Exhibit 9

Literature review of the science on wintering grouse ecology and anthropogenic influences

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We examined 15 peer-reviewed studies addressing wintering sage-grouse ecology and movement, especially in relationship to the effects of anthropogenic disturbances. All studies reviewed utilized GPS collar, VHF telemetry or aerial transect data to draw inferences about sage-grouse wintering or migrating habitat requirements. Researchers have stressed the overall importance of wintering areas to sage-grouse because sage-grouse rely solely on sagebrush for nutrition during the winter months (Connelly et al. 2000), have fidelity to wintering areas (Berry and Eng 1985) and tend to congregate in areas that are small relative to overall annual use areas (Beck 1977, Swenson et al. 1987, Caudill et al. 2013, Smith et al. 2014). For example, Beck (1977) found that 80% of the winter use was in 7% of the total area. Eng and Schladweiler (1972) conclude that "a winter use area appears to be both a key habitat segment and a major factor in sage grouse distribution over a large area."

Sage-grouse migration from late brood-rearing to wintering habitat is an important component in ensuring that sage-grouse can actually get to their preferred winter range (Connelly J W et al. 1988, Fedy et al. 2012). Fedy et al. (2012) found that the mean distance travelled in all movement studies in Wyoming was 14.4 km; but noted that the max recorded movement was 83 km in the Pinedale (SW Wyoming). This is important because as is noted by Connelly et al (2000), "protection of sagebrush within a 3.2-km radius of leks is not sufficient (Beck 1977) because protecting sagebrush habitats associated with leks will not ensure that year-long habitat requirements are met for migratory populations of sage grouse."

Winter survival of sage-grouse is typically high (Connelly et al. 2011), but it is understood that severe winters can contribute to reduced annual survival (Moynahan et al. 2006), as can changes to the quality and availability of winter habitats where removal of sagebrush from ploughing resulted in reductions in sage-grouse populations (Swenson et al. 1987). Ensuring that high quality winter use areas remain available will likely help buffer sage-grouse population declines from severe winter conditions. As Moynahan et al (2006) emphasize: "Our observations during the severe winter of 2003–2004 underscore these beliefs and demonstrate that occasionally, even in areas of expansive, high-quality habitat such as south Phillips County [Montana], winters may be so severe as to have clear and substantial population-level impacts. We echo other researchers' recommendations that Sage-Grouse managers prioritize the identification and conservation of wintering areas"

Nine studies examined habitat selection of wintering sage-grouse and six considered anthropogenic disturbance as a factor in selection. Overall, the 6 studies investigate sage-grouse response to anthropogenic disturbance during the winter suggest that sage-grouse strongly select for sagebrush cover above snow and use is influenced by sagebrush height, canopy cover and topography (Doherty et al. 2008, Carpenter et al. 2010, Dzialak et al. 2012, Dzialak et al. 2013b, Holloran et al. 2015). Each of these studies found that wintering grouse avoided anthropogenic disturbances in some way and were influenced by development density, distance, and/or human activity levels associated with infrastructure (Doherty et al. 2008, Carpenter et al. 2010, Dzialak et al. 2012, Dzialak et al. 2013b, Smith et al. 2014, Holloran et al. 2015). The window size examined between these studies differed and ranged from approximately 0.75 - 25 km^2, and not all studies examined a range of scales of influence (which makes it difficult to infer a potential threshold). These studies also differ in how development was quantified and measured (e.g.

density, distance effects or human activity). Below we provide a summary of the aforementioned studies stratified by these categories:

- **Density** - Smith et al. (2014) found that the relative probability of occurrence decreased by approximately 3.3% for every 1% increase in surface disturbance (including energy infrastructure) within 0.75 km^2. Holloran et al. (2015) reported that well pad density was a better predictor of sage-grouse habitat selection, and reported that sage-grouse avoided areas with increasing well density; the authors reported that for each additional well pad within 2.8 km of a location, the number of individual sage-grouse detected decreased by between 1 and 4. Doherty et al. (2010) found that sage-grouse were 1.3 times more likely to occupy sagebrush habitats that lacked coalbed methane wells within a 4-km^2 area, compared to those that had the maximum density of 12.3 wells per 4 km^2 allowed on federal lands.
- **Distance** - Carpenter et al. (2010) examined the continuous distances of development influence and found that the relative probability of habitat selection by sage-grouse dropped sharply for habitats within 1,900 m of an energy well. Among all the studies reviewed, this study is the closest to indicating a possible threshold for sage-grouse in terms of distance to development. Holloran et al. (2015) found a distance effect from development and reported that for each 1-km increase in distance from a given location to a well pad the number of individual sage-grouse detected increased by between 13 and 17. Dzialak et al. (2013) examined the distance to nearest anthropogenic feature and concluded that it was an important factor in regulating sage-grouse occurrence, but did not analyze whether there was a threshold for this distance.
- **Activity** – Dzialak et al. (2012) built selection models for both daytime and nighttime sage-grouse habitat selection and found that sage-grouse avoided natural gas wells during the day, but did not find the same nighttime effect, suggesting that "avoidance of human activity appears to be a general feature of winter occurrence among sage-grouse." Holloran et al. (2015) compared sage-grouse avoidance of LGS (liquid gathering systems – well pads with LGS have less human activity associated with them during production phases of development because condensate and produced water are transported off-site via underground pipelines alleviating the need to visit pads for removal of these liquids) versus conventional wells and found a stronger response to conventional wells, suggesting that they are sensitive to human activity levels associated with infrastructure.

There is considerable science to support the conclusion that wintering sage-grouse avoid areas that 1) have high densities of infrastructure, 2) are within 1.9 km of infrastructure and 2) have high levels of human activity. Furthermore, there is evidence to suggest that the removal of sagebrush in winter concentration areas could lead to population declines. However, for management purposes, an exact threshold for disturbance levels and the amount of sagebrush required on the landscape is not yet fully understood. Lacking data for a specific threshold, authors *repeatedly caution* managers to avoid or greatly minimize disturbances in wintering areas due to the reliance and fidelity of grouse on these areas (Moynahan et al. 2006, Carpenter et al. 2010, Dzialak et al. 2013a, Holloran et al. 2015). Dzialak et al. (2013) summarize the current state of knowledge well: "A conservation plan…should aim to retain big sagebrush throughout large areas and constrain human activity to the greatest extent feasible within patches that have been identified as critical habitat."

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