Chapter 6 Surface Occupancy and Disturbance

6.1 Approach

Chapter 4 established that the shallowest formations of interest, the Vermejo and Raton Formations, have the highest potential for resource occurrence and development. The RFDS anticipates that development would begin with an initial test drilling phase where some (perhaps 5 to 10) wells would be drilled and tested to confirm resource potential and then subsequently completed as producers once infrastructure is available. It is believed that all available 160-acre equivalent coalbed methane *subsurface reservoir cells* would be developed within the 20–year duration of the RFDS. A subsurface reservoir cell is the term used here to describe the 3-dimensional reservoir volume that statutory regulations allow an operator to drain with one vertical or near-vertical deviated well. A cell will usually have a square 160-acre surface projection with a drilling "window" for a vertical-well pad to be placed near the center of this area. With regulatory approval, irregularly-dimensioned cells may have an irregular projection at the surface. Depending upon if, and when, downspacing might occur during the 20-year life of the RFDS (an event we cannot predict or assign a probability to) some or all of 80-acre equivalent infill (reduced density) cells could be added. Deeper, non-CBM targets are possible, but these could be tested as a consequence of drilling deeper for the purpose of disposing of water produced by the shallow CBM play. The approach taken in Chapter 6 is to estimate the number of feasible subsurface completions (one in each cell for vertical wells) that would be desirable under a full development scenario and then estimate the surface disturbance area associated with these completions.

Not all subsurface completions cause additional *surface locations* (well pads) to be constructed. For example, there are savings in terms of number of surface locations if water disposal wells and deep tests can be placed on pads that also accommodate producing CBM wells. There are also potential savings in the number of surface locations if directional drilling should prove economically feasible in the 20-year term. At present we believe that it is currently not *economically* feasible for highly deviated (or horizontal) wells to be constructed for cell drainage, otherwise this technique would be applied today at the Vermejo Park Ranch where such technology could be beneficial. We cannot predict *if* and *when* such well tech technology (which certainly currently exists but is very expensive) might become economically feasible. However, we acknowledge that it could become potential to do so within a 20-year time frame.

On a total acreage-only basis, if the entire 40,000-acre eastern Valle Vidal Unit were available for development on 160-acre spacing of surface locations for vertical wells, and irregular well placement was allowed for by regulatory approval, there would be 250 reservoir cells available for producing wells. This assumes that the coalbed methane resource is minimally (but sufficiently)

economic using lowest-cost vertical wells. It is not the purpose of this RFDS to cause withdrawals of acreage associated with the surface expression of these cells for any reasons other than geologic and customary statutory reasons. Any subsequent analyses by the Carson National Forest would examine interaction and potential conflicts of the development described here on other resources and in terms of overall environmental impacts. Figure 6.1 illustrates the surface projection of 191 subsurface reservoir cells which could be accessed by vertical or slightly deviated wells. This reduced number of accessible cells (from 250) is predicted based on two limiting factors: statutory and geologic. Figure 6.1 was constructed assuming only full 160 acre quarter section surface projection (surface locations) per cell. There are a number of "slivers" of land less than square 160 acres along the boundaries of the area that would normally not be drilled under standard spacing and well location rules. Many of these slivers, particularly along the western and southern boundaries, are also not conducive to physical occupation due to topography (e.g. cliffs, canyon walls). This withdrawal reduces the number of reservoir cells that could be accessed by standard vertical wells by 21. In addition, it is believed that fractured igneous intrusions (dikes) would channel water to producing wells and be undesirable neighbors to wells. A ¼ mile buffer was drawn around intrusions. 160-acre quarter sections that have more than 40 acres covered by the buffer were withdrawn reducing the number of reservoir cells/surface locations able to be occupied by standard vertical wells by another 38. A 300 ft buffer was placed on two major access roads 1914 and 1950 for illustration purposes only.

Of the 191 subsurface reservoir cells remaining, it is clear that some cannot be occupied at the surface due to topography based on rules that require a narrow window for well placement at the center of the quarter section. This is particularly true along the western and north-central margins of the eastern Valle Vidal Unit. However, no withdrawal of area was applied to those locations because flexible well location rules, combined with deviated (not horizontal) drilling, could make those reservoir cells accessible. Again, it is assumed that deeper wells will be drilled with the dual purpose of water disposal and testing deeper plays. These wells can be placed on a pad with a shallow well, but the surface footprint of the pad would cover a larger area.

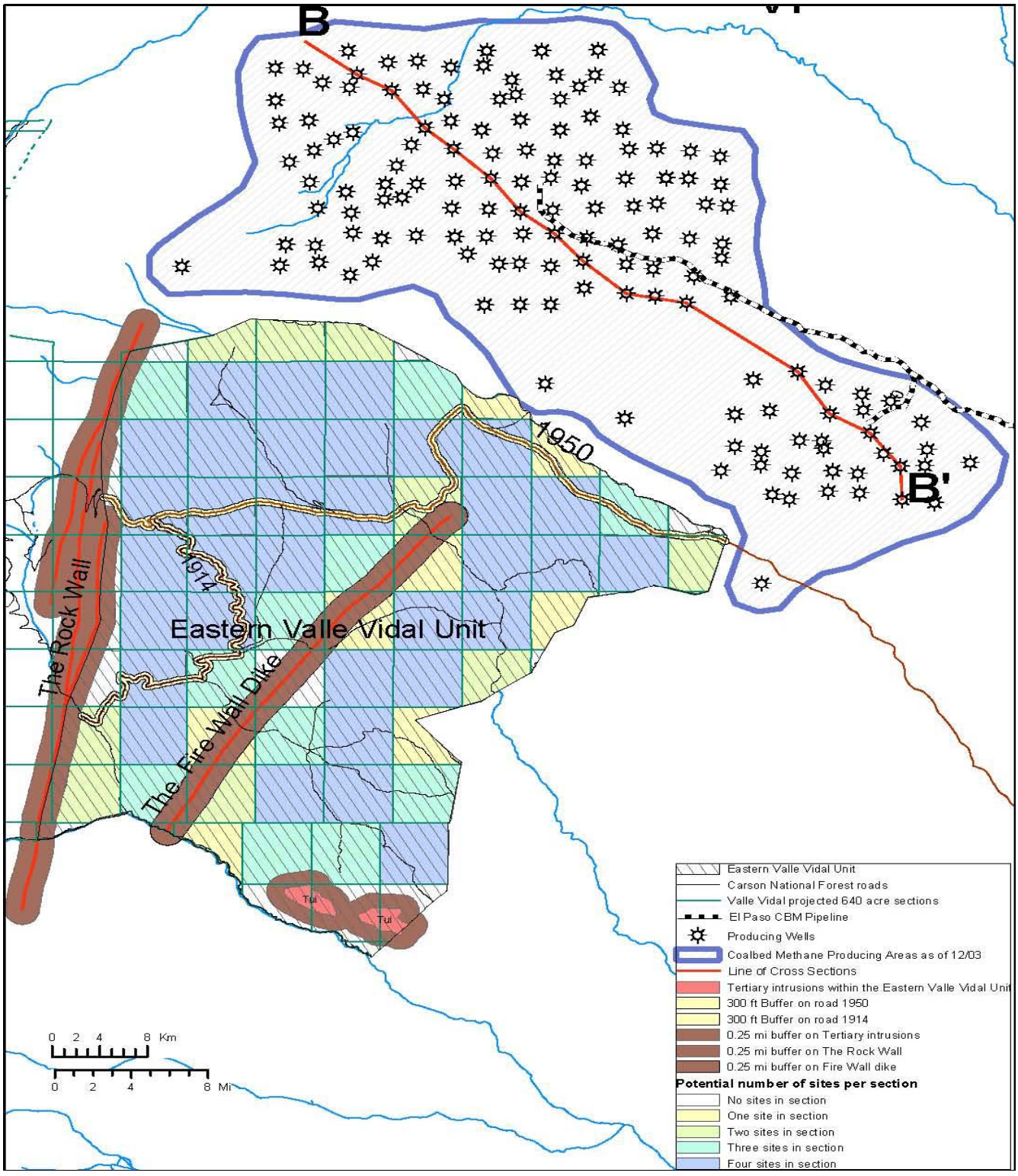

Figure 6.1 Map showing estimated minimum number of well locations for vertical wells for draining subsurface reservoir cells estimated to be likely for coalbed methane development in the eastern Valle Vidal Unit. To our knowledge, highlighted roads 1950 and 1914 are the only roads currently open for public access.

6.2 Surface well locations

A square-mile section equals 640 acres of surface area. Four, 160- acre vertical well locations can be placed in each section. Based on the approach outlined in section 6.1, a minimum of 191 surface locations would be required to fully develop the coalbed methane resource on of the eastern Valle Vidal Unit using vertical wells at 160-acre per well spacing. A surface location (well pad) is an area of land that is cleared and leveled to provide an area for temporarily accommodating, moving and storing large equipment for purposes of construction and maintenance of wells. Once wells are constructed, the area required for maintenance can be substantially less than that needed during the drilling and completion stages of construction. This is discussed further below.

An estimated four, deep, vertical, produced-water disposal wells will be required based on statutory regulations and operator practices on the Vermejo Park Ranch. These wells will not cause additional surface locations because they can be "twinned" on pads with producing wells, but the area of disturbance will be larger for surface locations that also accommodate disposal wells.

At this time, it is **not** anticipated that drainage of multiple subsurface reservoir cells will be economically achieved by drilling horizontally. The additional costs associated with horizontal drilling vary greatly depending upon the target the operator is trying to hit, the degree of accuracy that is required (the window of error) to hit the target, depth, reach (distance to terminus) of the well from drill pad, drilling methods (air, mud, foam, coiled tubing, etc.), availability of appropriate equipment, and transportation costs among others. We do not believe that this play is appropriate for horizontal drilling technology. This is due to the shallow depth of the CBM play, thin coal beds separated vertically over hundreds of feet (multiple targets), and potentially long horizontal reach.

6.3 Lease infrastructure

Lease infrastructure required includes natural gas- and water handling-related facilities and access roads. Natural gas infrastructure includes a trunk pipeline for transporting gas to market, a central compressor facility for compressing lease gas to required pipeline pressures, a gathering pipeline system that branches to the individual wells, and well pad equipment including wellheads and wellhead separators. It is assumed that the trunk pipeline would enter the property from the east, either connecting to the existing El Paso pipeline or following the right of way for Forest Road 1950 to connect to a pipeline paralleling Highway 64. Gas gathering pipelines could be laid beside access roads to individual wells. The central gas compression facility could be powered by combustion of lease gas or by electricity (the power source used at the Vermejo Park Ranch). If electricity is used, a power line would need to be strung or buried along the right of way accommodating the trunk gas pipeline.

Water handling-related infrastructure includes pump jacks to remove water from wells, flow lines to deliver water from wells to a storage tank battery, filtration equipment, injection pumps, and water disposal wells. Pump jacks could be powered by lease gas or by electricity (they are powered by electricity at the Vermejo Park Ranch). As many as four disposal sites may be required, each equipped with tanks and equipment houses. Flow lines between wells and disposal facilities can follow well access roads along with gas gathering lines. Electric lines, if used, could be strung or buried beside flow lines (lease power lines are buried at the Vermejo Park Ranch). .

6.4 Footprint of drilling and production operations

The surface disturbance normally associated with drilling and production operations is two acres per well pad plus an additional acre of right-of-ways for associated roads and pipelines. For 191 surface locations, this is 573 acres. Water disposal and central compression facilities would expand the footprint of a limited number of locations. Four water disposal facilities and one compressor site each having 3 acres of added area contribute an additional 15 acres for a *total infrastructure disturbance of 588 acres*. Additional surface disturbance would result if right-of-ways are not limited to roadways or if roadways are not placed optimally to reduce total surface area.

Of course the footprint of drilling and production operations is variable dependent upon the needs of the operator and the mutual goals set by the operator and land owner/manager. There are certainly alternative scenarios that could apply to the eastern Valle Vidal Unit. It is not the purpose of this RFDS to determine specific environmental impact of oil and gas operations, yet there are some obvious development alternatives that the land management agency could consider relative to oil and gas production options. The authors would encourage the Carson National Forest to consult with both the operator and surface owner of the Vermejo Park Ranch wells to consider potential working alternatives to standard oil and gas development practices. At the Vermejo Park Ranch, well pads have a much smaller (than standard) surface footprint, greatly reduced visual impact, reduced exhaust emissions, and reduced environmental impact overall due to specially negotiated conditions on timing and method of operations. As example, well locations take up only 0.5 acres. Roadways and right-of-ways are combined to a 30 ft wide path, but right-of-ways are immediately reclaimed to reduce the path to 20 ft. These measures alone reduce the surface disturbance attributable to individual wells by almost two-thirds. As described above, the assumption made to determine surface disturbance associated with individual well completions in this RFDS is the standard 2 acres per well pad plus an additional 1 acre of right-of-ways for associated roads and pipelines.