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**DETAILED OUTCROP MEASURED SECTIONS OF THE HORSESHOE CANYON FORMATION, RED  
DEER AND ROSEBUD RIVERS, DRUMHELLER AREA, SOUTHERN ALBERTA**

**By**

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Although every effort has been made to ensure accuracy, this Open File Report has not been edited  
for conformity with Geological Survey of Canada standards.

## INTRODUCTION

The enclosed measured outcrop description sections represent a complete composite succession through the Maastrichtian-age Horseshoe Canyon Formation (Edmonton Group). The nearly continuous 3-dimensional outcrops of the Red Deer River and tributaries in the Drumheller area, located about 150 km northeast of Calgary (Fig. 1), represent the most complete surface record of these strata in the Plains portion of the basin. The strata are nearly flat-lying, dipping less than  $0.5^\circ$  to the west-southwest, necessitating the use of multiple short sections spread over large lateral distances (here, about 50 km) to accumulate a complete view of the Formation. However, over this lateral distance, oblique to original depositional dip, there are likely dramatic facies and thickness changes, which are not obvious at any given outcrop. Based on regional subsurface studies, yet to be published, the thickness of the formation, and of the internal informal units delineated, decrease to the east or southeast.

The Horseshoe Canyon Formation of the Drumheller area has been studied numerous times over the past 100 years (see Hamblin, 1998b). The formation was formally defined and described by Irish (1970), using this as the type area. However, most studies tended either to be early regional outcrop stratigraphic studies (such as those of Allan and Sanderson, 1945, or Ower, 1960), or to be recent detailed outcrop sedimentology studies concentrating on the Bearpaw/Horseshoe Canyon transition in a small area between East Coulee and Willow Creek (such as Rahmani, 1983, or Ainsworth, 1994). Gibson (1977) provided the most complete outcrop stratigraphic study, utilizing the proposed lateral continuity of coal zones as a guide. Few studies have attempted to define regionally-correlatable internal stratigraphic subdivisions and no studies have tried to relate outcrop data to subsurface data. In addition, few studies have provided full, informative measured sections, that can be used by others. These are the objectives of my work, of which this report is a small part.

Background geological information on the Edmonton Group and Bearpaw Formation, both in surface and subsurface, were summarized in Hamblin (1998a, 1998b, 1998c, 1998d). In addition, information pertinent to the petroleum geology, discovered reserves and hydrocarbon potential of the strata of the Edmonton Group was detailed by Hamblin and Lee (1997). Further outcrop and subsurface studies of the Edmonton, and related St. Mary River Formation, are currently in progress.

The exposures are good to excellent, are scattered along about 50 km of the Red Deer and Rosebud Rivers (Fig. 1) in a line that is mostly perpendicular to the strike of the bedding and partly along depositional strike. Paleocurrent data, suggesting a dominant direction of sediment dispersal to the east or southeast, is summarized in Figure 2. The outcrops are primarily in an area less well studied and reveal most of the 150-300 m stratigraphic thickness of the formation. They are located in Twp. 27-28, Rge 17-21W4 (see Fig.3 a,b,c). Thirteen outcrop sections were measured, using standard field techniques, and are illustrated, from east to west and from base to top, in Figures 4-16. These sections have been related to each other, and to Bearpaw/Horseshoe Canyon stratigraphy as illustrated by the core of a nearby well (C.P.O.G. Strathmore 7-12-25-25W4: see Hamblin, 1998c for detailed description of this core) on Figure 17. Large-scale internal stratigraphic units, which appear to be correlatable over significant lateral distances, are reflected in this core and in these outcrops. They also can be tracked over very large distances in subsurface log cross sections, (unpublished work) suggesting they may represent mappable units of formational rank within the supposedly uniform Horseshoe Canyon Formation.

## SUMMARY OF SEDIMENTOLOGY AND STRATIGRAPHY

The composite succession of Maastrichtian rocks detailed here includes stratigraphically-overlapping individual sections which cover the entire Horseshoe Canyon Formation, except for a few minor gaps (Figs. 4-17). Because no individual outcrop presents a full vertical section, the actual thickness of the Horseshoe Canyon in the field area is only estimated, based on projection of subsurface trends from log cross sections 30+ km to the west. According to these trends the formation undergoes rapid thinning from the base, and is about 150 m thick at the eastern side of the field area and about 300 m thick at the western side. The upper Bearpaw and the base of the formation are exposed at the West Dorothy and East Coulee sections, and the interpreted top of the formation and base of the overlying Scollard is identified at the Rosebud section for the first time.

### ***Bearpaw Formation***

The Bearpaw Formation, exposed at three sections (West Dorothy, East Coulee Bridge, Hoodoos), consists predominantly of brownish grey silty mudstone, generally bioturbated, with thin siltstone to very fine sandstone and sideritic beds. At West Dorothy a pale grey weathering bentonite 6 m thick occurs as a distinctive white band in the surrounding hills. The most conspicuous feature of these deposits is their arrangement into prominent stacked coarsening- and thickening-upward sequences up to 15 m in thickness (eg. West Dorothy Section). These sequences begin with a sharp base, overlain by bioturbated mudstone, then thinly interbedded mudstone and siltstone to very fine sandstone. The thin sandstone beds generally have sharp bases and tops, horizontal lamination and minor ripples, *Ophiomorpha* burrows, and are up to about 25 cm thick. These sequences are commonly capped by pale grey fine sandstone up to 1 m thick with sharp bases and tops, trough cross bedding, low angle lamination and hummocky cross stratification.

These cycles are interpreted as the shallowing-upward, more distal expression of shallow marine progradational shoreline-related units. In a landward direction (westward/northwestward), each would pass gradationally into shoreface or incised distributary/estuarine deposits. Each sequence began with a rapid transgressive flooding event, followed by quiet water mudstone deposition, increasing input of sandier sediment as progradation proceeded and ended with deposition of thicker lower shoreface sandstones. In most cases the sequence is terminated by the next flooding event. At the top of the Bearpaw Formation (a different stratigraphic point at each location) these sequences are overlain sharply by the thick shoreline-related sandstones of the basal Horseshoe Canyon Formation. Micropalaeontological data from the C.P.O.G. Strathmore core (Wall *et al.*, 1971) indicates the Bearpaw was deposited in a shallow marine (inner neritic) setting (see Hamblin, 1998c).

### ***Horseshoe Canyon Formation***

The Horseshoe Canyon Formation of the Edmonton Group is characterized by thinly interbedded siltstone, fine sandstone, carbonaceous shale and coal, present in most of the measured sections in this report. These deposits represent a, primarily, nonmarine clastic wedge which prograded over the shallow marine sediments of the Bearpaw.

The lower ~40 m of the formation (exposed at East Coulee Bridge, Hoodoos and Aerial Suspension Bridge sections) includes a transitional succession of intertonguing shallow marine

and shoreline-related units. Brownish grey burrowed siltstone and silty fine sandstone alternates with thick sharp-based, fining-upward fine sandstone and numerous thin to thick coals. Thin, bioturbated coarsening- and thickening-upward successions occur. At the Hoodoos a thin siltstone with abundant pelecypod/gastropod shells occurs, and a number of thin bentonite beds are preserved at the Aerial Suspension Bridge section. Coals range up to 3 m thick. There are no siltstones which display pedogenic features, so common higher in the formation. Thick fining-upward, well sorted sandstone units are common, with erosional bases, rip-ups, trough cross bedding, low angle lamination, and inclined heterolithic stratification. These strata are interpreted as intertonguing shallow marine and shoreline-related units. Shorelines are primarily manifest as estuarine channel fill sandstones with paleoflow to the east or southeast, although one coarsening-upward shoreface sandstone body occurs at the base of the Aerial Suspension Bridge section. The lowest channel fill at the Hoodoos appears to correlate laterally (and in an offshore direction) with the highest Bearpaw coarsening-upward sequence exposed at West Dorothy about 10 km to the southeast. This suggests a stratigraphic arrangement of stacked composite offlapping regressive shoreline units similar to those documented in the Basal belly River (Foremost Formation) by Hamblin and Abrahamson (1996). Micropalaeontological data from the nearby Strathmore core (Wall *et al.*, 1971) suggests this portion of the Horseshoe Canyon was deposited in alternating shallow marine, brackish, shoreline and continental settings.

The succeeding ~40 m interval (exposed at East Coulee Bridge, Aerial Suspension Bridge, Rosedale Bridge #2, and Wayne sections) includes a series of thick fining-upward sandstone channels, grey sandy or carbonaceous siltstones with abundant wood fragments, roots and pedogenic features, interbedded with numerous thick coals. Sandstones are generally fine to medium grained, well sorted, multistoried, fining-upward, with erosional bases, trough cross bedding, low angle lamination and ripple cross lamination. They are typically 3-5 m thick. Minor inclined heterolithic stratification occurs in some cases. Siltstones 1-3 m thick are commonly greenish grey, massive, blocky and pedogenic, with roots and wood fragments. Carbonaceous shales and coals are up to 2 m thick with roots and wood fragments. Micropalaeontological data from similar strata at the Strathmore core (Wall *et al.*, 1971) indicates a continental setting of deposition. These strata are interpreted to represent lower floodplain marshy deposits with numerous moderate to high sinuosity fluvial channels.

The succeeding ~70 m interval (present at Rosedale Bridge #2, Wayne, CNR Iron Bridge, Taylor Siding, Beynon Ecological Preserve, and Blue Bridge sections) is a thick heterogeneous succession of mudstone-dominated strata. This includes thick units of siltstone with wood fragments/roots/pedogenic features, rusty weathering paleosol horizons, numerous thin sharp-based fining-upward sandstone units and a many thin carbonaceous mudstones and lignitic coals. Siltstones up to 5 m thick are greenish grey, very uniform, massive, blocky and pedogenic with thin horizons of sideritic concretions and dispersed sand grains, scattered roots and wood fragments. Several distinct, rusty-weathering, sideritic horizons with fractures, slickensides, roots and silicified wood fragments, 20 to 70 cm thick, are present and are interpreted as discrete paleosols. Fining-upward sandstone beds are up to 7 m, but typically 1-2 m thick, are well sorted, have erosional bases, rip-ups, trough cross bedding, low angle lamination, and ripple cross lamination. A few thin sandstone units are coarsening-upward with sharp flat tops. Carbonaceous shales are common but generally less than 1 m in thickness, and coals are generally lignitic, impure thin and less numerous than in the previous unit described. A few thick bentonites up to 1 m thick are preserved. All micropalaeontological data from similar strata in the Strathmore core

(Wall *et al.*, 1971) indicate a continental setting of deposition. These strata are interpreted as floodplain deposits, both subaerial and subaqueous, with a few small channels and many splay sands. Paleoflow indicators, although variable, indicate eastward sediment dispersal. Above the highest coal at Blue Bridge section there is a thin succession of thinly interbedded sandy siltstone, very fine sandstone and laminated claystone, with possible burrows. This may represent the "Drumheller Marine Tongue" known from outcrops along the Red Deer River to the north, but no other evidence was observed in this vicinity.

The overlying ~50 m interval (present at CNR Iron Bridge, Beynon Ecological Preserve, Range Road 21-2, and Mile 74 sections) is characterized by non-coaly greenish mudstone and thin fine sandstone. Massive, uniform, blocky greenish grey sandy siltstone with abundant pedogenic features and sideritic concretions makes up about 60-75% of the sediment volume in this interval. That facies alternates in monotonous succession with fining-upward, well sorted very fine to fine sandstones with sharp bases and low angle lamination. These average 0.5-1 m thick. There are no coals and only minor thin carbonaceous mudstones. The lowest deposits at the Range Road 21-2 section include pale grey fine sandstone with a deeply erosive base and inclined heterolithic stratification, which may represent a minor marine influence at this point in the stratigraphy, approximately the same position as the "Drumheller Marine Tongue" known to the north. All micropalaeontological data from correlative strata in the nearby Strathmore core (Wall *et al.*, 1971; see also Hamblin, 1998c) indicates a continental setting. These strata are interpreted as upper floodplain, primarily subaerial, deposits in an environment less conducive to thick peat accumulation. The dominant siltstone likely represents overbank deposition, but was continuously subjected to pedogenesis.

The uppermost interval, about 30 m thick (only observed at the Mile 74 and Rosebud sections of this study) are represented by interbedded sandstone, siltstone, thick coals and dark bentonitic mudstone. Sandstones are very fine to fine grained, fining-upward, commonly lens-shaped, with erosive bases and low angle lamination and ripple cross lamination. Siltstones are greenish grey, massive, blocky and pedogenic. Several black vitreous coal seams about 1 m thick are present. At the Rosebud section, two 1-2 m thick units of dark grey, very uniform bentonitic mudstone with distinctive "popcorn" weathering are present in the upper 7 m of the Horseshoe Canyon Formation. They are interpreted to be correlative to the Battle Formation defined by Irish (1970) in a similar position on the Red Deer River 15-20 km to the north. These facies are sharply overlain by the thick clean coarser sandstone unit of the lower Scollard Formation. The deposits described in this interval suggest the re-establishment of conditions suitable for coal swamp peat accumulation in a fluvial floodplain setting.

### ***Scollard Formation***

Only about 5 m of the overlying Scollard Formation is poorly exposed at the Rosebud Section. It comprises thick, brown to yellowish, fine to medium sandstone with a sharp base and trough cross bedding (limited paleoflow indicators to the northeast), and greenish to yellowish siltstone, in a fining-upward sequence. These are interpreted to represent fluvial channel deposits of a different (northeastward-flowing) depositional system.

## HYDROCARBON POTENTIAL

Further work is required to resolve the regional-scale stratigraphic architecture of the Maastrichtian deposits of southern Alberta. This may be important because a limited number of gas pools are known in the Horseshoe Canyon to the north, although relatively little exploration has ever been targeted directly toward these units. However, vast areas of Alberta shallowly underlain by these units are essentially unexplored at this stratigraphic level, and may offer undiscovered gas pools of modest size, low pressure, but inexpensive exploration costs. Refer to Hamblin and Lee (1997) and Hamblin (1998b) for further discussion of this topic.

The lower Horseshoe Canyon Formation includes shoreline-related sandstone trends, involving a series of sandy tongues which extend basinward into the Bearpaw marine shale. This relationship, similar to that of the "Basal Belly River" (Hamblin and Abrahamson, 1996) is hinted at in the outcrops included here. These potential reservoirs are present in the subsurface west of these outcrops, and minor gas pools are known to the north.

The middle and upper Horseshoe Canyon Formation includes thick fluvial sandstones and interbedded coal deposited in floodplain settings. These potential reservoirs are also present in the subsurface west of these outcrops, and minor gas pools are known to the north.

## LIST OF FIGURES

1. Location map for measured outcrop sections along Red Deer and Rosebud Rivers and C.P.O.G. Strathmore 7-12-25-25W4 near Drumheller. Dashed lines delineate previously-mapped base and top of Horseshoe Canyon Formation. Boxes indicate detailed location maps of Figure 3.
2. Summary of paleocurrent data from outcrops. A. Summary of measurements of trough cross bedding, ripple cross lamination and channel trends, with vector mean of dispersal direction. B. Summary of measurements of lateral accretion surfaces, inclined heterolithic stratification and inclined bedding surfaces, with vector mean of dispersal direction.
- 3 (a-c). Detailed location maps of outcrop measured sections. A. Sections of Bearpaw and lower Horseshoe Canyon formations between Dorothy and East Coulee. B. Sections of lower and middle Horseshoe Canyon Formation southeast of Drumheller. C. Sections of middle and upper Horseshoe Canyon Formation southwest of Drumheller.
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5. East Coulee Bridge measured section of upper Bearpaw/lower Horseshoe Canyon formations.
6. Hoodoos measured section of lower Horseshoe Canyon Formation.
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8. Rosedale Bridge #2 measured section of middle Horseshoe Canyon Formation.
9. Wayne measured section of middle Horseshoe Canyon Formation.
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13. Blue Bridge measured section of middle Horseshoe Canyon Formation.
14. Range Road 21-2 measured section of middle/upper Horseshoe Canyon Formation.
15. Mile #74 measured section of middle/upper Horseshoe Canyon Formation.
16. Rosebud measured section of upper Horseshoe Canyon/Scollard formations.
17. Comparison of measured core section from well 7-12-25-25W4 with measured outcrop sections from Red Deer and Rosebud Rivers.

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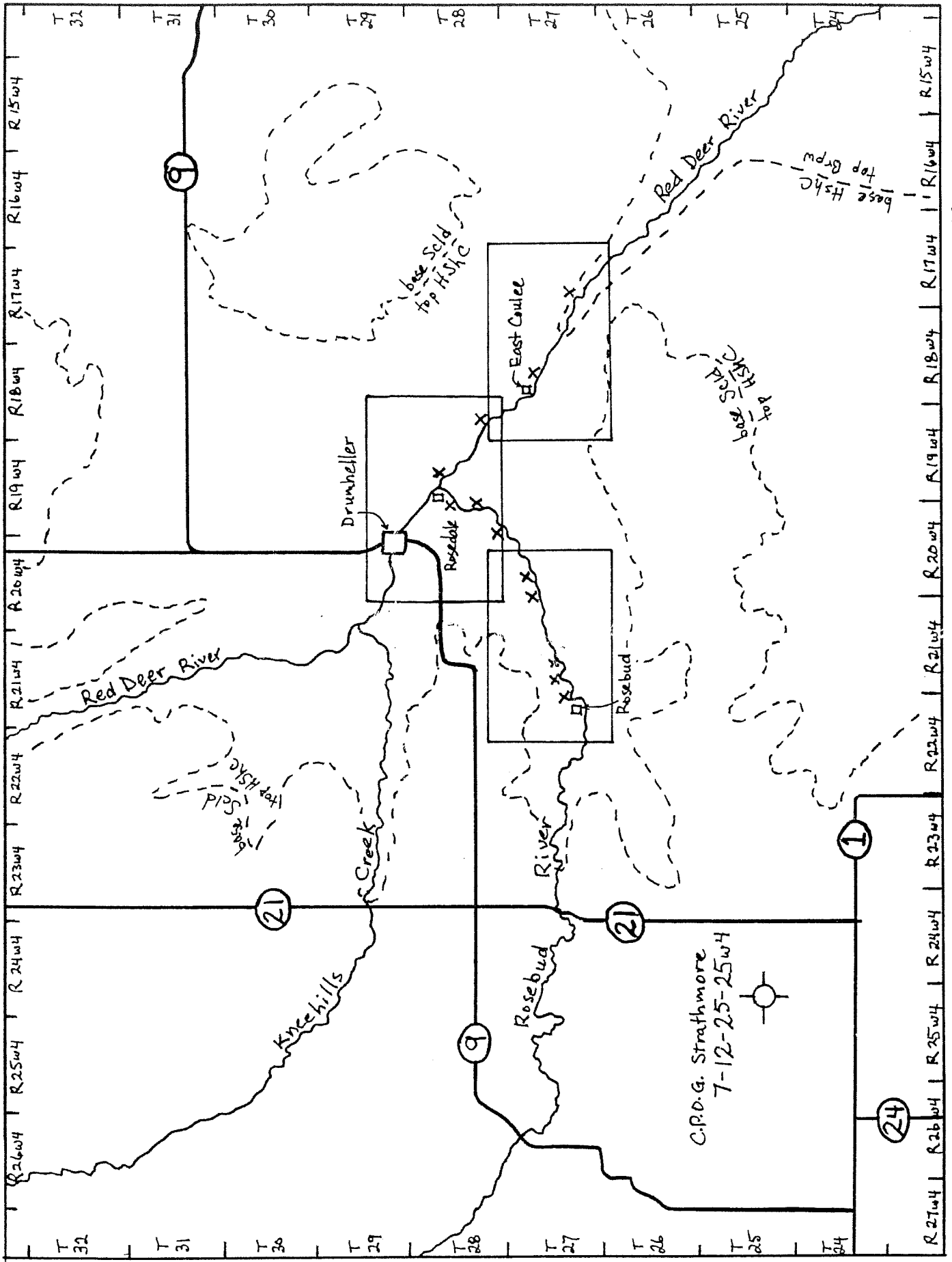
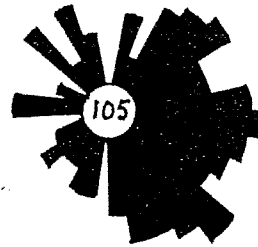


FIGURE 1.

Horseshoe Canyon Fm  
Red Deer R. - Rosebud R.  
13 outcrops  
92 txb  
11 rxl  
2 channel trend

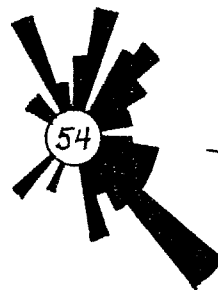


→  $\approx 115^\circ$



A.

Horseshoe Canyon Fm  
Red Deer R. - Rosebud R.  
13 outcrops  
18 LA surfs  
24 IHS  
12 IBS



→  $\approx 95^\circ$



B.

FIGURE 2.

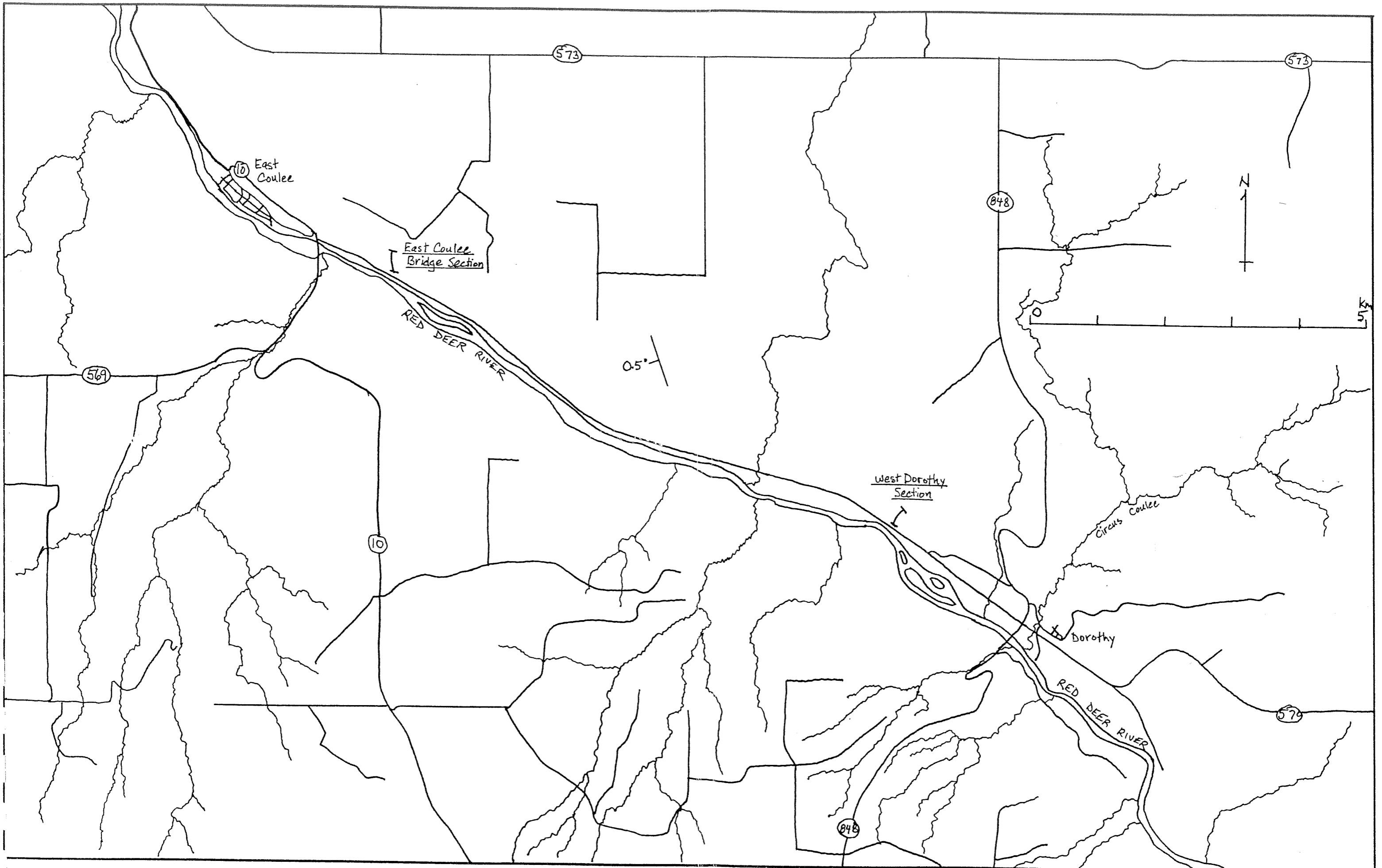


FIGURE 3 a

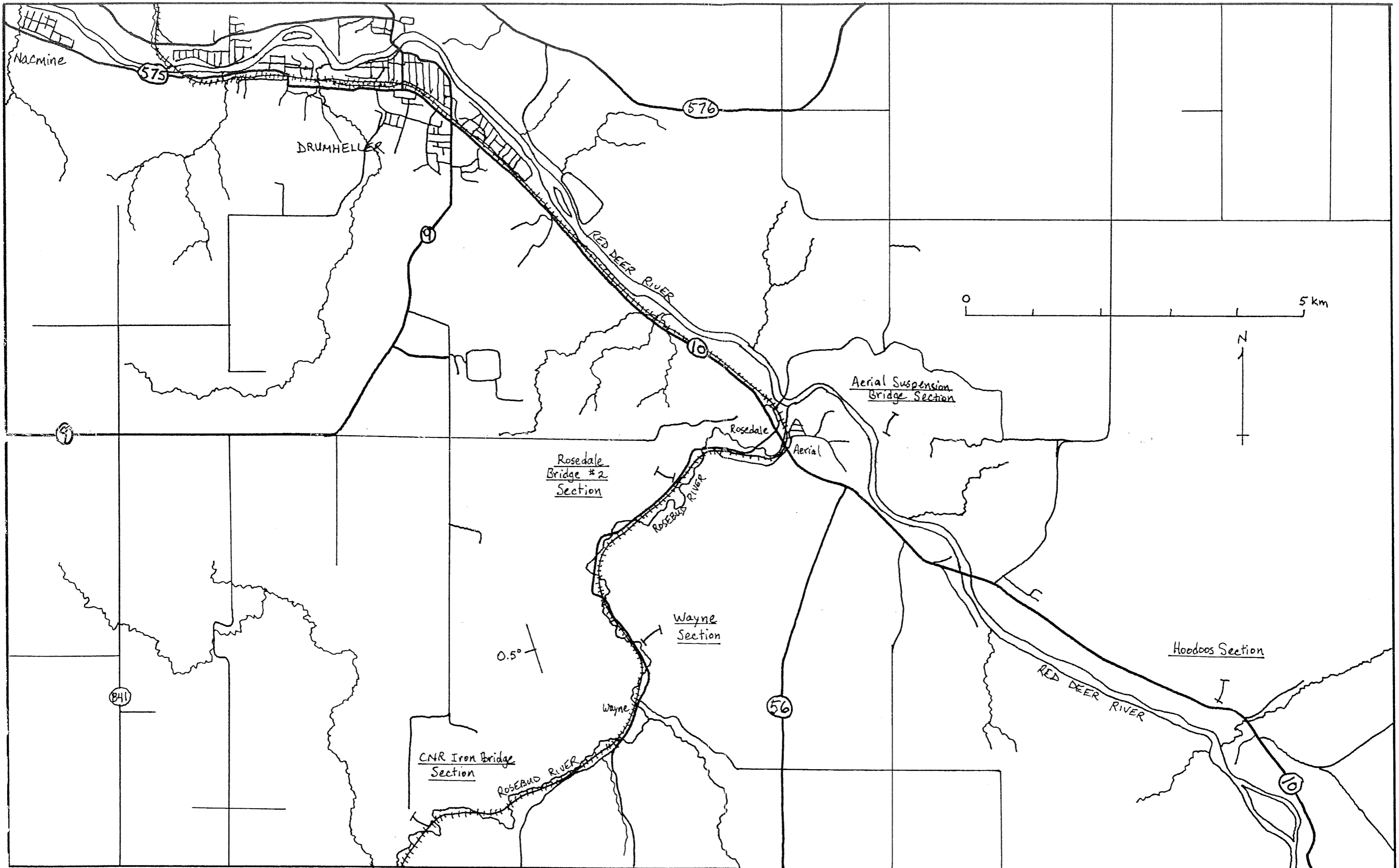


FIGURE 3 b

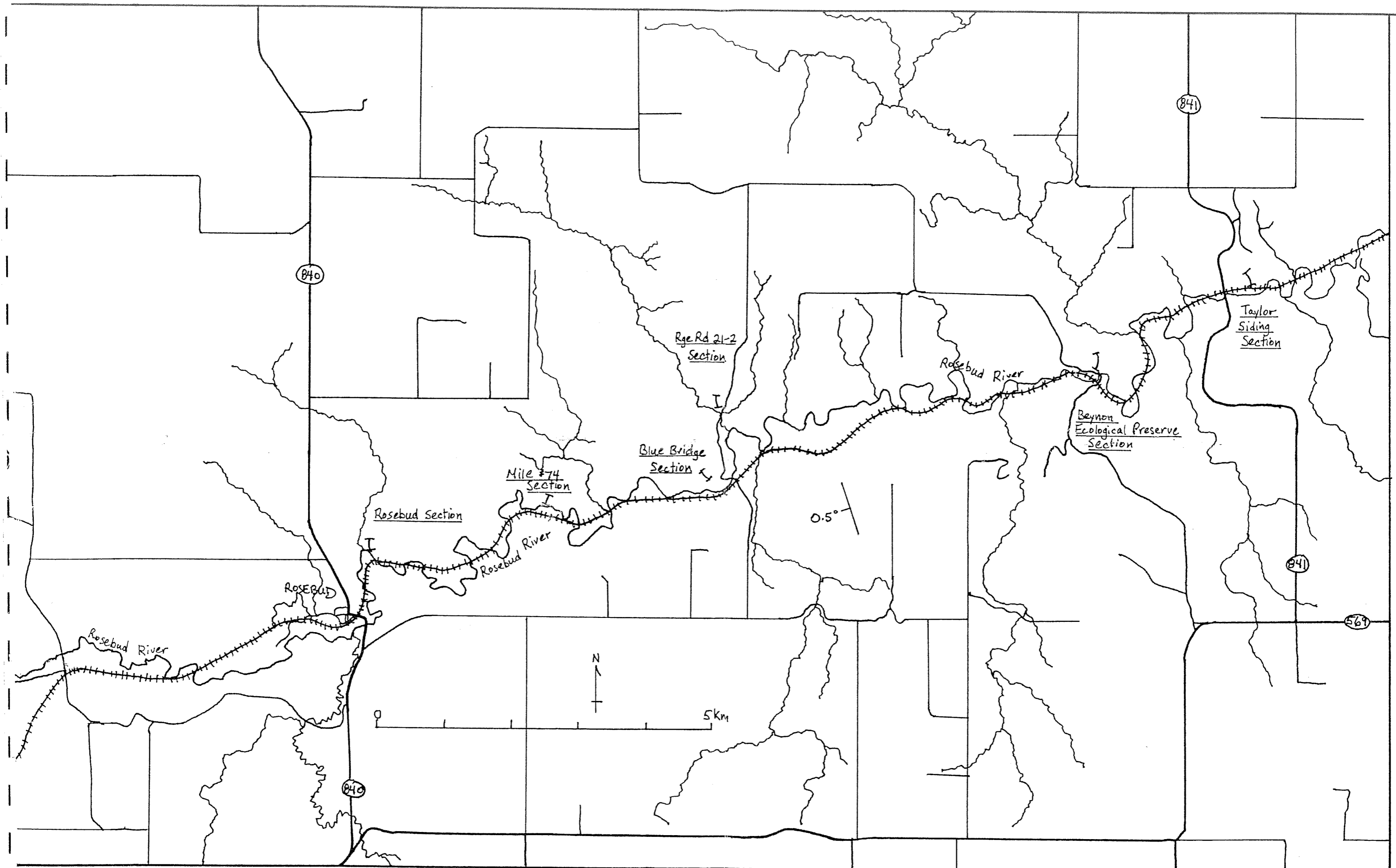
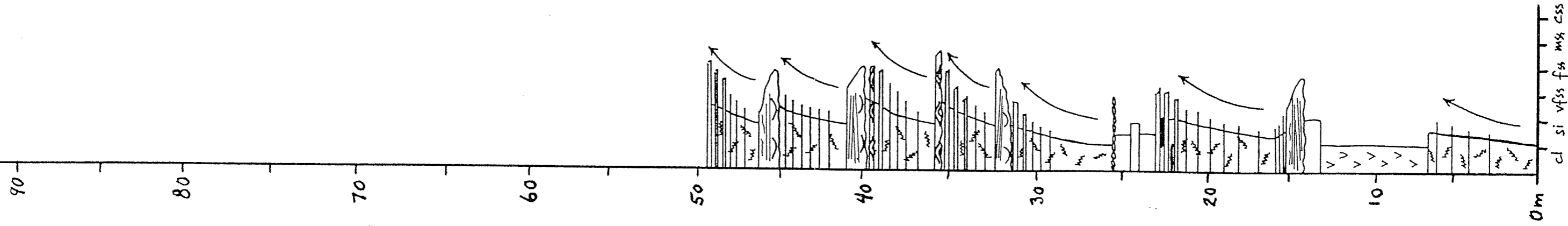


FIGURE 3c

WEST DOROTHY SECTION

(2 km w of village)  
Upper Bearpaw Fm

Map: Dorothy B2 P/B 056835  
Sec 8, Twp 27 Rge 17W4  
51° 18' N, 112° 21' W



- coarsening-upward sequence of thinly interbedded brownish grey bioturbated siltstone and grey v. fs.
- pale grey fs, sharp base, low angle lamination, slight fining-upward
- coarsening-upward sequence of thinly interbedded brownish grey bioturbated siltstone and grey v. fs, bioturbation
- pale grey fs, well sorted, sharp base, low angle lamination, fsb
- coarsening-upward sequence of thinly interbedded brownish bioturbated siltstone and grey silty v. fs with sharp bases + tops, HCS at top
- coarsening-upward sequence of thinly interbedded brownish bioturbated siltstone and grey silty v. fs with sharp bases + tops, HCS at top
- pale grey fs, erosional base, pinches out laterally over 50m, minor fsb, low angle lamination
- coarsening-upward sequence of thinly interbedded brownish silty mudstone and minor thin siltstones
- rusty weathering sideritic concretions horizon
- brownish grey silty mudstone with thin muddy siltstone bed
- coarsening-upward sequence of thinly interbedded brownish grey silty mudstone and siltstone to v. fs with sharp bases and horizontal lamination, bioturbated, few thin coaly streaks near top
- thinly interbedded brown muddy siltstone and siltstone
- pale grey v. fs, erosional base, fining-upward, low angle lamination
- light grey siltstone, v. uniform
- pale grey weathering, dark brownish grey bentonite, sharp base top, v. uniform + v. distinctive
- brownish grey silty mudstone, bioturbated, slightly coarsening-upward, few v. thin silty beds

FIGURE 4.

EAST COLLEE BRIDGE SECTION

(2 km E of bridge)

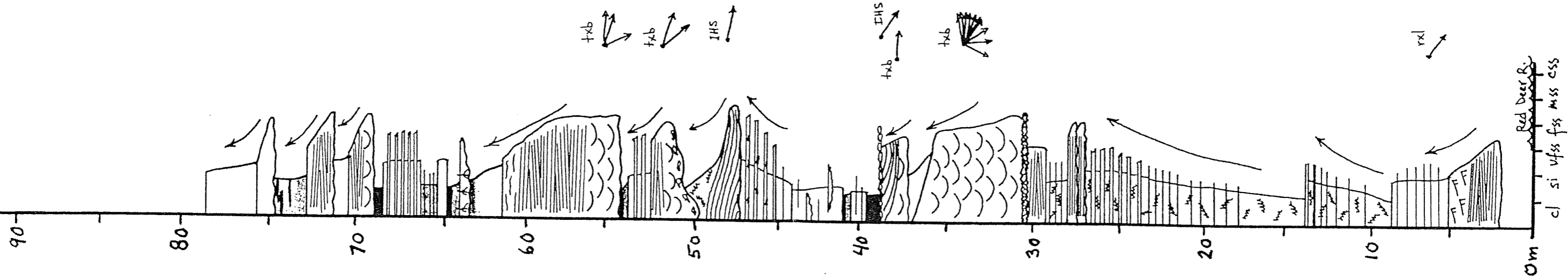
Upper Bearpaw/Lower Horseshoe Canyon Fms

Map: Dorothy B2 P/B 9B1873

Twp 27 Rge 18W4 Sec 28

51° 20' N, 112° 28' W

- fining-upward sequence from pale grey fss with sharp base and low angle lamination, to grey sandy siltstone
- fining-upward sequence from pale grey fss with sharp base and low angle lamination, to dark grey carbonaceous shale with coaly streaks
- fining-upward sequence from pale grey fss with sharp base + txb + low angle lamination to grey sandy siltstone
- coal
- thinly interbedded grey sandy siltstone and silty vss
- thinly interbedded carbonaceous shale and dark grey siltstone
- grey sandy siltstone
- dark grey carbonaceous shale grading up into coal
- grey vss, erosional base, lens-shaped, roots
- thick fining-upward sequence from pale grey vf-fss with erosional base + txb + low angle lamination, to brownish grey siltstone, to dark grey carbonaceous shale
- carbonaceous shale passing up into coal
- fining-upward sequence from pale grey fss with deeply erosional base + txb + low angle lamination, to thinly interbedded grey muddy siltstone and pale grey vss
- fining-upward sequence from thinly interbedded vss and si in IHS bedding to brownish grey siltstone with burrowing
- coarsening-upward sequence of thinly interbedded silty mudstone to siltstone and vf-fss capped by thin siltstone bed, abundant coaly fragments
- brownish grey silty mudstone, uniform, few discontinuous vf ss lenses
- dark grey carbonaceous shale to coal
- dark grey silty mudstone, few thin lenses of vss
- black bituminous coal
- pale grey silty fss, sharp base, txb, IHS
- brownish grey mud-filled channel 50 m wide
- fining-upward whitish grey fss, sharp base, well sorted, txb
- rusty weathering sideritic horizon, sharp base + top
- pale grey silty vss, well sorted, sharp base + top, low angle lamination
- thinly interbedded brownish grey silty mudstone and sandy siltstone, burrowing
- multistoried white fss, sharp base, well sorted, horizontal lamination
- coarsening-upward sequence from thick brownish grey bioturbated silty mudstone to thinly interbedded brownish grey silty mudstone and sandy siltstone with burrows, to thinly interbedded brownish burrowed siltstone and vss, Ophiomorpha
- coarsening-upward sequence from brownish grey bioturbated silty mudstone to brownish grey bioturbated siltstone with thin pale grey vss beds, incl. Ophiomorpha
- brownish grey thin bedded muddy siltstone with thin silty vss beds, horizontal lamination and minor rippling
- whitish grey vf-fss, well sorted, fining-upward, sharp base, low angle lamination and ripples

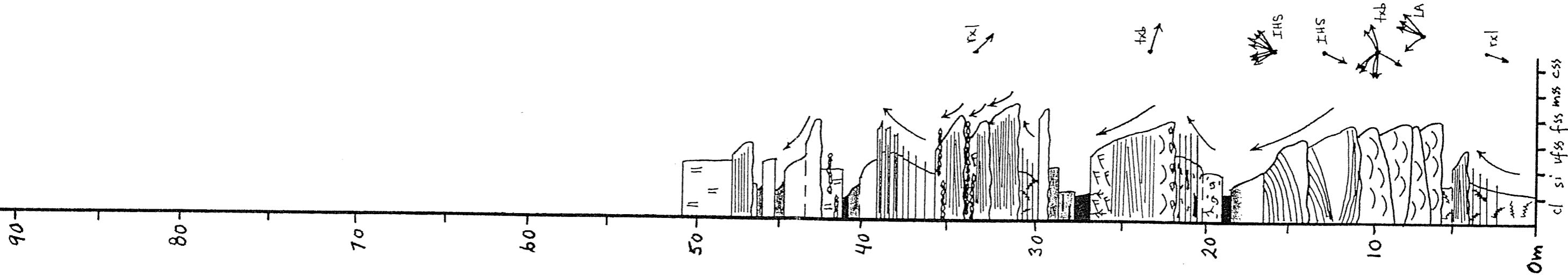


FIGURES

HOODS SECTION

(Just W of picnic ground)  
Lower Horseshoe Canyon Fm

Map: Drumheller 82 P/7 931932  
Sec 7 Twp 20 Rge 18/19 W4  
51° 23' N, 112° 32' W



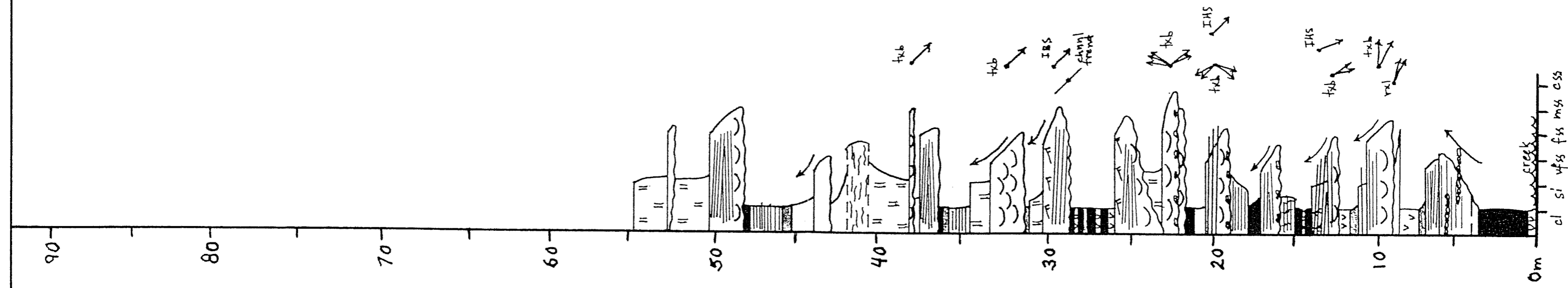
- greenish grey pedogenic sandy siltstone
- pale grey vfss, sharp base, horizontal lamination
- dark grey carbonaceous shale + grey uniform shale
- grey sandy siltstone
- fining-upward sequence from pale grey vfss with sharp base, to grey sandy siltstone, to dark grey carbonaceous shale
- greenish grey pedogenic siltstone, sideritic concretions
- dark grey carbonaceous shale passing up into coal
- grey sandy siltstone, gradational top
- coarsening-upward sequence from brownish grey, sandy siltstone, to thinly interbedded siltstone and vfss with horizontal lamin.
- multistoried, pale grey vf-m ss, well sorted, fining-upward units with sharp bases and low angle lamination, several thin sideritic horizons near tops, minor rippling
- coarsening-upward sequence of thinly interbedded vfss + si, burrowed
- greenish grey friable f-m ss, poorly sorted, sharp base + top
- dark grey carbonaceous siltstone
- black coal passing up into dark grey carbonaceous shale with coaly streaks
- pale grey fss, well sorted, fining-upward, erosive base with sideritic concretions, tabby low angle lamination, tab at base, rxl and roots at top
- coarsening-upward sequence from greenish grey siltstone with shell fragments and roots, to finely interbedded sandy siltstone and fss with wood fragments and coaly streaks
- black coal
- multistoried fining-upward sequence from pale grey fss with erosive base and multiple sets of IHS, to dark grey sandy carbonaceous siltstone
- multistoried pale grey fss, well sorted, erosional base, large lateral accretion surfaces, tab
- brownish grey muddy siltstone, burrowing
- pale grey silty vfss, sharp base, low angle lamination, sideritic horizons
- coarsening-upward sequence brownish grey silty mudstone with thin rippled sandy siltstone beds, bioturbated

FIGURE 6



AERIAL SUSPENSION BRIDGE SECTION  
 (tributary 300 m SE of bridge)  
 Lower Horseshoe Canyon Fm

Map: Drumheller 82 P/7 882 973  
 Sec 27 Twp 28 Rge 19 W4  
 51° 25' N, 112° 36' W



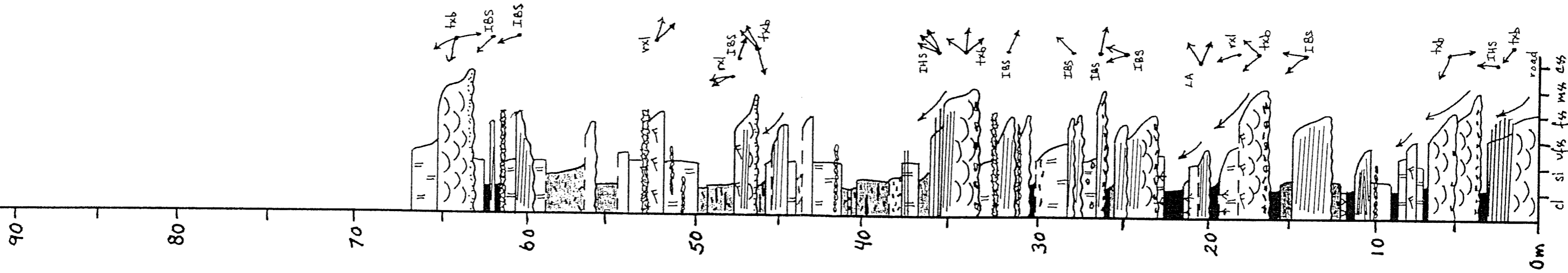
- greenish grey pedogenic siltstone
- pale grey fss, erosional base, lens shape pinches out to SW
- greenish grey pedogenic siltstone
- pale grey to buff f-m ss, fining-upward, well sorted, sharp flat base, txb, mostly low angle lamination
- black coal
- grey mudstone, laminated
- dark grey carbonaceous shak
- fining-upward sequence from pale grey v fss with sharp base to grey mudstone
- pale grey fss, gradational base+top, numerous silty interbeds
- greenish grey pedogenic siltstone
- brown f-m ss, erosional base, txb
- dark grey carbonaceous shale
- pale grey fss, sharp base+top, low angle lamination
- dark grey carbonaceous shale grading up into coal
- grey mudstone, laminated
- fining-upward sequence from brownish grey v-f ss with erosional base and txb, to greenish grey pedogenic siltstone
- fining-upward sequence from pale grey f-m ss with erosional base + txb, to greenish grey pedogenic siltstone to dark grey carbonaceous shale, channel pinches out to SW and NE
- thinly interbedded coal, carbonaceous shale and brownish grey bentonite, abundant wood fragments
- pale grey f-m ss, well sorted, deeply erosional base, low angle lamination, minor txb, minor rxl
- greenish grey pedogenic sandy siltstone
- pale grey mss, multistoried, erosional bases, lag of crss + calcrite nodules, txb, slightly fining-upward
- grey to brownish grey mudstone passing up into black coal
- pale grey f-m ss, fining-upward, sharp base with coaly lag, txb, IHS
- grey to greenish grey silty to sandy mudstone, coarsening-upward
- black lignitic coal
- dark grey v-f ss, erosional base, fining-upward
- brownish grey silty mudstone, laminated, burrowed
- thick coal with thin pale grey bentonite
- fining-upward sequence from white fss with erosional base + txb, to thinly interbedded siltstone and v fss IHS, roots at top
- pale grey uniform bentonite
- fining-upward sequence from pale grey f-m ss with sharp base and txb, to thinly interbedded v fss + si, to carbonaceous shale
- greenish grey bentonite
- dark grey carbonaceous shale
- coarsening-upward sequence from grey mudstone to pale grey siltstone, to fss with low angle lamination and sideritic horizons, to pale grey v-f ss with low angle lamination
- thick black coal
- thin pale grey bentonite

FIGURE 7

ROSEDALE BRIDGE #2 SECTION

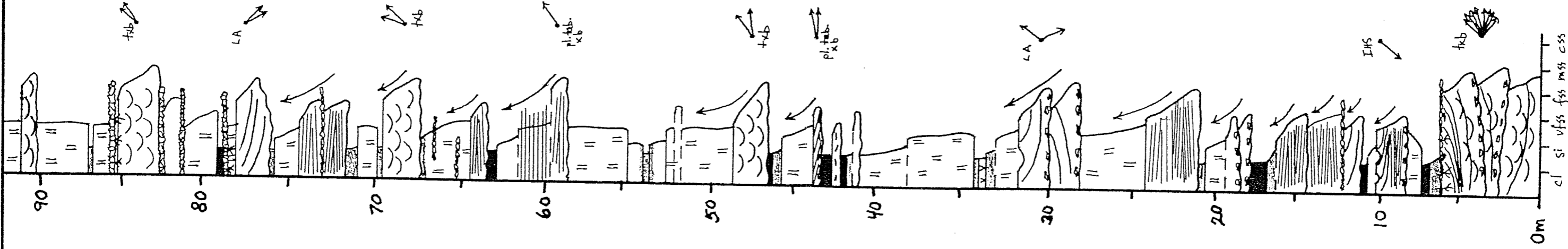
(1.5 km SW of village)  
Middle Horseshoe Canyon Fm

Map: Drumheller B2 P/7 B50 966  
Sec 19 Twp 28 Rge 19 W4  
51° 25' N, 112° 39' W



- greenish grey pedogenic sandy siltstone
- pale grey to buff f-m ss, well sorted, feldspathic, erosional base, txb
- greenish grey pedogenic siltstone, large sideritic concretions
- black coal
- pale grey fss, sharp base + top, inclined bedding
- black coal weathering sideritic paleosol, wood fragments
- pale grey fss, erosional base, fining-upward, lens pinches out to E
- greenish grey pedogenic siltstone
- dark grey carbonaceous silty mudstone, gradational base + top, abundant tiny wood fragments
- greenish grey vf-fss, sharp base, gradational top, bentonitic
- dark brownish carbonaceous shale
- pale grey sandy siltstone
- greenish grey pedogenic siltstone
- rusty weathering sideritic paleosol, fractured.
- pale grey fss, sharp flat base, rippled
- greenish grey pedogenic siltstone, horizons of siderite concretions
- brownish to blackish carbonaceous shale, wood fragments throughout, lignitic seams near base
- pale grey fss, well sorted, fining-upward, erosional base with moss lags, txb, low angle lamination, ripples
- fining-upward sequence from pale grey vf-fss with sharp base + inclined bedding to brown siltstone to dark grey carbonaceous shale + coal
- thickly interbedded greenish grey pedogenic siltstone with brownish silty mudstone with wood fragments, and pale grey fss, sideritic paleosol horizon near base
- dark brown carbonaceous shale with numerous thin streaks of lignitic coal, abundant wood fragments, and several thin bentonites
- grey silty mudstone, abundant tiny wood fragments
- greenish grey pedogenic siltstone, thin sandy beds at top
- fining-upward sequence from pale grey f-m ss with sharp base + sideritic lag + txb to thinly interbedded IHS bedding, to dark greenish grey carbonaceous silty mudstone
- greenish grey pedogenic siltstone
- rusty weathering sideritic paleosol
- multistoried pale grey vf-fss, sharp bases, fining-upward, siderite concretions
- thin black coal
- greenish grey pedogenic sandy siltstone, fining-upward, large wood fragments
- multistoried pale grey fss, sharp bases, inclined bedding
- greenish grey pedogenic siltstone, siderite concretions
- pale grey f-m ss, erosional base with coaly rip-ups, inclined bedding
- brown carbonaceous shale to coal
- multistoried pale grey fss, erosional bases with coaly lag, txb, inclined bedding
- brownish pedogenic siltstone, roots
- black coal, laminated
- fining-upward sequence from grey silty vfss with erosional base + coaly lag, to grey sandy siltstone to brown carbonaceous shale with roots
- fining-upward sequence from pale grey f-m ss with erosional base + lag of siderite nodules + txb + xl to greenish grey pedogenic sandy siltstone with roots, to black coal
- black coal
- dark brownish grey silty mudstone, wood fragments
- pale grey fss, sharp base, inclined bedding
- thinly interbedded brownish grey carbonaceous shale, black coal, and thin white bentonite
- pale grey silty vfss, sharp base, fining-upward, low angle lamination
- dark brownish grey silty mudstone, thin siderite concretion bed
- black coal
- fining-upward sequence from grey vfss with ripples to greenish grey pedogenic siltstone
- greenish grey pedogenic sandy siltstone
- coal
- multistoried pale grey fss, well sorted, erosional bases, coaly lags, fining-upward, txb,
- black coal
- fining-upward sequence from pale grey fss with txb to thinly interbedded IHS bedding of vfss + sl

FIGURE 8



- ### WAYNE SECTION (1 km N of village) Middle Horse Shoe Canyon Fr.
- Drumkeller 82 P/7 847 943  
Sec 18 Twp 28 Rge 19 W04  
51° 23' N, 112° 39' W
- greenish grey pedogenic siltstone
  - pale grey fss, sharp base + top, t.b
  - greenish grey pedogenic siltstone
  - dark grey carbonaceous shale
  - greenish grey pedogenic siltstone
  - sideritic paleosol horizon, fractures, roots
  - pale grey fss, fining-upward, well sorted, t.b
  - sideritic paleosol horizon, fractures
  - pale grey vss, silty, fining-upward
  - sideritic paleosol horizon
  - greenish grey pedogenic siltstone, fining-upward
  - coal
  - sideritic paleosol horizon, fractures, roots
  - pale grey fss, well sorted, erosional base, thins to N, lateral accretion surfaces
  - fining-upward sequence from multistoried pale grey fss with sharp bases + low angle lamination, to greenish grey pedogenic muddy siltstone, to dark grey carbonaceous shale
  - interbedded dark grey carbonaceous shale and greenish grey pedogenic siltstone
  - pale grey fss, fining-upward, sharp base, t.b
  - greenish grey sandy siltstone, slightly fining-upward, carbonaceous at top, sideritic concretions
  - pale grey vss, sharp base + top, low angle lamination
  - black coal
  - fining-upward sequence from pale grey fss with sharp base and low angle lamination, to thickly interbedded greenish siltstone and very fine sandstone, to dark greenish silty mudstone
  - greenish grey pedogenic siltstone
  - dark greenish grey silty mudstone with thin carbonaceous shale
  - fining-upward sequence from pale grey fss with sharp base and t.b, to thick greenish grey pedogenic siltstone with one more sandy zone near top
  - dark grey carbonaceous shale grading up into lignitic coal
  - fining-upward sequence from pale grey vss with sharp base + wood fragment lag, to greenish grey pedogenic siltstone
  - thinly interbedded brownish grey sandy siltstone to very fine sandstone and black lignitic coal
  - fining-upward sequence from greenish grey pedogenic siltstone, to greenish grey pedogenic silty mudstone
  - dark grey carbonaceous shale with large silicified wood fragments and one thick pale grey bentonite
  - fining-upward sequence from multistoried pale grey fss with erosional bases, low angle lamination and one silt-filled scour at the top, to greenish grey pedogenic siltstone
  - fining-upward sequence from pale grey fss with sharp base and low angle lamination, to greenish grey pedogenic siltstone
  - dark grey carbonaceous shale, coaly streaks
  - fining-upward sequence from multistoried pale grey fss with erosional bases, sideritized rip-ups and t.b + low angle lamination, to greenish grey pedogenic siltstone
  - dark grey carbonaceous shale grading up into black coal
  - multistoried fining-upward vss, pale grey, well sorted, low angle lamination with sideritic horizon at base
  - pale grey silty vss, lateral accretion surfaces, fining-upward
  - grey slightly sandy siltstone, fining-upward, more carbonaceous toward top
  - pale grey vss, fining-upward, erosional base with rip-ups, low angle and I.H.S. lamination, mud-filled scours at top
  - greenish grey pedogenic siltstone, coarsening-upward
  - dark grey carbonaceous shale grading up into lignitic coal
  - thin sideritic paleosol with wood fragments, roots + sharp top
  - multistoried, pale grey f-mss, well sorted, each unit has erosional base with rip-ups, wood fragments, lateral accretion surfaces, t.b + fining-upward, I.H.S. near top.

FIGURE 9

CNR IRON BRIDGE SECTION  
 (Mile 63.2, 4 km SW of Wayne)  
 Middle Horseshoe Canyon Fm

Drumheller B2 P19 B13916  
 Sec 2 Twp 28 Rge 20 W4  
 51° 22' N, 112° 42' W

- greenish grey pedogenic siltstone
- grey fss, fining-upward, sharp base, low angle lamination
- greenish grey pedogenic siltstone
- grey to pale grey fss, fining-upward, sharp base, low angle lamination
- light grey bentonite
- pale grey v fss, fining-upward, sharp base, low angle lamination
- greenish grey pedogenic siltstone
- grey bentonite
- Coal
- fining-upward sequence from yellowish v fss with sharp base and low angle lamination, to grey silty mudstone with sideritic concretions
- fining-upward sequence from yellowish v fss with sharp base, to greenish grey pedogenic siltstone
- thickly interbedded black coal and brown carbonaceous siltstone
- pale grey fss, sharp base, horizontal lamination, roots
- greenish grey pedogenic siltstone
- grey to yellowish grey fss, sharp base, IAS strata
- black coal
- grey silty bentonite
- coarsening-upward sequence of greenish grey pedogenic siltstone to pale grey v fss with horizontal lamination and sideritic horizons
- thin grey bentonite
- dark grey carbonaceous shale with coaly lenses
- fining-upward sequence from pale grey fss with sharp base + thick lag of rip-ups + IAS strata to greenish grey pedogenic muddy siltstone to dark greenish silty mudstone with wood fragments
- interbedded greenish grey pedogenic siltstone and dark grey carbonaceous shale and grey bentonite, sideritic horizons
- fining-upward sequence from pale grey fss with sharp base and low angle + ripple lamination, to greenish grey pedogenic siltstone
- interbedded greenish grey pedogenic siltstone with wood fragments and sideritic concretions, and silty v fss, and carbonaceous shale
- yellowish brown fss, erosional base downcuts laterally; txb
- greenish grey pedogenic siltstone
- black coal and brown carbonaceous shale
- fining-upward pale grey f-m ss, well sorted with sharp erosional base + rip-up lag + txb passing up into greenish grey sandy siltstone with IAS v fss beds
- black coal, lenses of carbonaceous shale
- pale grey fss, erosional base with sideritic lag and wood fragments, txb
- greenish grey pedogenic siltstone
- grey fss, erosional base, sideritic concretions horizon at top.
- black coal
- greenish grey pedogenic siltstone, fining-upward at top
- brown carbonaceous shale, coaly streak in middle
- grey fss, sharp base, IHS, fining-upward
- black coal
- coarsening-upward from sandy siltstone to v fss with roots
- coarsening-upward yellowish siltstone with sandy IHS grading up into pale grey fss, erosional base, sharp top.
- greenish grey pedogenic siltstone
- black coal
- thickly interbedded greenish grey pedogenic siltstone and brown carbonaceous shale and grey silty mudstone
- pale grey fss, well sorted, erosional base, txb
- greenish grey pedogenic siltstone, fining-upward, more carbonaceous at top
- black coal
- fining-upward sequence from pale grey v fss with erosional base + txb, to greenish grey pedogenic siltstone with carbonaceous shale + roots
- fining-upward sequence from pale grey v-m ss with erosional base + txb + lag of wood + bone, to greenish grey pedogenic sandy siltstone
- black coal
- fining-upward sequence from white fss with low angle lamination to grey sandy siltstone with v fss beds

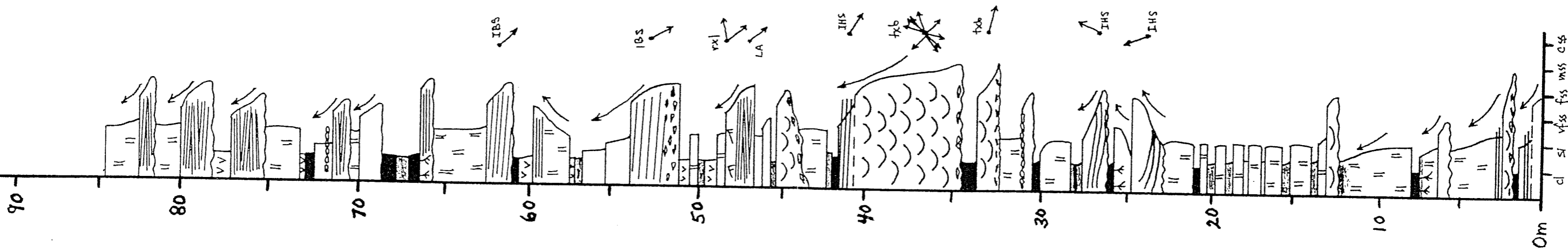
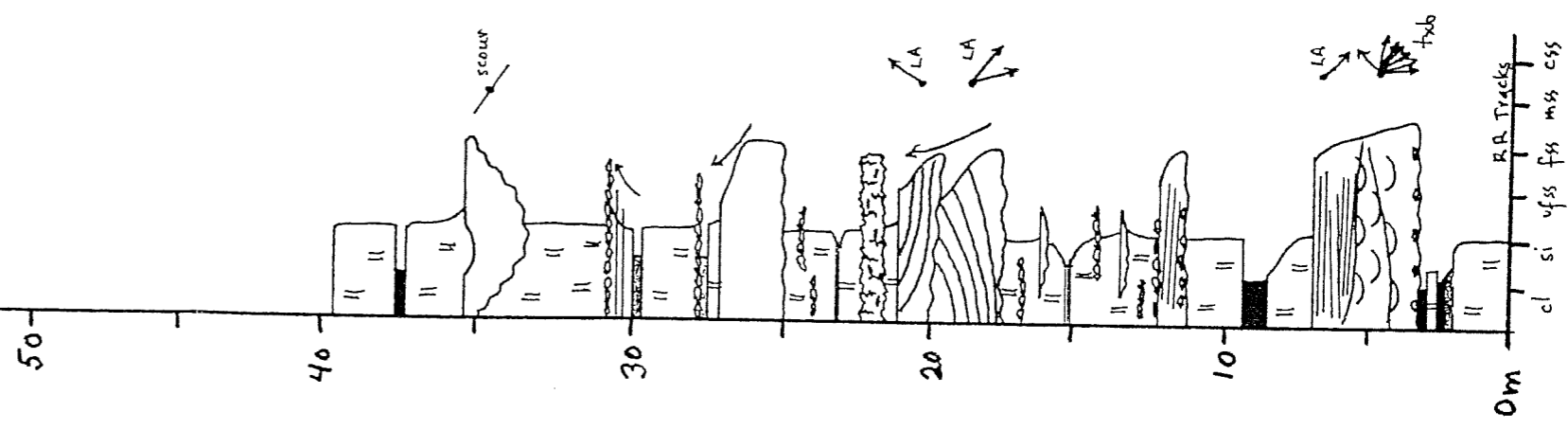


FIGURE 10

TAYLOR SIDING SECTION

(old RR yard, Hwy #841)  
Middle Horseshoe Canyon Fm

Map: Drumheller 82 P/7 776 895  
Sec 33 Twp 27 Rgc 20w4  
51° 21' N, 112° 45' W



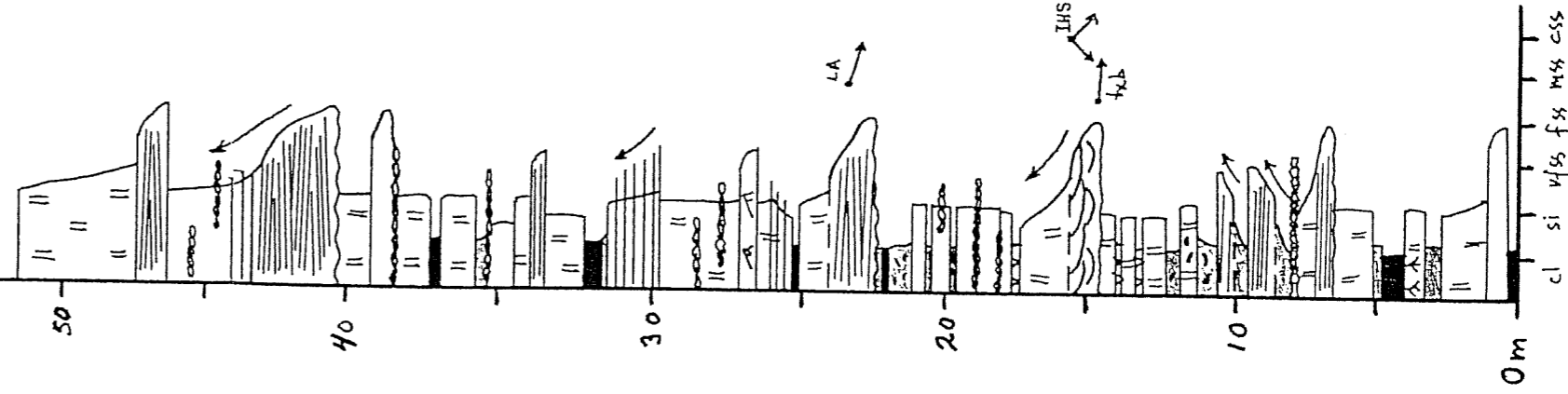
- greenish grey pedogenic siltstone
- coal
- greenish grey pedogenic siltstone
- white fs, well sorted, deeply erosional base, lens-shaped geometry pinches out over 20m laterally, siltstone-filled scour at top
- greenish grey pedogenic siltstone
- coarsening-upward sequence of interbedded pedogenic siltstone and thin vfss, dark grey carbonaceous shale
- greenish grey pedogenic siltstone
- fining-upward succession from pale grey fss with sharp base + low angle lamination and ripples, to greenish grey pedogenic siltstone, to dark grey carbonaceous shale, to sideritic paleosol
- greenish grey pedogenic siltstone with thin carbonaceous shale near base, siderite concretions
- rusty weathering sideritic paleosol, irregular sharp base+top, fractures, wood fragments
- multisorted pale grey vf-fss, well sorted, fining-upward, lateral accretion surfaces
- greenish grey pedogenic siltstone with several horizons of sideritic concretions and several thin vfss beds and one thin grey carbonaceous shale
- pale grey vf-fss, sharp base+top, low angle laminations, sideritic concretions at base+top
- greenish grey pedogenic siltstone
- coal
- greenish grey pedogenic siltstone, fining-upward
- pale grey f-m ss, well sorted, erosive base with rip ups, fxb, low angle lamination, horizontal lamination, lateral accretion surfaces
- interbedded black coal, dark grey carbonaceous shale and greenish grey pedogenic muddy siltstone
- greenish grey pedogenic siltstone, gradational top

FIGURE 11

BEYOND ECOLOGICAL PRESERVE SECTION

(Rosebud R. adjacent to bridge)  
Middle Horsehoe Canyon Fm

Map: Drumheller 82 P/7 754882  
Sec. 29 Twp 27 Rge 20W4  
51° 20' N, 112° 47' W

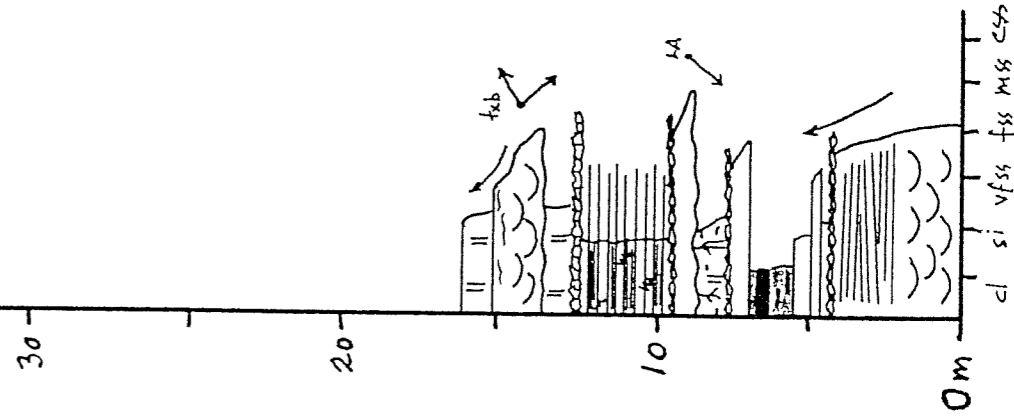


- greenish grey pedogenic sandy siltstone
- pale grey fss, well sorted, sharp base top, low angle lamination
- greenish grey to grey sandy siltstone, few of ss beds + sideritic horizons
- pale grey fss, well sorted, fining-upward, erosional base, low angle lamination
- thickly interbedded units of greenish grey pedogenic siltstone with sideritic horizons, and thin black coals or dark brown carbonaceous shales, and thin pale grey fss beds with sharp bases + tops and horizontal lamination
- fining upward sequence of thinly interbedded vss and green siltstone
- thick units of greenish grey pedogenic siltstone with numerous sideritic horizons and very thin of ss beds, one thicker ripped vss bed
- fining-upward succession from pale grey to white fss with erosive base and low angle lamination, to greenish grey pedogenic sandy siltstone, to thin coal
- thin coal overlain + underlain by dark brown carbonaceous shale with wood fragments
- greenish grey pedogenic siltstone with numerous sideritic concretions horizons and several v. thin carbonaceous shales
- pale grey thin bentonite
- fining-upward succession from pale grey fss with sharp base, tsb, and IHS lamination, to greenish grey pedogenic siltstone
- greenish grey muddy pedogenic siltstone with several thin laminated bentonites
- interbedded brown carbonaceous shale and greenish pedogenic siltstone, wood fragments
- stacked coarsening-upward sequences from brownish carbonaceous shale to pale grey vss with sharp tops and low angle laminations
- sideritic paleosol horizon, irregular upper surface, fractures
- fining-upward sequence from pale grey fss with sharp base and low angle lamination to vss to greenish grey pedogenic sandy siltstone
- greenish grey pedogenic siltstone
- interbedded black coal, brown carbonaceous shale and greenish grey pedogenic siltstone with roots
- greenish grey pedogenic siltstone
- pale grey fss, well sorted
- coal

FIGURE 12

BLUE BRIDGE SECTION  
 (Rosebud R, 300 m W of bridge)  
 Middle Horseshoe Canyon Fm

Map: Drumheller 82 P/7 695867  
 Sec 22 Twp 27 Rge 2 (w/4  
 51° 19' N, 112° 52' W)

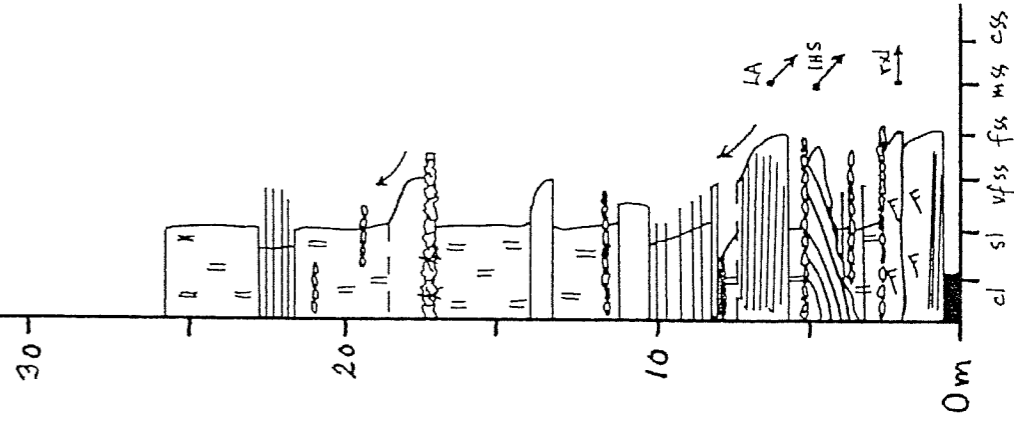


- greenish grey pedogenic siltstone
- pale grey fss, fining-upward, sharp base, tcb, silty at top
- greenish grey pedogenic sandy siltstone
- rusty weathering sideritic paleosol, fractured, irregular upper surface
- thinly interbedded greenish grey sandy siltstone and silty vfss, few thin clay-rich laminated beds, burrows?
- pale grey fss, erosive base with lag of rip-ups + wood frags, capped by thin sideritic concretion bed, large lateral accretion surfaces.
- greenish grey pedogenic siltstone, wood fragments, roots
- pale grey vf-fss, well sorted, sharp base, low angle lamination
- coal, overlain + underlain by dark brown carbonaceous shale
- thinly interbedded greenish grey muddy siltstone and pale grey vfss with sharp base + rcl
- pale grey to white fss, well sorted, capped by thin sideritic concretion bed, low angle lamination and tcb

FIGURE 13

RGE RD 21-2 SECTIONS  
 (tributary 1 km N of blue bridge)  
 Middle - Upper Horseshoe Canyon Fm

Map: Drumheller 82 P/7 697879  
 Sec 22 Twp 27 Rge 21 W4  
 51° 20' N, 112° 52' W



- greenish grey pedogenic siltstone
- thinly interbedded vf ss + si
- greenish grey pedogenic siltstone, discontinuous sideritic horizons
- pale grey v. ss, sharp base, gradational top, fining-upward + rusty weathering sideritic paleosol, fractures, roots
- greenish grey pedogenic siltstone
- pale grey vf ss, sharp base + top, fining-upward
- greenish grey pedogenic siltstone, sideritic concretions horizon
- greenish grey v. sandy siltstone, uniform
- thinly interbedded greenish grey siltstone and vf ss, fining-upward
- greenish grey pedogenic siltstone grading up into carbonaceous shale
- pale grey fs, fining-upward, sharp base, low angle lamination, gradational top
- greenish grey pedogenic siltstone
- pale grey fs, deeply erosive base downcuts to E, well sorted, IHS bedding, slight fining-up
- greenish grey pedogenic siltstone with thin vf ss beds and sideritic horizon
- pale grey multistoried fs, well sorted, sharp bases, low angle + ripple lamination
- coal

FIGURE 14



MILE 74 SECTION

(Mile 74 on RR tracks, 3 km w of blue bridge)  
Middle - Upper Horseshoe Canyon Fm

Map: Drumheller QR P/7 671863  
Sec 21, Twp 27 Rge 21 W4  
51° 19' N, 112° 54' W

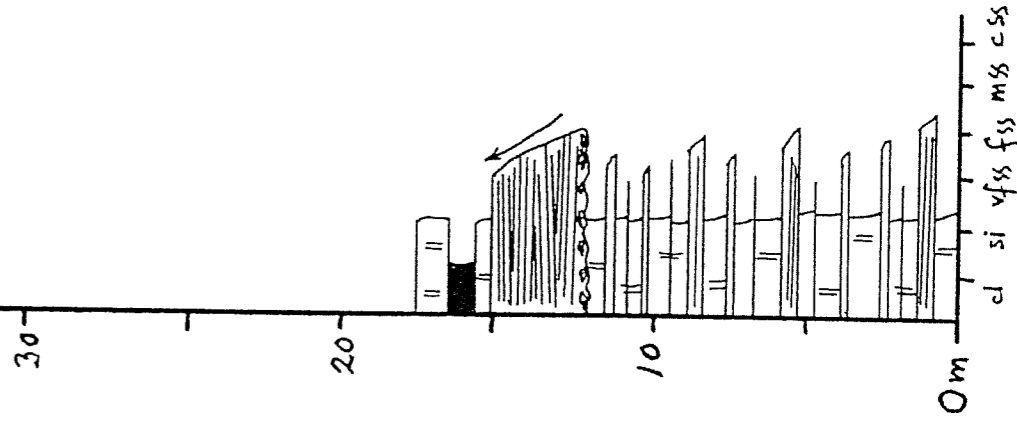
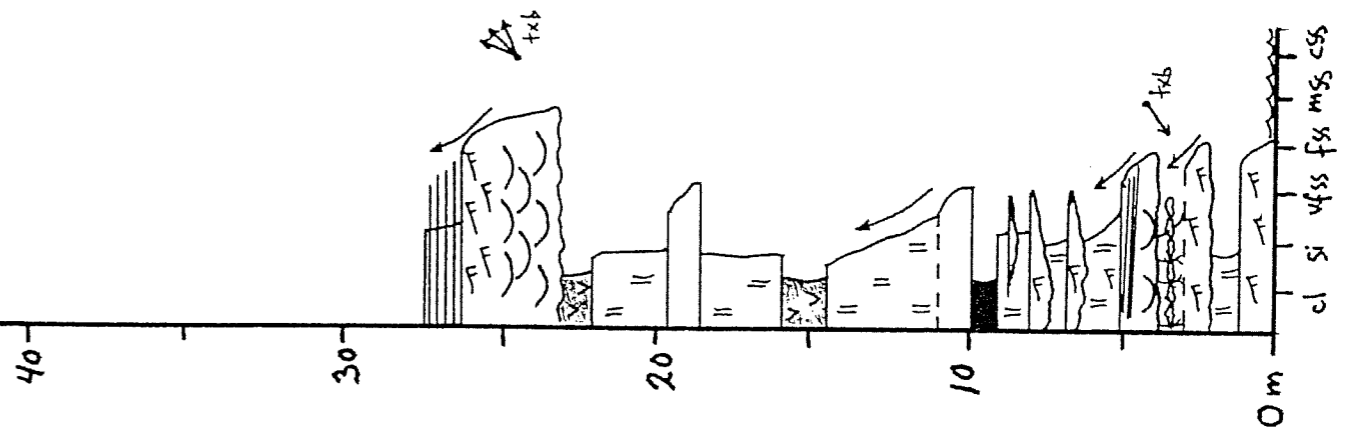


FIGURE 15

ROSEBUD SECTION

(Rosebud R. across from golf course)  
 Upper Horseshoe Canyon/Lower Scollard Fms  
 Map: Drumheller 82 P 17 645 057  
 Sec 18 Twp 27 Rge 21 W4  
 51° 18' N, 112° 57' W



- greenish to yellowish siltstone with thin v. f. ss beds
- yellowish brown to grey f. m. ss, well sorted, salt+pepper, slightly f-up, erosional base with abundant tiny ripples, abundant carbonaceous matter, mostly tab with ripples at top
- dark grey, v. uniform, bentonitic silty mudstone, popcorn weathering, sharp base + top
- greenish grey pedogenic silty mudstone with one thick pale grey v. ss bed in middle, poorly exposed
- dark grey, v. uniform, bentonitic silty mudstone, popcorn weathering, sharp base + top
- grey v. ss with sharp base + gradational top f-up into greenish grey sandy pedogenic siltstone to silty mudstone
- coal
- interbedded greenish grey pedogenic siltstone with several lenses of pale grey v. ss which pinch out laterally over 5-50m and have erosional bases
- pale grey v. f. ss, well sorted, fining upwards, erosional base, tab, low angle lamination
- greenish grey pedogenic siltstone with pebbles horizon of concretions, roots, wood frags.
- grey f. ss, well sorted, sharp base, fining-upward, rippled
- greenish grey pedogenic siltstone
- white f. ss, well sorted, fining-upward, rippled

FIGURE 16

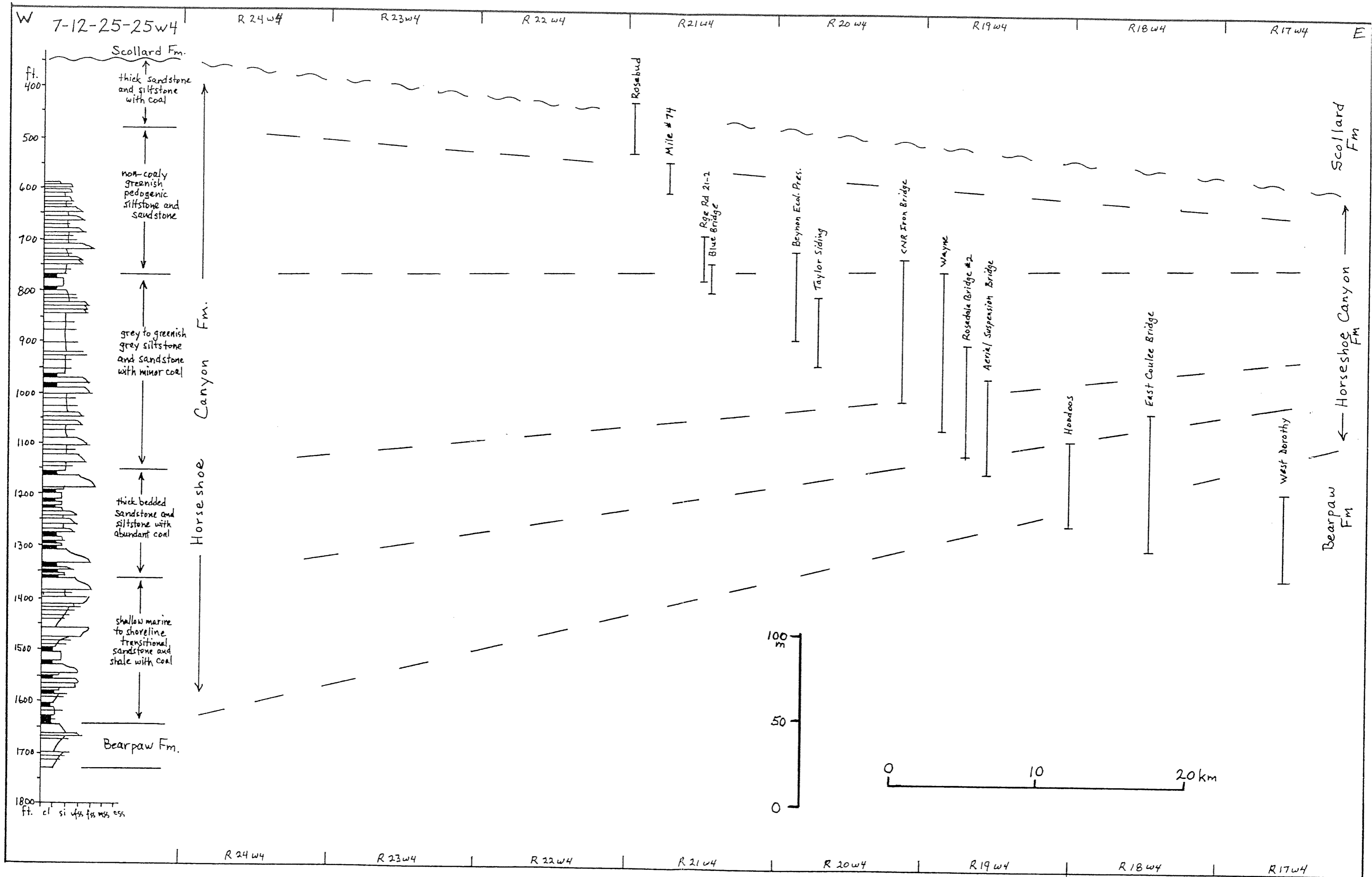


FIGURE 17