 40 acres to 160 acres. Extension of the Mist Field onto the adjacent Federal land, as defined by wells and mapped geology could result in approximately 68 wells on BLM-administered estate. Additional conventional and non-conventional development may occur in other sedimentary basins within the district. Coal bed natural gas development is occurring within Coos County. Exploration companies are mapping coal seams throughout Oregon for other potential resource areas. Coal has been historically mapped and mined throughout the Salem District. Coal bed natural gas development, however, is not expected above exploration within the next 10 years.

Coos Bay District

The Coos Bay District is located on the western edge of Southwest Oregon and encompasses lands in Douglas, Coos, Curry, Lane, and Josephine Counties. Conventional petroleum in the district has been the focus of numerous studies (Diller 1901 as found in Newton 1980, Niem and Niem 1990, and Ryu et al. 1996) with the projection of numerous plays and petroleum structures. The district has also been the focus of numerous industry explorations and investigations. Two speculative conventional petroleum systems have been identified within the district (Ryu et al. 1996). One coal bed natural gas play has also been identified within the district, and is currently being developed on private and Coos County lands. It is expected that most of the public domain and O&C and Coos Wagon Road lands will be available for leasing, subject to guiding stipulations.

Estimating how much oil and gas exploration and development will occur on Federal lands managed by the Coos Bay District during the next 10 years is difficult. Review of Oil and Gas Occurrence Potential, Oil and Gas System and Play Analysis, Leasing, and Oil and Gas Production Activities are needed to understand the oil and gas potential. This information was used to project activity through 2018. Where appropriate, the coal bed natural gas resource is discussed separately from conventional oil and gas.

The speculative conventional petroleum systems include the Umpqua-Dothan-White Tail Ridge hybrid petroleum system and the Umpqua-lower Tyee Mountain petroleum system. Both areas are contained in the southern Tyee sedimentary basin (Ryu et al. 1996) (see *Figure Q-1*). The Umpqua-Dothan-White Tail Ridge hybrid petroleum system is located in the mid-central portion of the district and encompasses an estimated 350 square miles; approximately 26% of which is managed by the district. The northern portion of the district contains approximately 200 square miles of the Umpqua-lower Tyee Mountain petroleum system. The BLM-administered lands comprise about 20% of the area. The coal bed natural gas play is focused mainly on the Coaledo Formations of the onshore portion of the Coos Basin (see *Figure Q*-2), which is an area of approximately 250 square miles located on the western edge of the district.

Although oil and gas exploration has been historically associated with these systems (Ryu et al. 1996, Newton 1980) and conventional oil and gas potential exists as identified speculative petroleum systems (Ryu et al. 1990), there is currently no known interest in exploration or development of these systems. It is anticipated, however, that the Coos Bay District could issue competitive and over-the-counter leases and authorize geophysical surveys. It is also estimated that up to three exploratory wells for conventional petroleum may be drilled during the life of this plan. Conventional exploration, coupled with coal bed natural gas exploration within coal seams beyond the Coos Basin, could increase the number of wells actually drilled.

Figure Q-1. Southern Tyee Sedimentary Basin

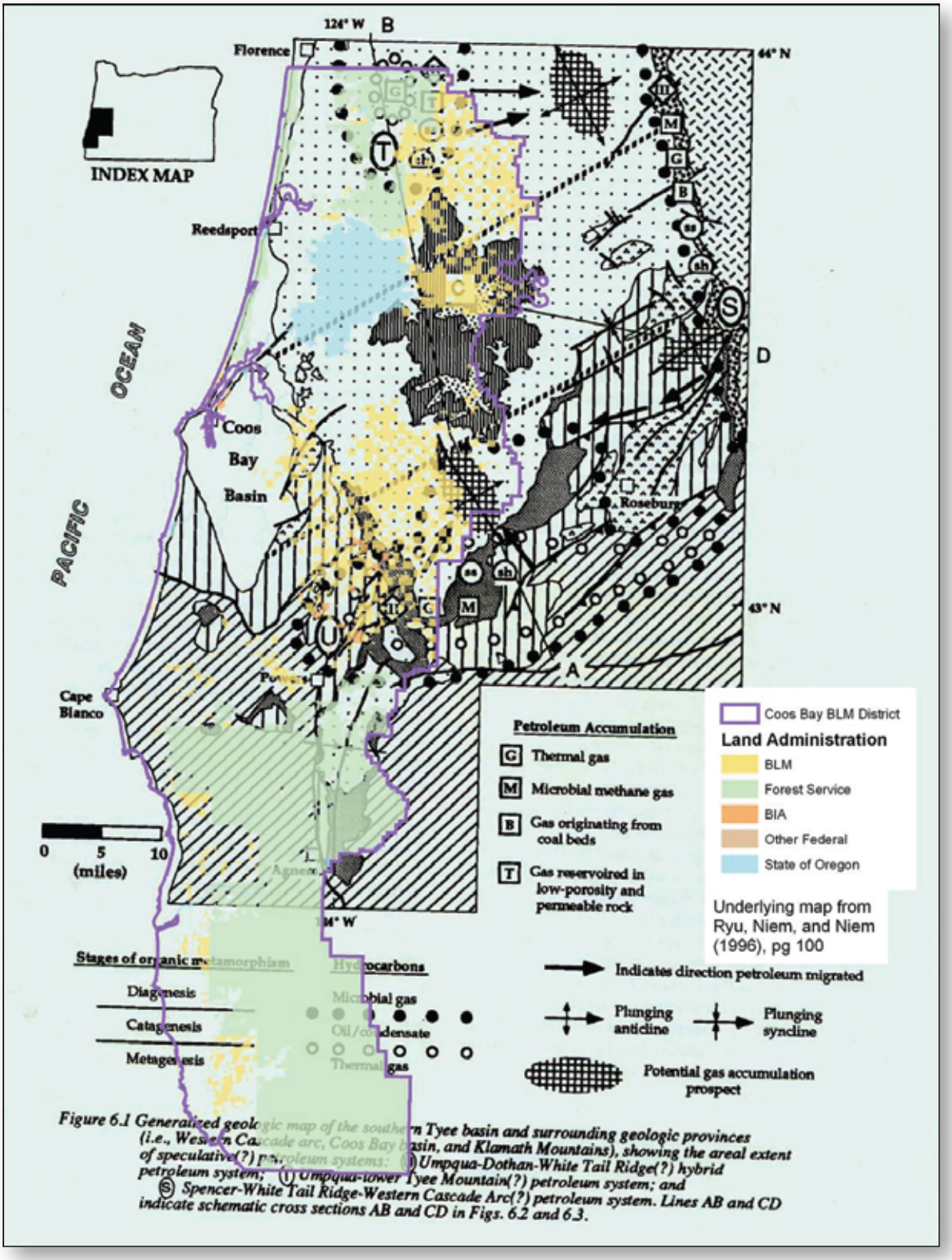
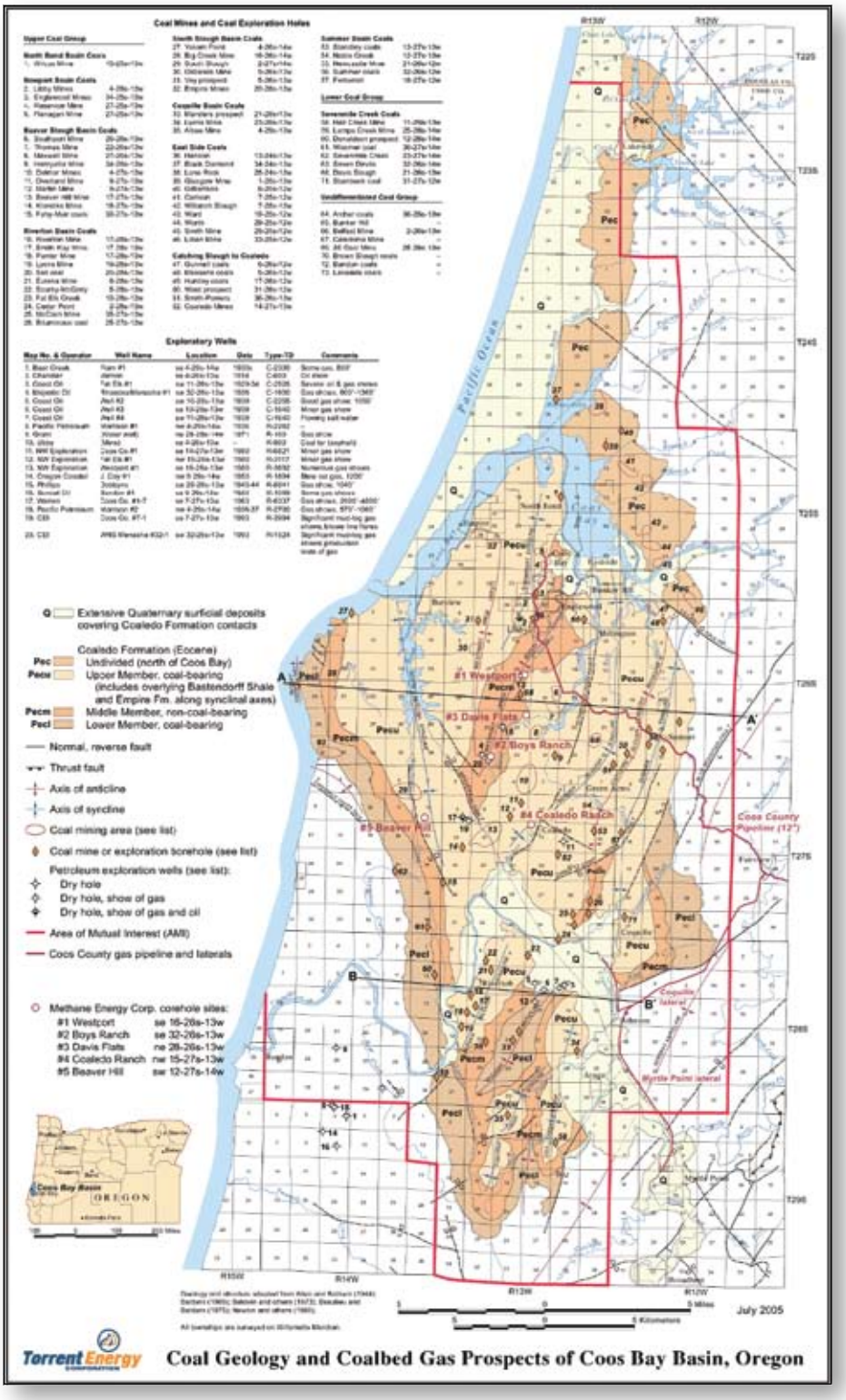


Figure 6.1 Generalized geologic map of the southern Tyee basin and surrounding geologic provinces (i.e., Western Cascade arc, Coos Bay basin, and Klamath Mountains), showing the areal extent of speculative(?) petroleum systems: (H) Umpqua-Dothan-White Tail Ridge(?) hybrid petroleum system; (U) Umpqua-lower Tyee Mountain(?) petroleum system; and (S) Spencer-White Tail Ridge-Western Cascade Arc(?) petroleum system. Lines AB and CD indicate schematic cross sections AB and CD in Figs. 6.2 and 6.3.

Source: Ryu et al. 1996

Figure Q-2. Coaledo Formations Of The Onshore Portion Of The Coos Basin



Source: Torrent Energy Inc. 2005

Current non-Federal lease holdings within the district are focused within the Coos Basin area, with the intention of coal bed natural gas development. Approximately 115,000 acres of the 160,000 acres within the Coos Basin are privately held. Federally-managed mineral estate represents approximately 12.3 percent of the Basin, with BLM-administered portion of roughly 7.6 percent.

Industry has estimated an in-place gas reserve for their lease holdings at 1,166 billion cubic feet (bcf) (1.2 trillion cubic feet (tcf)) for the privately held 115,000 acres (Sproule 2006). To develop this resource, industry estimates a total build-out of between 300 and 719 wells, with 300 being most likely within the next 10 years (Halferty 2007). Based on this estimate compared to proportional acreage, the Coos Bay District could see a total development on BLM-administered lands of between 37 and 77 wells. The total Coos Basin development could range between 436 wells and 1,001 wells. To date, industry has constructed approximately 18 single and multiple well pads consisting of both exploration and production wells. Foreseeable development of the coal bed natural gas play could result in an additional 25,000 acres of BLM-administered lease offerings.

Common to All Alternatives

Introduction

Reasonably Foreseeable Development (RFD) describes scenarios for leasable oil and gas commodities. The purpose of these scenarios is to provide rational models that anticipate the level and type of future petroleum development activity in the planning area, and to serve as a basis for cumulative impacts analysis. The RFD describes logical historic and current development based on plausible interpretation of available information. Future trends and assumptions for hypothetical exploration and development operations are then described.

Scope

The reasonably foreseeable developments are based on known and inferred mineral resource capability of the lands involved and apply to conditions and assumptions discussed under *Historic* and *Current Development*, as well as Future Trends and Assumptions. Possible changes in current geologic data, interpretation, and/or economic conditions would alter the reasonably foreseeable developments, resulting in deviation over time.

Impacts caused by oil and gas exploration and development cannot be assessed without estimating future oil and gas activity.

Estimates of future activity on the Salem District would need to take into account:

- oil and gas occurrence potential, as documented by historic research and papers
- oil and gas system and play analysis, including existing sites such as the Mist Gas Field and the potential development of new plays such as identified sediment basins and coal bed natural gas
- oil and gas production, including economics and technology
- potential for resource occurrence and development
- leasing and development, including Federal and non-Federal activities

Estimates of future activity on the Coos Bay District would need to take into account:

- oil and gas occurrence potential, as documented by historic research and papers
- oil and gas system and play analysis, including looking at the potential development of new plays, such as the identified petroleum systems and Coos Basin coalbed natural gas or interest in unknown discoveries

- leasing, including Federal and non-Federal activities
- oil and gas production, including economics and technology.

These factors cannot be predicted with absolute certainty, but reasonable generalizations are possible. The estimates presented here are based on past and present activities and trends, as well as future price deviations. The estimates may be lower than what actually happens if price and play development is more positive than anticipated. Likewise, if exploration in existing plays, such as the Coos Basin, is not successful and new plays are not developed and/or commodity prices are less than anticipated, estimates presented here may be exaggerated.

Potential for Resource Occurrence and Development

Potentials for resource occurrence and resource development (Haerter 2007) have been estimated for the districts. Definitions for potential for resource occurrence include:

- Low Potential - Hydrocarbon occurrence is unlikely.
- Moderate Potential - Conditions exist for hydrocarbons to occur.
- High Potential - Hydrocarbon shows have been documented, or production has been established.

Definitions for Potential for Resource Development Include:

- Low Potential - Economic or other conditions would likely preclude development.
- Moderate Potential – It is reasonable to conclude that development could occur.
- High Potential - Development is likely to occur within the life of the plan.

Leasing

After initial field work, research, and subsurface mapping, which may include seismic testing and data collection, leasing is often the next step in oil and gas development. Leasing may be based on speculation, with the riskiest leases usually purchased for the lowest prices.

Geophysical Exploration

Geophysical exploration is conducted in an attempt to determine the subsurface structure of an area. The three geophysical survey techniques generally used to define subsurface characteristics are measurements of the gravitational field, magnetic field, and seismic reflections.

Gravity and magnetic field surveys involve small portable measuring units which are easily transported via light-weight off-highway vehicles, such as four-wheel drive vehicles, or aircraft. Both off-highway and on-highway travel may be necessary in these two types of surveys. Usually a three-man crew transported by one or two vehicles is required. These two survey methods can make measurements along defined lines, but it is more common to use a grid with discrete measurement stations.

Seismic reflection surveys, which are the most common of the geophysical methods, produce the most detailed subsurface information. Seismic surveys are accomplished by sending shock waves, generally by a small explosion or mechanically beating of the ground surface, through the earth's surface, reflecting off some layers, thus depicting the underlying structure of the rock. The thumper and vibrator methods pound or vibrate the ground surface to create a shock wave. Usually four large trucks are used, each equipped with pads about four-feet square. The pads are lowered to the ground, and the vibrators are electronically triggered from the recording truck. After information is recorded, the trucks move forward a short distance and the process is repeated. Less than 50 square feet of surface area is required to operate the equipment at each recording site.

The small explosive method requires that charges be detonated on the surface or in a drill hole. Holes for the charges are drilled utilizing truck-mounted portable drills to create small-diameter (two or six-inch) holes to depths of 100 to 200 feet. Generally 4 to 12 holes are drilled per mile of line, and a 5- to 50-pound charge of explosives is placed in the hole, covered, and detonated. The created shock wave is recorded by geophones placed in a linear fashion on the surface. In rugged terrain, a portable drill carried by helicopter can sometimes be used. A typical drilling seismic operation may utilize 10 to 15 men operating five to seven trucks. Under normal conditions, three to five miles of line can be surveyed daily using this method. A drilling program may include the use of heavy truck-mounted drill rigs, track-mounted air rigs, water trucks, a computer-recording truck, and several light pickups to transport people conducting the survey.

Public and private roads and trails are used where possible. However, off-highway cross-country travel is also necessary in some cases. Graders and dozers may be required to provide access to remote areas. Several trips a day are made along a seismograph line, usually resulting in a well-defined two-track trail. Drilling water, when needed, is usually obtained from private landowners, but may be acquired from sources used for fire suppression, such as pump chances and ponds.

The surface charge method utilizes charges of between one and five pounds attached to wooden laths three to eight feet above the ground. Placing the charges lower than six feet usually results in destruction of the vegetation; placing the charges higher, or on the surface of deep snow, results in little visible surface disturbance.

Advanced Three Dimensional Survey analyzes five to six miles using lines with 1,700 shot holes at 70-foot spacing. The lines are spaced at 400 feet apart. The lines are hand brushed for survey. The survey crews utilize an Inertial Survey System that allows for accurate surveying without the need to maintain a line of sight. This allows flexibility in brushing paths. The shot hole pad is three feet by four feet in size and cleared to mineral soil with hand tools. The drill rig is then placed on the pad. If existing access to the pad is limited, the drill rig may be placed and removed by helicopter. The holes are drilled to 15-feet depths and the charges exploded subsurface, leaving no surface expression. Where there is surface expression, the damage is mitigated with hand tools. In open valleys and areas with access, thumper rigs are used, as they disturb even less ground.

Drilling and Production Phase

Notices of Staking are anticipated during the plan period. It is anticipated that the company would then submit an Application for Permit to Drill after the Notice of Staking is accepted. Private surface owner input, if split estates are involved, would be actively solicited during this stage. After an Application for Permit to Drill is approved, the operator initiates construction activities in accordance with stipulations and Conditions of Approval. Access road lengths vary, but usually the shortest feasible route is selected to reduce the haul distance and construction costs. In some cases, environmental factors or landowner's wishes may dictate a longer route. Drilling activity in the planning area is predicted to be done using existing roads and constructing short roads to access each drill site location. The district will utilize currently developed and utilized forest management Best Management Practices, in addition to the BLM's "Gold Book" (USDI/USDA 2006), for surface disturbance in road construction and pad development similar to landings.

Surface Impacts of Drilling and Production

During the first drilling phase, the operator would move construction equipment over existing maintained roads to the point where the new access road begins.

In the second part of the drilling phase, the operator would construct the drilling pad or platform, which is anticipated to involve approximately two acres per well site. Support facilities are also anticipated to disturb about two acres per well site. The likely duration of well development, testing, and abandonment is predicted to be approximately six months to one year for each drill site.

Plugging and Abandonment

Wells completed as dry holes are plugged according to a plan designed specifically for the down-hole conditions of each well. Plugging is accomplished by placing cement plugs at strategic locations from the bottom of the well to the surface. Drilling mud is used as a spacer between plugs to prevent communication between fluid-bearing zones. The casing is cut off at least three feet below ground level and capped by welding a steel plate on the casing stub. Wells will be plugged and abandoned at the end of their production life, with the pad, support facilities, and road reclaimed.

Surface Impacts of Plugging and Abandonment

After plugging, all equipment and debris would be removed and the drill site would be restored as near as reasonably possible to its original condition. If new roads constructed for drilling are not needed for future access to the area, they would be reclaimed using Best Management Practices, with the road prism revegetated as required by the Authorized Officer. Pipelines will be plugged and abandoned in place to minimize new surface disturbance.

District Specific

Historic and Current Development

Oil and Gas Occurrence Potential

Salem District

The Salem District is part of a structural sedimentary basin system that extends onshore and offshore from the Klamath Terrains boundary north to the Columbia River (extending into Washington) from the continental shelf east to the Cascade Mountain/Willamette Valley interface. This is known as the Western Tertiary Basin Province (Olmstead et al. 1989). It has been of interest for petroleum exploration since the 1880s (Newton 1969, Orr and Orr 2000) with oil and gas drilling exploration beginning in 1902 with the drilling of an exploration well near Newberg (Newton 1965, Olmstead et al. 1989). Two major peaks of petroleum exploration have occurred. The first occurred between 1920 and 1940 and was very wide-spread, as there was little geologic information guiding the exploration. The second peak occurred between 1940 and 1960, investigating the deeper Oligocene and Eocene marine sediments. These explorations cumulated in the discovery of the Mist Gas Field in 1979 (Olmstead et al. 1989, Olmstead and Alger 1985, Houston 1997).

Petroleum development on the Salem District has been the focus of numerous studies (Washburne 1914 in Olmstead et al. 1989, Stewart 1954 in Newton et al. 1965, Newton 1969, Olmstead et al. 1989, Niem et al. 1990, Houston 1997, and Meyer 2007). The district has also been the focus of industry explorations and investigations by companies such as Northwest Natural (Oregon Natural Gas Development), RH Exploration, Diamond Shamrock Corporation, Quintana Petroleum Corporation, Standard Oil Company of California, American Quasar Petroleum Company, ARCO Oil and Gas Company, Exxon Corporation, and The Texas Company (Texaco) (Olmstead et al. 1989).

At least 42 exploration wells, 16 water wells, and 7 seeps within the Salem District boundary and outside the 1985 Mist Gas Field boundary (see *Figure Q-3 below*) have had gas shows (Olmstead et al. 1989). As of 1989, a total of at least 108 wells drilled outside of Columbia County (which holds the Mist Gas Field) and within the Salem District (Olmstead et al. 1989) have defined specific sedimentary basins of the Western Tertiary Basin Province that exist within the district (Newton 1969, Olmstead et al. 1989). These basins have been the focus of historic investigation and contain potential conventional petroleum development (Newton 1969, Niem et al. 1985, Meyer 2007).

Non-conventional systems, such as coal bed natural gas, may be a possibility and are being researched where coal is present (Wiley 2006, Pappajohn 2007, Meyer 2007).

Coos Bay District

The Coos Bay District is part of a structural sedimentary basin system that extends onshore and offshore from the Klamath Terrains boundary (Middle Fork of the Coquille River) north to the Columbia River (extending into Washington), from the continental shelf east to the Willamette Valley. These basins have been the focus of petroleum exploration since the 1880s (Newton 1980, Orr and Orr 2000), with oil and gas drilling exploration of the district beginning in 1913 (Newton 1980). Conventional petroleum in the Coos Bay District has been the focus of numerous studies (Diller 1901 in Newton et al.1990, Ryu et al.1996) with the projection of numerous plays and petroleum structures. The district has also been the focus of industry explorations and investigations by companies such as AMOCO Production Company, Union Oil Company, Phillips Petroleum Company, Northwest Natural Gas Company (Newton 1980) and Methane Energy Corporation (Pappajohn 2002).

The most recent play and petroleum structure projections provide three possibilities within the District. These include portions of two potential conventional petroleum structures (Ryu et al. 1996) and a non-conventional coal bed natural gas play identified by Methane Energy Corporation (Pappajohn 2002).

Oil and Gas Structures and Plays

A speculative petroleum system presumes a direct relationship between a particular source rock and a resulting potential petroleum (or natural gas) accumulation (Ryu et al. 1996). An oil and/or gas play is an area, geologic formation, or geologic trend that has good potential for oil and/or gas development, or is generating a large amount of interest in leasing and drilling (USDI BLM 2001).

Salem District

The Western Tertiary Basin Province contained within the Salem District possesses at least six identified basins or sub-basins (Newton 1969, Orr and Orr 2000, Olmstead et al. 1989). These include:

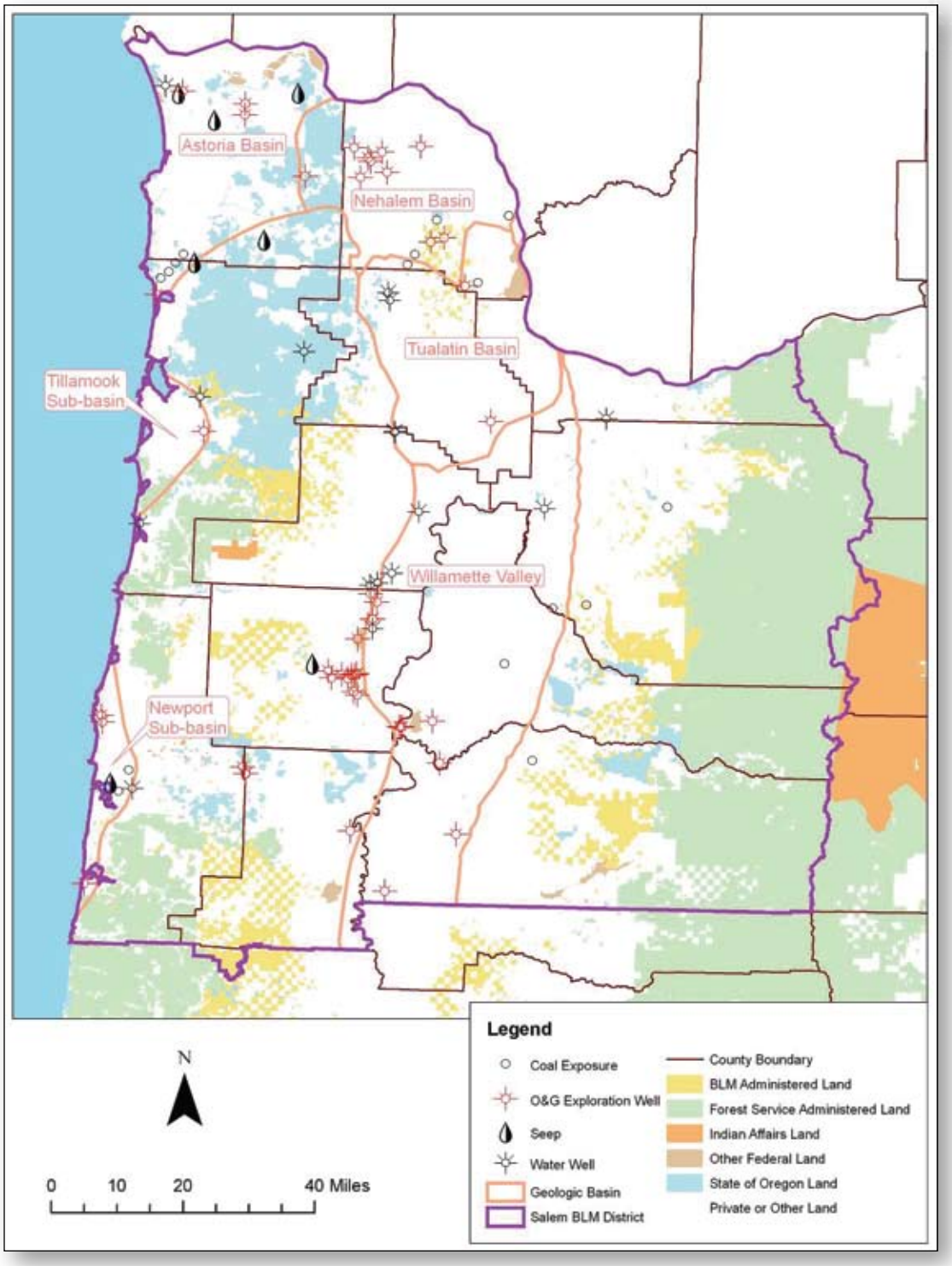
- Tualatin Basin, a sub-basin of the Willamette Valley
- Willamette Valley
- Newport Basin, a sub-basin of the larger off-shore Newport Basin
- Tillamook Basin, a sub-basin of the larger off-shore Newport Basin
- Astoria Basin
- Nehalem Basin or arch

See *Figures Q-3* and *Q-4*.

The basins structures are controlled by compression force of the sub-ducting easterly movement of the Juan de Fuca plate in relation to the overriding westerly movement of the North American Plate. The fold axes are oriented north-south (Orr and Orr 2000), and are defined by the contact between the Miocene or Oligocene rock and Eocene rock. This is a point of erosion of the Eocene rock, which was covered by Miocene or Oligocene rock, defined as a nonconformity (unconformity if covered by Miocene or Oligocene sedimentary rock). This break in the geologic column is considered the Eocene nonconformity and a focus of petroleum exploration. The Eocene rocks consist of marine sediments, with later sedimentation creating coal beds in many areas (Newton 1969) (see *Figure Q-4*). The Salem District manages a total of approximately 19,375 acres of surface estate within these basins (USDI BLM 2007).

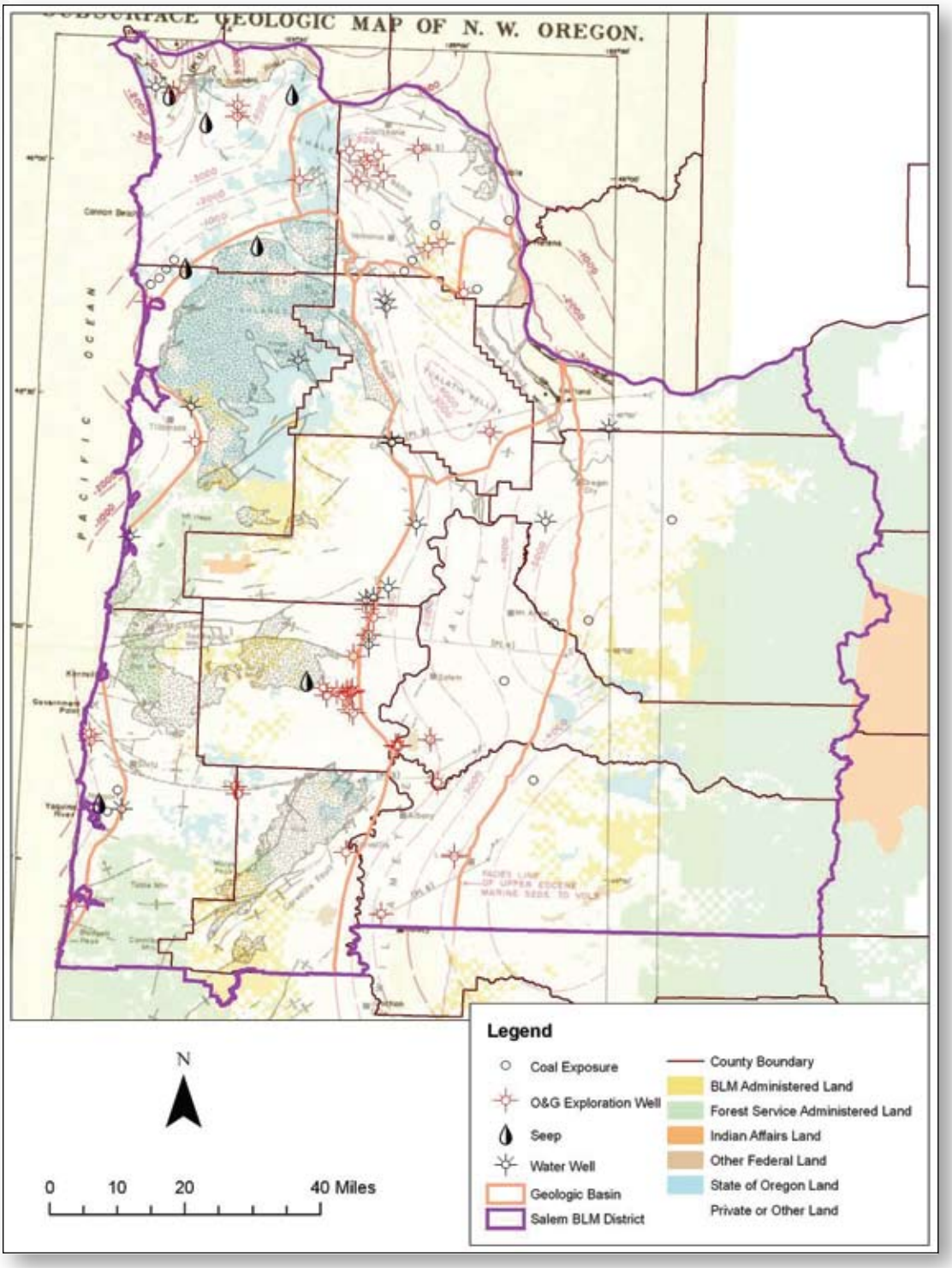
Tualatin Sub-Basin: The BLM manages approximately 8,858 acres of surface estate in the Tualatin Sub-Basin (USDI BLM 2007), which is considered part of the Willamette Valley. The lower rock is Eocene shale

Figure Q-3. BLM Oregon Salem District, Surface



Based on Newton (1969), Ferns and Huber (1984), Olmstead et al. (1989), and USDI BLM (2007)

Figure Q-4. Salem District BLM, Subsurface



Based on Newton (1969), Ferns and Huber (1984), Olmstead et al. (1989), and USDI BLM (2007)

and sandstone intermixed with basalt. Miocene Columbia River Basalts rest unconformably on top of the sedimentary rock and are covered by gravels and silts. The Eocene rock and sands have excellent reservoir characteristics as the faulting and overlying basalts provides trap structures (Newton 1969). The Eocene Nonconformity is at a maximum mapped depth of 4,000 feet below sea level (Newton 1969) (refer to *Figure Q-2*). It is thought that the Tualatin Sub-Basin is a source of petroleum for the Mist Gas Field (Olmstead and Alger 1985, Houston 1997).

Willamette Valley: The BLM manages approximately 644 acres of surface estate in the Willamette Valley, excluding the Tualatin Sub-Basin (BLM, 2007). The lower rock, or basement rock, is the Eocene Siletz River Volcanics or Kings Valley Siltstone. Overlying these are sandstones and siltstones of the Eocene Nonconformity, then covered by volcanics, and overlain by sandstone, limestone, and coal beds. This is capped by the Columbia River Basalts and then covered by tuff and silt. The petroleum potential Eocene rock boundary is defined to the east by the change from marine sediment to volcanic sediment (facies change) (Newton 1969) (refer to *Figure Q-4*). Numerous wells with gas shows have been drilled within the valley. The eastern valley edge provides numerous possibilities for structural traps, with the marine beds providing source rock. Even though numerous holes have been drilled and source and structure is present, true potential has not been clearly defined. The Eocene Nonconformity (marine facies) is at maximum mapped depth mapped of 5,000 feet below sea level (Newton 1969).

Newport Sub-Basin: The BLM manages approximately 443 acres of surface estate in the Newport Sub-Basin (USDI BLM 2007), which is part of the off-shore Newport Basin (Orr and Orr 2000). As most of the basin lays off-shore, little was found to be published about on-shore portions of the specific Newport Sub-Basin. Generally, the off-shore basins consist of thicknesses up to 15,000 feet of marine sediments, predominately siltstones and shales, with some sand shows. Oil and gas shows occurred in at least three of the off-shore wells (Orr and Orr 2000). Two exploratory gas wells with shows, one seep, and one gas show in a water-well have been reported within the Newport Sub-Basin (Olmstead et al. 1989). There are also occurrences of coal (Ferns and Huber 1984) (refer to *Figures Q-3* and *Q-4*). The Eocene Nonconformity is at a maximum on-shore mapped depth of 2,000 feet below sea level (Newton 1969) (refer to *Figure Q-4*).

Tillamook Sub-Basin: The BLM manages approximately 25 acres of surface estate within the Tillamook Sub-Basin (USDI BLM 2007), which is also a part of the off-shore Newport Basin (Orr and Orr 2000) described above. Gas show has been associated with one exploratory well and two water wells in the Tillamook Sub-Basin (Olmstead et al. 1989). The Eocene Nonconformity is at a maximum onshore mapped depth of 2,000 feet below sea level (Newton 1969) (refer to *Figure Q-4*).

Astoria Basin: The BLM manages approximately 39 acres of surface estate within the Astoria Basin (USDI BLM 2007). The lowest sequence of rock, considered the basement rock, is the upper Eocene Volcanics. There are a few thin beds of sandstone and mudstone that are inter-fingered with the Tillamook Volcanics. A few of these sedimentary layers have gas shows. The volcanics are overlain with the mudstone-dominated rock, with sandstone and conglomerate members. The mudstone is overlain by sandstone and siltstones. These sandstones (Cowlitz Formation) contain the Clark and Wilson Sandstone, which is the gas reservoir in the Mist Gas Field. Late Eocene mudstone and sandstone sequences then overlie the Clark and Wilson Sandstones (Niem et al. 1985, Houston 1997). A total of 49 noncommercial gas shows were recorded in eight wells developed within the basin. Gas shows, with the majority of hydrocarbon chains being methane, were recorded in all units except the Roy Creek conglomerate and sandstone, the Pittsburg Bluff Formation, and the Wickiup Mountain and Youngs Bay members of the Astoria Formation (Niem et al. 1985). The Eocene Nonconformity is at a maximum mapped depth of 5,000 feet below sea level (Newton 1969) (refer to *Figure Q-4)*. It is thought that the Astoria Basin is a source of petroleum for the Mist Gas Field (Olmstead and Alger 1985).

Nehalem Basin: The BLM manages approximately 9,366 acres of surface estate in the Nehalem Basin (USDI BLM 2007). It is in this basin that the Mist Gas Field exists (See *Figure Q-5*) the only official State of Oregon Designated Gas Field. This basin has the most potential for further gas development that may impact BLM-

administered lands (Houston 1997, Houston 2007, Meyer 2007). Although the Nehalem structure is defined as a Tertiary Basin by most researchers (Olmstead et al. 1989, Olmstead and Alger 1985, Newton 1969, Houston 1997), it has also been identified as an arch in comparison to the surrounding structures of the Astoria Basin to the west and the Tualatin Sub-Basin to the east (Armentrout and Suek in Niem et al. 1985, Orr and Orr 2000). The description of the structure as an arch provides mechanism for petroleum migration from the adjoining Astoria Basin and Tualatin Sub-Basin to the collection traps of the Nehalem Arch (Niem et al. 1985). However, the structure does have a down-warp, creating a closed structural basin (Newton 1969). A great deal of geologic work has occurred within the Mist Gas Field and surrounding areas of the Nehalem Basin (Niem et al. 1985 and 1990, Olmstead et al. 1985), including Three Dimensional Survey (Meyer 2007). Specific geologic interpretation was conducted on the Bacona Quadrangle containing BLM-administered lands located ten miles southeast of the Mist Gas Field (Houston 1997) (refer to *Figure Q-4*).

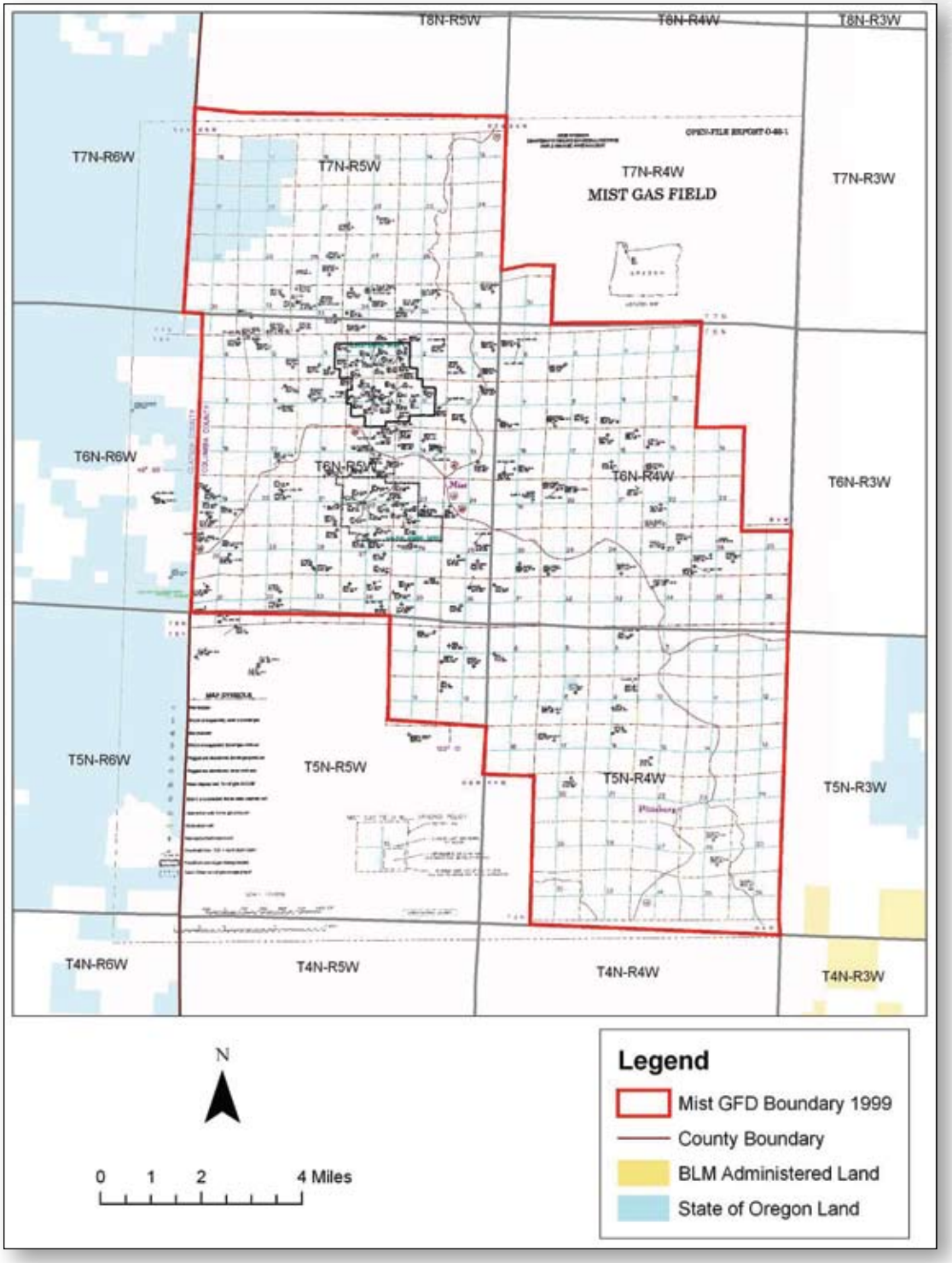
The Nehalem Basin consists of deltaic to shallow-marine and deep marine depositional environments, depositing thousands of feet of mud and sand. There was also intermittent volcanism (Houston 1997, Olmstead and Alger 1985). This lithified material creates the basin's stratigraphy. The oldest rock, considered the economic basement rock, is the Middle to Upper Eocene Tillamook Basalts. However, other localities show that deep-water depositions of the Yamhill Formation may underlie the Tillamook Basalts (Olmstead and Alger 1985). Houston (1997) has defined, at least in part, the Yamhill Formation as the Hamlet Formation. The mudstone of the Hamlet Formation is mature at depth and could be a source of petroleum within the Mist Gas Field. It is overlain by the Cowlitz Formation, separated by unconformity (Houston 1997, Olmstead and Alger 1985). The lowest member of the Cowlitz Formation is the Clark and Wilson Sandstone that serves as the major reservoir rock for the Mist Gas Field (Olmstead and Alger 1985) and reservoir potential outside the Mist Gas Field (Houston 1997). Coal also occurs within the sandstone (Olmstead and Alger 1985). The sandstone in the Mist Gas Field has flow rates of 10,000 to 20,000 cubic feet per day (Niem et al. 1985 in Houston 1997). However, the reservoir quality deteriorates southeast of the Mist Gas Field (Houston 1997) and BTU rates may also decline southeast of the Mist Gas Field (Meyer 2007).

Overlying Clark and Wilson Sandstone is a mudstone member of the Cowlitz Formation. This formation is a deep oceanic mudstone that acts as a seal to the Clark and Wilson Sandstone, helping form the petroleum trap (Houston 1997). After deposition of the Cowlitz Formation, the region was faulted, creating horst and graben environment, possibly forming structural traps. These fault patterns are not transferred to the younger overlying formations and, therefore, more recent faulting may not have compromised these traps. The faults truncate at the Keasey Formation-Goble Volcanics (Houston 1997 and 2007, Olmstead and Alger 1985).

Covering at least a portion of the Cowlitz Formation, and intermixed with the Keasey Formation, is the Goble Volcanics, shown as a 2,000-meter thick sequence in the exploration hole located on BLM-administered lands (see *Figure Q-6*). The Keasey Formation unconformably overlies the Cowlitz Formation where the Goble Volcanics are not present, and consists of silty mudstone (Houston 1997). It is in turn covered by the sandstones, mudstones, siltstones, and volcanics of the Oligocene Pittsburg Bluff Formation (Houston 1997, Olmstead and Alger 1985). Coal seams are also found in the Pittsburg Bluff Formation (Houston 1997). The Scappoose Formation unconformably overlies the sandstone Pittsburg Bluff Formation (Houston 1997) with flows from the Miocene Columbia River Basalts as an unconformable cap rock. The Eocene Nonconformity is at a maximum mapped depth of 500 feet below sea level (Newton 1969) (refer to *Figure Q-4*).

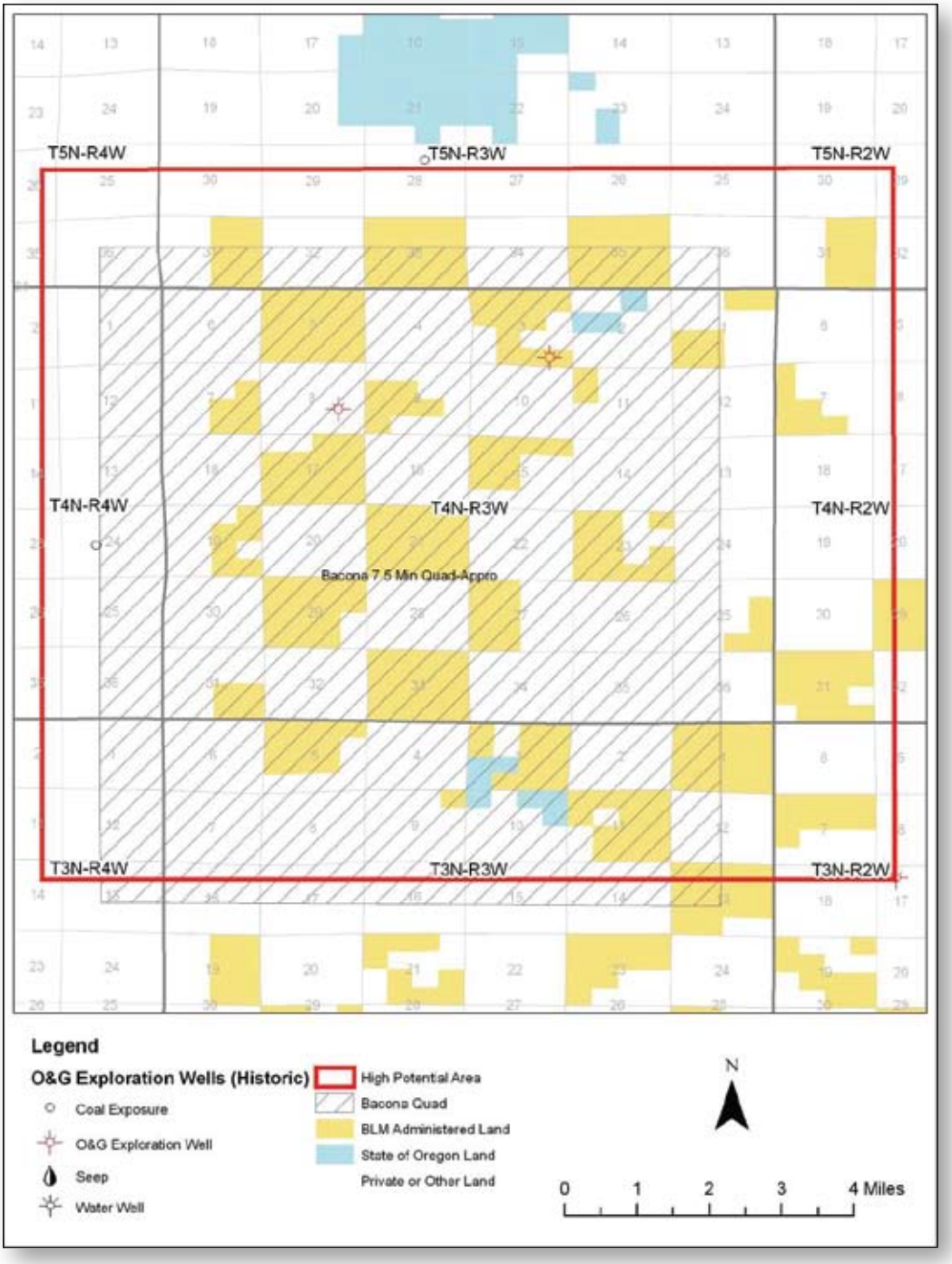
The Mist Gas Field Designation was initiated with the discovery of natural gas in 1979. The official boundaries as of 1985 consisted of 89,575 acres, approximately 140 square miles (State of Oregon 1985, Olmstead et al. 1985), including approximately 978 acres of BLM-administered surface estate. By 1999, the boundaries were reconfigured to a total acreage of 81,850 acres, approximately 128 square miles, with no BLM-administered surface estate (State of Oregon 1999, Houston 2007) (see *Figure Q-7).*

Figure Q-5. Mist Gas Field, 1999 Boundary



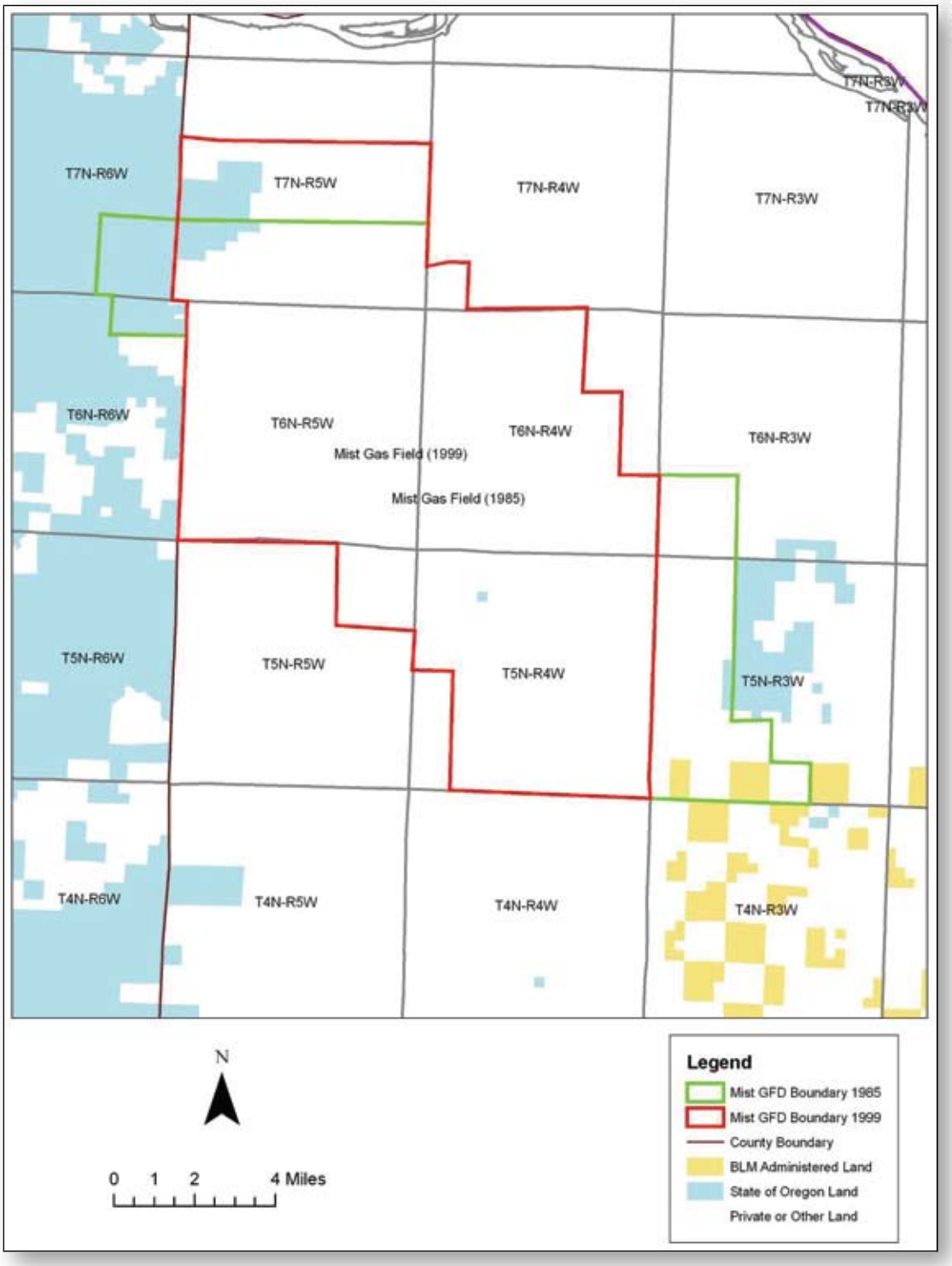
Source: DOGAMI 2003

Figure Q-6. Identified High Potential Area (This Report) And Bacona Geologic Quadrangle



Source: Houston 1997

Figure Q-7. Mist Gas Field Boundaries (1985 and 1999)



The main target zone is the reservoir rock of the Clark and Wilson Sandstone (Olmstead and Alger 1985). To date, there have been more than 45 separate pools identified (Meyer 2007) with two gas storage reservoirs (DOGAMI 2003). Locations of additional pools are expected with the use of Three Dimensional Survey (Meyer 2007). Current exploration is focused to the northwest of the Mist Gas Field (Houston 2007). However, this is due to economics as opposed to existence of resource. Exploration to the southeast, in the direction of BLM-administered lands, has been restricted to lower BTUs and depth of resource, not lack of product. All areas north of Vernonia, Oregon could be considered a viable extension of the Mist Gas Field (Meyer 2007).

Natural Gas production at the Mist Gas Field has been consistent since its discovery in 1979. As of 2006, two companies maintained production wells, Enerfin Resources with eight producing wells, and Northwest Natural with four producing wells. Other production wells of the companies were shut in for 2006. An annual production history of the past 10 years is as follows (DOGAMI 2003 and 2007)(see *Table Q-4*):

Gas production has decreased from its discovery in 1979 to the present (2006), depleting known pools. However, with the advancement of Three Dimensional Survey, it is probable that additional pools within and outside of the Gas Field Designation Boundary will be discovered and developed.

Table Q-4. Mist Gas Field 10-Year Production

Year	Cumulative Cubic Feet All Wells (million cubic feet)	Cumulative Therms All Wells (therms)
2006[a]	402,713	2,482,713
2005	305,433	2,744,415
2004	466,756	4,180,445
2003	733,537	6,500,818
2002	837,067	6,926,533
2001	2,674,673	10,037,413
2000	1,596,159	14,426,257
1999	1.554,717	13,534,088
1998	1,262,550	11,009,121
1997	1,380,509	12,023,109
10-Year Total	11,214,114	86,864,912

[a]Update on March 20,2007 of DOGAMI data base (DOGAMI 2007)

Oil and Gas Production

Salem District

Annual production for 2005 for the Mist Gas Field was 305,000 thousand cubic feet (mcf) (305 million cubic feet [mmcf] with a total life production to date of 70 mmcf (DOGAMI 2007). As of 2006, the field had produced approximately 68 bcf with a value of about $140 million (DOGAMI 2007). The State of Oregon applies a severance tax of 6% on the production designated to the common school fund. In total, over 500 oil and gas wells had been permitted in the field by 2003 (DOGAMI 2003). There are currently 18 producing wells, one water disposal well, 21 observation wells, and 20 gas injection/withdrawal wells operating on the site (DOGAMI 2007). Eight new Applications for Permit to Drill are being submitted to DOGAMI for additional exploration and production wells (Houston 2007).

In addition to production, the Mist Gas Field also contains two underground natural gas storage projects defined as the Flora/Bruer EFSC and the Calvin Creek EFSC (DOGAMI 2003). These storage facilities consist of six drained gas structures with a storage capacity of 12.5 bcf. As additional pools become depleted they may be converted to additional storage facilities. This is dependent on market supply and demand (DOGAMI 2006).

Water management for the Mist Gas Field is currently by deep well injection. In Oregon, discharge of produced water from onshore oil and gas activities into navigable waters is addressed in the 40 CFR, Part 435, Subparts C and E. With exceptions, produced water can be used for agriculture and wildlife propagation. Produced water discharges to streams or other surface water bodies must be authorized by a National Pollutant Discharge Elimination System (NPDES) permit issued by the Oregon Department of Environmental Quality (DEQ). Consistent with the Energy Policy Act of 2005, storm water discharges from oil and gas-related construction activities are exempt from NPDES permit coverage, except in limited instances. Injection wells used for the disposal of produced water are regulated by the Oregon DEQ Underground Injection Control program.

Coos Bay District

There is currently no coal bed natural gas production in Oregon. However, the Coos Basin is being developed as a production resource. Sproule (2004, 2005, 2006) has estimated base, high, and low isotherm projections for the industry's 115,000-acre lease holdings within the Coos Basin, with a base (average) isotherm projected in-place gas volume of 1,166 bcf. The low isotherm projects in-place gas volume of 725 bcf, with a high isotherm projection of 1,617 bcf.

The target coal groupings are split into the Lower Coaledo, Isthmus Slough, and South Slough groups. Sproule's (2005, 2006) average estimates for gas in-place for the Lower Coaledo Group is 854 mmcf per 80 acres. Estimates for the Isthmus Slough and South Slough groups are 268 mmcf per 80 acres and 186 mmcf per 80 acres, respectively.

Site-specific calculations for volumetric in-place gas content calculated from average in-situ-isotherms were completed by Sproule (2005). Some of these estimates were conducted for sections including or adjacent to Federally managed mineral rights. See *Tables Q-5, Q-6*, and *Q-7* for estimates for the three groups:

Table Q-5. Isthmus Slough Group Near Federal Mineral Rights

Location	Gas Content (scf[2]/ton)	Total Gas (millions of cubic feet)	Acres Sampled	Average Gas Per Acre (mmcf/acre)[3]
T. 27S, R. 13W., Sec. 11	71.4	828.521	300	2.76
T 27S., R. 13W., Sec 14	54.1	168.327	70	2.40
T 27S., R. 13W., Sec 15	90.4	2342.751	480	4.88
T. 27S., R. 13W., Sec 24	80.1	3115.784	640	4.87

Table Q-6. South Slough Group Near Federal Mineral Rights

Location	Gas Content (scf/ton)	Total Gas (millions of cubic feet)	Acres Sampled	Average Gas Per Acre (mmcf/acre)
T. 26S, R. 13W., Sec. 6	148.4	665.871	308	2.16
T 26S., R. 14W., Sec. 1	154.7	150.968	100	1.51
T 26S., R. 14W., Sec. 3	147.6	15.254	15	1.02
T. 26S., R. 14W., Sec. 4	68.2	0.0	0	0.00
T. 26S., R. 14W., Sec.28	110.6	280.005	160	1.75

Table Q-7. Lower Coaledo Group Near Federal Mineral Rights[a]

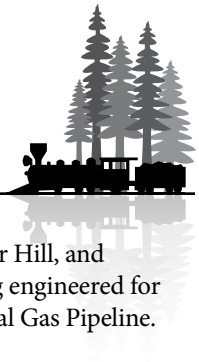
Location	Gas Content (scf/ton)	Total Gas (millions of cubic feet)	Acres Sampled	Average Gas Per Acre (mmcf/acre)
T. 27S, R. 13W., Sec. 11	158.4	2,174.382	360.8	6.03
T 27S., R. 13W., Sec. 12	147.6	590.400	285.9	2.07
T 27S., R. 13W., Sec. 13	146.0	0.0	0.0	0.0
T. 27S., R. 13W., Sec. 14	149.1	2,981.251	580	5.14
T. 27S., R. 13W., Sec. 24	158.4	1,140.074	640	1.78

[a]Most of the Lower Coaledo Isotherm Data in Sproule (2005) did not specify section location within a township. Therefore, position of Federal managed rights could not be determined in relation to the Methane Energy Corporation's cited acreage. These townships were not included in this report, but it should be noted that Federal holdings may be located near Sproule's (2005) projections.

Although, based on limited analysis (Sproule 2005), Federally managed mineral rights may contain less in-place gas volume than the average of industry's holdings, in-place gas is present in measurable volumes.

The analysis of coal bed natural gas potential is limited to the Coos Basin coals to a depth of 4,244 feet. Other coal seams occur at deeper intervals, with areas in the South Slough containing coals at depths greater than 10,000 feet. These deeper seams have not been included in the analysis (Sproule 2005). Gas content in the overlying coals may also imply migration of gas from deeper thermogenic sources as well as biogenic development in the target seams (Sproule 2004).

The Methane Energy Corporation is utilizing directional drilling of multiple wells from single pad locations. Engineering analysis (Sproule 2004) estimated a 160-acre well spacing on a 50,000-acre lease development. This would yield a maximum potential number of wells for 115,000 acres of development to approximately 719 wells.



The Methane Energy Corporation's pilot production program includes the Radio Hill, Beaver Hill, and Westport sites located in the center of the Coos Basin. Collection systems are currently being engineered for the Westport site, which will deliver production gas from the well to the Coos County Natural Gas Pipeline.

Initial results from the Radio Hill and Beaver Hill sites indicated that the coal bed natural gas was a dry gas, with little production water. This type of system is similar to Horseshoe Canyon coals of Alberta, the Hartshorne coals of the Arkoma basin, and the Fruitland coals of the south San Juan basin (Sproule 2006). However, future production of coal bed natural gas could encounter a wet gas system similar to the Powder River basin type. This could create substantial amounts of production water that will need to be managed. Initial results indicate brackish salinity in the production waters. Industry is currently reviewing injection potentials.

Examples of water management issues exist within current coal bed natural gas producing areas outside of Oregon and may be used for possible guidance of coal bed natural gas development in the District. Powder River Basin coal bed natural gas development has produced nearly four billion barrels (bbl) of water through 2006, equating to two bbl of water for every 1,000 cubic feet of gas. Operators discharge 61 percent of the water into ephemeral and perennial surface drainages, 31 percent into off-channel pits, and 5.7 percent for irrigation. Of the remainder, 1.4 percent is re-injected into the wells, and 1.2 percent is treated by ionic exchange. Only 25 percent of the shallow injection wells have been successful (Petzet 2007).

Potential for Resource Occurrence and Development

Salem District

Six distinct sedimentary basins or sub-basins have been the focus of petroleum explorations, the Eocene Unconformity being the primary target of exploration. In areas outside these basins, the target is above surface and eroded, creating the highlands. There has been little exploration of these areas, as any plays that might exist would be below the basement rock of Tillamook or Siletz River Basalts with low potential for occurrence and low potential for development. It is within these areas that the majority of the Salem District lands exist. It should be noted that private timber companies have been marketing the potential of all their lands in Oregon and Washington for the exploration and development of petroleum resources (Meyer 2007). Exploration has demonstrated the presence of petroleum in all six basins, although commercial development has been limited to one. Although the potential for resource occurrence in all six basins is moderate to high, the potential for resource development for five of the basins would be moderate, with little expectation for development within the 10-year life span of this scenario. The basins that would have high potential for resource occurrence, and moderate potential for resource development include:

- Newport Sub-Basin
- Tillamook Sub-Basin
- Astoria Basin (although, given the location of the Mist Gas field, development potential should be considered higher)
- Tualatin Sub-Basin (as with the Astoria Basin, development potential could be higher). However, a small portion of the Tualatin Sub-Basin may be included in the identified high potential area described below
- Willamette Basin

The Nehalem Basin, or Arch, has been the most extensively explored structure, resulting in the development of a commercially viable gas field. The basin maintains a high potential for resource occurrence and a high potential for resource development.

Based on geologic mapping showing similarities to the geology of the Mist Gas Field (Houston 1997), drilled exploration wells with petroleum shows (Olmstead et al. 1989) and discussions with DOGAMI and industry (Houston 2007, Meyer 2007), it is estimated that up to 50,200 acres containing both BLM-administered

surface estate and non-federal estate could be explored and developed for petroleum in the 10-year life of this scenario. Of this acreage, the district maintains approximately 10,800 acres of BLM-administered surface estate. The remaining 39,400 acres appears to be non-federal lands.

The lands are associated with the geologically mapped Bacona Quadrangle (Houston 1997), bound to the southeast by Leaseholding Syndicate's 1925-1927 exploration hole named Dutch Canyon. The well was located at the NW¼ of Section 17 in Township 3 North, Range 2 West. The well encountered gas at a depth of 1,850 feet. The pressure of the gas blew water and mud 20 feet above the casing. However, analysis of the gas determined that only 7.9% was methane and 91.8% was nitrogen. The identified high potential area is located southeast of the existing field (refer to *Figure Q-6*). Additional petroleum development could likely occur to the northwest of the current Mist Gas Field, an area of current focus of exploration. However, there is no known BLM-administered estate in that area (USDI BLM 2007).

It is assumed that if this area containing both federal and non-federal lands were developed, it would be as an extension of the current Mist Gas Field. Therefore, the current spacing plan of one well per 160 acres would likely apply (DOGAMI 2003, State of Oregon 1999), allowing for a total of approximately 314 wells within the identified high potential area, approximately 68 of which could be on BLM-administered surface estate. The district could foresee approximately 22 percent of the expansion development, with non-federal lands carrying approximately 78 percent of the expansion development (see *Figure Q-8).*

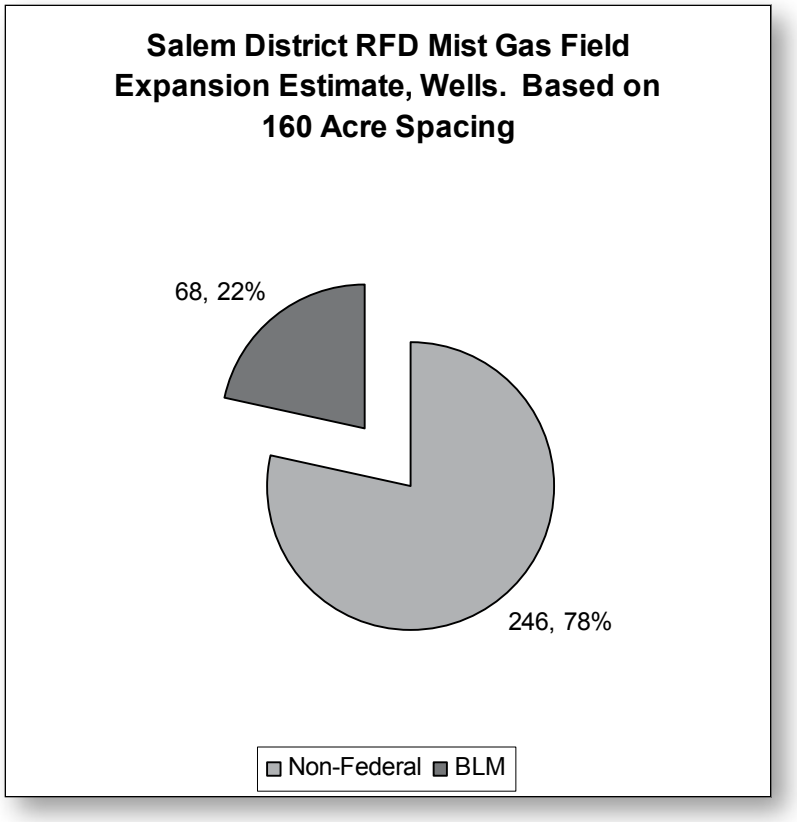


Figure Q-8. Salem District Mist Gas Field Expansion Estimate, 160-Acre Spacing

Coos Bay District

Three areas within the Coos Bay District have been identified as having petroleum potential. The two conventional petroleum structures described by Ryu et al. (1996) have a moderate to high potential for occurrence. The structures have been identified, and historic exploration has had both oil and gas shows. However, resource development potential is low to moderate. Although hydrocarbons may exist, it has not been historically economic to produce these resources. This is due to the lack of infrastructure, low price, and limited investigations.

The Coos Basin has a high potential for occurrence of coal bed natural gas. The structure has been identified and hydrocarbon shows have been documented. Although actual economic production from this play has not occurred, initial steps with the placement of infrastructure and wells as well as the Gas Field Designation process has been implemented. The potential for resource development is also high. It is likely that development will occur within the life of this plan, with private development already occurring.

Leasing

Salem District

Foreseeable development of the Mist Gas Field could result in potentially an additional 10,800 acres of BLM-administered lease offerings. If these offerings were sold for the 2006 average of $17.71 per acre, the net receipts would be nearly $191,268.

Coos Bay District

After lands are nominated and reviewed by BLM, leases on lands where the Federal government manages the oil and gas rights are offered via oral auction on a quarterly basis. The maximum lease size is 2,560 acres at a minimum bid of $2.00 per acre. An administrative fee of $75 per parcel is charged, and each successful bidder must meet citizenship and legal requirements. Lands not leased at auction are then available for over-the-counter leasing for a period of two years. Leases are issued for a 10-year term and charged a 12.5% royalty on production. In the first five years of a lease, annual rental is $1.50 per acre, and $2.00 per acre thereafter. Leases that become productive are "held by production" and do not terminate until all wells on the lease have ceased production.

Foreseeable development of the Coos Basin coal bed natural gas play could potentially result in an additional 25,000 acres of BLM-administered lease offerings. If these offerings were sold for the 2006 average price of $17.71 per acre, based on Federal proceeds from leasing in eastern Washington, the net receipts would approach $500,000.

Future Trends and Assumptions

Introduction

Salem District

Based on history of past exploration; historic, current, and projected development of the Mist Gas Field; mapped geology; and foreseeable development potential in the planning area, activity over the next decade may be stable to increasing. Current development within the Mist Gas Field as well as petroleum developments and interest in other BLM districts in Oregon, and the increasing value of petroleum products, indicate continued interest within the Salem District. Oil and gas activity on BLM-administered mineral rights within the district is expected to consist of competitive and over-the-counter leases, geophysical surveys, and processing of Applications for Permit to Drill for approximately 68 wells.

Some exploration for coal bed natural gas in the form of coal seam investigation and mapping is predicted, but development of coal bed natural gas is not expected within the next 10 years. The supply of natural gas in the region may be augmented by one or more proposed Liquefied Natural Gas terminals. Natural gas prices are expected to rise 0.3% (2004 purchase power) by 2034 with a 0.7% increase in demand over the same period (Energy Information Administration 2007). Consequently, while the petroleum industry does experience economic and production cycles, demand and price are projected to continue to increase.

Coos Bay District

Based on history of past drilling, current development of coal bed natural gas and foreseeable development potential in the planning area indicate activity over the next decade may be stable to increasing. Current development within the Coos Basin and the increasing value of petroleum products indicate continued interest within the Coos Bay District. Oil and gas activity on BLM-administered mineral rights within the district is expected to consist of competitive and over-the-counter leases, geophysical surveys, and processing of Applications for Permit to Drill for 50 to 80 wells.

Continued exploration and development for coal bed natural gas is expected. Some exploration for conventional natural gas is also predicted. The supply of natural gas in the region has been augmented by the Coos County Natural Gas Pipeline. A liquefied natural gas terminal and an associated second natural gas pipeline are being proposed. These systems provide export opportunities for natural gas produced in the district. Natural gas prices are expected to rise 0.3% (2004 purchase power) by 2034, with a 0.7% increase in demand over the same period (Energy Information Administration 2007). Therefore, although the petroleum industry does experience fluctuations in economic and production cycles, demand and price are projected to continue to increase.

The speculative conventional petroleum systems are the Umpqua-Dothan-White Tail Ridge hybrid petroleum system and the Umpqua-Lower Tyee Mountain petroleum system, located in the northern portion of the Coos Bay District are contained in the southern Tyee sedimentary basin (Ryu et al. 1996) (refer to *Figure Q-1*).

System 1: The Umpqua-lower Tyee Mountain petroleum system is located in the center of the Smith River Sub-Basin. The system may include a tight-gas sandstone reservoir. According to Ryu *et al.* (1996), gas could migrate along faults, forming small accumulations in the lower Tyee Mountain sandstones. Mudstones within the member would serve as additional seals within the traps. An unconventional over-pressured tight-gas mudstone reservoir is possible in the Umpqua Group of the Smith River area. Deep wells within the system have encountered over-pressured zones at approximately 7,000-foot depth. Characteristics of the zone are sufficient to generate thermogenic wet-gas (Ryu *et al.* 1996). The approximate area of this system within the district is 200 square miles. The BLM-surface management consists of approximately 20 percent of that area.

System 2: The Umpqua-Dothan-White Tail Ridge Hybrid Petroleum System is in the southern portion of the Tyee Basin, with a southern boundary defined by the Tyee Basin-Klamath Mountain contact. According to Ryu et al. (1996), the system may contain dry gas from both biogenic methane (similar to coal bed natural gas) and deeply buried conventional petroleum sources. It is possible the created gas migrates to accumulation zones which are located east of the Coos Bay District, extending into the BLM Roseburg District. It is also possible that the entire structure projects under the Klamath Mountains (Ryu et al. 1996). The approximate area of this system within the district is 350 square miles. The BLM-surface management consists of approximately 26% of that area.

System 3: The third opportunity is the coal bed natural gas play within the Coos Basin. This is the play that is currently producing the most interest and activity. The focus of production is within the Coaledo Formations mapped by Newton (1980). During deposition and compaction of the organic material which ultimately becomes coal, large quantities of methane are generated. Methane gas produced from coal may have lower energy content than conventional natural gas (USDI BLM 2001).

The approximate area of the coal bed natural gas play is 250 square miles, with producing Lower Coaledo Formation coals currently being sought at depths up to 4,500 feet. The Coos Basin is a folded structural basin, one of a series of onshore and offshore basins along the northwest coast, ranging from the Klamath Mountains north to the Columbia River in Oregon, and from the Columbia River north to the Puget Sound in Washington. The basins are located from the continental shelf offshore, east to the Willamette Valley. Sedimentary deposits including coals, sandstones, siltstones, and shales are within these structural basins (Orr and Orr 2000).

The Coos Basin structure is controlled by compression force of the subducting easterly moving Gordia subplate and Juan de Fuca plate in relation to the overriding westerly moving North American Plate. The fold axes are oriented north-south, plunging northward. The Coaledo Formation-Flournoy Formation contact generally defines the basin boundaries to the north, east, and south. The basin is thought to extend offshore to the west. The basin's rock sequence consists of sedimentary layers of sandstone, siltstone, and shales, with coal seams (Newton 1980). Surface exposures of the basin's coal seams have been economically mined since the 1800s (Orr and Orr 2000).

Current development of the coal bed natural gas resource is being conducted by Methane Energy Corporation which has completed numerous exploratory and production wells in the Coos Basin. The company has projected an "Area of Mutual Interest" incorporating the Coos Basin, an area of approximately 160,000 acres (see *Figure Q-9*).

The Methane Energy Corporation maintains approximately 115,000 acres of non-federal mineral lease rights, with an estimated in-place volume of 1.2 trillion cubic feet (Sproule 2006). Of the estimated 45,000

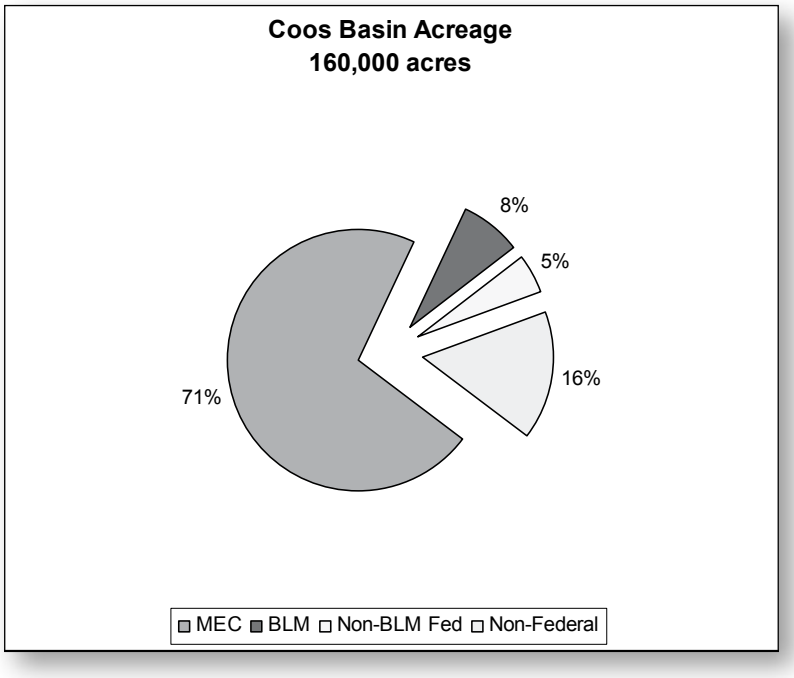


Figure Q-9. Coos Basin Acreage In Area Of Mutual Interest

acres not yet controlled by lease agreements, the Federal Government manages approximately 19,694 acres or approximately 44 percent (see *Figure Q-10*). Federal mineral rights account for approximately 19,694 acres of the basin area, and BLM-administered subsurface mineral rights (split and non-split estate) account for approximately 12,228 acres of the basin area. The remaining lands consist of non-federal and non-leased estate in private, city, county, and state ownership.

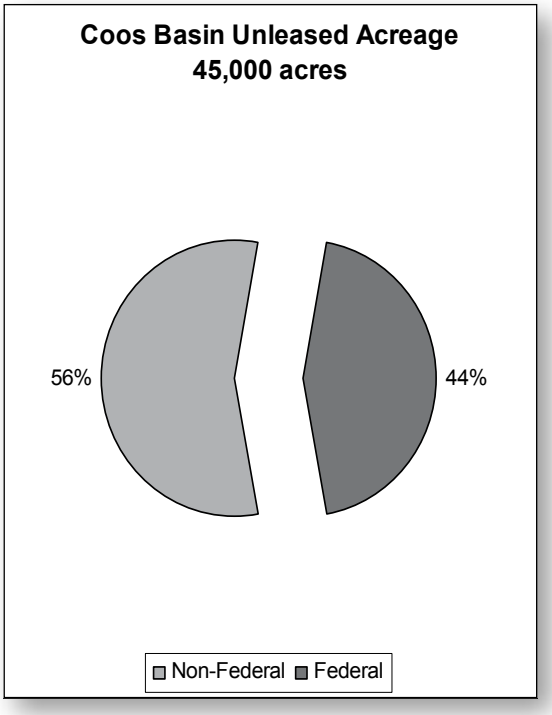


Figure Q-10. Coos Basin Unleased Acreage

The State of Oregon Department of Geology and Mineral Industries (DOGAMI) initiated a public meeting process to establish a Gas Field Designation for the Coos Basin. The first public meeting was conducted January 29, 2007. There is only one other Gas Field Designation in Oregon, which is the Mist Gas Field in northwest Oregon. The Gas Field Designation is required to fulfill state requirements to establish well spacing designations and control drainage. It may also increase competition, as more development companies may be interested in the resource after such a designation. The proposed Gas Field Designation is likely to incorporate the boundaries defined in Methane Energy Corporation's "Area of Mutual Interest". The boundary of the Gas Field Designation is simple to alter, needing only evidence of gas potential (additional formation mapping or shows of gas within a well). The designation will incorporate BLM and Forest Service lands, as well as other federal jurisdictions (Houston 2005).

All coal seams in western Oregon could produce coal bed methane. However, the potential is completely unknown, as these resources have not been investigated. Potential could exist within the coal seams of the Umpqua Group, as well as their correlating formations north through the coast range. If coal bed methane is producible in the Coos Basin, exploration could occur within these other speculative formations (May 2005).

Geophysical Exploration

Salem District

Advanced Three Dimensional Survey is utilized within the Mist Gas Field. These requirements are in place because the Mist Gas Field is located in commercial forest land and is required by the land manager to minimize disturbance to near non-existent levels (Meyer 2007).

Surface Impacts of Geophysical Explorations

Salem District

It is anticipated that the foreseeable geophysical activity in the identified high potential area would consist of the currently used the Three Dimensional Survey. The total area of the identified potential expansion is 81 square miles, or approximately 50,200 acres. Using the Three Dimensional Survey spacing of shots, it is anticipated that complete investigation of the area could utilize 22,950 shots. With pad ground disturbance of 12 square feet, the total disturbance area could be up to 6.3 acres. The Salem District manages

approximately 22% of the area of interest, so potential surface impacts to BLM-administered lands by Geophysical Explorations are expected to be approximately 1.4 acres. This disturbance is created exclusively with hand tools and based on experience in the Mist Gas Field, is completely reclaimed in five years or less (Meyer 2007). Disturbance will be less where pre-existing roads and/or landings can be used.

Coos Bay District

Geophysical exploration techniques are not commonly utilized in coal bed natural gas production, but may be utilized in developing conventional petroleum plays within the Coos Bay District. It is anticipated that the foreseeable geophysical activity in the planning area will consist of seismic reflection surveys, utilizing existing roads. Surface impacts would involve temporary blockage of the roads by the large trucks used to gather the data, but this type of equipment is not expected to damage the roads.

The small explosive method is also anticipated to be used on approximately 20 miles of line. Surface disturbance is expected to consist of drilling 4 to 12 holes per mile of line. Each drill hole would impact about 200 square feet, but 90 percent of these holes would be drilled on existing landings, spur roads, or timber haul roads. Altogether, 7,200 square feet (approximately 0.2 acre) of existing road surface would temporarily be impacted by drilling activities and low power blasting.

Blasting would not be powerful enough to impact any surface resources or improvements. It is anticipated that four drill holes would be made on currently undeveloped areas. Drill holes would impact about 200 square feet each, and short spur roads 100 feet by 25 feet wide constructed to each drilling location another 2,500 square feet each. Total surface disturbance for the anticipated four drill holes would be approximately 0.25 acre. Total surface disturbance for blasting and drilling combined is expected to total approximately 0.5 acre. An increase in conventional petroleum development would increase these estimates.

Drilling and Production Phase

Salem District

Based on past oil and gas drilling in Oregon, it is projected that three conventional petroleum exploratory "wildcat" wells would be drilled within the Salem District. The estimated success rate of finding hydrocarbons is predicted to be no greater than 10 percent, based on the average U.S. wildcat well success rate. Future identification of additional structures would increase this estimate. Development within the identified high potential area would be directed by Three Dimensional Survey as opposed to wildcatting (Meyer 2007).

Coos Bay District

The Methane Energy Corporation estimates of development for coal bed natural gas for their current leases range from 300 to 719 wells. Based on well spacing assumptions (Sproule 2004) of 160 acres per well, Coos Basin development could eventually involve 436 to 1001 wells. As previously described, spacing rules will be developed during the DOGAMI Gas Field Designation process. If all remaining Federal and non-federal leasable land was open for surface occupancy, well development on federally-managed lands (BLM, USFS, and BIA) could range between 59 and 124 wells. Both highs and lows are extremes (see *Figures Q-11* and *Q-12*).

Surface Impacts of Drilling and Production

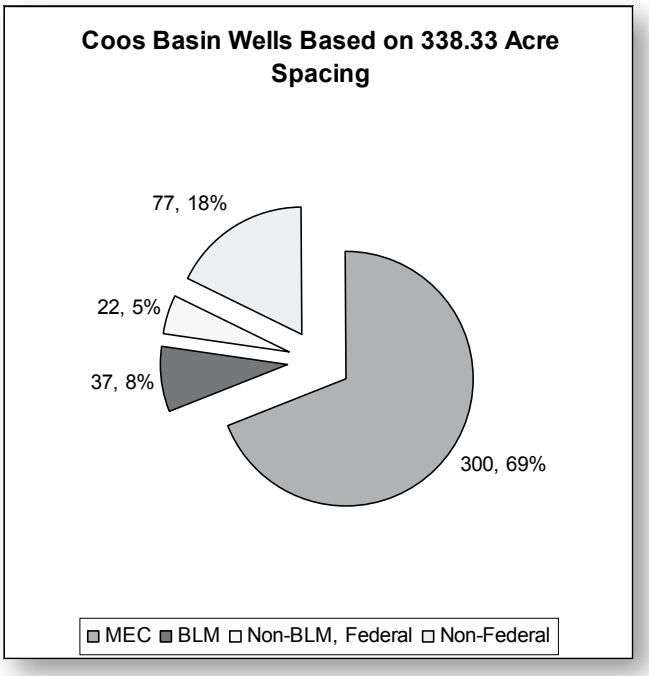


Figure Q-11, Coos Basin Wells Based On 338-Acre Spacing

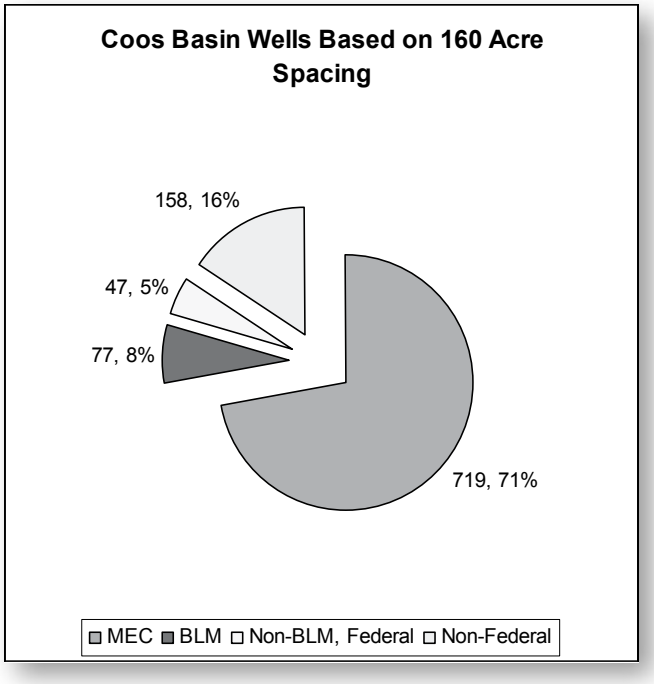


Figure Q-12. Coos Basin Wells Based On 160-Acre Spacing

Salem District

The Mist Gas Field has maintained production since 1979. More than 500 wells have been permitted, although 60 wells are currently in operation. Abandoned well sites have been reclaimed and surface disturbance mitigated. Consequently, the current surface disturbance is limited to 60 wells. Development of the identified high potential area or development of an unknown field could add an additional 314 wells, with 68 wells on BLM-administered lands. It is anticipated that all gas production would be transported by pipelines, most of which would be located within road rights-of-way. It is estimated that up to 20 miles of pipelines could be sited outside road rights-of-way. All well service requirements would be provided by established companies.

Pipelines totaling 20 miles in length within a 30-foot wide right-of-way would disturb about 72.5 acres. Due to the checkerboard public land ownership in this area, it is estimated that only 22 percent or 16 acres would be on lands administered by the BLM.

Given the existing infrastructure of the Mist Gas Field, timber management of other lands within the district, the amount of existing roads within the identified high potential area, use of Three Dimensional Survey to optimize directional drilling, the ability to place multiple wells on a single pad (Meyer 2007), and development scenarios of other BLM Oregon districts, it is anticipated that most well development will utilize existing road infrastructure to develop the resource. However, it may be necessary to construct up to 0.25-mile of access road for each pad to remove the facilities from active roadways. Based on the ability to cluster wells, an assumption for calculation of four wells per pad was used. Therefore, it is estimated that no more than 20 miles of new road construction would be needed in full development. This would be moderate duty access road with a surface 18 to 20 feet wide, anticipated to be constructed on both private and BLM-administered lands. The clearing width would average 40 feet including ditches, utilities, pipelines, cuts, and fills. The total acreage impacted would total approximately 97 acres for all lands within the Salem District, approximately 22 acres of which would involve BLM-administered lands. Roads not retained for other resource management purposes would be reclaimed at the end of the project.

Total disturbance of both BLM-administered lands and other lands for wells, support services, pipeline and new road construction is expected to be approximately 1,426 acres or 2.8% of the total high potential acreage. Surface disturbance would be restricted, as much as possible, to previously disturbed areas such as logging roads and landings. Industry is currently utilizing a multi-well to single pad approach which minimizes impact. Interim reclamation will also reduce initial disturbance. After initial construction, well sites pad areas will be reclaimed while the wells are in production. Disturbance will be limited to areas within overwork foundation structures and necessary infrastructure, such as well heads, pipelines, and access roads.

Coos Bay District

It is estimated that the productive life span of a single well within the coal bed natural gas could range to greater than 14 years. Total lifespan of the field would be determined on the type of phased development and exploration of the previously untested deeper resources greater than 4,000 feet. All gas production would be carried by pipelines. Most, if not all, pipeline will be contained within road rights-of-way. It is estimated that up to 40 miles of pipeline could occur outside a road right-of-way. Additional conventional petroleum structures totaling 550 square miles have also been identified within the Coos Bay District.

Based on potential for resource development (described above) and utilizing access road built for well accessed timber development (most likely for the BLM-administered parcels within the Coos Basin), it was estimated that between five to no more than 10 miles of moderate duty access road with a surface 18 to 20 feet wide is anticipated to be constructed. The surface disturbance width would average 40 feet including ditches, utilities, pipelines, cuts, and fills. The acreage impacted by new road building would total between approximately 24.25 acres and 48.5 acres for the Coos Bay District. Roads not incorporated into other resource management would be reclaimed at the end of the project.

Altogether, the total disturbance for the wells, support services, and new road construction on BLM-administered mineral estate is expected to range between 194.25 acres (1.6% of BLM-administered area: 37 wells) to 404.25 acres (3.3% of BLM-administered area: 77 wells). Surface disturbance would be restricted, as much as possible, to previously disturbed areas such as logging roads and landings. Industry is currently utilizing a multi-well to single pad approach which minimizes impact.

A pipeline 40 miles in length with a right-of-way width of 30 feet would disturb about 145 acres. Due to the checkerboard public land ownership in this area, it is estimated that only 50 percent of that acreage would be on public lands administered by the BLM. Altogether, it is estimated that about 73 acres of BLM-administered land would be impacted from pipeline construction. The total surface disturbance of field development and production on BLM-administered land would range between 291.5 acres and 525.75 acres.

Total field development disturbance within the district, both Federal and non-Federal, could range between 2,289 acres (338.33-acre well spacing) and 5,255.25 acres (160-acre well spacing). Communitization and Unitization agreements (both State and Federal) can drastically reduce surface disturbance for both Federal and non-Federal lands. These cooperative agreements allow the sharing of wells, pads, and infrastructure; combining uses; and minimizing the need for new development.

Limitations

Salem District

The acreage estimates used for BLM-administered surface estate are based on current GIS layers. The accuracy of this information has not been verified by Master Title Plat Maps. The GIS coverage for subsurface estate within the District is incomplete. Therefore, the existence and location of BLM-administered subsurface estate on the Salem District is unknown.

A brief review of the Master Title Plat Maps was completed within and near the 1985 Mist Gas Field boundaries. Federal subsurface estate identified on the Master Title Plat Maps was not recorded on the GIS layers. Most of the Master Title Plat Maps identified federal subsurface parcels outside the Mist Gas Field boundaries. Due to the incompleteness of the GIS layers, especially within subsurface estate, the potential of BLM-administered subsurface estate was not addressed in this report.

Ten-Year Reasonably Foreseeable Development Of Oil And Gas Resources Scenario For The BLM Eugene, Roseburg, And Medford Districts And The Klamath Falls Resource Area Of The Lakeview District

Summary

This report estimates the potential for occurrence of oil and gas activity on Federal acreage managed by the BLM in the Eugene, Roseburg, and Medford Districts, and in the Klamath Falls Resource Area of the Lakeview District during the next 10 years. The analysis is based on current developments within and outside of these Districts, including historical Oil and Gas investigations that began with the first exploration well dilled near Newberg in 1902. This analysis compliments the similar discussion for the Coos Bay and Salem Districts where proven hydrocarbon resources exist.

It is expected that, with a few exceptions, most public domain and revested Oregon and California Railroad Grant lands will be available for leasing of hydrocarbon energy resources subject to management by guiding stipulations. A review of oil and gas occurrence Potential, oil and gas system and play analysis, oil and gas production activities, potential for resource occurrence and development, and leasing was made to establish the understood the oil and gas potential presented here. This information was used to project activity through 2018. Given the current incipient nature of petroleum development in Oregon in 2007 (i.e., current coalbed natural gas development and new exploration of the Mist Gas Field), completely new assumptions and information that could impact Reasonably Foreseeable Development scenarios for each district may be had during the course of the next 10 years and beyond.

The districts are in western Oregon and encompass lands within all or parts of eight counties: Linn, Lane, Douglas, Jackson, Josephine, Curry, Coos, and Klamath. The potential for occurrence of conventional petroleum in the districts has been the focus of numerous studies. These investigations have resulted in one developed field in the Salem District (Mist Gas Field), beginning with a discovery well in 1979. A prospect for coalbed natural gas is being developed in the Coos Bay District. However, small amounts of conventional and unconventional oil and gas have been found throughout western Oregon, based on the projected sedimentary basins.

Research has identified sedimentary basins, petroleum systems, and coal basins. Based on these petroleum systems, five plays and associated prospects have been identified. The research cited within this report projects that these plays have low to moderate potentials for development.

Based on BLM protocol for mineral potentials, it is further projected that the Eugene and Medford Districts, and the Klamath Falls Resource Area have low to moderate potential for petroleum occurrence and low potential for development. Therefore, it is unlikely that petroleum will be developed in these BLM administrative areas within the 10-year Reasonably Foreseeable Development scenario for the planning area. The Roseburg District contains plays, prospects, and an area of focused petroleum shows that project a moderate potential for petroleum occurrence and a moderate potential for development. The BLM-administered acreage with this moderate potential is approximately 37,000 acres.

It is anticipated that the Roseburg BLM-administered lands could have a development of up to 114 wells, with total disturbed acreage up to approximately 153 acres within the 10-year Reasonably Foreseeable Development scenario.

Common to All Alternatives

Introduction

This Reasonably Foreseeable Development (RFD) describes scenarios for leasable oil and gas commodities within lands managed by the BLM's Eugene, Roseburg, and Medford Districts and the Klamath Falls Resource Area of the Lakeview District (collectively referred to as districts). The purpose of this RFD scenario is to provide models that anticipate the level and type of future petroleum development activity in the planning area, and to serve as the basis for analyzing cumulative impacts. The RFD first describes historic and current development. Future trends and assumptions for hypothetical exploration and extraction operations are then described. All projections are estimates based on available information presented in the Historic and Current Development section.

Methodology

Extensive review of existing literature was completed, as well as acquisition of unpublished information. Resulting information, such as prospects, plays, basins, exploration wells, seeps, coal exposures, and petroleum encounters in water wells, were crafted into Geographic Information Systems (GIS) map layers. These layers were then incorporated into GIS maps of BLM-administered lands and geologic mapping. The results provided quantifiable locations and acreages estimates of petroleum potentials, or lack of, for BLM-administered lands within each district boundary (USDI BLM 2008).

Scope

This RFD is based on the known and inferred mineral resource capabilities of the lands involved, and applies to conditions and assumptions discussed under Historic and Current Development, as well as Future Trends and Assumptions. Changes in geologic data, interpretation, and/or economic conditions that alter the RFD may result in deviation of these projections over time.

Impacts caused by oil and gas development, as well as impacts to oil and gas development, cannot be assessed without estimating future oil and gas activity. Such estimates of future activity incorporate:

- oil and gas occurrence potential, as documented by historic research and papers
- oil and gas system and play analysis (including existing plays currently developed and the potential development for new plays such as identified sediment basins and Coalbed Natural Gas
- oil and gas production, including economics and technology
- potential for resource occurrence and development
- leasing and development, including Federal and non-Federal activities

The above factors cannot be predicted with certainty, but some generalizations are possible. The estimates presented here are based on past and present activities as well as on trends within and without the Districts, including future price deviations. These estimates may be lower than what may actually happen if price and play developments are more positive than anticipated. Likewise, if expansion of existing plays is not successful, if new plays are not developed, and/or if commodity prices are less than anticipated, these estimates may be exaggerated.

Historic And Current Development

Oil and Gas Occurrence Potential

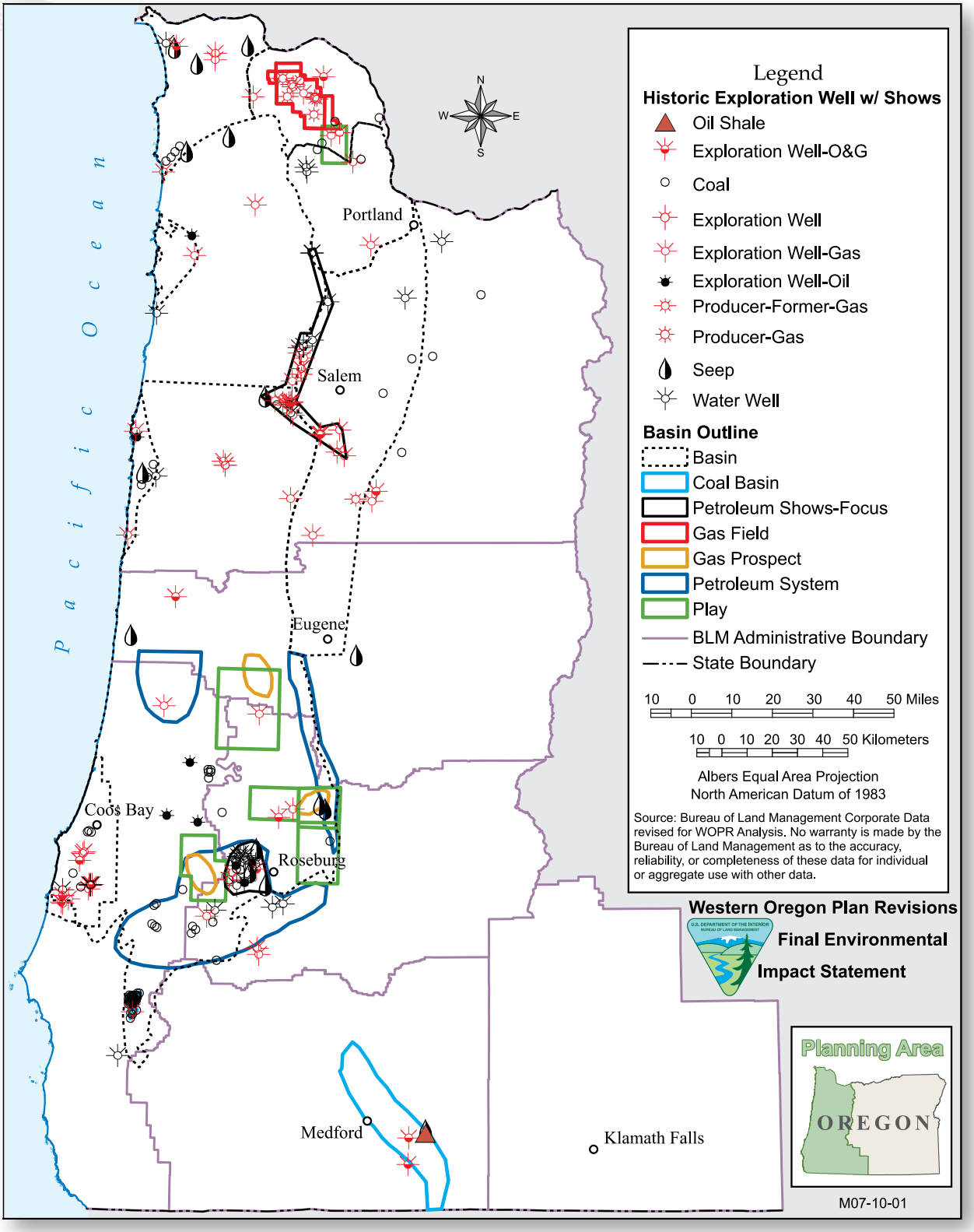
The districts encompass lands in eight counties, including Linn, Lane, Douglas, Jackson, Josephine, Curry, Coos, and Klamath counties. The districts are located in western, southwestern, and southern Oregon. The BLM-management extends to both Public Domain (PD) and revested Oregon and California Railroad (O&C) lands. It is expected that most of these lands will be available for mineral leasing.

Petroleum development in the districts has been the focus of numerous studies such as Dillar (1909, 1914, as found in Weissenborn 1969 and others), Washburne (1914 as found in Olmstead et al. 1989), Stewart and Newton (1954), Newton (1969), Newton (1980), Olmstead et al. (1989), Niem and Niem (1990), and Ryu et al. (1996). The districts have also been the focus of numerous industry explorations and investigations, by such companies as Northwest Natural (Oregon Natural Gas Development), Mobil Oil Corporation, Methane Energy Corporation, Standard Oil Company of California, Guarantee Oil Company, Sinclair Oil & Gas Company, Amoco, as well as numerous others (Olmstead et al. 1989, Niem and Niem 1990, Stewart and Newton 1954, Meyer 2007).

Although exploration of Western Oregon has been more or less continuous since 1902, three major peaks of petroleum exploration have occurred. The first took place between 1920 and 1940. This peak of exploration was very wide-spread, as there was little geologic information guiding the exploration. The second peak occurred between 1940 and 1960, and investigated the deeper Oligocene and Eocene marine sediments. This phase cumulated in the discovery of the Mist Gas Field in 1979 (Olmstead et al. 1989, Olmstead and Alger 1985, Houston 1997). The third occurred in the 1980s, with the placement of deep wells up to 13,177 feet total depth (Niem and Niem 1990). This third peak has continued into the search and development of unconventional petroleum resources such as Coalbed Natural Gas, with a play being developed in the Coos Bay Basin.

Little oil and gas exploration has been conducted in the Medford District and Klamath Resource Area (Niewendorp 2008, Wiley 2008, Wells 2008). Oil and gas exploration wells have been drilled, with at least two shows (see *Figure Q-13*). A potential oil shale deposit was also been identified. These are located in or near a delineated coalfield, identified as the Rogue River Coalfield (Olmstead et al. 1989, Stewart 1954, Sidle 1981; Jackson County 1989, 2004, 2006). Most energy investigations have focused on geothermal explorations (Niewendorp 2008).

Figure Q-13. Western Oregon Oil and Gas Investigations and Projections



Source: USDI BLM 2008, Olmstead et al. 1989, Niem and Niem 1990, Newton et al. 1980, Stewart and Newton 1954, Sidle 1981, Newton 1969, Kvenvolden et al.1995, Mason and Erwin 1955

Oil and Gas System and Plays

The Eugene and Roseburg Districts are part of a structural sedimentary basin system that extends onshore and offshore from the Klamath Terrains boundary north to the Columbia River (extending into Washington as the Puget-Willamette Trough); from the continental shelf east to the Cascade Mountain/Willamette Valley interface. This is known as the Western Tertiary Basin Province (Olmstead et al. 1989). This province has been of interest for petroleum exploration since the 1880s (Newton 1969, Orr and Orr 2000), with exploratory oil and gas drilling beginning in 1902 near Newberg (Stewart and Newton 1954, Olmstead et al. 1989).

The northern portion of the Western Tertiary Basin Province possesses at least six identified basins or sub-basins (Newton 1969, Orr and Orr 2000, Olmstead et al. 1989). These basins include:

- Tualatin Basin (a sub-basin of the Willamette Valley)
- Willamette Valley
- Newport Basin (a sub-basin of the larger off-shore Newport Basin)
- Tillamook Basin (a sub-basin of the larger off-shore Newport Basin)
- Astoria Basin
- Nehalem Basin (or arch)

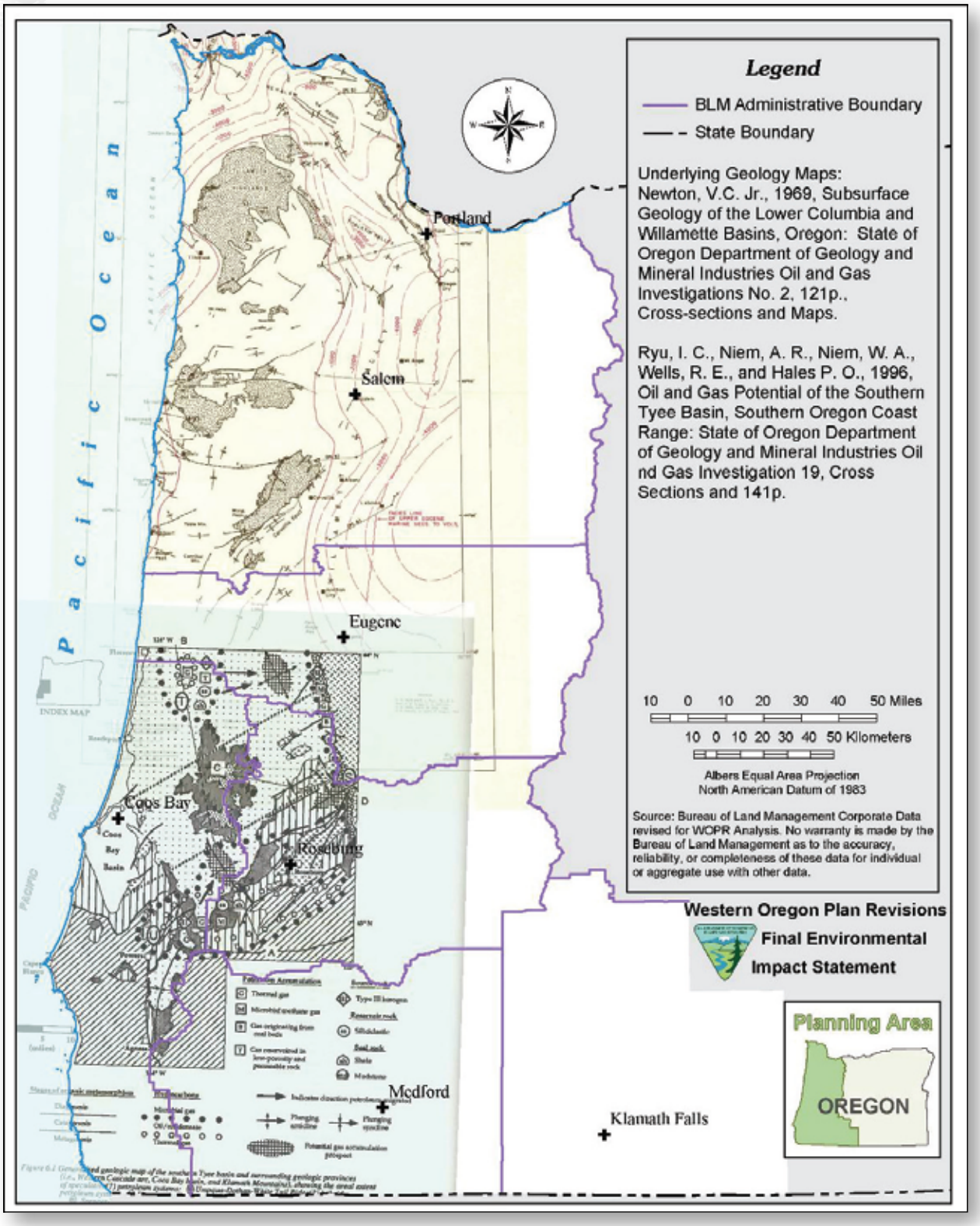
Of these, the Willamette Basin extends into the Eugene District (see *Figure Q-14*).

The Willamette Valley basin extends from the southern end of the Puget Sound Trough at the Columbia River south into the Eugene District. This basin is mapped adjacent to the Tyee Basin through parts of the Salem District and the Eugene District (see *Figures Q-14* and *Q-15*) (Newton 1969, Ryu et al. 1996). The lower rock, or basement rock, is the Eocene Siletz River Volcanics or Kings Valley Siltstone. Overlying these are sandstones and siltstones to the Eocene Nonconformity. This nonconformity is covered by volcanics, overlain by sandstone, limestone, and coal beds. The assemblage is capped by the Columbia River Basalts, which are covered by tuff and silt. The petroleum potential boundary in the Eocene rock is defined to the east by the change from marine sediment to volcanic sediment (facies change) (Newton 1969) (see *Figure Q-14*). Numerous wells with gas shows have been drilled within the valley. The eastern edge of the valley provides numerous possibilities for structural traps, with the marine beds providing source rock for petroleum accumulations. Even though numerous holes have been drilled and source and structure is present, true potential has not been clearly defined. The Eocene Nonconformity (marine facies) is at maximum the mapped depth of 5,000 feet below sea level (Newton, 1969).

The southern portion of the Western Tertiary Basin Province is identified as the Tyee Basin. This basin extends north from the Klamath Terrains to approximately the Lincoln City-Salem Latitude (Ryu *et al*, 1996). The Tyee Basin is actually composed of two basins: the NE-SW oriented Umpqua basin of early Eocene age and the north-south oriented Tyee Forearc Basin of middle Eocene age. The Umpqua Basin is divided by the Umpqua Arch, composed of a volcanic high. The two sub-basins include the Smith River Sub-Basin, located east of Florence and Reedsport, and the Myrtle Point-Sutherlin Sub-Basin along the southern boundary (Ryu et al. 1992, 1996). The Yaquina Sub-Basin of the Salem District could be considered as part of the Tyee Basin, as well as the southern portion of the Willamette Valley Sub-Basin (Ryu et al. 1996; Newton 1969). The Coos Basin overlies and bounds by mapping, the Tyee Basin to the west (Ryu et al. 1996) (refer to *Figure Q-14*).

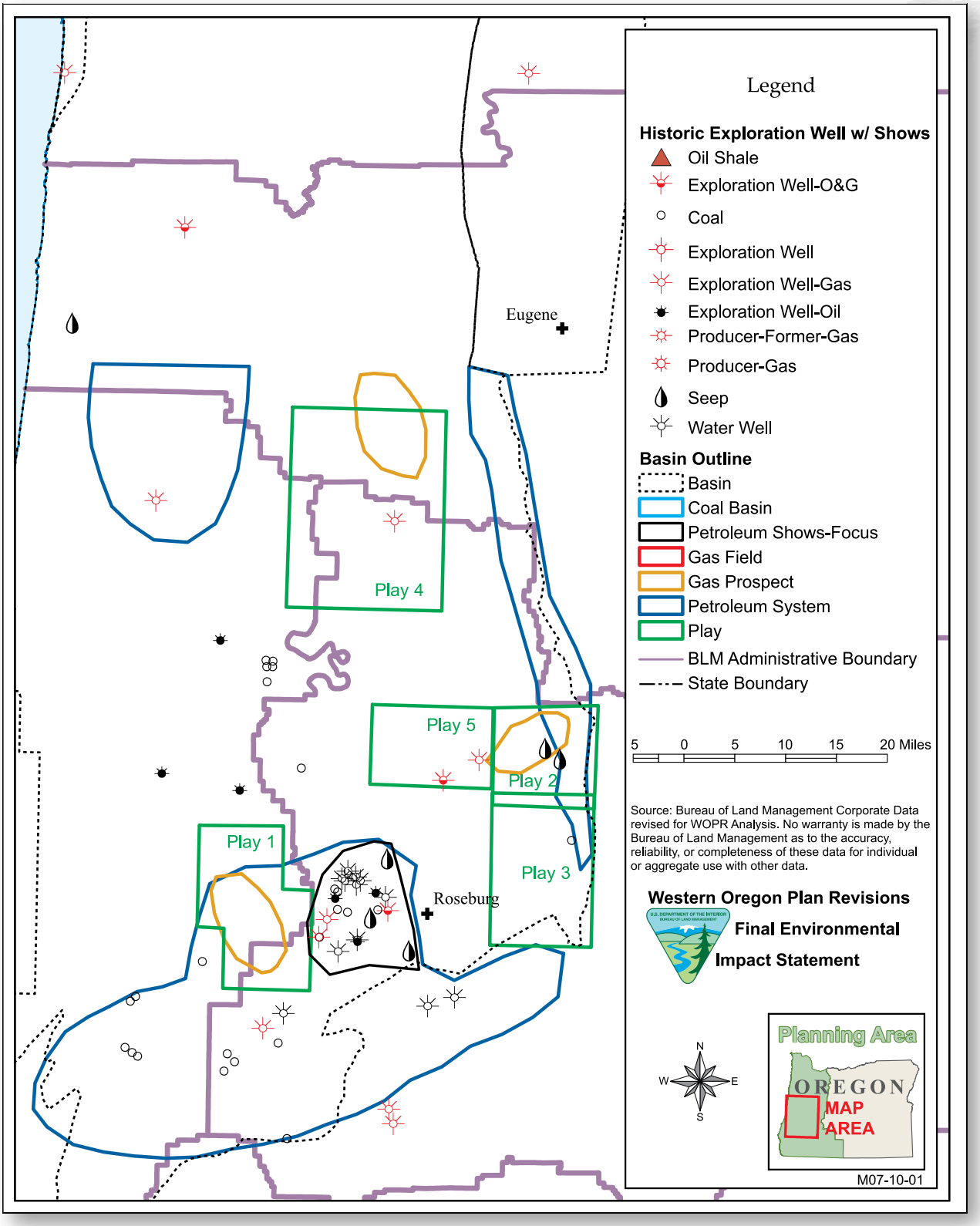
The basin structure is controlled by compression resulting from the subducting easterly moving Juan de Fuca plate in relation to the overriding westerly moving North American Plate. The fold axes are oriented north-south (Orr and Orr 2000). The northern basins are defined by the contact between the Miocene or Oligocene rock and Eocene rock. This is a point of erosion of the Eocene rock, which was covered by Miocene or Oligocene rock, defined as a nonconformity (unconformity if covered by Miocene or Oligocene sedimentary rock). This break in the geologic column is considered the Eocene nonconformity and a focus

Figure Q-14. Basic Underlying Geology



Source: Newton 1969, Ryu et al. 1996

Figure Q-15. Basin, Petroleum Systems, Plays, and Prospects



Sources: USDI BLM 2008, Olmstead et al. 1989, Niem and Niem 1990, Newton et al. 1980, Stewart and Newton 1954, Sidle 1981, Newton 1969, Kvenvolden et al. 1995, Mason and Erwin 1955

of petroleum exploration. The Eocene rocks consist of marine sediments, with latter sedimentation creating coal beds in many areas (Newton 1969) (refer to *Figure Q-14*).

The Tyee Basin structure is a result of compressional tectonics. However, rotation of tectonic forces produced differing orientations for the Umpqua Basin and the Tyee Forearc Basin (Ryu et al. 1996, Wells et al. 2000). In general, the projected conventional oil and gas systems result from organic rich source rock and coal from the Umpqua Basins being trapped by the rock of the overlying Tyee Forearc Basin (Ryu et al. 1996). The coal seams of the Coos Basin (Coos Bay District) are currently being investigated for coal bed natural gas. However, deeper source rocks may exist and contribute to the coal bed natural gas resource. These source rocks would be part of the underlying Tyee Basin (Pappajohn 2007, Newton et al. 1980).

Based on geologic interpretation and petroleum exploration, Ryu et al. (1996) identified petroleum systems, plays, and prospects within the Tyee Basin. An oil and/or gas play is an area, geologic formation, or geologic trend that has good potential for oil and/or gas development, or is generating a large amount of interest in leasing and drilling (USDI BLM 2001). As defined by Magoon (1988 as found in Ryu et al. 1996):

- A **Petroleum System** is a relationship of source rock and the resulting petroleum accumulation. This relationship contains a source rock for petroleum; migration paths; reservoir rock; seal; trap; and the appropriate geologic processes that form these hydrocarbon materials. The extent of the Petroleum System can be delineated as an area that contains both the mature source rock and oil or gas accumulations. The name of the Petroleum System would consist of the name of the source rocks, followed by the name of the reservoir rock, followed by the level of certainty for its occurrence.

There are three levels of certainty: known, hypothetical, and speculative. Known systems have a strong geochemical match between the source rocks and an existing petroleum accumulation. These are identified in the name by an exclamation point in parentheses: (!). Hypothetical systems have geochemical data that identify a source rock, but do not link the source rock to a known petroleum accumulation. These are identified in the name by a period in parentheses: (.). An example is the Mist Gas Field. The Speculative system has geological or geophysical evidence used to project the existence of a link between source rocks and potential petroleum accumulations. These are identified in the name by a question mark in parentheses: (?).

- A **Play** is the existence of a trap (a geologic structure that allows petroleum to accumulate) that is detectable with geological, geophysical, or geochemical technology. A play does not need all of the elements of a petroleum system.
- A **Prospect** is a drillable trap that is located within a play.

Ryu et al. (1996) identified three distinct speculative petroleum systems, five distinct plays, and three distinct gas prospects within the Tyee Basin (refer to *Figure Q-15*). The identified petroleum systems include:

— *The Umpqua-Dothan-White Tail Ridge (?) Hybrid Petroleum System*: There is a potential of dry gas (methane) from buried coals and carbonaceous mudstone of the White Tail Ridge Formations, with migrations to traps of the Tyee Sandstones. Because there is no known connection between the potential source of petroleum and the potential traps and because there is no known commercial accumulations of natural gas, the system is considered speculative. According to BLM GIS-based estimates, the total acreage of this petroleum system is approximately 574,000 acres. Of this, approximately 215,000 acres are within the Coos Bay District, approximately 352,000 acres are within the Roseburg District, and approximately 8,000 acres are within the Medford District.

— The Umpqua-lower Tyee Mountain (?) Petroleum System; Basin Center Gas (?): This system may contain a tight-gas sandstone reservoir, collecting thermogenic (temperature-induced conversion to petroleum) wet-gas and oil derived from mudstone of the Umpqua Group. The model projects natural gas migrating along fractures to accumulate in Tyee Mountain turbidite sandstones. An unconventional mudstone reservoir is possible in the Umpqua Group. According to BLM GIS, the total acreage of this petroleum system is approximately 145,000

acres. Of this, approximately 116,000 are within the Coos Bay District and approximately 29,000 acres are within the Eugene District.

— The Spencer-White Tail Ridge-Western Cascade Arc (?) Petroleum System: The petroleum sources of this system are the coals and carbonaceous mudstone and sandstones of the Spencer Formation and White Tail Ridge Formation, generated by the deep burial and heating by the Western Cascades arc plutons. The reservoir rock would be the overlying sandstones and delta facies. According to BLM GIS, the approximate total acreage of this petroleum system is 119,000 acres. Of this, approximately 69,000 acres are within the Eugene District and approximately 50,000 acres are within the Roseburg District.

All of these systems are considered speculative. Additional drilling and exploration may alter that qualifier (or completely remove the potential). As an example, the Mist Gas Field was considered a speculative field until the discovery well was drilled in 1979, which lead to its designation as a gas field (Ryu et al. 1996).

In addition to the three petroleum systems, Ryu et al. (1996) have identified five different plays described below in the *order of their potential to produce hydrocarbons,* as shown in *Figure Q-15*:

1. The Williams River-Burnt Ridge anticlinal Plays: This is a complex domal structure in the Tyee Formation (Play 1 of 5). Natural gas might be found in the lower Umpqua strata in the footwall beneath Siltez River Volcanics. The White Tail Ridge sandstone could also serve as a trap. Isolated faults and thrust faults, as well as pinchouts and unconformities, also provide potential traps. A gas prospect may exist within this play. According to BLM GIS, the total acreage of this play is approximately 94,000 acres. Of this, approximately 20,000 acres are within the Roseburg District and approximately 74,000 acres are within the Coos Bay District.
2. Western Cascades plays and Bonanza thrust near Nonpareil: This system incorporates anticlines and faults, including the extension of the Bonanza Fault, at the contact of the Tyee Basin and the Western Cascades (Play 2 of 5). The potential reservoir rocks include the Spence and White Tail Ridge formations. Source rock includes several one- to six-foot thick coal beds, carbonaceous sandstone, and mudstone. Other plays may exist in the foothills of the Western Cascades, with the buried Spencer Formation being the structural or stratigraphic play. The Spencer Formation is exposed from Glide to Cottage Grove. A gas prospect is projected within the play. According to BLM GIS, the total approximate acreage of this play is 64,000 acres, all of which is contained within the Roseburg District.
3. Klamath Mountains sub-thrust play, Glide area: It is interpreted that the Klamath Mountains (Klamath Terrains) are thrust over the Coast Range rocks, burying parts of the Southern Tyee Basin. Possible plays may exist in the underlying Tyee Basin stratigraphy in the areas of the Wildlife Safari fault and southeast and southwest of Glide (Play 3 of 5). The White Tail Ridge Formation is the potential reservoir unit with source being derived from the Remote Member and Tenmile Formations. However, it is debated whether the Tyee stratigraphy (Siletz River Basalts) formed in place through an abandoned rift zone. This would mean that there is no overthrusting of the Klamath Terrains over the Tyee Basin, and therefore no associated traps or plays (Ryu et al. 1996). However, more recent geology mapping has indicated that the overthrusting does exist (Well et al. 2000, DuRoss et al. 2002, Wells 2008). Therefore, while unexplored, potential for petroleum traps along the Klamath Terrains/Tyee Basin boundaries may exist. According to BLM GIS, the total approximate acreage of this play is 96,000 acres, all of which is contained within the Roseburg District.
4. Tyee Mountain anticlinal plays: Several untested anticlines exist in the Tyee Mountain and Baughman members of the Tyee Formation beyond the Williams River-Burnt Ridge anticlinal plays (Play 4 of 5). Stratigraphic traps could exist along the flanks of the Siletz River Volcanics in the Umpqua Arch. A specific untested anticlinal structure exists at Stony Point. While these untested structures exist, the potential of the northern anticlines is low when compared to the southern anticline systems, due to the lack of maturation, organic-rich source rock, and reservoir rocks.

However, a gas prospect may exist in the northern portion of the play. According to BLM GIS, the total approximate acreage of the play and prospect is 203,000 acres. Of this, approximately 25,000 acres are located within the Coos Bay District, approximately 91,000 acres are located within the Eugene District, and approximately 87,000 acres are located within the Roseburg District.

5. Anticlinal and subthrust plays in the Myrtle Point-Sutherlin Sub-Basin: These plays consist of thrust faults and anticlinal and synclinal folds of rock of the Umpqua Group, Bushnell, and White Tail Ridge formation in the Myrtle Point-Sutherlin Sub-Basins. The area of the play is the Roseburg-Sutherlin-Glide area (Play 5 of 5). Gas shows have been encountered in tight sandstones and methane emanations from water wells. However, there has been no commercial production. According to BLM GIS, the total approximate acreage of the play is 60,000 acres, all of which is contained within the Roseburg District.

Additionally, numerous exploration wells, seeps, and petroleum producing water wells exist within the districts. As shown in *Figure Q-15*, an area of concentration of petroleum shows is located within the Umpqua-Dothan-White Tail Ridge (?) hybrid petroleum system. Although shows are found throughout the four districts, this concentration provides a concentrated area of petroleum shows. According to BLM GIS, the total acreage of this focus of petroleum shows is approximately 68,000 acres, of which all is contained within the Roseburg District.

All of these structures and systems completely or in part underlay the Eugene and Roseburg Districts. Areas of gas and oil exploration and shows also exist throughout the Districts (Olmstead et al. 1989, Niem and Niem 1990, Newton et al. 1980, Stewart and Newton 1954, Newton 1969, Sidle 1981, Kvenvolden et al. 1995) (refer to *Figure Q-15*).

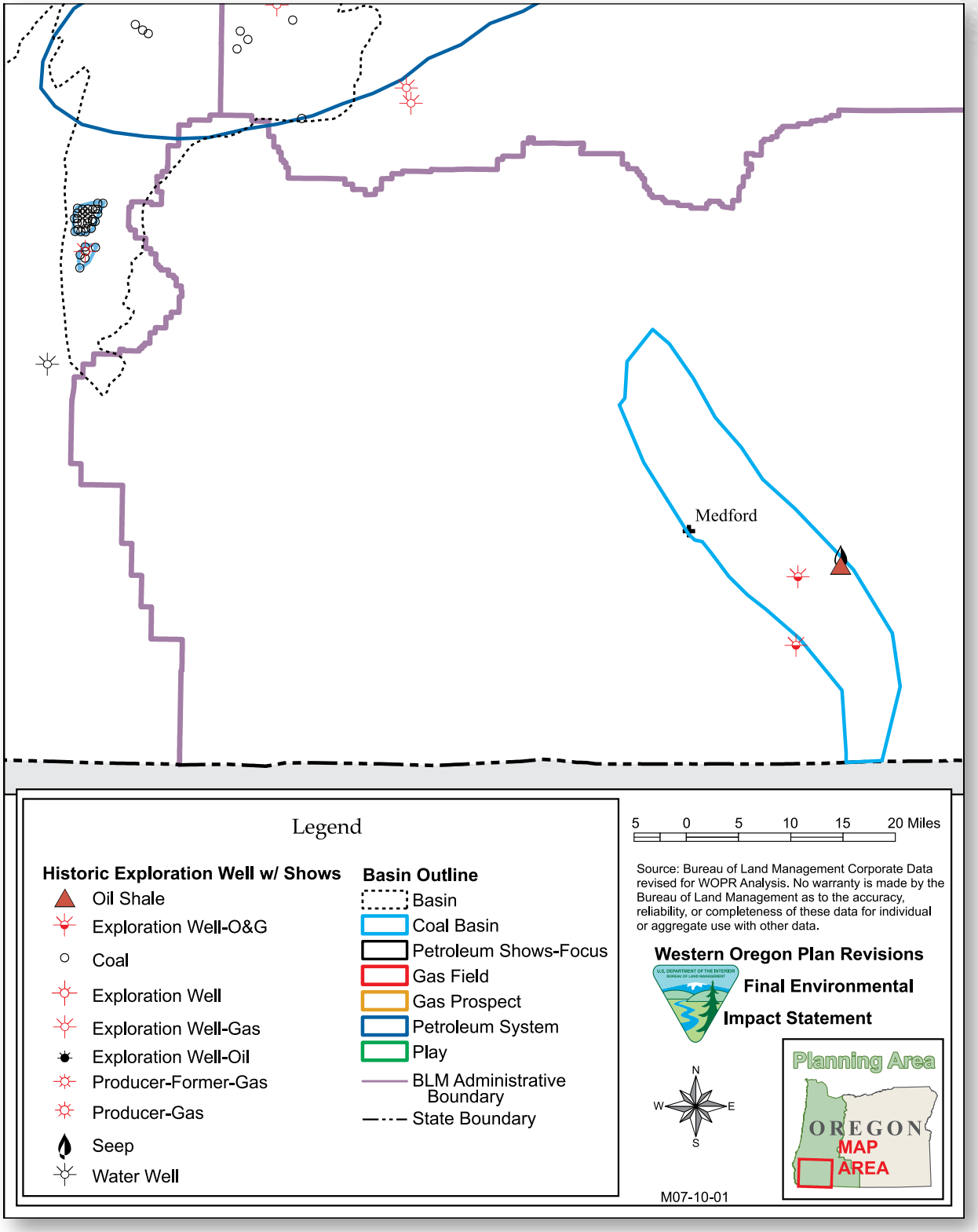
The Medford District is south and east of the Tertiary Basin System/Tyee Basin, incorporating Klamath accreted terrains in the west and the Cascade Volcanics and Basin and Range structures to the East. The Klamath Resource Area of the Lakeview District lies east of the Medford District and incorporates "Basin and Range" structures. The accreted Klamath terrains are bound by the Tyee Basin (The Tyee Basin is the southern portion of the Western Tertiary Basin System) to the North. They extend into northern California and are variously bounded on the east by Cascade Volcanics and rocks within the Basin and Range province. The Oregon portion of the Basin and Range province is a northern projection of the crustal extension that extends through the southwestern United States.

Coal exposures and basins exist throughout western Oregon (Mason and Erwin 1955) (refer to *Figure Q-13*). One major coal basin has been identified in the Medford District within Jackson County (Sidle 1981; Jackson County, 1989, 2004, 2006; Weissenborn 1969). This coal field is known as the Rouge River Coal Field. The field extends southward from Evans Creek to a point about 10 miles south of the Oregon-California border (Weissenborn 1969) (see *Figure Q-16*). According to BLM GIS, the total approximate acreage of the Rouge River Coal Field is 221,000 acres, all of which is contained within the Medford District boundaries (the portion in California is not analyzed).

All coal seams in western Oregon could produce coal bed natural gas. However, the true potential is unknown, as investigations for coal bed natural gas potential for these seams are just beginning (Wiley 2006, Pappajohn 2007, Meyer 2007). Potential could exist within the coal seams of the Umpqua Group, as well as with coeval formations north throughout the coast range. If coal bed natural gas is producible in the Coos Basin, exploration may extend to other speculative formations (May 2005, Pappajohn 2007).

Current development of the coal bed natural gas resource is being conducted by the Methane Energy Corporation within the Coos Bay District. The company has completed numerous exploratory and production wells within the Coos Basin. Based on this exploration, the company has projected a defined area for coal bed natural gas development, described as an "Area of Mutual Interest" (AMI). This incorporates the Coos Basin (Torrent Energy Corporation 2008).

Figure Q-16. Coal Basins



Sources: USDI BLM 2008,Olmstead et al. 1989; Niem and Niem 1990, Newton et al. 1980, Stewart and Newton 1954, Sidle 1981, Newton 1969, Kvenvolden et al. 1995, Mason and Erwin 1955

The following descriptions of oil and gas occurrence potential are projected for BLM-administered mineral rights within the western Oregon Districts. Prospects, Plays, Basins and other potentials overlap district boundaries. Therefore, a total system potential may incorporate more than one district.

Eugene District

The Eugene District incorporates portions or all of Linn, Lane, and Douglas counties. At least one exploration well with shows of oil and gas (Fed-Mapleton 1) and two petroleum seeps are within the Eugene District boundary. Sedimentary basins underlying the Eugene District include both the Tyee Basin and the Willamette Valley Basin. Two Petroleum Systems extend into the district, as well as the Tyee Mountain anticlinal play and its associated Gas Prospect (see *Figure Q-17, later in this appendix*)

Table Q-8 represents the approximate acreage of the basins, systems, plays, and prospects located within the Eugene District.

Roseburg District

The Roseburg District incorporates the major portion of Douglas County, with minor portions of Linn and Jackson Counties. The district has been the focus of historical exploration with at least 2 oil and gas exploration well shows, 7 exploration gas well shows, 3 exploration oil well shows, 5 petroleum seeps, 12 petroleum shows in water wells, and 12 coal exposures. Sedimentary basins underlying the Roseburg District include the Tyee Basin. Two petroleum systems extend into the Roseburg District, as well as five projected plays. One complete gas prospect and another partial gas prospect associated with two plays exist, as well as one focused area of petroleum exploration (see *Figure Q-18*).

Table Q-9 represents the approximate acreage of the basins, systems, plays, and prospects within the Roseburg District.

Medford District

The Medford District incorporates portions or all of Jackson, Josephine, Douglas, Curry and Coos Counties. At least two oil and gas exploration wells with shows, one petroleum seep, one oil shale prospect, and one coal field exist within the Medford District boundary. A small portion of the Tyee Basin sedimentary basin and a petroleum system underlies the northwest part of the district. No plays or prospects have been mapped within the District (see *Figure Q-19*).

Table Q-10 represents the approximate acreages of basins, petroleum systems, and coalfields located within the Medford District.

Klamath Falls Resource Area of the Lakeview District

The Klamath Falls Resource Area of the Lakeview District incorporates Klamath County. No recorded exploration wells with shows, seeps, water wells with petroleum shows, or coal were found in the literature search or in agency communications (see *Figure Q-20*). Most energy wells drilled have been in the search and delineation of geothermal energy. It should be noted that the lack of exploration does not indicate a lack of petroleum potential, but simply a lack of information. Therefore, future potential cannot be analyzed. Gas and oil production has been located in similar basin and range provinces, such as in the state of Nevada (Hess 2001).

Table Q-8. Eugene District Acreages

System	Total Acreage Within the Eugene District	Total BLM-Managed Surface Acreage	Total BLM-Managed Sub-Surface Split-Estate Acreage
Tyee Basin	794,000	160,000	500
Willamette Sedimentary Basin	252,000	5,000	12,000
Spencer-White Tail Ridge-Western Cascade Arc (?) Petroleum System	69,000	13,000	100
Umpqua-lower Tyee Mountain (?) Petroleum System	29,000	4,000	0
Tyee Mountain anticlinal play and associated gas prospect (Play 4 of 5)	91,000	55,000	0

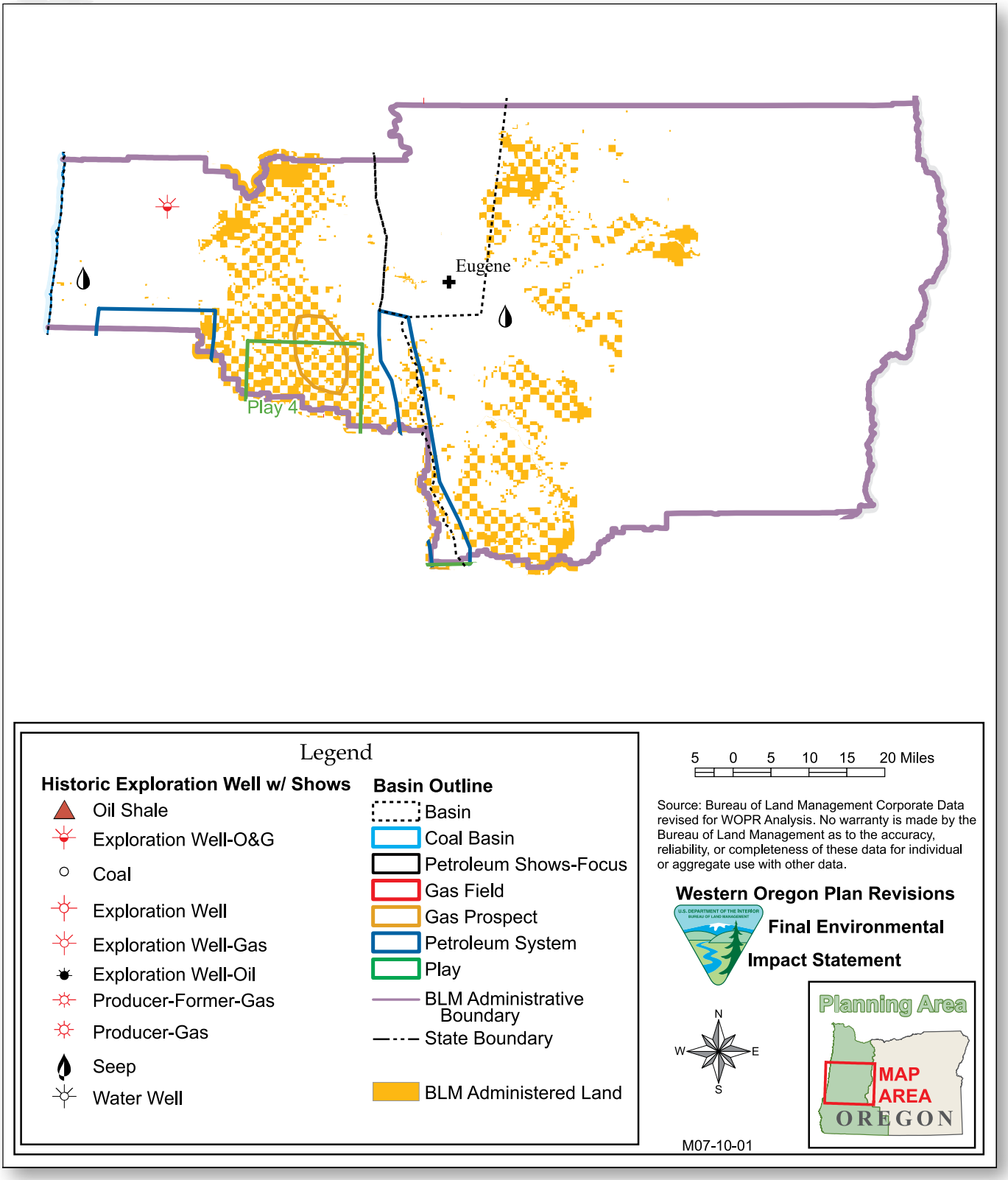
Table Q-9. Roseburg District Acreages

System	Total Acreage Within the Roseburg District	Total BLM-Managed Surface Acreage	Total BLM-Managed Sub-Surface Split-Estate Acreage
Tyee Basin	889,000	207,000	300
Spencer-White Tail Ridge-Western Cascade Arc (?) Petroleum System	50,000	11,000	0
Umpqua-Dothan-White Tail Ridge (?) hybrid Petroleum System.	352,000	83, 000	0
Williams River-Burnt Ridge Anticlinal Play and associated Gas Prospect (Play 1 of 5)	20,000	7,000	0
Western Cascades Plays and Bonanza Thrust near Nonpareil and associated Gas Prospect (Play 2 of 5)	64,000	10,000	0
Klamath Mountains Subthrust Play, Glide Area (Play 3 of 5)	96,000	18,000	0
Tyee Mountain Anticlinal play (Play 4 of 5)	87,000	41,000	0
Anticlinal and Subthrust Plays in the Myrtle Point-Sutherlin Subbasin (Play 5 of 5)	60,000	3,000	0
Area of Focused Petroleum Shows	68,000	2,000	0

Table Q-10. Medford District Acreages

System	Total Acreage Within the Medford District	Total BLM-Managed Surface Acreage	Total BLM-Managed Sub-Surface Split-Estate Acreage
Tyee Basin	20,000	4,000	0
Umpqua-Dothan-White Tail Ridge (?) Hybrid Petroleum System	8,000	2,000	0
Rogue River Coal Field	221,000	33,000	3,000

Figure Q-17. Eugene District



Sources: USDI BLM 2008, Olmstead et al. 1989; Niem and Niem 1990, Newton et al. 1980, Stewart and Newton 1954, Sidle 1981, Newton 1969, Kvenvolden et al. 1995, Mason and Erwin 1955

Oil and Gas Production

Conventional Oil & Gas Resources

There is no current petroleum production within the Eugene, Roseburg, or Medford Districts or the Klamath Falls Resource Area of the Lakeview District. The only commercial production within Western Oregon occurs in the Mist Gas Field, located within the Salem District.

The Mist Gas Field Designation (see Figure Q-21) was initiated with the discovery of natural gas in 1979. The main target zone is the reservoir rock of the Clark and Wilson Sandstone (Olmstead and Alger 1985). As of 2007, there have been over 45 separate pools identified (Meyer 2007) with two gas storage reservoirs (DOGAMI 2003). Locations of additional pools are expected with the use of 3-D Survey (Meyer 2007). Current exploration is focused to the northwest of the Mist Gas Field (Houston 2007). However, this is due to economics as opposed to existence of resource. All areas north of Vernonia, Oregon could be considered possible extensions of the Mist Gas Field (Meyer 2007).

Annual production for 2005 from the Mist Gas Field was 305 million cubic feet (MMcf), with a total field production to date of 70 billion cubic feet (Bcf) (DOGAMI 2007). As of 2006, the Mist Field had produced approximately 68 Bcf, with a value of about $140 million (DOGAMI 2007). The State of Oregon applies a severance tax of 6% on production, which goes to the common school fund. In total, over 500 oil and gas wells have been permitted in the field by 2003 (DOGAMI 2003). There are currently 18 actively producing wells, one water disposal well, 21 observation wells, and 20 gas injection and/o withdrawal wells operating on the site (DOGAMI 2007). Eight new Applications for Permit to Drill (APD) are being submitted to DOGAMI for additional exploration and production wells (Houston 2007).

An annual production history of the Mist Gas Field for the past 10 years is shown on *Table Q-4* earlier in this appendix (DOGAMI 2003 and 2007).

Non-Conventional Petroleum (Coal Bed Natural Gas)

There is currently no coal bed natural gas production in Oregon. However, the Coos Basin, located in Coos County, is being developed as a production resource. The current development of the coal bed natural gas resource is being conducted by the Methane Energy Corporation. The company has completed numerous exploratory and production wells within the Coos Basin. The Methane Energy Corporation has also received National Pollutant Discharge Elimination System permits for surface disposal of production water.

The DOGAMI has initiated a public meeting process to establish a Gas Field Designation for the Coos Basin. The first public meeting was conducted on January 29, 2007. There is only one other Gas Field Designation in Oregon, which is the Mist Gas Field. The Gas Field Designation is required to fulfill state requirements regarding well spacing designations, mineral rights, and control drainage.

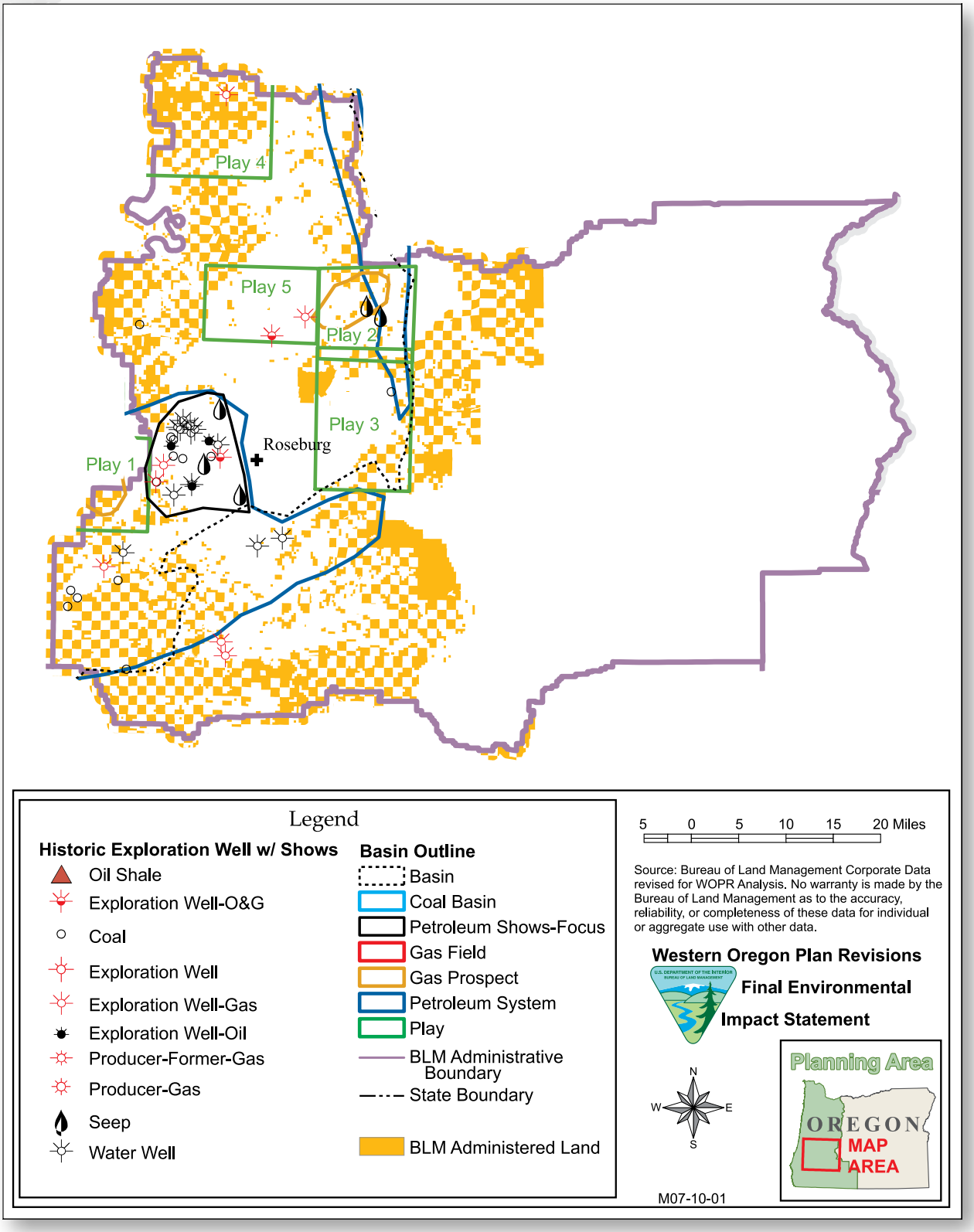
Coal bed natural gas development is also beginning in southwest Washington, approximately 20 miles north of the Salem District. Exploration is being completed by the Methane Energy Corporation's sister company (a subsidiary of Torrent Energy Corporation), Cascade Energy Corporation (Torrent Energy Corporation 2008). There is also interest in the southwest Washington coal fields from Comet Ridge Limited (Meyer 2007).

Potential for Resource Occurrence and Development

Potentials for resource occurrence and potentials for resource development (USDI BLM 1985) have been estimated for the districts. Definitions for potential for resource occurrence include:

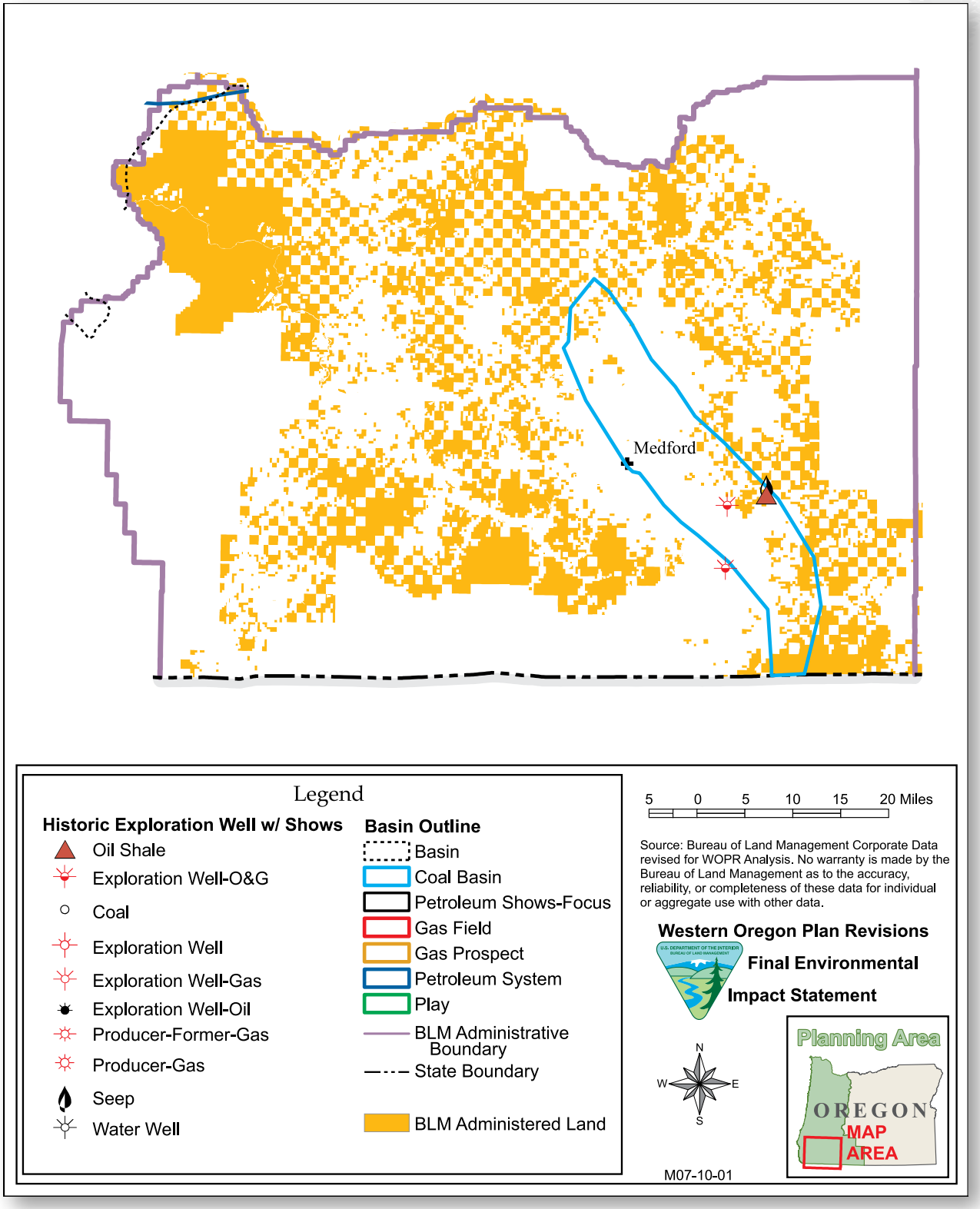
- Low Potential - Hydrocarbon occurrence is unlikely.
- Moderate Potential - Conditions exist for hydrocarbons to occur.
- High Potential - Hydrocarbon shows have been documented or production has been established.

FIGURE Q-18. ROSEBURG DISTRICT



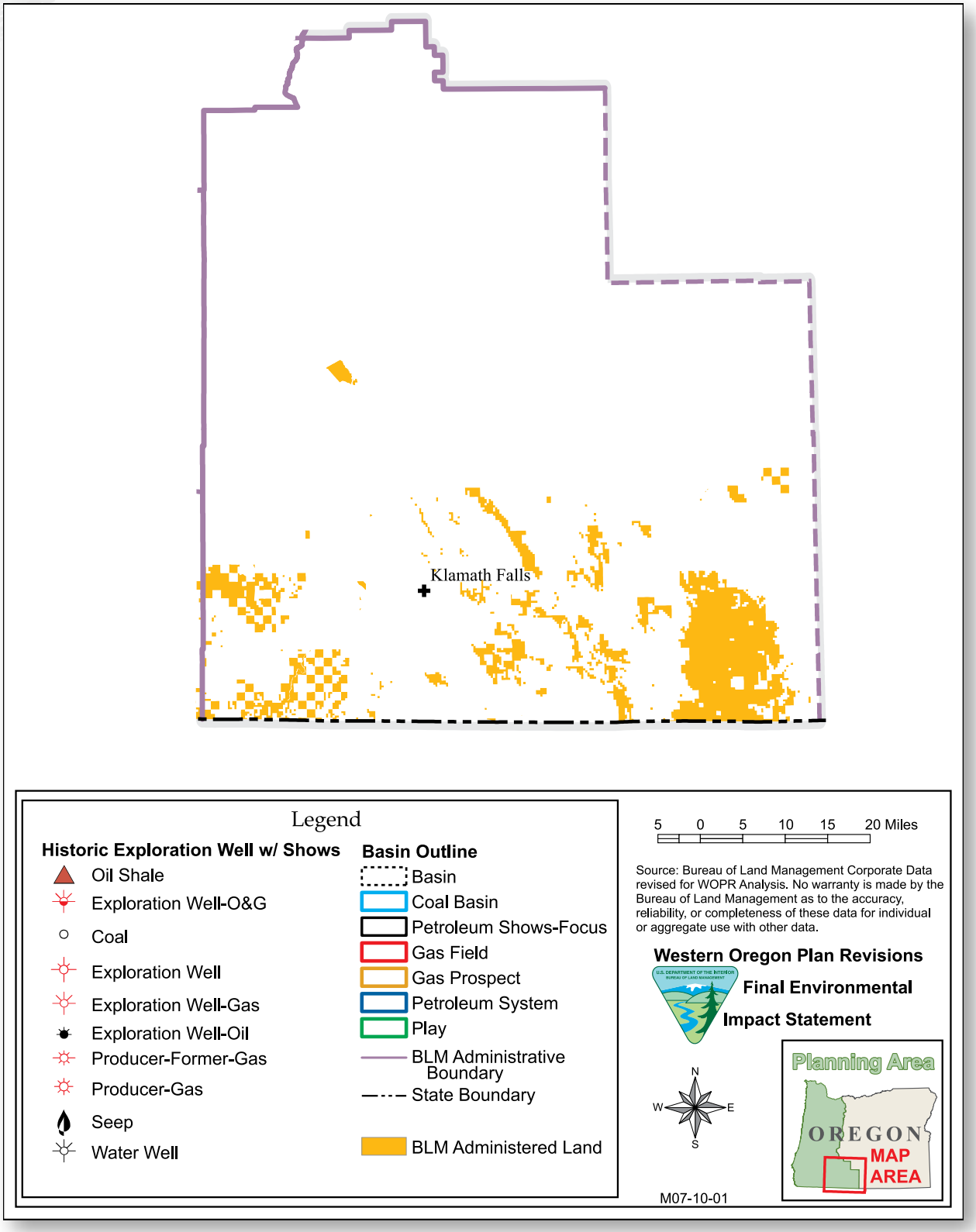
Sources: USDI BLM 2008, Olmstead et al. 1989, Niem and Niem 1990, Newton et al. 1980, Stewart and Newton 1954, Sidle 1981, Newton 1969, Kvenvolden et al.1995, Mason and Erwin 1955)

Figure Q-19. Medford District



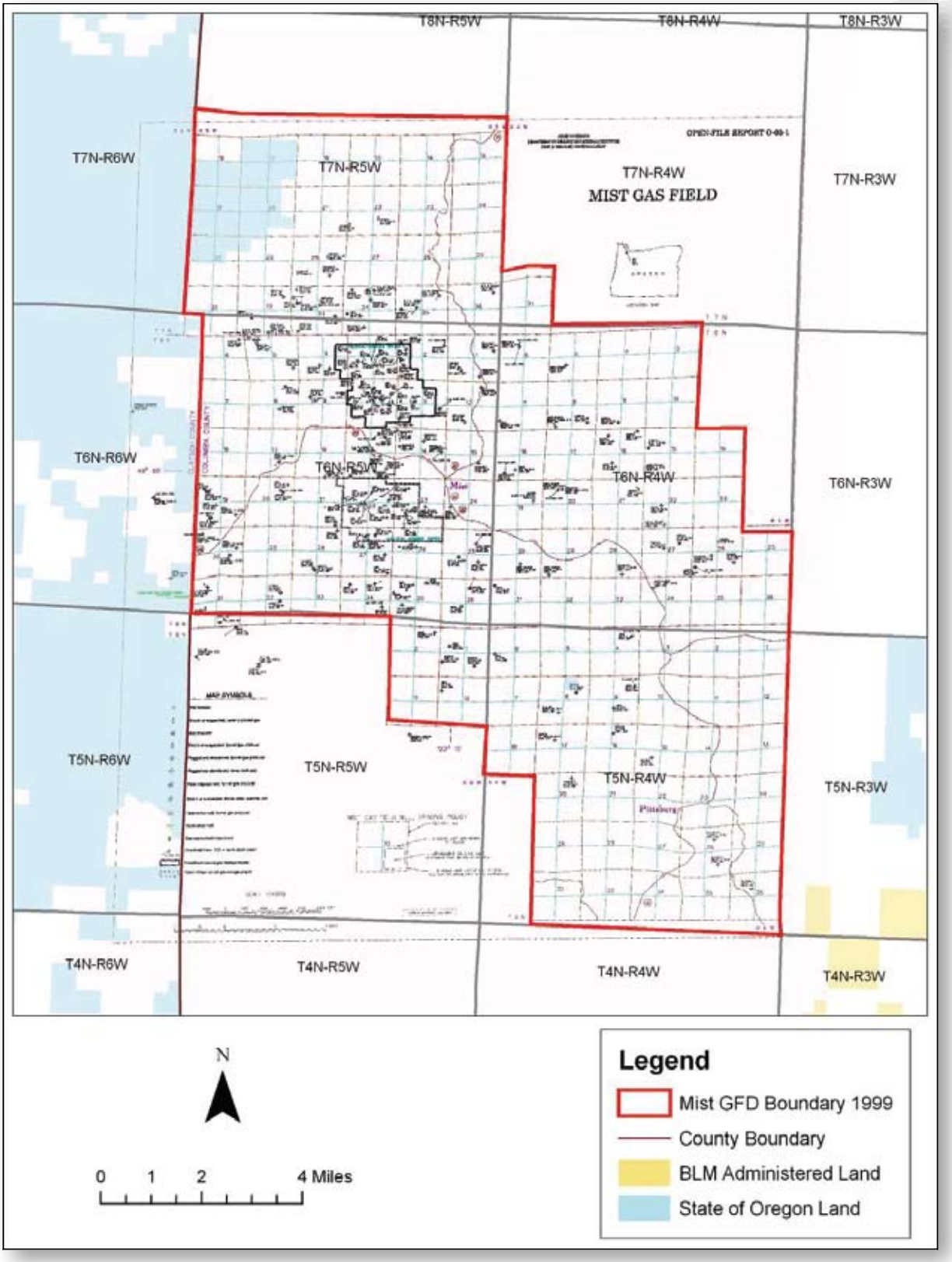
Sources: USDI BLM 2008, Olmstead et al. 1989, Niem and Niem 1990, Newton et al. 1980, Stewart and Newton 1954, Sidle 1981, Newton 1969, Kvenvolden et al.1995, Mason and Erwin 1955

Figure Q-20. Klamath Falls Resource Area



Sources: BLM 2008, Olmstead et al. 1989, Niem and Niem 1990, Newton et al. 1980; Stewart and Newton 1954, Sidle 1981, Newton, 1969, Kvenvolden et al. 1995; Mason and Erwin 1955

Figure Q-21. Mist Gas Field, 1999 Boundary



Source: DOGAMI 2003

Definitions for potential for resource development include:

- Low Potential - Economic or other conditions would likely preclude development.
- Moderate Potential - It is reasonable to conclude that development could occur.
- High Potential - Development is likely to occur within the life of the plan.

The districts contain two identified sediment basins, three petroleum systems, five plays, three prospects, one focused area of petroleum shows, and one identified coal field. However, according to Ryu et al.(1996), the southern Tyee Basin (which incorporates the Eugene and Roseburg Districts) has a low to moderate petroleum potential. Yet, as shown by the potential systems, plays, and prospects, there are several areas that have not been investigated.

Ryu et al. (1996) have ranked the five plays in order of potential to produce hydrocarbons, with "1" being the greatest potential and "5" having the least potential. This is based on the size and closure of the structures; position of source, reservoir, and seals; and the timing of the play formation in relation to the timing of potential hydrocarbon migration to the play.

There has been little exploration of portions of the districts outside the Tyee Basin (i.e., Medford District and Klamath Falls Resource Area). Therefore, future potential cannot be analyzed. However, gas and oil production has been located in similar basin and range provinces, such as in the State of Nevada (Hess 2001).

Eugene District: **Moderate Potential for Occurrence**
Low Potential for Development

Two sedimentary basins, two petroleum systems, one play, and one prospect have been projected for the Eugene District. The sedimentary basins have a low to moderate petroleum potential. The identified play is ranked as fourth of five plays in potential. The petroleum systems, plays, and prospect have potential for the existence of hydrocarbons (Ryu et al. 1996). Wells and seeps have confirmed the presence of hydrocarbons within the district. However, because production has not been established and the play has a low potential in its ranking compared to the five identified plays, the potential for occurrence is *moderate*.

There is no additional public record that indicates petroleum investigation of lands within the Eugene District has occurred since 1996 (Ryu et al. 1996). The last petroleum exploration well was drilled in 1955 (refer to *Figure Q-17*) (Olmstead et al. 1989). There has been no commercial development of the systems. The identified play is ranked fourth of five. Petroleum accumulations would need to be confirmed and the petroleum system move to "known" status for resource development to occur. Therefore, the potential for development within the plan's 10-year forecast is *low*.

The potential acreage of BLM-administered lands to have *moderate potential for occurrence* and *low potential for development* is approximately 72,000 acres.

Roseburg District: **Moderate Potential for Occurrence**
Moderate Potential for Development/Low Potential for Development

One sedimentary basin, two petroleum systems, five plays, two prospects, and one concentration of petroleum shows have been projected for the Roseburg District. The sedimentary basin has a low to moderate petroleum potential. The identified plays rank from highest to lowest (1 to 5) in potential out of five plays. The petroleum systems, plays, and prospects have potential for existence of hydrocarbons (Ryu et al. 1996). Numerous wells and seeps have confirmed the presence of hydrocarbons within the district. However, because production has not been established, the petroleum systems are speculative, and the plays have not been confirmed, the potential for occurrence is moderate.

There is no additional public record that indicates petroleum investigation of the lands within the Roseburg District has occurred since before 1996 (Ryu et al. 1996). The last petroleum exploration well was drilled in 1990 (refer to *Figure Q-18)* (Niem and Niem 1990). There has been no commercial development of the systems. However, the projected plays range in a ranking of one to five for potential and there has been a definable area of exploration and petroleum shows. Therefore, based on the ranking of the plays and their associated petroleum systems, the potential for development within the Plan's 10-year forecast is *low* to *moderate*.

The potential acreage of BLM-administered lands to have *moderate potential for occurrence* and *moderate potential for development* (Plays 1, 2, and 3 and the area of exploration and petroleum shows) is approximately 37,000 acres.

The potential acreage of BLM-administered lands to have *moderate potential for occurrence* and *low potential for development* (Plays 4 and 5 and petroleum systems outside of Plays 1, 2, and 3) is approximately 124,000 acres.

Medford District:	**Low Potential for Occurrence** **Low Potential for Development**
Non-Conventional:	**Moderate Potential for Occurrence** **Low/Moderate Potential for Development**

The Medford District contains petroleum shows, an oil shale prospect, a small portion of a petroleum system boundary, and an identified coal field. However, for conventional petroleum systems, there is insufficient information for the occurrence of commercial quantities of hydrocarbons. Therefore, the potential for occurrence is *low*.

Due to the lack of evidence for commercial petroleum accumulations, the potential for development within the plan's 10-year forecast is *low*.

Non-conventional petroleum development in the form of coal bed natural gas is occurring within the Coos Basin of Oregon and within southwest Washington. The Rogue River Coal Field exists within the Medford District. It is known by the nature of coal that methane is associated with the beds. Investigations of known coal exposures are currently being done. If coal bed natural gas becomes commercial in the developing fields, industry may look at the potential of developing other coal fields (Pappajohn 2007). In addition, a single identified Oil Shale prospect also exists. Therefore, the potential for nonconventional oil and gas resource occurrence in the Medford District is *moderate*.

Currently there is a lack of an existing commercial coal bed natural gas project. If coal bed natural gas becomes commercially successful in other districts, development potential of other coal systems could occur within the 10-year scenario (Pappajohn 2007). Resource development potential is dependent on the future of current enterprises. Although the Medford District does have an oil shale potential and the Energy Policy Act of 2005 (U.S. 109th Congress 2005) emphasizes the development of oil shale, any potential for future development will be many years away, and the focus of development is on larger prospects within the United States. Therefore, the potential for nonconventional development within the plan's 10-year forecast is extremely *low*.

The potential acreage of BLM-administered lands to have *moderate potential for occurrence* and *low potential for development* is approximately 33,000 acres.

Klamath Falls Resource Area: **Low Potential for Occurrence**
Low Potential for Development

There are no petroleum seeps or exploration shows, identified sedimentary basins with petroleum potentials, petroleum systems, plays, or prospects located within the Klamath Falls Resource Area of the Lakeview District. While oil and gas potentials do exist in similar geologic provinces (Basin and Range), little to no investigation has been performed within this Resource Area. Energy exploration that has been conducted has focused on geothermal potential. Therefore, largely due to the lack of information, the potential for occurrence is *low*.

Likewise, due to the lack of information, the potential for development within the plan's 10-year forecast is *low*.

Leasing

After initial field work, research, and subsurface mapping (which may include the acquisition of seismic data), leasing is often the next step in oil and gas development. Leasing may be based on speculation, with the riskiest leases usually purchased for the lowest prices.

Leases on lands where the Federal Government manages the oil and gas rights are offered via oral auction. Auctions typically occur at least quarterly. The maximum lease size is 2,560 acres, and the minimum bid is $2.00 per acre. An administrative fee of $75 per parcel is charged and each successful bidder must meet citizenship and legal requirements. Leases are issued for a 10-year term, and a 12.5% royalty rate on production is required to be paid. Federal Regulations pertaining to oil and gas leasing are located at 43 CFR 3100. All monies from lease and royalty receipts are payable to the Mineral Management Service. Leases which become productive are "held by production," and typically do not terminate until all wells on the lease have ceased production, with all of the wells plugged and abandoned, and the surface reclaimed to an acceptable condition.

The Oregon-Washington BLM lease sales are generally held on a quarterly basis, offering nominated and internally selected lands. Federal oil and gas leases sold within the Oregon/Washington BLM for 2006 have ranged from a high of 227,392 acres in the March sale, to a low of 20,919 acres in September. The total lease acreage sold from March to December (four sales) was approximately 308,610 acres. From those sales, the Oregon/Washington BLM received approximately $5,467,720 in oil and gas lease revenues.

Non-federal leasing and APDs for production in the State of Oregon are currently focused in the vicinity of the Mist Gas Field, the Coos Basin, and Eastern Oregon. The Mist Gas Field currently maintains 16 production wells. The DOGAMI has recently (2006-2007) received eight APDs submitted for production (Houston, 2007). The Coos Basin currently has 115,000 acres of leased land, with three multi-well/single pad and single pad/single well production systems. Foreseeable development of the Mist Gas Field in the Salem District could result in potentially an additional 10,800 acres of BLM-administered lease offerings. If these offerings were sold for the 2006 average of $17.71 per acre, the net receipts would be nearly $191,268.

At this time, there has been no expressed interest in oil and gas leases in Western Oregon outside of the Salem and Coos Bay Districts.

Future Trends And Assumptions

Based on history of past exploration; historic, current, and projected development of oil and gas in other BLM Districts; mapped geology; and foreseeable development potential in the planning area, activity over the next decade may be stable to increasing. Current petroleum developments and interest in other BLM Districts in Oregon, and the increasing value of petroleum products (Energy Information Administration 2007), indicates potential interest within the districts. The supply of natural gas in the region may be augmented by one or more proposed Liquefied Natural Gas terminals that may be sited within the districts' boundaries. Oil and gas activity on BLM-administered mineral rights within the Districts is expected to

consist of competitive and over-the-counter leases, geophysical surveys, and processing of Applications for Permit to Drill.

Some exploration for coal bed natural gas in the form of coal seam investigation and mapping is also predicted, especially of the Rouge River Coal Field. However, development of coal bed natural gas in the district is not expected within the next 10 years. This is due to the length of research time needed to delineate a field and the current rate of advancement of the Coos Basins field. It should be noted that if commercial coal bed natural gas developments do occur within the State, other coal bed natural gas prospects could develop rapidly.

Of the districts analyzed, the Roseburg District maintains the highest potential, although moderate in classification. Three identified plays and area of exploration have a *moderate potential for occurrence* and a *moderate potential for development*. Therefore, it is projected that the acreages managed by the Roseburg BLM within these plays and area of exploration would have the greatest probability for exploration and development within the next 10 years. All of the other Districts analyzed in this study would have a *low probability* for development within the next 10 years. Therefore, acreages of impacts will only be analyzed for those BLM-administered *moderate potential* lands located within the Roseburg District.

Because the lands in the Roseburg District are considered *moderate in potential* (USDI BLM 1985) and due to the classification of low to moderate potential by Ryu et al. (1996), development of these lands could range from none to the maximum. Therefore, while there is no indication of eminent development, the following analysis will utilize the maximum potential. That potential is based on development of *moderate potential* lands at one well per 160-acre spacing (spacing currently employed at the Mist Gas Field). The total BLM-administered and non-BLM-administered acreage of this defined *moderate potential* is approximately 247,000 acres The total acreage of BLM-administered *moderate potential* lands in the Roseburg District is approximately 37,000 acres or 15% of the area. Total well development of both BLM and non-BLM managed area would be 1,555 wells. Maximum development on BLM-administered lands would be 228 wells. However, as these are unproven potentials, and the reservoir will not be uniform, it is unlikely that more than 50% of total development will occur within the 10-year scenario. Therefore, given the *moderate potential* of the area, the range of development for BLM lands in the 10-year scenario is 0 to 114 wells.

Geophysical Exploration

Geophysical exploration is conducted to try to determine the subsurface geologic structure of an area. The three geophysical survey techniques generally used to define subsurface characteristics are measurements of the gravitational field, magnetic field, and seismic reflections.

Gravity and magnetic field surveys usually involve the use of aerial surveillance, utilizing aircraft. There are usually no ground disturbing activities to the project areas associated with this analysis.

Seismic reflection surveys, which are the most common of the geophysical methods, produce the most detailed subsurface information. Seismic surveys are accomplished by sending shock waves, generally by a small explosion or mechanically vibrating the ground surface. Instruments measure the time and intensity with which the waves reflect off stratigraphic layers. This information can be used to depict the subsurface structure of the rock. Vibroseis (Thumper) methods vibrate the ground surface to create a shock wave. "Thumper" trucks are quite large and are equipped with "pads" that cover about four-feet square. The pads are lowered to the ground, and the vibrators are electronically triggered in close coordination with the technicians operating the recording equipment. After the signal is recorded, the trucks move forward a short distance and the process is repeated. Up to 50 square feet (five square meters) of surface area is required to operate the equipment at each recording site.

The small explosive method requires that charges be detonated on the surface or in a drill hole. Holes for the charges are drilled utilizing truck-mounted portable drills to create small-diameter (two or six-inch) holes,

which are typically drilled to depths of between 50 and 100 feet. Generally 4 to 12 holes are drilled per mile of line and a 5 to 50-pound charge of explosives is placed in the hole, covered, and detonated. The created shock wave is recorded by geophones placed in a linear fashion on the surface. In rugged terrain, a portable drill carried by helicopter can sometimes be used. A typical drilling seismic operation may utilize 10 to 15 men operating five to seven trucks, although portable "buggies" that can be hauled behind smaller four-wheel drive All Terrain Vehicles are also commonly used in more sensitive areas.

Advanced Three Dimensional Survey (3-D Survey) is utilized within the Mist Gas Field. This process analyzes five to six miles using lines with 1,700 shot holes at 70-foot spacing. The lines are spaced at 400 feet apart. The lines are hand brushed (no surface disturbance) for survey. The survey crews utilize an Inertial Survey System that allows for accurate surveying without the need to maintain a line of sight. This allows flexibility in brushing paths. The shot hole pad is three feet by four feet (3x4) in size. The pad is hand cleared to mineral soil with hand tools. The drill rig is then placed on the pad. If existing access to the pad is limited, the drill rig is placed and removed by helicopter. The holes are drilled to 15-foot depths. The charge is exploded subsurface, leaving no surface expression. Where there is surface expression, the damaged is mitigated with hand tools. In open valleys and areas with access, thumper rigs are used, as they disturb even less ground. These requirements are in place because the Mist Gas Field is located in Commercial Forest land and is required by the land manager to minimize disturbance to near non-existent (Meyer 2007).

Surface Impacts of Geophysical Explorations

It is anticipated that the foreseeable geophysical activity in the identified Moderate Potential lands within the Roseburg District would consist of the currently used 3-D Seismic process. The total area of the identified BLM-administered potential expansion area is approximately 57 square miles (approximately 37,000 acres). Using the 3-D spacing of shots, it is anticipated that complete investigation of the area could utilize 16,150 shots. With pad ground disturbance of 12 square feet, the total disturbance on BLM-administered lands could be up to 4.5 acres. This disturbance is created using hand tools, no power tools other than those needed for brushing, and, based on experience in the Mist Gas Field, is completely reclaimed within five years or less (Meyer 2007). Disturbance will be less where pre-existing roads and/or landings can be used. Therefore, estimates to disturbance on non-BLM managed lands are indeterminate.

Drilling and Production Phase

Notices of Staking may occur during the plan period. Companies usually submit an Application for Permit to Drill after the Notice of Staking is accepted. Private surface owner input, if a split estate is involved, would be actively solicited during this stage. After the Application for Permit to Drill is approved, the operator initiates construction activities in accordance with stipulations and Conditions of Approval (COAs). Access road lengths vary, but usually the shortest feasible route is selected to reduce the haul distance and construction costs. In some cases, environmental factors or landowner's wishes may dictate a longer route. Drilling activity in the planning area is predicted to be done using existing roads and constructing short roads to access each drill site location. The district will utilize currently developed and utilized forest management Best Management Practices, in addition to the BLM's "Gold Book" (USDI/USDA 2007), for surface disturbance in road construction and pad development similar to timber harvest landings.

Based on past oil and gas drilling in Oregon, it is projected that three conventional petroleum exploratory "wildcat" wells could be drilled within the Roseburg District. The estimated success rate of finding hydrocarbons is predicted to be no greater than 10 percent, based on the average U.S. wildcat well success rate. Future identification of additional structures would likely increase this estimate. Development within the identified *moderate potential* area would be directed by 3-D Survey as opposed to wildcatting (Meyer 2007).

Based on spacing units established within the Mist Gas Field, full production development of the projected approximate 37,000 acres of BLM-administered *moderate potential* lands within the Roseburg District would

require a total of 228 wells. However, as these are unproven potentials, and the reservoir will not be uniform, it is unlikely that more than 50% of total development will occur within the 10-year scenario. Therefore, given the Moderate Potential of the area, the range of development for BLM-administered lands in the 10-year scenario is 0 to 114 wells.

Surface Impacts of Drilling and Production

There are currently no production or exploration wells or pads within any of the districts' boundaries. Development of the *moderate potential* lands identified within the Roseburg District could require up to 114 wells on BLM-administered lands within the 10-year scenario. It is anticipated that all gas production would be carried by collector pipelines placed within road rights-of-way.

The identified plays range from 5 miles to 22 miles from the north-south Northwest Pipeline System that runs within the I-5 Corridor. A review of existing private and public roadways between the plays and the pipeline indicates an adequate transportation system of road right-of-way to accommodate collector pipelines (USDI BLM 2008). The only additional pipeline right-of-way that would be required would be to connect new wells to existing roadways. These lines would be placed along right-of-ways for new road construction. Therefore, it is not anticipated that pipeline rights-of-way would create an additional disturbance beyond existing and new road rights-of-way.

Initially operators would move construction equipment over existing roads to the point where the new drill site access road begins. Based on existing road systems and access, the use of 3-D Survey, and directional drilling, it is anticipated that most well development will utilize existing road infrastructure to develop the resource. However, it may be necessary to construct up to a quarter mile of access for each pad to remove the facility from the active roadway. Based on the ability to cluster wells (assumed to be four wells per pad), it is estimated that no more than 97 miles total of new road construction would be required on both BLM-administered and non-BLM lands. No more than 7.0 miles of new road construction on BLM-administered lands would be needed in full development of 114 wells. Most would be moderate duty access roads with a travel surface 18 to 20 feet wide. The total surface disturbance width would average 40 feet including ditches, utilities, pipelines, cuts, and fills. The total acreage impacted by new road building for both BLM and non-BLM managed lands would be 470 acres. Total disturbance for new roads on BLM-administered land would be approximately 34 acres. Roads not subsequently needed for other resource management would be reclaimed at the end of the project (USDI/USDA 2007).

In the second part of the drilling phase, the operator would construct the drilling pad or platform, anticipated to involve approximately two acres per well site. Support facilities are anticipated to disturb about two acres per well site. Total disturbance could be up to four acres per pad, with each pad containing four or more wells. The likely duration of well development and testing is predicted to be approximately six months to one year for each drill site. Total disturbance to BLM-administered and non-BLM lands in the *moderate potential* area is estimated to not exceed 1,555 acres. Disturbance of BLM-administered lands within the Moderate Potential area is not to exceed 114 acres.

Total disturbance of both BLM-administered lands and other lands for wells, support services, pipeline and new road construction within the District is expected to be approximately 2,025 acres (1% of the total Roseburg District Moderate Potential acreage). Total disturbance for <u>just</u> BLM-administered land with development of 114 wells is expected to be approximately 153 acres (0.5% of projected BLM-administered within the Roseburg District Moderate Potential acreage).

Surface disturbance would be restricted, as much as possible, to previously disturbed areas such as logging roads and landings. Industry is currently utilizing a multi-well to single pad approach which minimizes impact.

Interim reclamation would reduce initial disturbance. After initial construction, unused portions of well site areas would be reclaimed while the wells are in production. Disturbance will be limited to areas within overwork foundation structures and necessary infrastructure, such as well heads, pipelines, and access roads, as described in federal reclamation guidance (USDI/USDA 2007).

Therefore, the maximum development disturbance for the *moderate potential* lands managed by the BLM assumed in this 10-year scenario would range from zero to the maximum disturbance of approximately 153 acres.

Plugging and Abandonment

Wells that are completed as dry holes are plugged according to a plan designed specifically for the down-hole conditions of each well. Plugging is usually accomplished by placing cement plugs at strategic locations from the bottom of the well to the surface. Drilling mud is used as a spacer between plugs to prevent communication between fluid-bearing zones. The casing is cut off at least three feet below ground level and capped by welding a steel plate on the casing stub. Wells will be plugged and abandoned at the end of their production life, with the pad, support facilities, and road fully reclaimed.

Surface Impacts of Plugging and Abandonment

After plugging, all equipment and debris would be removed and the drill site would be restored as near as reasonably possible to its original condition. If new roads constructed for drilling are not needed for future access to the area, the road would be reclaimed using Best Management Practices established for the District, with the road prism revegetated as required by the Authorized Officer. Pipelines will be removed or plugged and abandoned in place to minimize new surface disturbance (USDI/USDA 2007).

Limitations

The acreage estimates used for BLM-administered surface estate are based upon current GIS layers, with acreage approximations to the nearest thousand. The accuracy of this information has not been verified against the Master Title Plats. The GIS coverage for subsurface estate within the district is incomplete. Therefore, the existence and location of BLM-administered subsurface estate within the district is not fully known.

A brief review of the Master Title Plats was completed within and near the Mist Gas Field, 1985 boundaries. Federal subsurface estate identified on the Master Title Plats was not recorded on the GIS layers. Most of the Mater Title Plats that identified federal subsurface parcels were outside the Mist Gas Field boundaries. One parcel was identified within the Mist Gas Field boundary. Due to the incompleteness of the GIS layers, BLM-administered acreage of the surface and subsurface will need to be verified through review of Mater Title Plats prior to exploration and development.

Proposed Restrictions and Requirements on Mineral and Energy Exploration and Development Activity

Introduction

This section discusses the leasing stipulations as they will be applied to BLM-administered lands in the planning area under each alternative. Operating standards pertinent to the locatable and salable minerals program are also described. Mineral exploration and development on Federal lands must also comply with laws and regulations administered by several agencies of the State of Oregon; however, these requirements are not discussed in this document.

Leasable Mineral Resources

Oil and Gas Leasing

The Mineral Leasing Act of 1920 (as amended) provides that all publicly owned oil and gas resources be open to leasing, unless a specific land order has been issued to close the area. Through the land use planning process, the availability of these resources for leasing is analyzed, taking into consideration development potential and surface resources. Constraints on oil and gas operations are identified and placed in the leases as notices and stipulations. Oil and gas leases are then issued from the BLM Oregon State Office in Portland. Specific proposed notices and stipulations are listed by alternative later in this appendix.

The issuance of a lease conveys to the lessee an authorization to actively explore and/or develop the lease, in accordance with the attached stipulations and the standard terms outlined in the Federal Onshore Oil and Gas Leasing Reform Act (FOOGLRA). Restrictions on oil and gas activities in the planning area will take the form of timing limitations, controlled surface use, or no surface occupancy stipulations used at the discretion of the Authorized Officer to protect identified surface resources of special concern.

The field office that reviews the lease tract will attach stipulations to each lease before it is offered for bid. The review will be conducted by consulting the direction given in this Resource Management Plan. In addition, all lands administered by BLM within the planning area will be subject to the lease notices as shown on the following pages. All Federal lessees or operators are required to follow procedures set forth by: Onshore Oil and Gas Orders, Notices to Lessee (NTL), The Federal Oil and Gas Royalty Management Act (as amended), The Federal Onshore Oil and Gas Leasing Reform Act, and Title 43 Code of Federal Regulations, Part 3100.

Oil and Gas Operations

Geophysical Exploration

Geophysical operations may be conducted regardless of whether the land is leased or not. Notices to conduct geophysical operations on BLM surface are received by the resource area. Administration and surface protection are accomplished through close cooperation of the operator and the BLM. Seasonal restrictions may be imposed to reduce fire hazards, conflicts with wildlife, watershed damage, etc. An operator is required to file a "Notice of Intent to Conduct Oil and Gas Exploration Operations" for all geophysical activities on public land administered by the BLM. The notice should adequately show the location and access routes, anticipated surface damages, and time frame. The operator is required to comply

with written instructions and orders given by the Authorized Officer, and must be bonded. Signing of the Notice of Intent by the operator signifies agreement to comply with the terms and conditions of the notice, regulations, and other requirements prescribed by the Authorized Officer. A pre-work conference and/ or site inspection may be required. Periodic checks during and upon completion of the operations will be conducted to ensure compliance with the terms of Notice of Intent, including reclamation.

Drilling Permit Process

The federal lessee or operating company selects a drill site based on spacing requirements, subsurface and surface geology, geophysics, topography, and economic considerations. Well spacing is determined by topography, reservoir characteristics, protection of correlative rights, potential for well interference, interference with multiple-use of lands, and protection of the surface and subsurface environments. Close coordination with the State would take place. Written field spacing orders are issued for each field. Exceptions to spacing requirements involving Federal lands may be granted after joint State and BLM review.

Notice of Staking

After the company makes the decision to drill, it must decide whether to submit a Notice of Staking or apply directly for a permit to drill. The Notice of Staking is an outline of what the company intends to do, including a location map and sketched site plan. The Notice of Staking is used to review any conflicts with known critical resource values and to identify the need for associated rights-of-way and special use permits. The BLM utilizes information contained in the Notice of Staking and obtained from the on-site inspection to develop conditions of approval to be incorporated into the application for permit to drill. Upon receipt of the Notice of Staking, the BLM posts the document and pertinent information about the proposed well in the District Office for a minimum of 30 days prior to approval, for review and comment by the public.

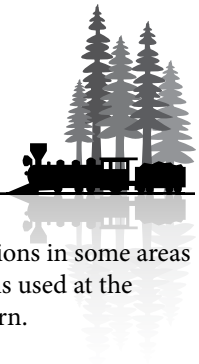
Application for Permit to Drill (APD)

The operator mayor may not choose to submit a Notice of Staking; in either case, an Application for Permit to Drill must be submitted prior to drilling. An Application for Permit to Drill consists of two main parts: a 12-point surface plan that describes any surface disturbances and is reviewed by resource specialists for adequacy with regard to lease stipulations designed to mitigate impacts to identified resource conflicts with the specific proposal, and an 8-point subsurface plan that details the drilling program and is reviewed by the staff petroleum engineer and geologist. This plan includes provisions for casing, cementing, well control, and other safety requirements. For the Application for Permit to Drill option, the onsite inspection is used to assess possible impacts and develop provisions to minimize these impacts.

Geothermal Leasing

The Geothermal Steam Act of 1970 (as amended) provides for the issuance of leases for the development and utilization of geothermal steam and associated geothermal resources. Geothermal leasing and operational regulations are contained in Title 43 Code of Federal Regulations, Part 3200. Through the land use planning process the availability of the geothermal resources for leasing is analyzed, taking into consideration development potential and surface and subsurface resources. Constraints on geothermal operations are identified and placed in the leases as stipulations. Geothermal leases are then issued by the BLM Oregon State Office in Portland.

Geothermal resources are first offered by competitive sale. Prior to a competitive lease sale, or the issuance of a noncompetitive lease, each tract will be reviewed, and appropriate lease stipulations will be included. The review will be conducted by consulting the direction given in this resource management plan. The issuance of a lease conveys to the lessee authorization to actively explore and/ or develop the lease in accordance with regulations and lease terms and attached stipulations. Subsequent lease operations must be conducted in accordance with the regulations, Geothermal Resources Operational Orders, and any Conditions of



Approval developed as a result of site-specific NEPA analysis. In the planning area, restrictions in some areas will include timing limitations, controlled surface use, or no surface occupancy stipulations used at the discretion of the Authorized Officer to protect identified surface resources of special concern.

In addition to restrictions related to the protection of surface resources, the various stipulations and conditions could contain requirements related to protection of subsurface resources. These may involve drainage protection of geothermal zones, protection of aquifers from contamination, or assumption of responsibility for any unplugged wells on the lease. Development of geothermal resources can be done only on approved leases. Orderly development of a geothermal resource, from exploration to production, involves several major phases that must be approved separately. Each phase must undergo the appropriate level of NEPA compliance before it is approved and subsequent authorizations are issued.

Leasing Notice and Stipulation Summary

On the following pages, the mineral leasing notices and stipulations are shown as common for all alternatives. These are considered to be the minimum necessary to issue leases in the operating area. Under all alternatives, the standard and the special status species leasing stipulations will be utilized on most lands. The powersite stipulation (USDI BLM Form 3730-1, Powersite Stipulation) would be utilized on lands within powersite reservations.

Stipulations also include waiver, exception, and modification criteria. If the Authorized Officer determines that a stipulation involves an issue of major concern, waivers, exceptions, or modifications of the stipulation will be subject to at least a 30-day advance public review. Waiver, exception, and modification are defined as follows:

- *Waiver* - The lifting of a stipulation from a lease that constitutes a permanent revocation of the stipulation from that time forward. The stipulation no longer applies anywhere within the leasehold.
- *Exception* - This is a one time lifting of the stipulation to allow an activity for a specific proposal. This is a case-by-case exemption. The stipulation continues to apply to all other sites within the leasehold to which the restrictive criteria apply. It has no permanent effect on the lease stipulation.
- *Modification* - This is a change to a stipulation that either temporarily suspends the stipulation requirement or permanently lifts the application of the stipulation on a given portion of the lease. Depending on the specific modification, the stipulation mayor may not apply to all other sites within the leasehold to which the restrictive criteria apply.

Whenever a special stipulation, such as No Surface Occupancy (NSO), Timing, or Controlled Surface Use (CSU) is used, the need for the special stipulation is described in the "Objective" that follows the stipulation. By imposing these special stipulations, it has been concluded that less restrictive stipulations would not be adequate to meet the stated objective.

Leasing Notices

The following Notices are to be included in each lease for all lands administered by BLM within the planning area where the pertinent resource potential exists. Lease notices are attached to leases in the same manner as stipulations; however, there is an important distinction between lease notices and stipulations: lease notices do not involve new restrictions or requirements. Any requirements contained in a lease notice must be fully supported by either laws, regulations, policy, onshore oil and gas orders, or geothermal resources operational orders.

Leasing Notices Common to All Alternatives

Notice

Special Status Species Stipulation

Resources: Botany and Wildlife

Stipulation: (All the)/(Certain) lands within this lease are within the suitable habitat of the (identify all Federal Threatened (FT), Endangered (FE) or Proposed Threatened (PT) and Proposed Endangered (PE) species, including scientific names), (an officially listed)/(a proposed for listing) Threatened or Endangered species. The Authorized Officer, through an environmental review process, has determined that because of the habitat characteristics of this species, all future post-lease operations must be analyzed and subjected to a U.S. Fish and Wildlife Service (FWS) Section 7 consultation or conference to ensure the action is not likely to jeopardize the continued existence of the species or result in the destruction or adverse modification of critical habitat.

(All the)/(Certain) lands within this lease are known to bear the species listed (Insert list of species) which has (have) protected status as (State Threatened (ST); State Endangered (SE); Federal Candidate (FC); Bureau Sensitive (BS)); or are within the suitable habitat of (identify all State Threatened, State Endangered, Federal Candidate, or Bureau Sensitive species, including scientific names). These species are protected by BLM policy as described in Manual 6840. All future post-lease operations must be analyzed, utilizing recent field data collected at the proper time of year, to identify the presence of such species. If the field examination indicates that the proposed activity may adversely impact FC species, technical assistance will be obtained from FWS to ensure that actions will not contribute to the need to list a federal candidate as a federal threatened or endangered species. Technical assistance may be obtained from FWS to insure that actions will not contribute to the need to list a ST, SE, or BS species as a federal threatened or endangered species. Therefore, prior to any surface disturbing activities or the use of vehicles off existing roads on (this lease)/(the lands legally described as: _____. BLM approval is required. This restriction also applies to geophysical activities for which a permit is required. The approval is contingent upon the results of site specific inventories for any of the above mentioned species. The timing of these inventories is critical. They must be conducted at a time of year appropriate to determine the presence of the species or its habitat. The lessee is hereby notified that the process will take longer than the normal 30 days and that surface activity approval will be delayed.

If no FT, FE, PT, or PE species, or suitable habitat, are found during the inventories, then no formal Section 7 consultation with the USFWS will be necessary and the action will be processed using the procedures found in the applicable oil and gas Onshore Orders or geothermal resources operational orders. However, the lessee is hereby notified that, if any FT, FE, PT, PE, ST, SE, FC, or BS species are found during the inventories, or if the actions are proposed in designated or proposed critical habitat, then surface disturbing activities may be prohibited on portions of, or even all of the lease, unless an alternative is available that meets all of the following criteria: (a) The proposed action is not likely to jeopardize the continued existence of a threatened or endangered species; (b) the proposed action is not likely to destroy or adversely modify critical habitat for a threatened or endangered species; (c) the proposed action is consistent with the recovery needs in approved Fish and Wildlife Service recovery plans or BLM Habitat Management Plans for the threatened or endangered species; and (d) the proposed action will not contribute to the need to list species as federal threatened or endangered.

Objective: To protect officially listed or proposed threatened or endangered plant or wildlife species; and to insure that post leasing oil and gas or geothermal operations will not likely contribute to the need to list other special status species as threatened or endangered.

Exception: An exception may be granted by the Authorized Officer, if review of the proposed plan submitted by the operator indicates that the proposed action will have no effect on the (common name of species).

Modification: The boundaries of the stipulated area may be modified, by the Authorized Officer, if it is determined that portions of the area do no have any officially listed or proposed threatened or endangered species, federal candidate, state threatened or endangered species, or Bureau sensitive species, or their habitat.

Waiver: This stipulation may be waived if the (common name) is declared recovered and is no longer protected under the Endangered Species Act, or if other species found within the lease are no longer considered to be in the federal candidate, state threatened or endangered, or Bureau sensitive categories.

Notice

Cultural Resources: An inventory of the leased lands may be required prior to surface disturbance to determine if cultural resources are present and to identify needed mitigation measures. Prior to undertaking any surface-disturbing activities on the lands covered by this lease, the lessee or operator shall:

1. Contact the Bureau of Land Management (BLM) to determine if a cultural resource inventory is required. If an inventory is required, then;
2. The BLM will complete the required inventory; or the lessee or operator, at their option, may engage the services of a cultural resource consultant acceptable to the BLM to conduct a cultural resource inventory of the area of proposed surface disturbance. The operator may elect to inventory an area larger than the standard 10-acre minimum to cover possible site relocation, which may result from environmental or other considerations. An acceptable inventory report is to be submitted to the BLM for review and approval no later than that time when an otherwise complete application for approval of drilling or subsequent surface-disturbing operation is submitted.
3. Implement mitigation measures required by the BLM. Mitigation may include the relocation of proposed lease-related activities or other protective measures such as data recovery and extensive recordation. Where impacts to cultural resources cannot be mitigated to the satisfaction of the BLM, surface occupancy on that area must be prohibited. The lessee or operator shall immediately bring to the attention of the BLM any cultural resources discovered as a result of approved operations under this lease, and shall not disturb such discoveries until directed to proceed by the BLM.

Authorities: Compliance with Section 106 of the National Historic Preservation Act is required for all actions that may affect cultural properties eligible to the National Register of Historic Places. Section 6 of the Oil and Gas Lease Terms (DOI BLM Form 3100-11, Offer to Lease and Lease for Oil and Gas) requires that operations be conducted in a manner that minimizes adverse impacts to cultural and other resources.

Special Leasing Stipulations

The following special stipulations are to be utilized on specifically designated tracts of land as described under the various alternatives.

Leasing Stipulations Common To All Alternatives

No Surface Occupancy

Resource: Land Use Authorizations

Stipulation: Surface occupancy and use is prohibited on Recreation and Public Purposes (R&PP) and FLPMA leases.

Objective: To protect uses on existing R&PP and FLPMA leases.

Exception: An exception to this stipulation may be granted by the Authorized Officer, if the operator submits a plan demonstrating that impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The area affected by this stipulation may be modified by the Authorized Officer, if the land use authorization boundaries are modified.

Waiver: This stipulation may be waived by the Authorized Officer, if all land use authorizations within the leasehold have been terminated, canceled, or relinquished.

No Surface Occupancy

Resource: Recreation Sites

Stipulation: Surface occupancy and use are prohibited within developed recreation areas.

Objective: To protect developed recreation areas.

Exception: An exception to this stipulation may be granted by the Authorized Officer, if the operator submits a plan demonstrating that impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The boundaries of the stipulated area may be modified by the Authorized Officer, if the recreation area boundaries are changed.

Waiver: This stipulation may be waived, if the Authorized Officer determines that the entire leasehold no longer contains developed recreation areas.

No Surface Occupancy

A 30-day public notice period will be required prior to modification or waiver of this stipulation.

Resource: Special Areas Stipulation: Surface occupancy and use are prohibited within Areas of Critical Environmental Concern (ACEC).

Objective: To protect important historic, cultural, scenic values, natural resources, natural systems or processes, threatened and endangered plant species, and/or natural hazard areas of the ACEC.

Exception: An exception to this stipulation may be granted by the Authorized Officer, if the operator submits a plan demonstrating that impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The boundaries of the stipulated area may be modified by the Authorized Officer, if the ACEC or Environmental Education Area (EEA) boundaries are changed.

Waiver: This stipulation may be waived, if the Authorized Officer determines that the entire leasehold no longer contains designated ACECs or EEAs.

No Surface Occupancy

Resource: Progeny test sites.

Stipulation: Surface occupancy and use are prohibited within progeny test sites.

Objective: To protect progeny test sites.

Exception: None.

Modification: The boundaries of the stipulated area may be modified by the Authorized Officer, if the progeny test site boundaries are changed.

Waiver: This stipulation may be waived, if the Authorized Officer determines that the entire leasehold no longer contains progeny test sites.

No Surface Occupancy

A 30-day public notice period will be required prior to modification or waiver of this stipulation.

Resource: Visual Resource Management (VRM) Class I

Stipulation: Surface occupancy and use are prohibited in VRM Class I areas.

Objective: To maintain soil productivity, provide necessary protection to prevent excessive soil erosion on steep slopes, and to avoid areas subject to slope failure, mass wasting, piping, or having excessive reclamation problems.

Objective: To preserve the existing character of the landscape. Exception: An exception to this stipulation may be granted by the Authorized Officer, if the operator submits a plan demonstrating that impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The boundaries of the stipulated area may be modified by the Authorized Officer, if the boundaries of the VRM Class I area are changed.

Waiver: This stipulation may be waived by the Authorized Officer, if all VRM Class I areas within the leasehold are reduced to a lower VRM class. Areas reduced to VRM Class II will be subject to the Controlled Surface Use stipulation for visual resources, and areas reduced to VRM Class III will be subject to standard lease stipulations.

Controlled Surface Use

Resource: Soils

Stipulation: Prior to disturbance of any suspected unstable slopes or slopes over 60 percent, an engineering/ reclamation plan must be approved by the Authorized Officer. Such plan must demonstrate how the following will be accomplished:

- Site productivity will be restored.
- Surface runoff will be adequately controlled.
- Off-site areas will be protected from accelerated erosion, such as rilling, gullying, piping, and mass wasting.
- Water quality and quantity will be in conformance with state and federal water quality laws.
- Surface-disturbing activities will not be conducted during extended wet periods.
- Construction will not be allowed when soils are frozen.

Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan, which demonstrates that the impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The area affected by this stipulation may be modified by the Authorized Officer, if it is determined that portions of the area do not include suspected unstable slopes or slopes over 60 percent.

Waiver: This stipulation may be waived by the Authorized Officer if it is determined that the entire leasehold does not include any suspected unstable slopes or slopes over 60 percent.

Controlled Surface Use

A 30-day public notice period will be required prior to modification or waiver of this stipulation.

Resource: Visual Resource Management (VRM) Class II.

Stipulation: All surface-disturbing activities, semi-permanent and permanent facilities in VRM Class II areas may require special design including location, painting and camouflage to blend with the natural surroundings and meet the visual quality objectives for the area.

Objective: To control the visual impacts of activities and facilities within acceptable levels.

Exception: None. Modification: None.

Waiver: This stipulation may be waived, if the Authorized Officer determines that there are no longer any VRM Class II areas in the leasehold.

Note: **The following controlled surface use stipulations do not apply to the No Action Alternative.**

Controlled Surface Use

Resource: Deferred Timber Management Areas

Stipulation: Unless otherwise authorized, drill site construction and access through Deferred Timber Management Areas within this leasehold will be limited to established roadways.

Objective: To substantially maintain the existing level of older and multi-layered conifer forest through year 2023.

Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan demonstrating that impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The area affected by this stipulation may be modified by the Authorized Officer if it is determined that portions of the area do not include Deferred Timber Management Areas.

Waiver: This stipulation may be waived by the Authorized Officer if it is determined that the entire leasehold does not include Deferred Timber Management Areas.

Controlled Surface Use

Resource: Riparian Management Areas

Stipulation: Unless otherwise authorized, drill site construction and access through riparian management areas within this leasehold will be limited to established roadways.

Objective: To protect riparian vegetation and reduce sedimentation.

Exception: An exception to this stipulation may be granted by the Authorized Officer, if the operator submits a plan which demonstrates that impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The area affected by this stipulation may be modified by the Authorized Officer, if it is determined that portions of the area do not include riparian areas, floodplains, or water bodies.

Waiver: This stipulation may be waived by the Authorized Officer, if it is determined that the entire leasehold no longer includes Riparian Management Areas.

Controlled Surface Use

Resource: Late-Successional Management Areas

Stipulation: Unless otherwise authorized, drill site construction and access through Late-Successional Management Areas (LSMAs) within this leasehold will be limited to established roadways.

Objective: To protect vegetation and to retain and/or restore old-growth forest characteristics.

Exception: An exception to this stipulation may be granted by the Authorized Officer if the operator submits a plan which demonstrates that impacts from the proposed action are acceptable or can be adequately mitigated.

Modification: The area affected by this stipulation may be modified by the Authorized Officer if it is determined that portions of the area do not include LSMAs.

Waiver: This stipulation may be waived by the Authorized Officer if it is determined that the entire leasehold does not include LSMAs.

Locatable Minerals Surface Management Standards for Exploration, Mining, and Reclamation

The following operational standards for mining activities have been compiled to assist the miner in complying with the 43 CFR 3809 regulations, which apply to all mining operations on BLM administered lands. The manner in which the necessary work is to be done will be site specific, and all of the following standards may not apply to every mining operation. It is the mining claimant's and operator's responsibility to avoid "unnecessary or undue degradation," and to perform all the necessary reclamation work. Refer to the 43 CFR 3809 regulations for general requirements.

There is an intergovernmental agreement between the BLM and the Oregon Department of Geology and Mineral Industries that is designed to avoid duplication of regulations, inspections, and approval of reclamation plans as well as to minimize repetitive costs to mining operators. The following guidelines include some, but not all, of the requirements of the various State agencies overseeing mining operations.

Prospecting, Exploration, and Mining

Surface Disturbance

BLM Requirements

Operations ordinarily resulting in only negligible disturbance as defined in 43 CFR 3809.0-5(b) are considered to be casual use and no notification to or approval by the BLM is required. All operators proposing occupancy, timber removal, use of mechanized earth moving equipment, or suction dredges having hoses with an inside diameter greater than 4 inches which would cause a surface disturbance of 5 acres or less during any calendar year must provide written notice to the District Office at least 15 days prior to the commencement of any surface mining disturbance. For operations in sensitive areas or which will cause greater than 5 acres of surface disturbance, the operator is required to submit a plan of operations pursuant to the regulations in 43 CFR 3809.1-4.

State of Oregon Requirements

Any person engaging in mineral exploration that disturbs more than one surface acre or involves drilling to greater than 50 feet must obtain an exploration permit from the Oregon Department of Geology and Mineral Industries (DOGAMI). Mining operations involving 5,000 or more cubic yards of material per year or disturbing one or more acres of land will require an operating permit from DOGAMI.

Vegetation/Timber Removal

Remove only that vegetation which is in the way of mining activities. An application must be submitted to the Authorized Officer pursuant to 43 CFR 3821.4 describing the proposed use of merchantable timber from O&C lands for mining purposes. No merchantable trees may be cut until the application is approved and the trees are marked. The Roseburg BLM office recommends that small trees (less than 7 inches dbh) and shrubs be lopped and scattered, or shredded for use as mulch. Trees greater than or equal to 7 inches diameter breast height (dbh) are to be bucked and stacked in an accessible location unless they are needed for the mining operation

Firewood

Merchantable timber may not be used for firewood. Firewood permits may be issued to the operator for use in conjunction with the mining operation but no wood may be used until a permit is obtained from the BLM. Permits will be limited to hardwoods or salvage timber which is not considered to be merchantable. Firewood authorized for use in conjunction with a mining operation is not to be removed from the mining claim.

Topsoil

All excavations should have all the productive topsoil (usually the top 12 to 18 inches) first stripped, stockpiled, and protected from erosion for use in future reclamation. This also includes removal of topsoil before the establishment of mining waste dumps and tailings ponds, if the waste material will be left in place during reclamation.

Roads

Existing roads and trails should be used as much as possible. Temporary roads are to be constructed to a minimum width and with minimum cuts and fills. All roads shall be constructed so as to minimize negative impacts to slope stability.

Water Quality

When mining will be in or near bodies of water, or sediment (or other pollutants) will be discharged, contact the Department of Environmental Quality. A settling pond is required when mining operations discharge turbid water. It is the operator's responsibility to obtain any needed suction dredging, stream bed alteration, or water discharge permits required by the DEQ or other State agencies. Copies of such permits shall be provided to the Authorized Officer when a Notice or Plan of Operations is filed. All operations including casual use shall be conducted in a manner so as to prevent unnecessary or undue degradation of surface and subsurface water resources and shall comply with all pertinent Federal and State water quality laws.

Claim Monuments

State law prohibits the use of plastic pipe for claim staking in Oregon. The BLM policy requires all existing plastic pipe monuments to have all openings permanently closed. Upon loss or abandonment of the claim, all plastic pipe must be removed from the public lands. When old markers are replaced during normal claim maintenance, they shall be either wood posts or stone or earth mounds, constructed in accordance with the requirements of State law.

Drill Sites

Exploratory drill sites should be located next to or on existing roads when possible without blocking public access. When drill sites must be constructed, the size of the disturbance shall be as small as possible. Any operator engaging in mineral exploration that involves drilling to greater than 50 feet must obtain an exploration permit from the Oregon Department of Geology and Mineral Industries (ORS 517.962).

Dust and Erosion Control

While in operation, and during periods of shut-down, exposed ground surfaces susceptible to erosion will need to be protected. This can be accomplished with seeding, mulching, installation of water diversions, and routine watering of dust-producing surfaces.

Fire Safety

All State fire regulations must be followed, including obtaining a campfire permit or blasting permit, if needed. All internal gas combustion engines must be equipped with approved spark arresters.

Safety and Public Access

Under Public Law 167, the Government has the right to dispose and manage surface resources (including timber) on mining claims located after July 23, 1955. These rights are limited to the extent that they do not

endanger or materially interfere with any phase of an ongoing mining operation or uses reasonably incident thereto. Claims located prior to July 23, 1955 may have surface rights, if such claims were verified as being valid under Sections 5 and 6 of the Act. Most of the claims of record do not have surface rights.

Mining claimants shall not exclude the public from mining claims with force, intimidation, or "no trespassing" signs. In the interest of safety, the general public can be restricted only from specific dangerous areas (e.g., underground mines, open pits, and heavy equipment storage areas) by erecting fences, gates and warning signs. It is the operator's responsibility to protect the public from mining hazards. Gates or road blocks may be installed on existing or proposed roads only with BLM approval. Gates restricting public access onto a mine site will only be considered in such cases where there is a large area safety hazard created by the mining activity. The determination as to whether a safety hazard is large enough to warrant a gate will be determined on a case-by-case basis. Fences (rather than gates) or other approved barriers shall be utilized to protect the public from hazards related to small excavations, tunnels, and shafts.

Roads that cross private land to reach BLM-administered lands are controlled by the private parties. Although some of these roads have been assigned BLM road numbers, access may only be granted for administrative use to the BLM and its licensees and permittees under a nonexclusive easement. Mining claimants are not considered licensees or permittees and, therefore, must make their own arrangements with the private party to use such roads. No right is granted under any of the mining laws to use a road involved in a nonexclusive easement.

Sewage

Self-contained or chemical toilets are generally to be used at exploration or mining operations and their contents shall be disposed of at approved dump stations. Out-houses and uncontained pit toilets are considered unnecessary and undue degradation and are not allowed. Uncontained pit toilets are not allowed for other users of the public land in this district. No special rights regarding this issue are granted under the mining laws. County sanitation permits are required for all other types of sanitation facilities.

Structures

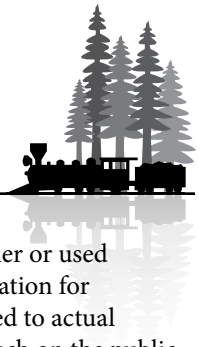
Permanent structures will not be allowed for exploration or prospecting operations. Permanent structures are fixed to the ground by any of the various types of foundations, slabs, piers, poles, or other means allowed by State or County building codes. The term shall also include a structure placed on the ground that lacks foundations, slabs, piers or poles, and that can only be moved through disassembly into its component parts or by techniques commonly used in house moving. Any temporary structures placed on public lands in conjunction with prospecting or exploration are allowed only for the duration of such activities, unless expressly allowed in writing by the Authorized Officer to remain on the public lands. Temporary structures are defined as structures not fixed to the ground by a foundation and that can be moved without disassembly into their component parts.

Permanent structures (as described in the paragraph above) may be allowed for mining operations if they are deemed reasonably incident to conducting the operations. Mining operations are defined as all functions, work, facilities, and activities in connection with development, mining, or processing mineral deposits.

All permanent or temporary structures placed on public lands shall conform with the appropriate State or local building, fire, and electrical codes, and occupational safety and health and mine safety standards.

Equipment

The claimant must maintain the claim site, including structures and equipment, in a safe and orderly condition. Only equipment and supplies that are appropriate, reasonable, and regularly used for exploration



or mining will be allowed on the claim. Equipment transportable by a pickup or small trailer or used only infrequently should not be stored on the claim and will not be considered as a justification for site occupancy. Accumulation of unused and/or inoperable equipment, materials not related to actual operations, and trash, garbage, or junk is not allowed on the public lands. The storage of such on the public land is unnecessary and undue degradation and will be treated accordingly.

Animals

If dogs or cats are to be present at the work site, the operator is required to keep them under control at all times so that they do not chase wildlife, or threaten other people, including government employees conducting site inspections on the public lands. Unless otherwise permitted, animals such as cows, chickens, goats, pigs or horses are not considered necessary to conduct mining operations and are not allowed on mining claims.

Suction Dredging

BLM Requirements

Cases Where a Notice or Plan of Operations is Required

Filing either a Notice or Plan of Operations may be required for all suction dredge operations where the dredge has an intake nozzle equal to or greater than 4 inches in diameter, or where any suction dredge operator proposes occupancy on BLM land (in excess of 14 calendar days per year) or the installation of structures of any kind. The determination of the need for a notice on smaller dredges will be made on a case by case basis.

No Notice or Plan of Operations Required

The use of a suction dredge in a stream, and having an intake nozzle of less than 4 inches in diameter, where no structures or occupancy beyond the 14 calendar day per year camping limit is proposed, will not generally require the filing of a Notice or Plan of Operations. Such activity is generally considered casual use.

State of Oregon Requirements

All suction dredge operations must be authorized by Permit #0700-J issued by the Department of Environmental Quality. This permit is issued free of charge for dredges having hoses with an inside diameter of 4 inches or less. Registration and a filing fee of $50 is required for suction dredges having hoses with an inside diameter greater than 4 inches. Mining operators should contact the Department of Environmental Quality, Water Quality Division, 811 S.W. Sixth Avenue, Portland, Oregon 97204, or the Roseburg DEQ office.

Suction dredging outside the "permitted work period" established for certain waterways by the Oregon Department of Fish and Wildlife (ODFW) will require written permission by an appropriate ODFW District Biologist.

The river beds of navigable waterways are controlled by the Oregon Division of State Lands.

Tailings Ponds

Settling ponds must be used to contain sediment, and any discharge must meet the standards of the Oregon Department of Environmental Quality.

Solid and Hazardous Waste

Trash, garbage, used oil, etc. must be removed from public land and disposed of properly. Trash, garbage or hazardous wastes must not be buried on public lands. The accumulation of trash, debris, or inoperable equipment on public lands is viewed as unnecessary degradation and will not be tolerated. Operators conducting illegal disposals shall be held financially responsible for the clean-up of such disposals.

Cultural and Paleontological Resources

Operators shall not knowingly alter, injure, or destroy any scientifically important paleontological (fossil) remains or any historical or archaeological site, structure, or object on federal lands or any identified traditional use areas. The operator shall immediately bring to the attention of the Authorized Officer, any paleontological (fossil) remains or any historical or archaeological site, identified traditional cultural properties, structure, or object that might be altered or destroyed by exploration or mining operations, and shall leave such discovery intact until told to proceed by the Authorized Officer. The Authorized Officer shall evaluate the discovery, take action to protect or remove the resource, and allow operations to proceed.

Threatened and Endangered Species of Plants and Animals

Operators shall take such action as may be needed to prevent adverse impacts to threatened or(endangered species of plants and animals and their habitat that may be affected by operations, as stipulated in guidelines developed through consultation with the U.S. Fish and Wildlife Service. Under Notice-level operations, if the review of the notice by BLM reveals that a potential conflict with a threatened or endangered species exists, the operator will be advised not to proceed and informed that a knowing violation of the taking provision of the Endangered Species Act will result in a notice of noncompliance and may result in criminal penalties. If the operator wishes to develop measures that will eliminate the conflict, then the Authorized Officer will arrange for the participation of BLM resource specialists and the U.S. Fish and Wildlife Service in reviewing the proposed revision to the Notice. If processing a proposed Plan of Operations indicates that a potential conflict exists with a threatened or endangered species or its habitat, the Authorized Officer shall notify the operator that the plan cannot be approved until BLM has complied with Section 7 of the Endangered Species Act. Special status species (Federal Candidate/ Bureau Sensitive) plants and animals, and their habitat will be identified by the Authorized Officer, and shall be avoided wherever possible.

Occupancy at Mining Sites

Living on public land in excess of 14 days per calendar year must be reasonably incident to and required for actual continuous mining or diligent exploration operations and will require either a Notice or Plan of Operations. In general, operations at the casual use level are not sufficient to warrant occupancy on a mining claim. The following discussion of occupancy only applies to those operators wishing to assert their right to live for an extended period or full-time on public lands pursuant to privileges granted under the mining laws. It does not apply to operators proposing to camp at prospecting or mining sites on weekends or one to two days during the week

Only those persons working on a continuous mining or exploration operation will be allowed to live on the claim beyond the 14-day per calendar year camping limit. A continuous mining or exploration operation is defined as an operation necessitating at least 40 hours of work per week at the operating site. The Oregon State Bureau of Labor and Industries generally considers that full-time work consists of a minimum of 40 hours worked per week. Each person proposing to live full-time at the site would be expected to conduct a minimum of 40 hours of work each week. Work hours are to be specified in the Notice or Plan of Operation at the time of submittal to the district BLM office. Should work hours be altered periodically or seasonally, it is the responsibility of the operator to notify the BLM (prior to the change) so that the Notice or Plan can be modified. Camping sites used in conjunction with mineral exploration or extraction operations are expected to be kept in a neat and orderly condition. If operations cannot be pursued due to high fire danger

in forested areas, then living on the claim site will not be permitted. Any occupancy beyond 90 days must be in accordance with the requirements of the County Planning Department.

Security Guard

In some cases, it may be reasonably incident for a security guard to live onsite to protect valuable property, equipment, or workings that are necessary for the mining operation, or to protect the public from site hazards. The need for a security guard shall be such that the person with those duties is required to be present at the site whenever the operation is shut down temporarily; or at the end of the workday; or whenever the mining claimant, operator, or workers are not present on the site. The proposed occupancy by a security guard must be described in the Notice or Plan of Operations.

Reclamation

Reclamation of all disturbed areas must be performed concurrently or as soon as possible after exploration or mining ceases and shall conform to the guidelines described in BLM Handbook H-3042-1. Reclamation shall include, but shall not be limited to:

1) saving topsoil for final application after reshaping disturbed areas;
2) measures to control erosion, landslides, and water runoff;
3) measures to isolate, remove or control toxic materials;
4) reshaping the area disturbed, applying topsoil, and revegetating disturbed areas where reasonably practicable; and
5) rehabilitation of fisheries and wildlife habitat.

When reclamation of the disturbed area has been completed, except to the extent necessary to preserve evidence of mineralization, the BLM must be notified so that an inspection of the area can be made.

Equipment and Debris

All mining equipment, vehicles, and structures must be removed from the public lands during extended periods of non-operation and/or at the conclusion of mining, unless authorization from the BLM is given to the operator or claimant in writing. Accumulations of debris and trash on mining claims are considered unnecessary and undue degradation and must be removed immediately regardless of the status of the operation. Failure to do so will result in the issuance of a notice of noncompliance or a citation under State law.

Backfilling and Re-contouring

The first steps in reclaiming a disturbed site are backfilling excavations and reducing high walls, if feasible. Coarse rock material should be replaced first, followed by medium sized material, with fine materials to be placed on top. Re-contouring means shaping the disturbed area so that it will blend in with the surrounding lands, minimize the possibility of erosion, and facilitate re-vegetation.

Seedbed Preparation

Re-contouring should include preparation of an adequate seedbed. This is accomplished by ripping or disking compacted soils to a depth of at least 6 inches in rocky areas and at least 18 inches in less rocky areas. This should be done following the contour of the land to limit erosion. All stockpiled settling pond fines, and then topsoil, shall be spread evenly over the disturbed areas.

Fertilizer

Due to the generally poor nutrient value of mined soils, it may be necessary to use fertilizer to ensure maximum yield from the seeding mixture. The fertilizer (16-16-16, or other approved mix) should be spread at the rate of 200 lbs/acre, but not allowed to enter streams or bodies of water.

Seeding

The BLM approved seeding prescription must be used to provide adequate re-vegetation for erosion control, wildlife habitat, and productive secondary uses of public lands. Seeding should be done in September or October in the Roseburg District to ensure that seed is in the ground prior to the first significant winter rains. If seeding fails, or is done at the wrong time, the operator may be asked to reseed the area at the appropriate time, as determined by the Authorized Officer.

Broadcast seeding is preferable on smaller sites. When using a whirlybird type seed spreader, it is important to keep the different seeds well mixed to achieve even seed distribution. For the best results, a drag harrow should be pulled over the seeded area to cover the seed before mulching. The Authorized Officer may recommend hydro-seeding on critical sites for rapid coverage and erosion control on cutbanks, fill slopes, and any other disturbed areas.

Tree Replacement

Replacement of destroyed trees may be necessary with the planting of seedlings or container stock.

Mulch

As directed by the BLM, during review of the Notice or Plan of Operations, the disturbed area may require mulching during interim or final reclamation procedures. Depending on site conditions, the mulch may need to be punched, netted, or blown on with a tackifier to hold it in place. In some cases, erosion control blankets may be cost effective for use.

Roads

After mining is completed, all new roads shall be reclaimed, unless otherwise specified by the BLM. High walls and cutbanks are to be knocked down or backfilled to blend with the surrounding landscape. All culverts shall be removed from drainage crossings and the fill shall be cut back to the original channel. The roadbed should be ripped to a minimum depth of 18 inches to reduce compaction and provide a good seedbed. The road must then be fertilized, seeded and mulched if necessary. When necessary, water bars are to be used to block access and provide drainage.

Tailings Ponds

The ponds should be allowed to dry out and the sediments removed and spread with the topsoil, unless the sediments contain toxic materials. If the ponds contain toxic materials, a plan will be developed to identify, dispose, and mitigate effects of the toxic materials. If necessary, a monitoring plan will also be implemented. The ponds should then be backfilled and reclaimed.

Visual Resources

To the extent practicable, the reclaimed landscape should have characteristics that approximate or are compatible with the visual quality of the adjacent area.

Guidelines for Development of Salable Mineral Resources

Proposed Operations

All proposed salable mineral developments, and any exploration that involves surface disturbance, should have operation and reclamation plans approved by the Authorized Officer. All proposals will undergo the appropriate level of review and compliance with the National Environmental Policy Act.

Quarry Design

Due to steep terrain in the operating area, most quarry developments would require a series of benches to effectively maximize the amount of mineral materials to be removed in a safe manner. In all cases, bench height shall not exceed 40 feet. If the bench would be used by bulldozers to access other parts of the quarry, the width of the bench should be at least 25 feet. If the bench won't be used by equipment, then this width can be reduced to approximately 10 feet.

Clearing of timber and brush should be planned at least 10 feet beyond the edge of the excavation limit. Most often the brush would be piled and burned at the site, or scattered nearby.

If at all possible, all topsoil and overburden should be stockpiled and saved for eventual quarry site reclamation. These piles may need to be stabilized by mulching or seeding in order to minimize erosion during the winter months.

As a standard procedure, the excavation of the quarry floor should be designed with an outslope of approximately two percent to provide for adequate drainage of the floor. Compliance with this design should be made a requirement of all operators at the site.

Operating Procedures

Where practicable, the following requirements should be made a part of every contract or permit providing for the use of mineral material sites on the district:

- Oversized boulders shall not be wasted, but shall be broken and utilized concurrently with the excavated material unless otherwise specified.
- The operator shall comply with local and State safety codes covering quarry operations, warning signs and traffic control. All necessary permits must be obtained from State and County agencies.
- Use of the site for equipment storage and stockpiling rock material is allowed for the duration of the contract or permit. Use of the site beyond that time would be authorized under a temporary use permit.
- All topsoil shall be stockpiled or windrowed as appropriate, for use in reclamation.
- Prior to abandonment, all material sites will be graded to conform with the surrounding topography. Topsoil will be utilized to create a medium for re-vegetation. Reseeding and tree planting, if necessary, will be done as prescribed by the Authorized Officer. Access roads no longer needed by the BLM will be abandoned and reclaimed as directed by the Authorized Officer.