GEOLOGICAL SURVEY OF WYOMING
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INVESTIGATION OF THE POTENTIAL FOR NEAR-SURFACE EXPLOSIVE CONCENTRATIONS OF METHANE TO OCCUR IN THE RAWHIDE VILLAGE SUBDIVISION, CAMPBELL COUNTY, WYOMING

by

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PLATES

CONCLUSIONS

Based on field and laboratory investigations of methane concentrations underlying the Rawhide Village subdivision, it is concluded that the entire subdivision is probably currently underlain by potentially explosive concentrations of methane (Plate C). Explosive concentrations (defined as between 5 and 15 percent methane) occur at less than four feet depth in an area centered in the southcentral portion of the subdivision in the vicinity of Salt Box Lane and Sitting Bull Lane (Plate C). The rest of the subdivision between the houses along Long's Lane and extending south to the southern margin of the subdivision (Plate C) is also underlain by potentially explosive concentrations of methane gas. The methane in these areas occurs at depths greater than four feet, but probably less than ten feet.

The trailer court area north of the subdivision known as Horizons was not tested by drilling during the investigation, but extrapolation of information from areas south of Horizons suggests that it may also be underlain by potentially explosive concentrations of methane. Drilling and testing in the Horizon's area, however, would be needed to verify this observation. For now, the existence of potentially explosive concentrations of methane beneath the Horizon's trailer park is not proven.

METHODOLOGY AND RESULTS

In an effort to define the potential risks of methane fires and explosions in the Rawhide Village subdivision, structure contour maps of the Upper and Lower Wyodak coals, a coal thickness map of the Lower Wyodak coal bed, an overburden thickness map on top of the Upper and Lower Wyodak coal beds, studies of coal gas

desorption, and an analysis of downhole methane concentrations based on mudlogs from 14 drill holes were prepared by the Geological Survey of Wyoming (Jones, et. al., 1987). In addition, a soil gas survey by Merschat, 1987, was examined and reviewed.

Since these initial investigations, the Geological Survey of Wyoming has also prepared (1) an isopach map of the total thickness of coal underlying the subdivision, which shows the combined thickness of the Upper and Lower Wyodak coal beds beneath the subdivision (Plate A), (2) an isopleth map of average methane concentration in the combined thickness of these two coals (Plate B), and (3) an isopleth map of near-surface methane concentrations based on Merschat's (1987) soil gas survey and methane concentrations indicated by mudlogs of the recent holes drilled in or adjacent to the subdivision (Plate C).

Based on both the earlier investigations (Jones et. al., 1987; Merschat, 1987) and more recent evaluations of these data (this report), it is apparent that the entire Rawhide Village subdivision is underlain by downhole and near-surface methane concentrations which indicate a high probability that methane could occur in high enough concentrations (5 to 15 percent methane) to ignite or explode anywhere in the subdivision.

ISOPACH MAP OF TOTAL COAL THICKNESS

Drilling in the Rawhide Village subdivision has established the existence of coal beds beneath the entire development (Jones, et. al., 1987). In this report, these coal beds are called the Upper and Lower Wyodak where they occur as two separate beds and the Wyodak coal bed where the Upper and Lower Wyodak coal beds merge to form a single, thick coal bed. The Wyodak coal bed is mapped as a single

bed where the Upper and Lower Wyodak coal beds are separated by less than ten feet of rock between them. The approximate position where the Wyodak "splits" into upper and lower coal beds is shown by the "split line" on Plate A.

In the area located approximately between Salt Box Lane and Crazy Horse Lane and in the east portion of the Rawhide Park area south of Long's Lane, the Upper Wyodak or the upper part of the Wyodak coal bed is absent, having been replaced by non-coal rocks of an ancient river channel system. This paleochannel directly overlies the Lower Wyodak coal bed or the lower part of the Wyodak coal bed.

Plate A shows the total thickness of the Wyodak coal bed as well as the cumulative total thickness of the Lower and Upper Wyodak coal beds. Rock partings within these coal beds as well as rocks between the Upper and Lower Wyodak coal beds were not included in the coal thicknesses. The thickest coal occurs in the subdivision at the intersection of War Chant Drive and Sitting Bull Lane, where it exceeds 130 feet in thickness. From this point, the coal thins to less than 60 feet thick in the southwest, east, and in an area along the eastern part of Battle Cry Lane. The thinnest coal drilled in the subdivision was at drill hole TH-13A, where a total of 54.5 feet of coal was drilled. The average thickness of coal encountered in the holes drilled in the subdivision is 94 feet.

AVERAGE METHANE CONCENTRATIONS IN WYODAK COAL BEDS

Using values reported on mudlogs, average methane concentrations in the Wyodak coal beds were calculated for 13 test holes drilled south of and within the Rawhide Village subdivision. Although these concentrations are more qualitative than quantitative, they do show the relative concentrations of methane present within the coal beneath the subdivision.

To calculate the average concentrations of methane in the 13 test holes, coal boundaries were picked from gamma ray-density logs. The methane concentrations were read at two-foot increments using the methane concentration curve on the mudlogs between the boundaries of the coal picked from the gamma ray-density logs. An average methane concentration for the total thickness of coal in each of the 13 wells was calculated (Plate B), and a isopleth map of average methane concentrations in the Wyodak coal beds beneath the subdivision was generated (Plate B).

The highest average methane concentration in the coal was in test hole TH-6A. Other very high average methane concentrations occurred in TH-17A, TH-22A, and TH-23A with somewhat lower values in TH-2A, TH-3A, TH-14A, and TH-19A. Based on the isopleth map, which depicts these concentrations (Plate B), there is an area of relatively high average methane concentration (40,000 ppm to greater than 160,000 ppm) in the southern end of the subdivision trending roughly east-west, which includes most of the area of high soil-gas methane as defined by Merschat, 1987. Average methane concentrations are generally higher where there are thicker expressions of total coal (Plate A). One exception is test hole TH-1A which had the lowest average methane concentration in the coal of all 13 test holes, yet the coal was 109.5 feet thick in that hole. One explanation for the relatively low methane concentrations in the coal in this drill hole is the thin overburden above the coal. The thin overburden coupled with the methane seeping at Rawhide Creek may have allowed the methane to escape in this area.

Another relationship exists between relatively high average methane concentrations in the coal and the depth of overburden. All drill holes which showed average methane concentrations in the coal of over 60,000 ppm, with the exception of TH-23A, had overburden thicknesses of 100 feet or more (Jones, et. al., 1987, Plate XI). Although TH-23A only had 52.5 feet of overburden, there is a large

split between the Upper and Lower Wyodak coals in this hole. The Lower Wyodak is over 160 feet deep and fairly thick (62 feet) and its average methane values are more than 2.5 times as large as the Upper Wyodak's.

ISOPLETH MAP OF NEAR-SURFACE METHANE CONCENTRATIONS

Using data generated by the methane soil gas survey by Merschat (1987) and near-surface methane concentrations as determined from mudlogs of holes drilled in and adjacent to the subdivision, an isopleth map of near-surface methane concentrations was prepared (Plate C). For comparative purposes, the isopleth intervals shown on the isopleth map are drawn using the same intervals as used by Merschat (1987), with one exception. The 50,000 ppm (five percent) isopleth line was extrapolated from Merschat's (1987) methane soil gas survey. Concentrations of near-surface methane above 10,000 ppm exceed 40,000 ppm in the subdivision north of the 10,000 ppm isopleth line (Plate C). These concentrations are annotated beside each of the drill hole locations in this portion of the subdivision.

From this isopleth map, it is apparent that methane concentrations under the entire subdivision could exceed the concentrations necessary for ignition and(or) explosion of methane (5 to 15 percent). Merschat's (1987) methane soil gas survey indicates these concentrations are within four feet of the surface in the south-central portions of the subdivision in the vicinity of Salt Box Lane and Sitting Bull Lane. Because near-surface concentrations of methane from mudlogs fit Merschat's isopleth lines in the southcentral portion of the subdivision, it can be concluded that relatively high, near-surface concentrations of methane as indicated from the mudlogs are valid throughout the subdivision. It is also concluded that in areas where the mudlog concentrations are greater than concentrations indicated by Merschat (1987), the drill hole concentrations are measuring subsurface methane

concentrations at depths greater than four feet. Although the exact depth of these concentrations is unclear, these concentrations are believed to be between four feet and no more than ten feet below the surface. Although it is unclear why these concentrations are not detectable at the surface, apparently there is currently some near-surface barrier that prevents the gas from coming to within four feet of the surface. A denser sampling interval for methane soil gas using Merschat's techniques, however, may indicate that there are more areas where the methane is closer to the surface.

SUMMARY

In summary, the entire subdivision is currently underlain by near-surface methane concentrations that could reach concentrations sufficient to allow ignition or explosion of methane. Although it is currently impossible to quantitatively assess the long term potential for increased surface manifestations of methane concentrations under the subdivision, the high concentrations of methane intersected downhole in the drill holes (Plate B) indicates that given the right set of circumstances, this downhole methane could vent at the surface. Activities by man such as digging, drilling, or mine dewatering, as well as natural fluctuations in the water table i.e., drought conditions, or even recent and future seismic activity could affect the upward propagation of methane to the surface.

The methane venting problem at the Rawhide Village subdivision is apparently the result of many factors to include the facts (1) that it was built over a thick expression of coal (54.5-130 feet) which has been shown to desorb methane, (2) that structural features under the subdivision are natural accumulation areas for methane, (3) that paleochannel margins under the subdivision are in some cases related to surface discharge points for methane, and (4) that there are signifi-

cantly high concentrations of downhole methane in both the overburden and coals under the subdivision (Jones et. al., 1987). Taken collectively, all these observations indicate a high probability for continued and probably accelerated releases of methane to occur in this area.

REFERENCES

Jones, R.W., DeBruin, R.H., and Glass, G.B., 1987, Investigation of venting methane and hydrogen sulfide gas at Rawhide Village, Campbell County, Wyoming *in* Rawhide II Project Report, Appendix I. Geology: Geological Survey of Wyoming, Laramie, Wyoming, 23 p., 12 plates.

Merschat, W.R., 1987, Soil gas survey, Rawhide Village, Campbell County, Wyoming *in* Rawhide II Project Report, Appendix II: Exploration Technologies, Inc., Casper, Wyoming, 8 p., 1 plate.

EXPLANATION

- 57 — Data point; total coal thickness in feet.
- ——— Isopach line; dashed where inferred; contour interval = 10 feet.
- 2W / 1W — Split line between Upper and Lower Wyodak (rock parting between beds is less than 10' thick); 2 W = Upper and Lower Wyodak (where Upper Wyodak present) are separate beds; 1 W = Upper and Lower Wyodak merged.
- Approximate extent of Upper Wyodak coal bed; arrows point where Upper Wyodak is present.

GRAPHIC SCALE 1"=100'

Base map from Campbell County Engineer's Office
Topography and grid from Amax Coal Co.

PLATE A. ISOPACH MAP OF TOTAL COAL THICKNESS OF UPPER AND LOWER WYODAK COAL BED(S)

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PLATE A

EXPLANATION

TH-22A 4286 116,550ppm — Drill hole designation showing elevation above sea level, and average concentration of methane in the Wyodak coal beds.

Isopleth of average concentration of methane in the Wyodak coal beds, isopleth interval = 20,000ppm.

GRAPHIC SCALE 1"=100'

Base map from Campbell County Engineer's Office
Topography and grid from Amax Coal Co.

PLATE B ISOPLETH MAP OF AVERAGE METHANE CONCENTRATION IN WYODAK COAL BEDS

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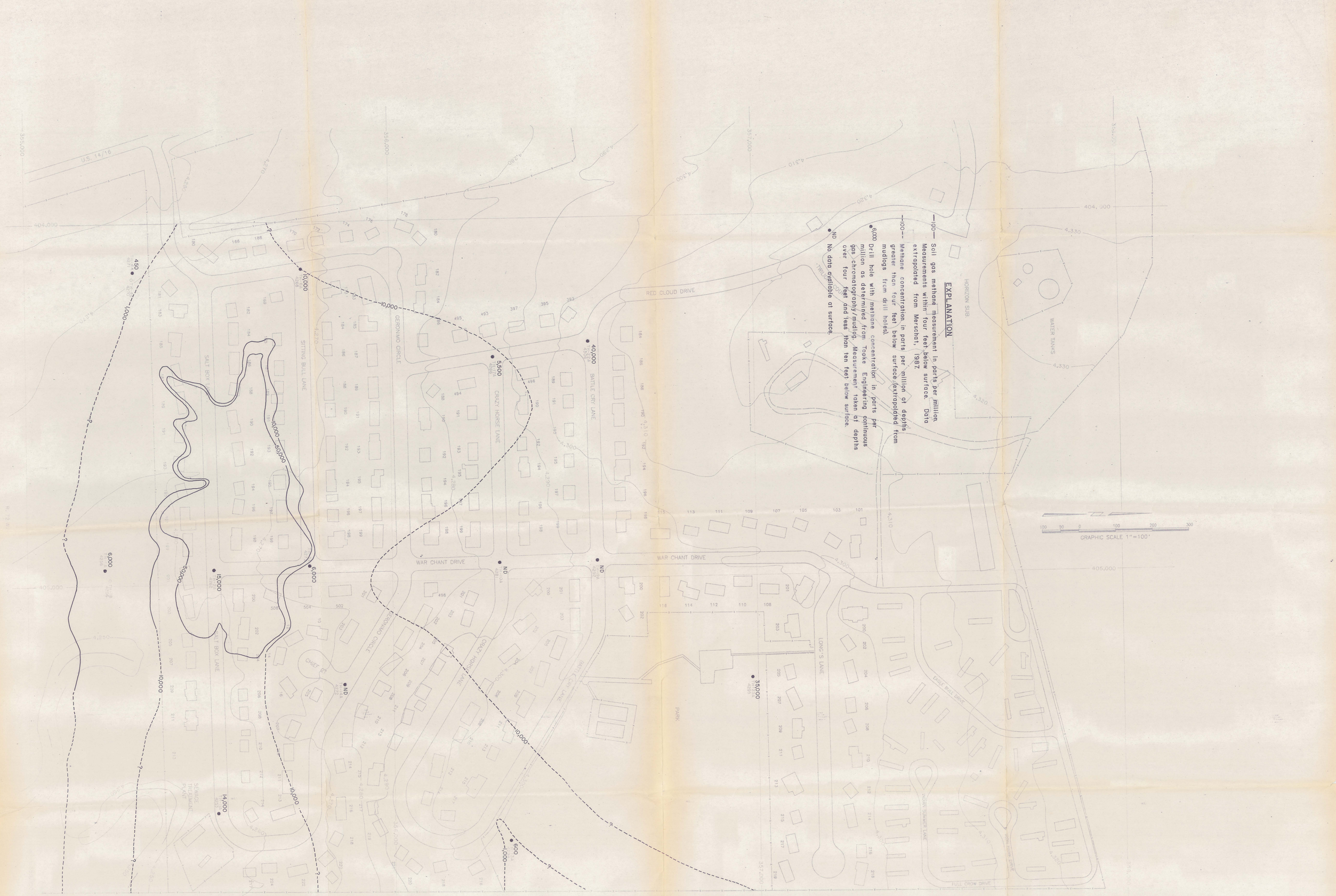
PLATE B



Base map from Campbell County Engineer's Office
Topography and grid from Amax Coal Co.

PLATE C. ISOPLETH MAP OF NEAR-SURFACE CONCENTRATIONS OF METHANE GAS, RAWHIDE VILLAGE SUBDIVISION

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PLATE C

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