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Water erosion potential of soils in Alberta

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WATER EROSION POTENTIAL OF SOILS IN ALBERTA

Estimates using a modified USLE

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ABSTRACT

Attention has recently been focussed on water erosion in Alberta. This has resulted in an increased demand for data on erodibility of various soils and erosion potential in different parts of the province. The application of the Universal Soil Loss Equation (USLE) was evaluated as a method for assessing water erosion.

This report describes the adaptation of USLE Factors to Alberta conditions. A major modification was made to the precipitation component (R) to recognize the contribution of spring snow melt. Tables or maps are given for values of K, SL, R_T and C factors. The use of USLE is discussed and a generalized (1:1M) map of erosion potential, compiled with the aid of the computerized soil survey data base (SIDMAP) is enclosed.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

Soil erosion has been recognized as a potential problem in Alberta since the early part of this century. However, with the exception of the Peace River region, wind rather than water was thought to be the main agent of erosion. In the course of more recent soil surveys visible signs of water erosion such as rill formation, thinning of A horizons on slopes and deposition of eroded soil at the base of slopes, depressions or ditches were observed in all parts of the Province including the Brown Soil Zone.

Several investigations of water erosion in specific areas of Alberta have been made in the last two decades. Toogood (1963) studied water erosion on a fine-textured Black Chernozemic soil and found that, on slopes of less than 4%, soil losses are negligible during the growing season. The study of water erosion in Alberta continues and has been expanded to the Peace River region (Chanasyk 1983). Other scientists limited their assessment of soil erosion to a simple rating of inherent soil erodibility and slope steepness, mainly due to lack of published rainfall and other indices for Alberta (Coen and Holland 1976). Signs of water erosion were apparent in Warner County of southern Alberta (Kjearsgaard et al. 1984) and a preliminary application of the Universal Soil Loss Equation (Wischmeier 1965) supported the conclusion that there was a significant potential for water erosion despite the semiarid climate of the area.

With more attention focused on water erosion in Alberta in recent years, the question of assessment of potential soil erosion for the whole province became a concern. Although the soil survey has collected information on various soil properties for many years, only a recently developed computerized land database **SIDMAP** (Patterson and Peterson 1984) made it possible to fully utilize that information. Wischmeier and Smith's (1965) Universal Soil Loss Equation (**USLE**) was adopted for a general assessment of soil erosion in Alberta.

The objectives of this study were:

a) to estimate potential erodibility for major soil series, in all geographical regions of Alberta covered by reconnaissance soil surveys,
b) to compile a soil erodibility map for Alberta, and
c) to provide information for the assessment of erosion and design of conservation measures on specific parcels of land.

To accomplish these objectives, some factors of the USLE had to be modified to reflect the specific climatic and topographical conditions in Alberta. While these modifications have not been tested, it is felt that relative erosivity will be valid and that this adaptation of the **USLE** should provide a reasonable first approximation of water erosion risk. Additional research in water erosion processes and means of control with respect to diversity of climatic, soil and topographic conditions in Alberta are necessary for quantitative assessments.

1.1 Water erosion

Soil erosion by water is a naturally occurring landforming process. It includes both, general (sheet and rill) erosion as well as more site specific gully erosion. The general or non- specific erosion is the least apparent, but is the most damaging as it causes gradual thinning of the soil profile over the entire slope. Both the splash effect of rainfall and the movement of shallow layers of water over the soil surface are involved. The first predominates on upper slopes and ridges, while the more visible rills form in the area of concentrated flow of runoff water on mid and lower slopes. Gullies, the most dramatic expressions of water erosion, are caused by further concentration of runoff into larger rills. Although not usually included in erosion assessment, the deposition of eroded soil at the base of slopes or in ditches incurs additional losses and costs.

Soil erosion is a two-step process. During the first step, detachment, small soil particles or aggregates break away at the soil surface either by the impact of raindrops or the shear force of running water. Whether or not detachment will occur depends on the ability of particles to resist the erosive forces. Well aggregated, humus rich and finer textured soils are generally more resistant to detachment than silty or fine sandy soils with weak-structure.

The second stage, which results in actual soil loss, is the transportation of detached soil particles primarily by runoff water and to lesser extent by raindrop splash. Runoff will occur only when the amount of water exceeds the soil infiltration rate. This can happen during intensive rainstorms or during late stages of spring thaw when the soil is frozen and the thin thawed surface layer of soil is fully saturated. Any bare soil surface exposed at the time of spring runoff is especially vulnerable to erosion. Maximum storm activity in Alberta occurs in the June to August period. At this time on cultivated fields, crops offer better protection to the soil surface, substantially reducing erosion risk as compared to fallowed land. Both rainfall and runoff must be considered in the assessment of the water erosion problem.

Slope gradient and length are also important factors controlling water erosion mainly because of their effect on the carrying capacity of overland flow. Increasing slope steepness allows less time for infiltration thereby enhancing the amount of overland flow as well as increasing the speed or energy of the runoff water. A longer slope contributes to concentration of larger volumes of water which is particularly conducive to gully erosion.

Vegetation cover plays an important role in determining of the intensity of both the displacement and transportation of soil particles. It protects the soil surface from direct rain impact and greatly reduces runoff. For example, dense forest or grass cover reduces soil loss to nearly zero even on steep slopes. Any practice, such as cultivation, that deprives soil of protective vegetation cover or decreases soil aggregate stability will increase soil erosion level. The use of farming practices such as excessive length of field in relation to the slope steepness, up-and-down slope cultivation and excessive tillage will all increase the risk of erosion.

The erosion rate for a given site is determined by the combined effect of all the physical and management variables. Several methods such as the use of Cesium^{137} (DeJong 1983) or landscape analysis (Mermut et al.1983), can be used to quantify the combined erosion rate but they do not estimate the contribution of individual factors in the erosion process. It is essential to evaluate the effect of each variable and to identify specific causes in order to develop and prescribe corrective conservation measures. Mathematical models can be used to partition the process into components and enable the prediction of soil losses resulting from specific site conditions. The most widely used model is the Universal Soil Loss Equation developed by Wischmeier and Smith (1965).

2.0 The Universal Soil Loss Equation (USLE)

The Universal Soil Loss Equation is a model of soil erosion designed to predict a long term average of soil losses for a specific field area in specific cropping and management systems. Long term data are used to average out the random short term fluctuations in influential variables. The basic equation is:

A=R.K.LS.C.P.[1]

Average annual soil loss (**A**) is expressed in terms of rainfall intensity (**R**), soil erosivity (**K**), topography (LS), cover (**C**) and conservation practices (**P**). The computed soil loss includes both sheet and rill erosion caused by raindrop impact and surface runoff. However, gully erosion or mid slope deposition of sediments cannot be predicted by the **USLE**. Because of the unpredictability in short time fluctuation of some variables, particularly rainfall, the prediction of soil loss for specific events by mathematical models is substantially less accurate. A discussion of the individual factors follows.

2.1 R Factor - Rainfall (snowmelt)

The numerical values used for the rainfall factor (R) quantify the erosive effect of raindrop and surface runoff caused rain. However, in Alberta, the use of a rainfall factor alone could underestimate annual soil losses. Both Nicholaichuk (1967) and Chanasyk (1983) pointed out that much of the annual surface runoff was related to snowmelt and that spring runoff could cause significant erosion, especially in areas of snow accumulation or on plowed fields. Frozen soil results in quick saturation of the thin thawed surface layer and soil erosion can begin

[1] the units used in this publication are SI (metric) units:
A=t/ha/yr; R=mm; L=m; S=%; K, C and P=dimensionless

as soon as the soil is exposed, even though the early rates of melt may be small. Repeated thawing and freezing and puddling of the saturated layer promotes the breakdown of soil aggregates making the soil more erodible and thus increasing soil losses. Therefore snowmelt must be considered in any assessment of water erosion on the prairies and a new precipitation factor $\mathbf{R_T}$ is required.

$\mathbf{R_T = R + R_s}$ where: R_T = total precipitation factor
R = rainfall component
R_s = snowmelt component

The combined contribution of rainfall and snowmelt to total soil loss was estimated by McCool et al. (1982) in an average erosion index, $\mathbf{R_T}$, for soil loss assessment of the Pacific Northwest region. He used the following formula:

$\mathbf{R_T = 0.417P^{2.17*} + 1.0P_{D\text{-}M}}$ where: R_T = rainfall and runoff erosivity factor (MJ mm/ha • h • y)
P = 2yr return interval, 6hr duration precipitation (mm)
$P_{D\text{-}M}$ = December to March precipitation (mm)

* $0.417P^{2.17}$ is the original Wischmeier R factor (1974) modified for SIunit (Foster 1981)

However, climatic conditions in Alberta are significantly different from those in the Pacific Northwest. Firstly, winter precipitation is mainly in the form of snow. Secondly, the period of continuous snow cover changes significantly in Alberta from north to south. Data compiled by McKay (1968) showed that the longest snow cover period, October 31 to April 20 is in the extreme northern part of the province, while the shortest period December 6 to March 10 is in the extreme south (Fig.1). His data are substantiated by the results of satellite records (Berry and Scholefield 1979).

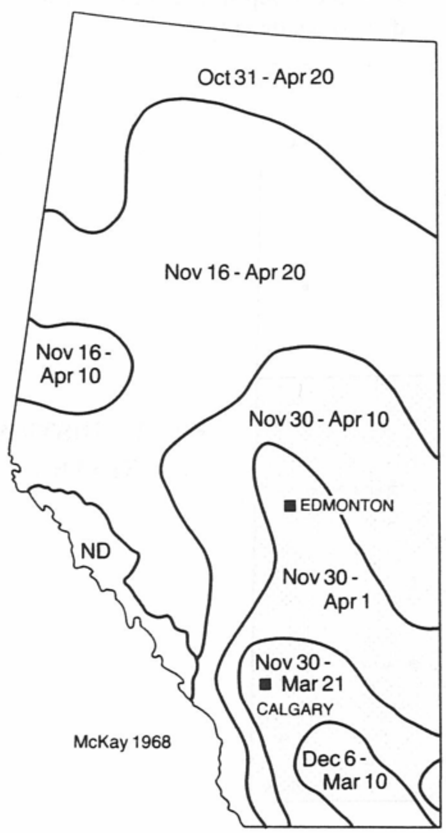

FIG. 1. THE RESIDENT TIME OF SNOW COVER IN ALBERTA.

The matter is further complicated by significant losses of snow due to sublimation and gradual thaw. Closer examination of data from a snow course project by Atmospheric Environmental Services[2] indicated that as much as 70% of the fallen snow could be lost before spring runoff, particularly in the southern chinook belt. Under such circumstances the McCool formula had to be modified and $\mathbf{R_T}$ calculated from snow on the ground at the time of spring thaw.

The intensity of snow induced erosion is largely determined by the rate of production and total quantity of meltwater and by the amount of runoff. The surface runoff occurs mainly during continuous thaw, when a substantial portion of snow layer melts within 10 - 20 days (Zachar 1983). Therefore the rate of snow thaw should be included in the assessment of the snow component ($\mathbf{R_s}$).

Zachar(1983) suggested that the snow erosion factor could be approximated by:

$R_s = m \cdot h \cdot k$ where m = average thaw rate (mm/day)
h = water equivalent of snow (cm)
k = runoff coefficient ranging from 0.75 to 1.5

Assuming a thaw rate of 2mm / day and assigning a value of 0.75 to k:

$R_s = 2(S_t.d).0.75$ where: S_t = snow depth at time of thaw
d = snow density

Therefore, the new equation for the precipitation erosion index R_T became:

$$\mathbf{R_T = 0.417P^{2.17\,*} + 1.5(S_t \cdot d)}$$

where: P = 6 hour precipitation intensity (mm) on 2 year return basis.
S_t = snow depth at time of thaw
d = snow density

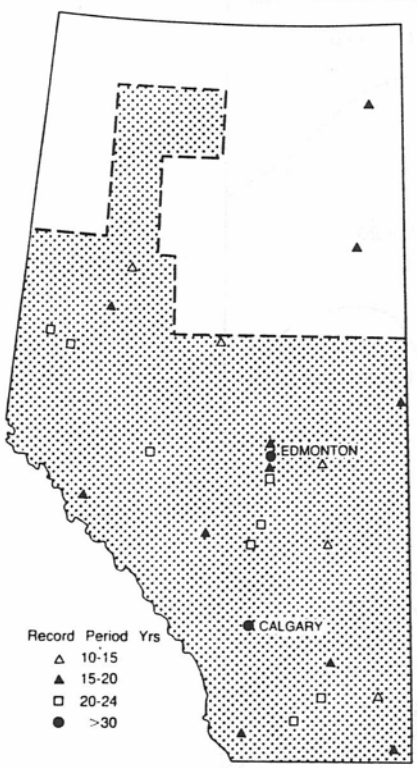

FIG. 2. DISTRIBUTION OF CLIMATOLOGICAL STATIONS WITH RAIN INTENSITY DATA

[2]Atmospheric Environment Service, Edmonton - Personal Communication.

The rainfall intensity data for 25 stations in Alberta used for computation of R were provided by AES Edmonton. In addition, some stations from Saskatchewan and British Columbia were used to supplement the data. The record period for individual stations ranged from 10-60 years. Obtained R values for all stations are significantly lower than values published for eastern Canada by Wall (1983), mainly due to shorter storm duration.

Stations with a record period shorter than 15 years or those with incomplete data were used as supplementary source only. Although stations are unevenly distributed throughout Alberta, the area covered by **SIDMAP** (Fig.2) is reasonably well represented. Due to the low density of the station network, the influence of factors such as local variation in topography are not expressed.

Snow depth data from monthly AES reports were used for the computation of spring runoff erosivity. The time of spring thaw was taken as March 31 for the area north of Calgary and February 28 for the south. The record period was 30 years. The source for snow density data used for conversion into water equivalents was, the AES snow course project [2]. The average thawing rate 2 mm per day was also estimated from the AES data.

Examples of calculated $\mathbf{R_T}$, snow density and percent of $\mathbf{R_S}$, are shown in Table 1. Highest $\mathbf{R_T}$ values were obtained for Edmonton and the Foothills, while the lowest $\mathbf{R_T}$ were in the northern and southern part of the province.

TABLE 1. PRECIPITATION FACTOR (RT) FOR SELECTED STATIONS IN ALBERTA

(2 year return)

Station	R SIU	R_T SIU	S % of R_t	Snow Density g/cc
Ft. Chipewyan	-	473	67	0.28
Peace River	-	564	39	0.28
Grande Prairie	-	452	36	0.28
Jasper	-	274	36	0.22
Edmonton Int. A	-	644	16	0.22
Ellerslie	-	864	17	0.22
Calgary	-	487	7	0.19
Lethbridge	-	602	4	0.19
Manyberries	-	423	4	0.17
Medicine Hat	-	410	6	0.17
Saskatoon*	850	-	15	-
Winnipeg*	1160	-	15	-
Toronto*	1140	-	30	-
Halifax*	1960	-	30	-

* data from G.J.Wall (1983)

[2] Atmospheric Environment Service, Edmonton - personal communication.

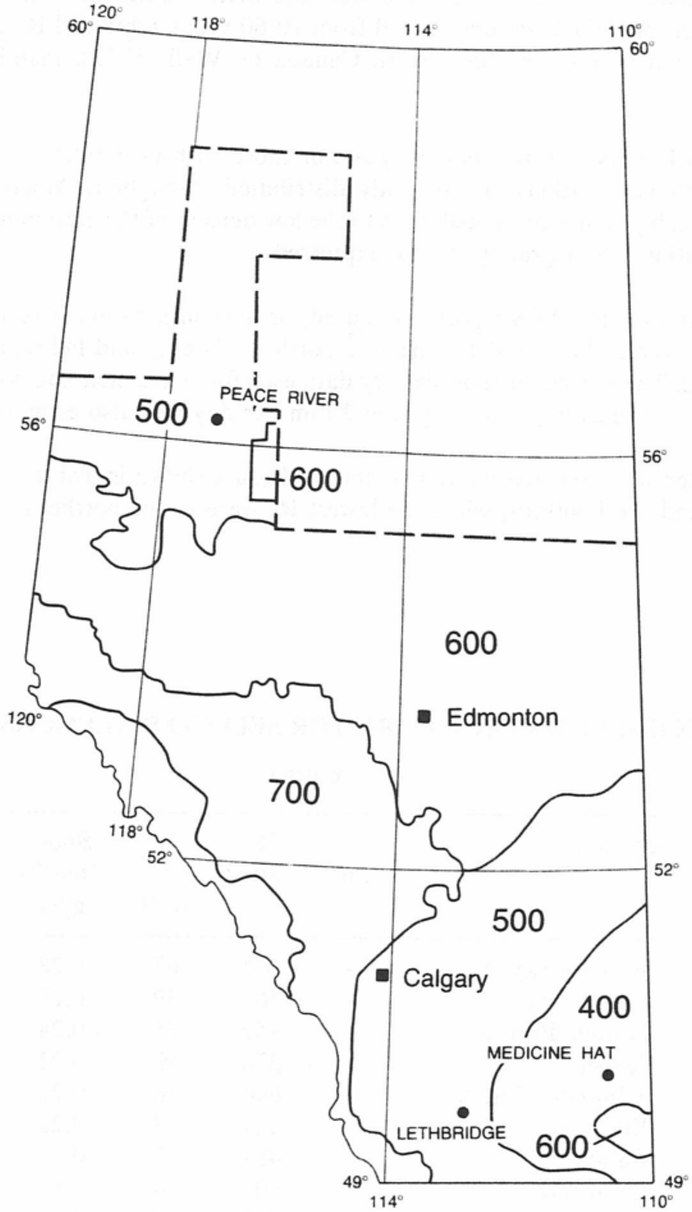

FIG. 3. ISOERODENT MAP FOR ALBERTA

Also the increased contribution of $\mathbf{R}_s$ from south to north is clearly shown in this table. A comparison of the Edmonton and Ellerslie data indicates the wide variation in $\mathbf{R}_T$ that can occur over short distances. Computed $\mathbf{R}_T$ values were used for compilation of an isoerodent map for Alberta (Fig. 3). Individual $\mathbf{R}_T$ values on this map represent an average combined erosivity by rainfall and spring runoff of broader geographical areas.

It should also be noted that identical $\mathbf{R}_T$ values, from different geographical regions on the map may differ in the contribution of snowmelt to total erosivity and by the variable monthly distribution patterns of rainstorms. This is particularly noticeable in the Peace River area where the maximum erosivity shifts from mid summer to April (Fig.4). This is in agreement with observations of maximum erosion and supports the inclusion of the snowmelt component into the **R** factor. The monthly distribution patterns are important for assessment of the cropping factor (**C**) for the various climatic regions of Alberta.

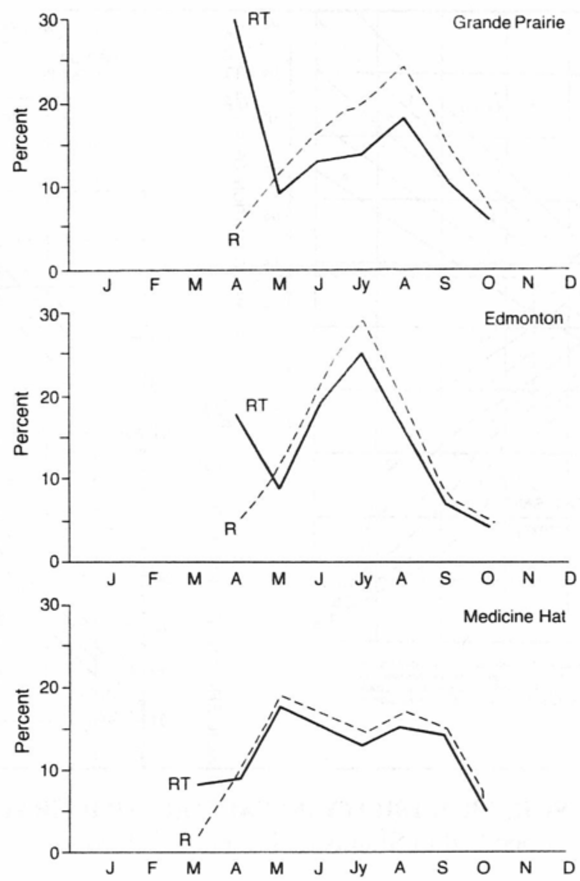

FIG. 4. MONTHLY DISTRIBUTION PATTERNS OF R_T FOR SELECTED STATIONS IN ALBERTA
(As a percentage of the individual totals)

2.2 K Factor inherent soil erodibility

The inherent susceptibility of soil to detachment and transportation by water is expressed by the **K** factor. **K** values were experimentally determined for many soils in the United States using standard plots in many parts of the country. To assign **K** values for individual soils, Wischmeier (1971) constructed a simple nomograph (Fig. 5). Five soil parameters (% silt + very fine sand, % sand, % organic matter, type of soil structure and soil permeability) are used to obtain the numerical value for any given soil.

Computed **K** factor values for most of the soil series recognized in Alberta are based on soil descriptions and analytical data for several profiles from each soil series. Several assumptions were made:

a) The average depth of surface horizon was assumed to be 20 cm.

b) organic matter contents were assumed to be; 2% for soils in the Brown soil zone and Gray Luvisols, 3% for the Dark Brown and Dark Gray Luvisols, 4% for soils in the Black soil zone and 5% for Humic Gleysols.

The obtained **K** values were than adjusted to reflect the center of the range for individual series. Missing values were estimated from related soils with respect to similarities in parent material, texture and soil development. A few problems were encountered with use of the Wischmeier's nomograph for several Alberta soils. Some of the soils were on the outer limits of VfS+Si content specified in the nomograph. Also, some soil structures common to Ap horizons of cultivated soils in Alberta were not included and the assessment of permeability was difficult for some soils. Although these problems require further investigations and adjustments, the obtained **K** values should rank the relative erodibility of individual series.

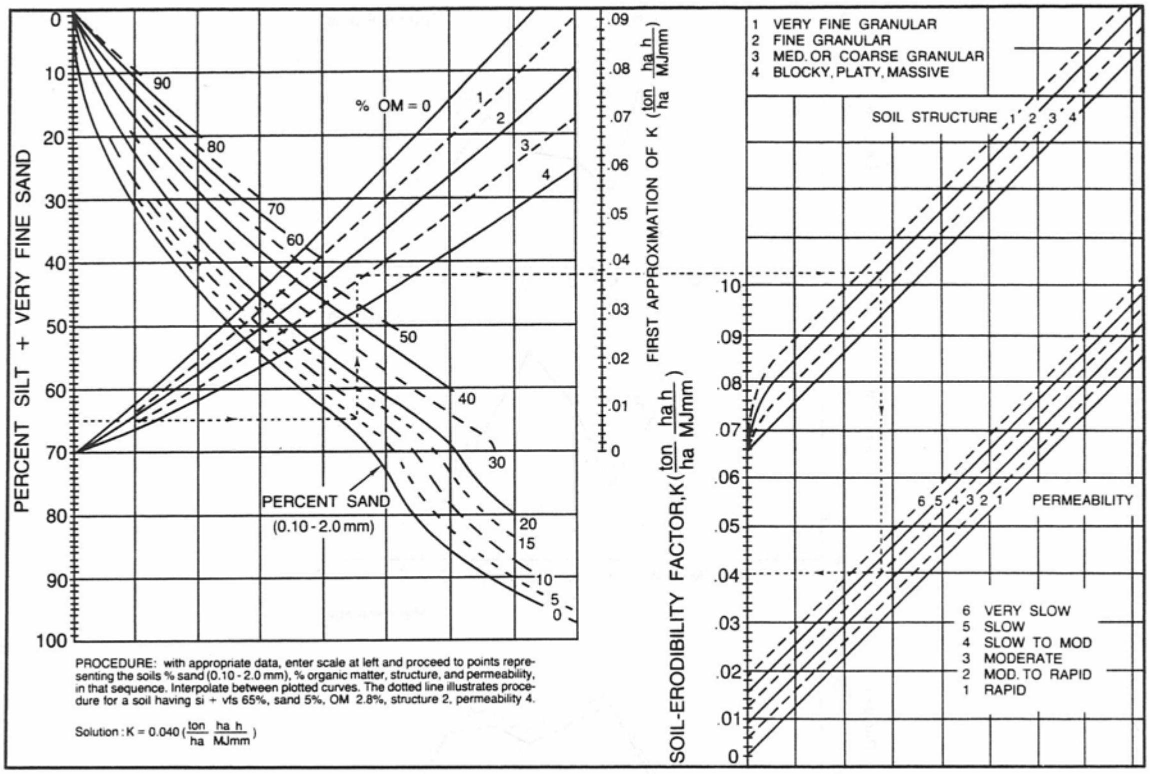

Fig. 5. SOIL ERODIBILITY (K) FACTOR NOMOGRAPH
(modified to SIunits by Foster et.al. 1981)

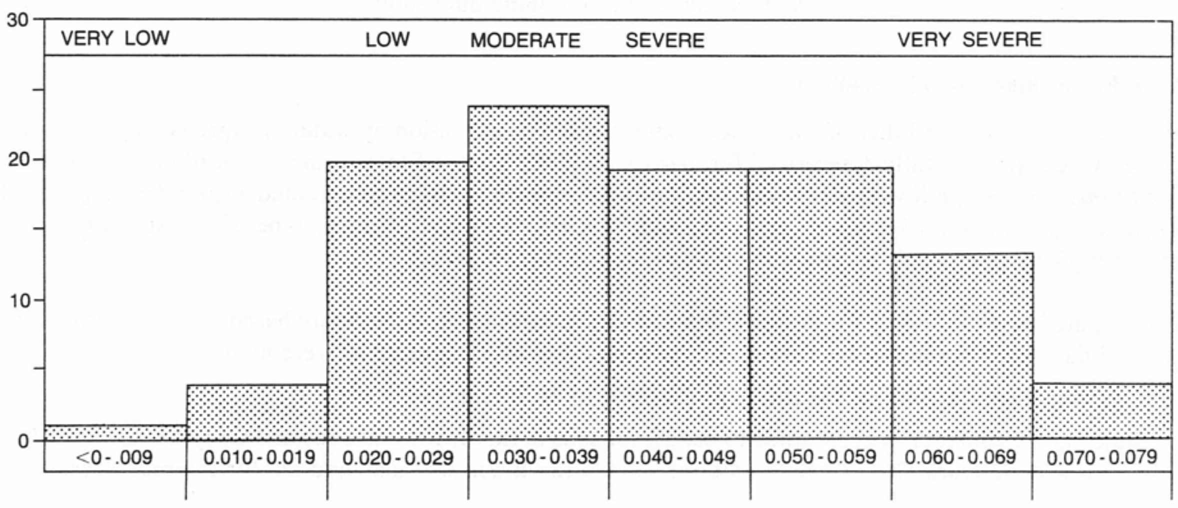

Fig. 6. DISTRIBUTION OF SOIL SERIES IN INDIVIDUAL ERODIBILITY CLASSES

Computed **K** values for Alberta soils range from 0.007 for coarse textured sandy soils to 0.072 for deeply leached soils with silty, poorly structured surface horizons (Table 2). This wide range reflects the variation in texture and pedogenesis of soils in Alberta. The overall erosivity potential is moderate to high with more than 30% of soils having **K** values higher than 0,05 and only 3% with values lower than 0.02 (Fig. 6).

Most erodible are Brunisolic Gray Luvisolic soils followed by Luvisols and those soils from the Solonetzic order with deep silty Ae horizons. These soils will pose a high erosion risk whenever natural vegetation cover or leaf litter is removed.

A complete list of **K** values for surface horizons of all series recognized in Alberta is in Appendix A. These average values may be used for a detailed evaluation of potential water erosion on specific parcels of land.

TABLE 2. ESTIMATED K VALUES FOR SELECTED SOILS IN ALBERTA
(for 0-20cm)

SOIL SUBGROUP	PARTICLE[1] SIZE CLASS	K^2 (SIU)
Orthic Brown Chernozemic	S	0.020
-"-	COL	0.032
-"-	FNL	0.036
-"-	C	0.025
Orthic Black Chernozemic	S	0.011
-"-	FNL	0.026
-"-	C	0.013
Brown Solodized Solonetz	FNL	0.049
Black Solodized Solonetz	FNL	0.040
-"-	C	0.040
Orthic Gray Luvisol	FNL	0.053
Solonetzic Gray Luvisol	C	0.059
Brunisolic Gray Luvisol	FNL	0.072

NOTE 1) S=sandy, COL=coarse loamy, FNL=fine loamy, C=clayey
2) K values reflect the center of the range for individual soils with an expected variation of +/- 20%.

2.3 LS Factor - Length and steepness of slope

This factor reflects the combined influence of the slope gradient and length on soil loss. Numerically the **LS** factor is a ratio of soil loss per unit area to that from the standard Wischmeier plot. On simple slopes the **LS** value for specified slope length and uniform gradient could be read directly from the **LS** factor chart in USDA Handbook 537 (1978). The **LS** values from the nomograph predict average soil loss over an entire slope. However, under field conditions the rate of soil loss will change with distance from the top to toe as well as with shape of slope. It should be noted however, that the Wischmeier (1965) equation and the nomograph were based on plots with gradients ranging from 3-18% and 9-90m in length and the accuracy of the relationship beyond these ranges has not been determined by direct measurements.

In Alberta the nomograph (Fig.7) was modified for use with metric units. Average **LS** values used in this project were also adjusted with respect to slope shape. A detailed description of **LS** factor assessment for irregular slopes is outlined in the USDA Handbook 573 (USDA 1978).

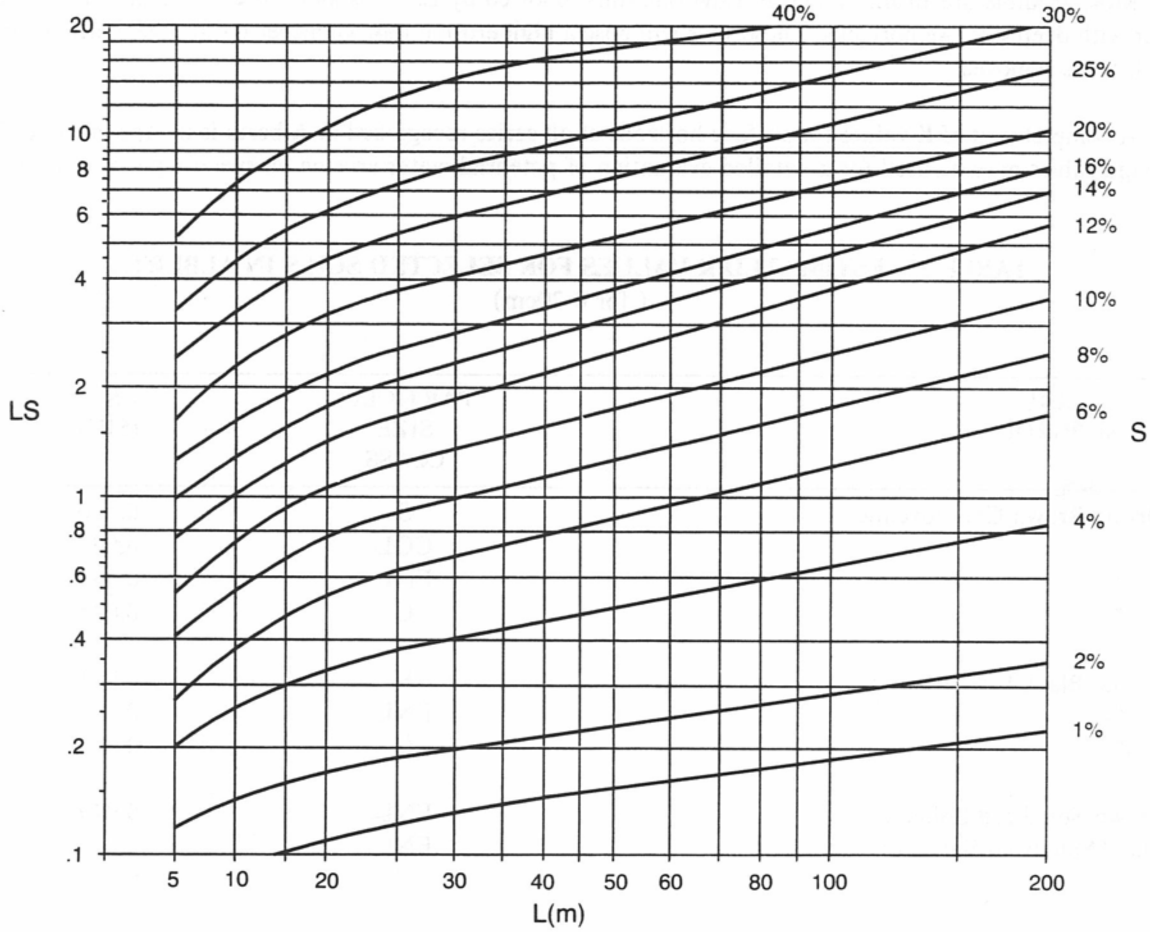

FIG. 7. NOMOGRAPH FOR ASSESSMENT OF LS FACTOR VALUES

TABLE 3. LS VALUES ASSOCIATED WITH LANDFORMS IN ALBERTA
(for scale 1:1M)

LANDFORM	S(%)	L(m)	LS
Undulating or terraced (Mu, Ft, Lu, Lv/Lu•		30	0.4
Level (Ll, Fl,)	0-5	50	0.4
Level to inclined (Ll, Li) (P.River)		200	0.6
Hummocky or ridged (Mh, Mr)		30	0.8
Rolling or inclined (Mm, Mi, Mb/Rm)	5-9	100	1.5
Inclined (Mi, Li, Mv/Ri)		200	2.0
Hummocky or ridged (Mh, Mr)		50	2.5
Rolling or inclined (Mm, Mi)	9-15	100	3.5
Steeper slopes (Mh,Mvb/Rm)	>15	30	5.0

•F=fluvial, L=lacustrine, M=morainal, R=rock
b=blanket, h=hummocky, m=rolling, r=ridged, u=undulating,
v=veneer.

Values of **LS** used in this study (Table 3) represent the average slope length and steepness associated with typical landforms in Alberta. The information on landforms was based on the Physiographic Region Map for Alberta[3]. Four slope classes and three slope lengths were used to characterize these landforms. Obtained **LS** values ranged from 0.4 - 5 and are valid only for large scale mapping (1:1M scale)

2.4 C Factor - Cover-management

This factor represents the ratio of soil loss for cropped land under specific cropping or cover conditions to the corresponding soil loss from continuously tilled or fallow land for the same soil, slope and rainfall intensity. Cover and management effects must be evaluated together because there are many inter-relationships. For example, the kind of tillage affects the amount of residue which is a cover consideration. Also cropping rotations, particularly involving summerfallow, and the time of seeding strongly influence the kind and amount of cover and its distribution over the year. The considerations must in turn be integrated with seasonal distribution of precipitation factor. A high $\mathbf{R_T}$ value may not be too serious if it occurs at a time when there is good plant cower, but if it coincides with a period of bare soil the results may be disastrous. The interdependence of these many components gives the **C** factor a strong geographical orientation.

TABLE 4. CROPPING FACTORS (C) FOR ALBERTA

	CEREALS	W.WHEAT	CANOLA	ALFALFA	GRASS	ROW-CROP
P.River	0.30 0.26*	–	0.42	0.025	0.006	–
Foothills	0.28	–	–	0.025	0.004	–
Central Alberta	0.27	–	0.34	0.025	0.004	0.45
Dark Brown Zone	0.30	0.27	0.39	0.025	0.01	0.45
Brown Zone	0.39**	0.29	–	0.025	0.01	0.45
Bush with thick litter	0.0005					
Bush with grazing	0.009					
Summerfallow	0.60 - 0.75 (depending on amount of residue)					

Notes: * with clover or alfalfa in rotation
** cereal summerfallow rotation

The **C** factor values for various geographical regions of Alberta (Table 4) are based on common agricultural practices, average time sequence of various operations and annual distribution of the $\mathbf{R_T}$ factor in a given region. The procedure used followed the USDA Handbook 537 (USDA 1978) with modifications for Alberta conditions. The five geographic areas correspond to the broad regions shown on the isoerodent map (fig 3) with the $\mathbf{R_T}$ evaluated for time of occurrence as well as total amount. Planting dates were assumed to vary from May 5 in the south to May 25 in the north with individual crop stages calculated from those dates. Other assumptions included:

a) a 2 yr. rotation in the Brown Zone

b) a 3 yr. rotation in the Dark Brown Zone

c) a 5 yr. rotation for the remainder

2.5 P Factor - Support practices

This factor in the **USLE** is the ratio of soil loss with specific support practices to corresponding loss from field with up-and-down-slope cultivation. Conservation practices such as contour tillage, strip cropping on the contours, mulching or terracing will slow the runoff of water thus reduce the amount of soil particles it can carry. The **P** factor reflects the effect of these practices on the reduction of soil loss.

[3] Pettapiece W.W unpublished data

Improved tillage practices, grass strips, or greater quantities of crop residues left on the field also contribute to soil erosion control. However, these are considered as cropping practices and are included in the **C** factor.

No **P** factor was used in the computation of soil loss as these soil conservation practices are not used in Alberta at the present time.

3.0 GENERALIZED WATER EROSION POTENTIAL IN ALBERTA

3.1 The use of SIDMAP

The computerized land database **SIDMAP** was used for mapping soil erosion potential in Alberta. This database contains the necessary data on soil and slope characteristic for each 1/4 section of land covered by soil survey. Computed values for individual factors used in the **USLE** were combined with **SIDMAP** and the average annual soil loss was calculated for individual section (250ha) cells. Computed soil loss values were ranked into five erodibility classes and used for compilation of the Potential Erosion Map for Alberta (see pocket) The following individual operations were involved (Fig. 8).

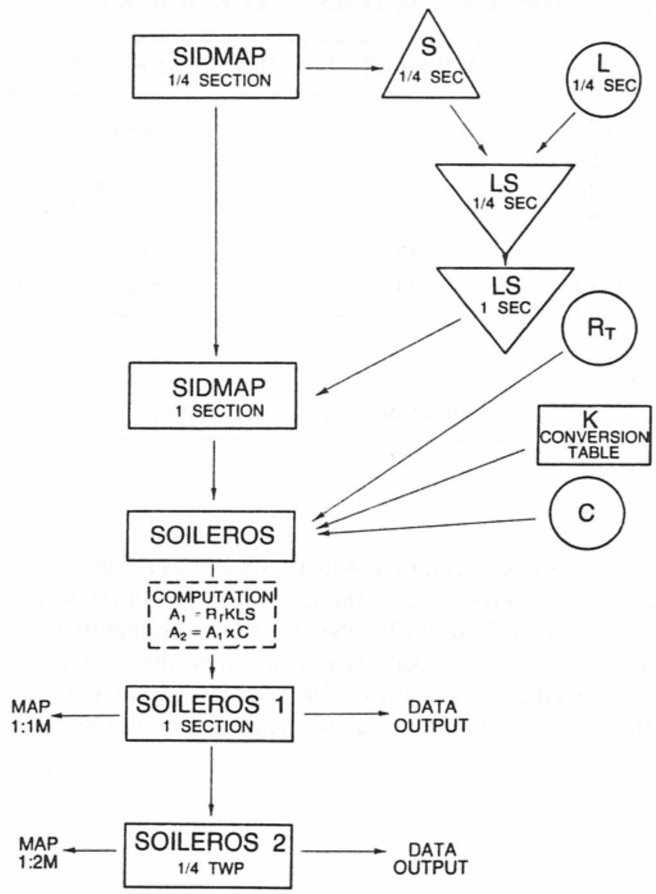

FIG. 8. FLOWCHART OF INDIVIDUAL OPERATIONS

a) data on location, soil series, slope steepness class and some supplementary data were extracted from **SIDMAP** and a new **SOILEROS** database was created.

b) coded information on slope length (L) was merged with the database and the **LS** FACTOR for individual one section cells determined by computer (from a look up table).

c) R_T values and **C** values for individual geographical areas were coded and merged with the **SOILEROS** base after expanding them first to the section cell level.

d) **K** values for individual soil series were added to the **SOILEROS** base in the form of a look up table. The **K** values for each cell was determined by automatic conversion for the dominant series in each cell.

e) average annual soil loss for bare soil and small grains was computed for each one section cell and placed into classes. (following the method of Patterson[4])

Presently available information used for the assessment of individual factors of **USLE** as well as the level of detail in **SIDMAP** only permit calculation for the dominant soil in each cell.

3.2 DISCUSSION

The calculated values represent the potential erodibility for the dominant soil series and landform in the given section under average climatic conditions and average cropping practices in specific geographical region.

Computed average annual soil losses ranged from 0.4 t/ha to 70 t/ha, with the higher values associated with areas of higher R_T. In general, due to significantly lower R_T factor, the potential soil loss for Alberta conditions is about 50% that of comparable soil in Ontario. But, despite lower precipitation erosivity more than 25% of area covered by the **SOILEROS** database has a fairly high potential erosion and 5% of the area is extremely erodible. While there is evidence of significant erosion by water in Alberta, much of the sediment is transported for only short distances, often being redeposited in the same field. This is a result of relatively low R_T factor and glacial landscapes with short slopes and poor surface drainage. Consequently, the main source of sediments in our streams is the erosion of river and stream banks. Exceptions could include heavy spring runoff, collection of water from long slopes or during extreme rainstorms.

The spring runoff contribution to soil loss is highest in the Peace River area where the maximum erosivity occurs in April at the time when vegetation provides minimal protection for the soil.

The K factor does not have a major affect on soil loss if the LS FACTOR is low but as slope steepness and length increase the inherent soil susceptibility to erosion becomes critical (Fig. 9).

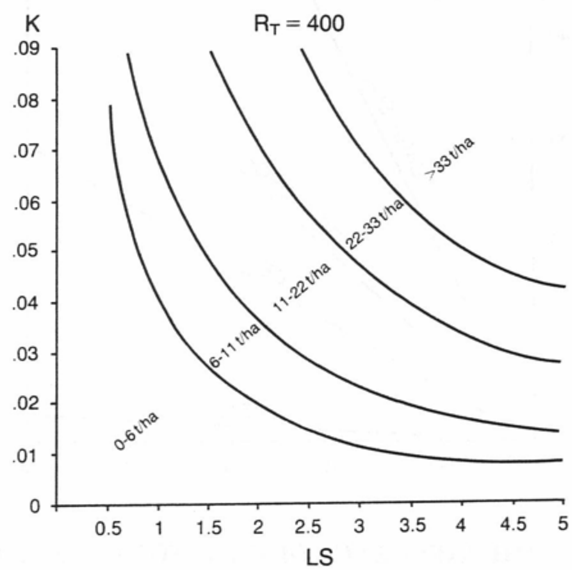

FIG. 9. THE COMBINED EFFECT OF LS AND K ON SOIL LOSS UNDER SPRING WHEAT

[4]personal communications

Although both the slope length and steepness have a strong influence on soil loss, excessive field length with respect to slope gradient appears to be a major cause of increased erosion from cultivated land in Alberta. Approximately 25% from the area covered by the SOILEROS database occurs on landforms with slopes longer than 50 m. Soil loss increases 1.5 times with an increase in length from 30m to 200m on slopes with gradients less than 5% and 2.5 times for gradient of 8% (Fig. 7). This suggests that on slopes with gradient less than 9% the adjustment of field length could be an effective conservation measure in Alberta. However, on slopes of 10 - 15% an adjusted length of field must be combined with other conservation techniques to achieve desired results. About 9% of the area has slopes steeper than 15% as compared to 56% with slopes less than 5%. Although this area is mostly uncultivated it requires special attention in management as these are the most susceptible to erosion. A special problem is posed by hummocky topography. In these areas of short slopes water erosion is caused mainly by the splash effect of raindrops and to a much smaller extent by surface runoff in the lower slope position. Another factor which might be important on such slopes is mechanical or aration erosion (Zachar 1982): the downhill displacement of soil by implements. Although not too apparent, aration erosion is very effective in the gradual down hill transfer of the cultivated layer. The rate of soil displacement is directly proportional to the gradient of slope and the velocity of the implement. For example, a single cultivation operation 10 cm deep and 10m wide coming down a 10% slope at 5 km per hour could result in the downslope displacement of approximately 0.1 t/ha of soil. Steeper slopes and higher speeds would increase the effect. Aration erosion occurs with every cultivation operation and affects the whole slope. The usage of large rigid beam implements, which do not conform to the surface contour of fields with hummocky topography, can result in much deeper cultivation on knolls and accelerated degradation. Only limited or zero till practices could effectively prevent such erosion.

Changes in **C** values for different crops or cropping systems have a major influence on soil loss (Fig. 10). For example, annual average soil loss on a medium textured Chernozemic soil would be 19 t/ha for bare soil, 8 t/ha for canola, 6 t/ha for cereals and 0.5t /ha for alfalfa. Similarly a Luvisolic soil under protection of bush has much lower erosion potential (0.01 t/ha) than under cereals (21 t/ha).

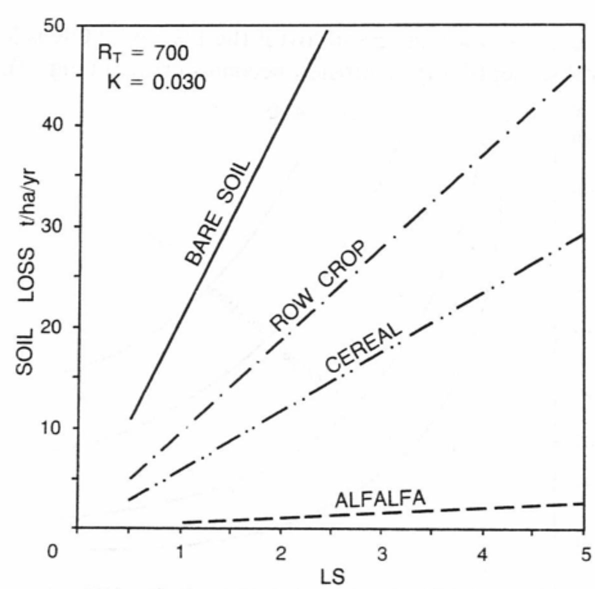

FIG. 10. THE INFLUENCE OF C FACTOR ON SOIL LOSS

The erodibility map, **SOILEROS** database and this report serve as a source of basic data for the assessment of erosion on specific parcels of land and for the design of specific conservation measures. The map of potential soil erosion provides generalized information on the degree and spatial distribution of erosion risk in Alberta and serves as a tool in the broad planning of land utilization and conservation.

The map is based on estimated soil loss values for small grain farming. The actual vegetation cover (cultivated, pasture, forest) could not be used because it would not permit comparisons from one parcel of land to another and it changes from time to time. Six potential erosion classes are used on the map to represent the relative annual soil loss.

class	category	potential loss t/ha/yr
1	negligible	< 6
2	slight	6-11
3	moderate	11-22
4	severe	22-33
5	very severe	33-55
6	extreme	>55

Some areas with high or severe or higher potential erodibility shown on the map are not cultivated at the present time or are not suitable for cultivation, these were included to show their susceptibility to water erosion should the natural vegetation be removed.

The largest single category includes areas of slight erosion potential with average soil losses below 6 t/ha/yr. For land with moderate or higher erosion potential, which represents approximately 15% of the province, proper conservation measures must be devised and used to keep erosion under control. On some highly erodible cultivated land, water erosion can be economically reduced only by returning this land to grass. In areas with uncultivated soil of extreme erosion potential care must be taken in grazing or logging not to destroy the protective vegetation cover.

It must be noted that the information in the **SOILEROS** file as well as on the map represent the dominant soil and slope only. Although minor areas with higher or lower erosion could occur within these delineations, associated with inclusions of different slopes or soil conditions, they all are too small to be shown at a 1:M scale. In addition, some damage to crops could occur from deposition of eroded soil in areas adjacent to fields with higher erosion potential.

4.0 OTHER APPLICATIONS OF THE USLE

4.1 Detailed assessment of water erosion potential.

Computation of potential erosion for a particular parcel of land requires detailed assessment of the individual factors used in the **USLE.** The $\mathbf{R_T}$, **C** and **K** factors provided in this report are valid for this task, but some additional information on slope gradient, length and shape as well as soil series must be obtained. Also it must be stressed that the $\mathbf{R_T}$ represents broad geographical regions only and can not at the present time describe local variation in precipitation erosivity. Obtained soil loss will represent relative values only as the validity of **USLE** and individual factors has not been experimentally tested in Alberta.

The following procedure should be used:

4.11) If soil survey map is available

1) find or identify the soil series occurring on a given landscape and the length and steepness of associated slopes.
2) from the nomograph (Fig. 6) obtain the corresponding LS factor.
3) from the table in the Appendix A, find the **K** value for the identified soil series.
4) determine the $\mathbf{R_T}$ FACTOR using the isoerodent map (Fig. 2)
5) select the proper **C** factor value for the given geographical area from Table 4.
6) apply these values to the USLE or use the erosion calculator (Fig. 11) and compute the potential soil loss.

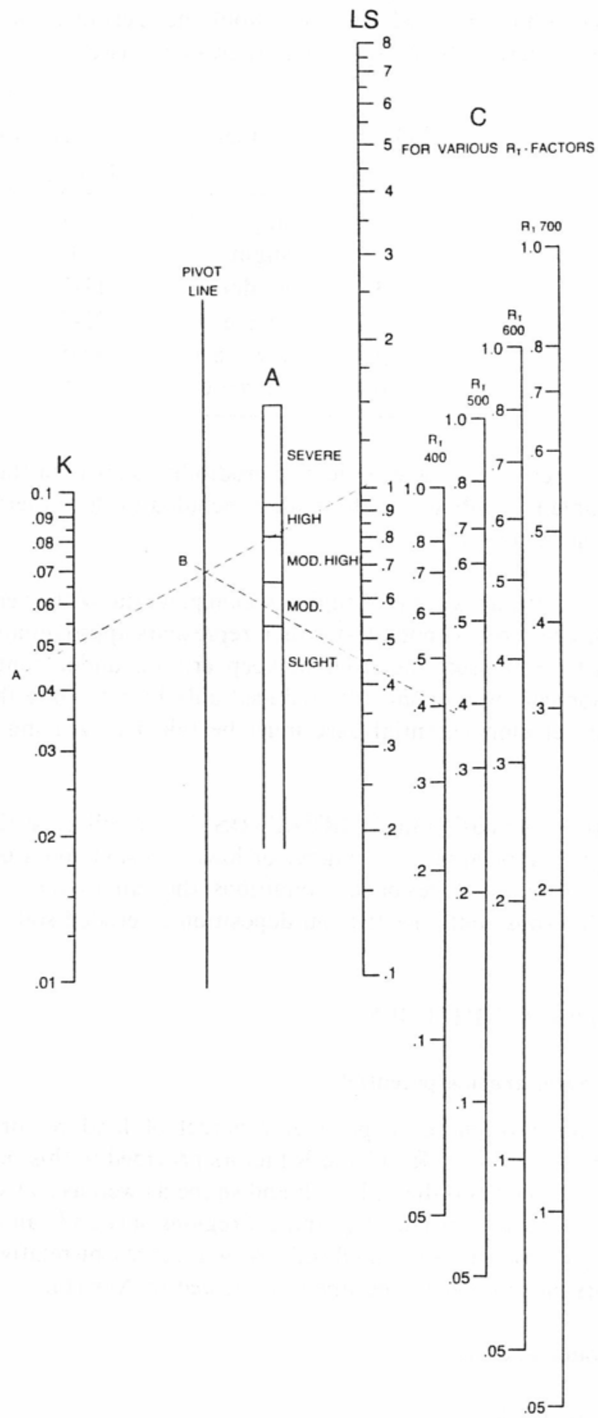

FIG. 11. THE EROSION CALCULATOR FOR ALBERTA

1) plot **K**,**LS** and **C** value on respective scale — note that the **C** scale must correspond to the correct $\mathbf{R_T}$ for a given geographical area.
2) draw line **"A"** and mark pivot point on the pivot line.
3) draw line **"B"** from pivot point to point on **C** scale. 4) read the potential erodibility from scale **A**

4.12) If the soil series are unknown, determine the texture and Subgroup of the soil and from Appendix B estimate the **K** factor. Continue as in paragraph 4.11.

4.13) When soil loss is calculated for long or irregular slopes, adjustments should be made to reflect the contribution of different parts of the slope to soil loss over its entire length.

The slope shape can affect soil loss, particularly on irregular slopes where the use of the average gradient would either underestimate the soil movement on convex slopes or overestimate it in concave slopes. Such slopes can be divided into individual segments of equal length with a nearly uniform gradient and the **LS** FACTOR can be derived by combining appropriate values from an **LS** nomograph and the appropriate fraction values for each segment.

The change in soil type for each segment can also be considered by including the corresponding **K** factor values in the calculation. However, individual segments cannot be evaluated separately when runoff flows from one segment to the next, nor do these calculations take into account any deposition of sediments with change of slope. Several detailed discussions of this problem have been published (Wischmeier 1974, USDA 1978).

4.2 Application of USLE for conservation.

The USLE can be used to determine the contribution of individual factors to soil erosion and to devise appropriate land use and management combinations that would minimize soil loss. If erosion is to be limited to some predetermined level the **USLE** can be modified by replacing the soil loss, **A**, in the equation with the tolerable erosion value,**T**. The commonly used **T** value in the United States is 6 t/ha/yr.(ASA 1979), a value which presumably represents the natural rate of soil renewal, or is considered economically acceptable. This value may be too high for the relatively thin soils of the semiarid to subhumid conditions of the Canadian prairies. Furthermore, the productivity of soils with thin profiles or limited subsoil will decline faster under the same rate of erosion than the productivity of well developed soils with thick surface horizons.

Although several methods for establishing **T** values have been proposed none have been experimentally tested under prairie condition. In order to provide some guidelines the following **T** values are suggested for Alberta.

TABLE 5. T VALUES FOR ALBERTA*

Kind of Soil	(t/ha/yr.)
Deep Chernozemic soils	6
Dark Brown soils and soils with less than 50cm to C horizon	4
Brown soils , Luvisols and soils with less than 50cm to C horizon	2
Solodized Solonetz and soils with less than 50 cm to gravel or bedrock or other limiting layer	1

* note: 1 mm over 1 ha is equivalent to about 12 t.

The R_T,S, and to great extent **K** factors are determined by natural conditions and are essentially fixed for given field. The remaining factors of the **USLE**, the **C**, **P** and **L**, could be influenced by management decisions or conservation practices. To compute the optimal value for **CP**,the **USLE** must be rewritten:

CP=T/RKLS where: **T** = value from table 7.
R,K,L,S = factors of **USLE** for a given situation

From the Table 4, and Appendix D (or similar table) find the proper combination of cropping and supporting practices to match the computed **CP** value.

The maximal length of field for designing of conservational practices, could be computed by the rewritten **USLE** equation:

L=T/RKSCP where: **T** = value from table 7.
S = value for given slope gradient (Table 8)
R,K,C,P = factors of the **USLE** for a given situation

Graphs (Fig. 12) of soil loss for various **L**, **S** and **K** factors and for spring wheat were compiled with the use of the modified **USLE** equation.

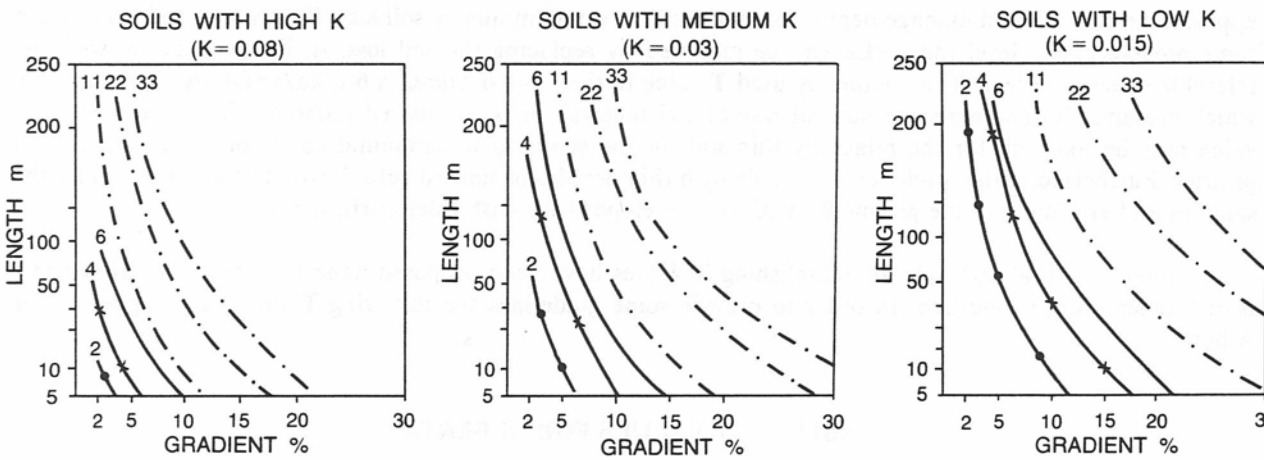

FIG. 12. SOIL LOSS RELATIONSHIP FOR VARIOUS L , S AND K FACTORS

TABLE 6. VALUES OF SLOPE STEEPNESS FACTOR S.

Slope grad.%	2	3	4	5	6	7	8	9	10	11	12	13	14
S	0.18	0.26	0.35	0.45	0.57	0.70	0.84	1.0	1.17	1.35	1.55	1.75	1.97
Slope grad.%	15	16	18	20	22	24	26	28	30				
S	2.21	2.46	2.99	3.57	4.21	4.90	5.66	6.43	7.28				

TABLE 7. VALUES OF SLOPE LENGTH FACTOR L.

Slope length m	5	10	15	20	30	40	50	60	80	100	150	200
L	0.48	0.68	0.82	0.95	1.17	1.35	1.52	1.66	1.91	2.13	2.61	3.02
Slope length m	250	300	350	400	450	500	600	700	800	900		
L	3.38	3.69	3.99	4.27	4.52	4.77	5.22	5.64	6.04	6.39		

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APPENDIX A

K FACTOR VALUE (in SI UNITS) FOR RECOGNIZED SOIL SERIES IN ALBERTA
(Values Computed for AP/0-20 cm)

SERIES	K FACTOR VALUE	CLASS	K FACTOR SERIES	VALUE	CLASS	K FACTOR SERIES	VALUE	CLASS
ABC	0.063	5	BTH	0.040	3**	CVL	0.055	5
ABT	0.040	3	BTN	0.059	5	CYG	0.026	2
ACV	0.025	2	BUD	0.053	4	DAU	0.072	6
ADY	0.036	3**	BUL	0.036	3	DBO	0.059	5
AGS	0.020	2	BUT	0.040	3**	DCY	0.026	2**
AID	0.026	2	BVA	0.034	3	DDY	0.026	2
ALC	0.063	5	BVH	0.026	2	DEK	0.072	6
ALT	0.040	3	BVL	0.032	3	DEL	0.026	2
AMK	0.026	2	BWF	0.030	3	DES	0.013	1**
ANO	0.032	3	BWY	0.053	4	DHP	0.046	4
ARM	0.040	3	BYR	0.066	5**	DHS	0.049	4
ASL	0.063	5	BZC	0.020	2	DIG	0.050	4
ATL	0.026	2	BZR	0.026	2	DIM	0.040	3
ATO	0.034	3	CAR	0.072	6	DIN	0.066	5
ATP	0.020	2	CAW	0.046	4	DKN	0.033	3**
AWD	0.041	4	CCL	0.040	3	DKT	0.053	4
AYL	0.034	3	CDM	0.053	4	DLB	0.033	3
BAB	0.050	4	CFD	0.040	3	DMH	0.021	2**
BAT	0.066	5	CFT	0.034	3**	DMT	0.059	5
BBN	0.063	5	CGE	0.034	3**	DMY	0.053	4
BCR	0.040	3	CHN	0.040	3	DNT	0.059	5
BED	0.040	3	CHZ	0.040	3	DON	0.066	5
BEN	0.053	4	CIO	0.034	3	DPV	0.040	3**
BFD	0.037	3	CIV	0.059	5	DSJ	0.020	2
BFT	0.032	3	CLD	0.021	2	DUG	0.034	3
BGY	0.063	5	CLR	0.045	4	DVG	0.026	2
BIL	0.053	4	CMO	0.036	3	DVS	0.059	5
BIS	0.033	3**	CMY	0.026	2**	DWT	0.020	2**
BIT	0.026	2**	CNY	0.026	2**	DXV	0.059	5
BKE	0.021	2	COA	0.057	5	DYD	0.037	3**
BLA	-	-	COD	0.033	3	EBG	0.059	5
BLD	0.026	2	COH	-	-	EBO	0.040	3**
BLP	0.040	3	COP	0.046	4	EDG	0.030	3
BLY	0.040	3**	COR	0.046	4	EDW	0.020	2
BMT	0.053	4	COS	0.046	4	EGL	-	-
BMY	0.059	5	CRD	0.034	3	EGO	0.034	3
BNN	-	-	CRN	0.055	5	EKW	0.026	2
BOC	0.033	3	CSP	0.059	5	ELB	0.050	4**
BOV	0.017	2**	CTE	0.066	5	END	0.033	3
BPT	0.020	2	CTN	0.021	2	EOR	0.026	2
BPW	0.033	3**	CTW	-	-	ERR	0.059	5
BRK	0.040	3	CUL	0.053	4	ERS	0.063	5
BSK	0.032	3	CUN	0.040	3	ERT	0.020	2**
BSU	0.026	2	CVD	0.020	2	ESH	0.053	4

K FACTOR VALUE (in SI UNITS) FOR RECOGNIZED SOIL SERIES IN ALBERTA
(Values Computed for AP 0-20 cm)

SERIES	K FACTOR VALUE	CLASS	K FACTOR SERIES	VALUE	CLASS	SERIES	K FACTOR VALUE	CLASS
ETA	0.059	5	HDY	0.042	4	KIN	0.040	3
ETC	0.053	4	HEG	0.028	3	KKN	0.034	3
ETH	0.040	3	HEN	0.020	2	KKY	0.040	3
EVL	0.034	3**	HER	0.026	2**	KLM	0.040	3**
EXP	0.045	4**	HGT	0.020	2**	KNA	0.007	1**
EZM	0.013	1**	HGV	0.063	5	KNK	0.026	2**
FAL	0.053	4	HGW	0.059	5	KNT	0.013	1
FBG	0.020	2**	HID	-	-	KNZ	-	-
FDL	0.053	4	HIW	0.011	1**	KPO	0.038	3
FLU	0.034	3	HKR	0.040	3	KSD	0.046	4**
FMN	0.034	3	HLB	0.040	3**	KSR	0.026	2
FMT	0.040	3	HLM	0.032	3	KSY	0.033	3**
FNH	0.024	2	HLW	0.013	1**	KTH	0.059	5
FNR	0.020	2**	HMS	0.045	4	KTM	0.046	4
FOR	0.026	2**	HND	0.030	3	KUR	0.034	3**
FRY	0.026	2	HNL	0.059	5	KVG	0.040	3
FSH	0.013	1	HOD	0.046	4**	KWO	0.059	5
FST	0.033	3	HPE	0.030	3	LAD	0.040	3
FTH	0.026	2	HPV	0.022	2**	LCY	0.059	5
FTO	0.053	4	HRK	0.007	1	LET	0.034	3
FVW	0.040	3	HRT	0.020	2	LEV	0.053	4
FWT	0.053	4	HSY	0.072	6	LFE	0.034	3
GAG	0.024	2	HTW	0.063	5	LFN	0.026	2
GBL	0.040	3**	HUB	0.053	4	LHD	0.029	3**
GBU	0.040	3**	HUK	0.045	4	LIH	0.040	3
GDB	0.041	4**	HYH	0.053	4	LIZ	0.020	2
GDI	0.059	5	HYL	0.033	3	LLD	0.040	3
GEM	0.046	4	HZM	0.066	5	LLK	0.030	3**
GGG	0.026	2	IMY	0.040	3	LNN	0.040	3
GIF	0.033	3	IND	0.046	4	LOB	0.072	6
GLS	0.026	2	INS	0.033	3	LOM	0.033	3**
GMC	0.040	3**	IRM	0.024	2**	LRC	0.066	5
GMT	0.053	4	IWT	0.046	4**	LSD	0.043	4
GMW	0.043	4	JAT	0.033	3	LTA	0.032	3**
GOG	0.059	5	JFF	0.026	2**	LTC	0.053	4
GS	0.013	1	JOP	0.033	3	LUP	0.034	3
GOY	0.063	5	JRV	0.053	4	LVT	0.059	5**
GPH	0.032	3	JUH	0.050	4	LVY	0.024	2
GRD	0.020	2**	JUY	0.059	5	LWT	0.066	5**
GRG	0.040	3	JVE	0.046	4	MAA	0.053	4
GUR	0.007	1**	KBD	0.046	4	MAB	0.036	3
GUN	0.033	3	KCP	0.046	4	MAC	0.020	2**
HAN	0.030	3**	KEG	0.026	2	MCA	0.040	3**
HBG	0.059	5	KG	0.032	3**	MCL	0.072	6
HBK	0.020	2	KGT	0.034	3	MCN	0.040	3
HBM	0.032	3	KHO	0.043	4	MCO	0.028	3
HBR	0.059	5**	KHS	0.053	4**	MCT	0.028	3
HCH	0.007	1**	KHW	0.034	3	MDE	0.046	4

K FACTOR VALUE (in SI UNITS) FOR RECOGNIZED SOIL SERIES IN ALBERTA
(Values Computed for AP 0-20 cm)

SERIES	K FACTOR VALUE	CLASS	SERIES	K FACTOR VALUE	CLASS	SERIES	K FACTOR VALUE	CLASS
MDP	0.024	2**	OHS	0.072	6	RND	0.017	2
MER	0.059	5	OKY	0.026	2	ROL	0.036	3
MET	0.026	2**	ONW	0.033	3	RRD	0.032	3
MEW	0.034	3**	OSN	0.033	3**	RSN	0.050	4
MFT	0.032	3**	OVE	0.033	3	RSV	0.063	5
MGR	0.026	2	OWD	0.036	3	RVN	0.013	1
MGS	0.011	1**	OXY	0.036	3	RSV	0.063	5
MHN	0.040	3	PAR	0.040	3	RYF	0.040	3
MIC	0.028	3**	PCO	0.066	5	RYF	0.040	3
MIQ	0.059	5**	PDY	0.059	5	SAD	0.053	4
MJU	0.040	3**	PED	0.032	3**	SAK	0.032	3
MKN	0.046	4	PER	0.036	3	SBN	-	-
MKR	0.020	2	PGN	0.037	3	SBT	0.046	4**
MLA	0.050	4	PGS	0.053	4	SCD	0.020	2**
MLY	-	-	PHF	0.043	4	SCH	0.072	6
MMO	0.021	2	PHS	0.024	2	SCO	0.017	2
MNK	0.059	5**	PIB	0.026	2	SDN	0.053	4
MNT	-	-	PLS	0.020	2**	SFD	0.040	3
MPH	0.059	5	PMA	0.043	4	SHL	0.024	2**
MPV	0.046	4	PNC	0.059	5	SHP	0.059	5**
MSB	0.053	4	-	-	-	-	-	-
MSK	0.046	4	PNR	0.021	2	SHS	0.040	3
MSN	0.040	3	POK	0.032	3	SIG	0.040	3
MUD	0.046	4	POT	0.013	1**	SIL	0.047	4
MYW	0.063	5	PPE	0.033	3	SIS	0.020	2
MZY	0.021	2	PPS	0.046	4	SKY	0.040	3
NDG	0.066	5	PRT	0.026	2**	SLN	-	-
NDP	0.053	4	PRV	0.050	4	SLY	0.020	2**
NED	0.020	2	PSO	0.030	3	SND	0.020	2**
NEM	0.034	3	PTA	0.036	3	SNP	0.046	4
NFK	0.040	3	PTO	0.059	5	SOF	0.032	3
NHL	0.072	6	PUR	0.030	3	SOL	0.028	3
NIB	0.038	3	PUY	0.034	3	SPR	0.059	5
NIT	0.020	2	PZY	0.059	5	SPS	0.025	2
NKM	0.046	4	RAM	0.040	3	SPY	0.026	2**
NKU	0.066	5	RAT	0.046	4	SRC	0.032	3**
NKW	0.040	3	RBB	0.059	5	SRV	0.032	3
NMP	0.040	3	RCS	0.020	2	STB	0.072	6**
NNK	0.040	3	RDM	0.030	3	STC	0.053	4**
NPA	0.066	5	RDW	0.013	1	STE	0.030	3
NRM	0.026	2	RED	0.011	1**	STT	0.040	3**
NSK	0.030	3	RFD	0.024	2	SUC	0.046	4
NTW	0.020	2	RHS	0.020	2**	SUD	0.032	3**
NUT	0.034	3	RIB	0.013	1**	SUL	0.029	3**
NVR	0.021	2	RIR	0.032	3	SVG	0.020	2**
NWB	0.053	4	RKV	0.030	3	SWY	0.033	3
OAS	0.034	3	RLK	0.053	4	SXH	0.026	2**
OGR	0.046	4	RMR	0.033	3	SXT	0.026	2
OHD	0.055	5	RMY	0.034	3	SYK	0.020	2

K FACTOR VALUE (in SI UNITS) FOR RECOGNIZED SOIL SERIES IN ALBERTA
(Values Computed for AP 0-20 cm)

SERIES	K FACTOR VALUE	CLASS	SERIES	K FACTOR VALUE	CLASS	SERIES	K FACTOR VALUE	CLASS
TAB	0.040	3**	TWG	0.021	2**	WHF	0.036	3
TAG	0.055	5	TWH	0.013	1	WHM	0.059	5
TBR	0.013	1**	TWS	0.032	3**	WHW	0.055	5
TBY	0.043	4	TYK	0.050	4**	WHY	0.072	6
TCK	–	–	UCS	0.053	4	WID	0.040	3
TEP	0.033	3	UKT	0.024	2**	WKM	0.024	2**
THA	0.030	3**	VAC	0.034	3	WKN	0.040	3
THH	0.021	2**	VEB	0.036	3	WLB	0.046	4
TIK	0.040	3**	VET	0.046	4**	WLD	0.072	6
TIY	0.040	3	VGR	0.046	4**	WLH	0.020	2
TLA	0.045	4	VIL	0.026	2	WNY	0.034	3
TMK	–	–	VST	0.020	2	WOT	0.072	6
TML	0.059	5	VTR	0.040	3	WPS	0.063	5
TMN	0.057	5	VVW	0.043	4	WST	0.050	4**
TNW	0.053	4	WAB	0.053	4	WTB	0.040	3
TOD	0.072	6	WBG	0.059	5**	WTN	0.021	2
TOM	0.059	5	WBH	0.021	2**	WWO	0.046	4
TOR	0.053	4**	WCT	0.059	5	WWT	0.013	1
TPE	0.040	3	WDN	0.028	3**	YNY	0.020	2
TTH	0.030	3**	WDW	0.049	4	YTW	0.032	3
TVS	0.045	4**	WES	0.040	3**			

** estimated

note: expected range in values is +/. 20%

APPENDIX B

ESTIMATED K FACTOR FOR Ap OF ALBERTA SOILS
(based on averages of K value for recognized soil series)

	SSK +/-50%	S +/-50%	LSK +/-30%	COL +/-30%	FNL +/-30%	FNSi +/-20%	C +/-20%
CHERNOZEMIC							
ORTHIC BROWN	0.015	0.020	0.026	0.032	0.039	0.042	0.026
REGO BROWN	0.015	0.020	0.028	0.038	0.042	0.045	0.030
SOLONETZIC BROWN	–	–	0.026	0.032	0.039	0.043	0.028
ORTHIC DARK BROWN	0.015	0.018	0.020	0.026	0.034	0.040	0.021
REGO DARK BROWN	0.015	0.018	0.020	0.026	0.034	0.040	0.021
SOLONETZIC DARK BROWN	–	–	0.024	0.030	0.037	0.040	0.025
ORTHIC BLACK	0.010	0.011	0.020	0.023	0.029	0.030	0.017
REGO BLACK	0.010	0.011	0.020	0.023	0.034	0.040	0.025
ELUVIATED BLACK	–	–	0.020	0.025	0.030	0.035	0.020
SOLONETZIC BLACK	–	–	0.020	0.025	0.030	0.035	0.020
ORTHIC DARK GRAY	0.010	0.013	0.020	0.023	0.034	0.035	0.020
SOLONETZIC DARK GRAY	–	–	0.020	0.025	0.030	0.035	0.020
SOLONETZIC							
BLACK SOLONETZ	–	0.015	–	0.030	0.036	0.040	0.034
BROWN SOLOD. SOLONETZ	–	–	–	0.032	0.045	0.050	0.040
DARK BROWN SOLOD. SOLONETZ	–	0.020	–	0.030	0.041	0.045	0.040
BLACK SOLOD. SOLONETZ	–	0.015	–	0.030	0.036	0.045	0.040
D. GRAY SOLOD. SOLONETZ	–	0.015	–	0.035	0.043	0.048	0.043
BROWN SOLOD	–	0.020	–	0.035	0.042	0.050	0.045
DARK BROWN SOLOD	–	–	–	0.035	0.040	0.045	0.045
BLACK SOLOD	–	–	–	0.030	0.038	0.043	0.043
DARK GRAY SOLOD	–	–	–	0.035	0.044	0.050	0.048
LUVISOLIC							
ORTHIC GRAY LUVISOL	–	–	0.035	0.049	0.057	0.063	0.060
DARK GRAY LUVISOL	–	–	0.020	0.037	0.051	0.058	0.050
SOLONETZ. GRAY LUVISOL	–	–	0.035	0.050	0.060	0.065	0.060
BRUNISOLIC GR. LUVISOL	0.056	0.046	0.055	0.059	0.072	0.072	0.070
OTHERS							
ORTHIC BRUNISOLS	0.015	0.020	0.025	0.035	0.040	0.050	0.035
ELUVIATED BRUNISOLS	0.023	0.023	0.035	0.030	0.056	0.065	0.060
PODZOLS	0.015	0.020	0.030	0.030	0.055	0.065	0.060
HUMIC LUVIC GLEYSOL	–	–	–	0.035	0.046	0.50	0.033
ORTHIC HUMIC GLEYSOL	0.015	0.020	0.025	0.030	0.035	0.040	0.020
REGO GLEYSOL	0.020	0.030	0.035	0.035	0.046	0.050	0.024

APPENDIX C

FORMATION OF SOIL EROSION POTENTIAL FILE RECORD: SOILEROS

The **SOILEROS** database contains an average annual soil loss value for bare soil (A1) and spring wheat (A2) as well as a data for individual factors in the **USLE** and additional information for individual 1 section cells in the area covered by the **SIDMAP** database. Soil loss values were computed for the dominant soil series and slope only. **SOILEROS 1** retains the same organization as the **SIDMAP** database it was derived from. Figure (13) shows the layout of the **SOILEROS** database.

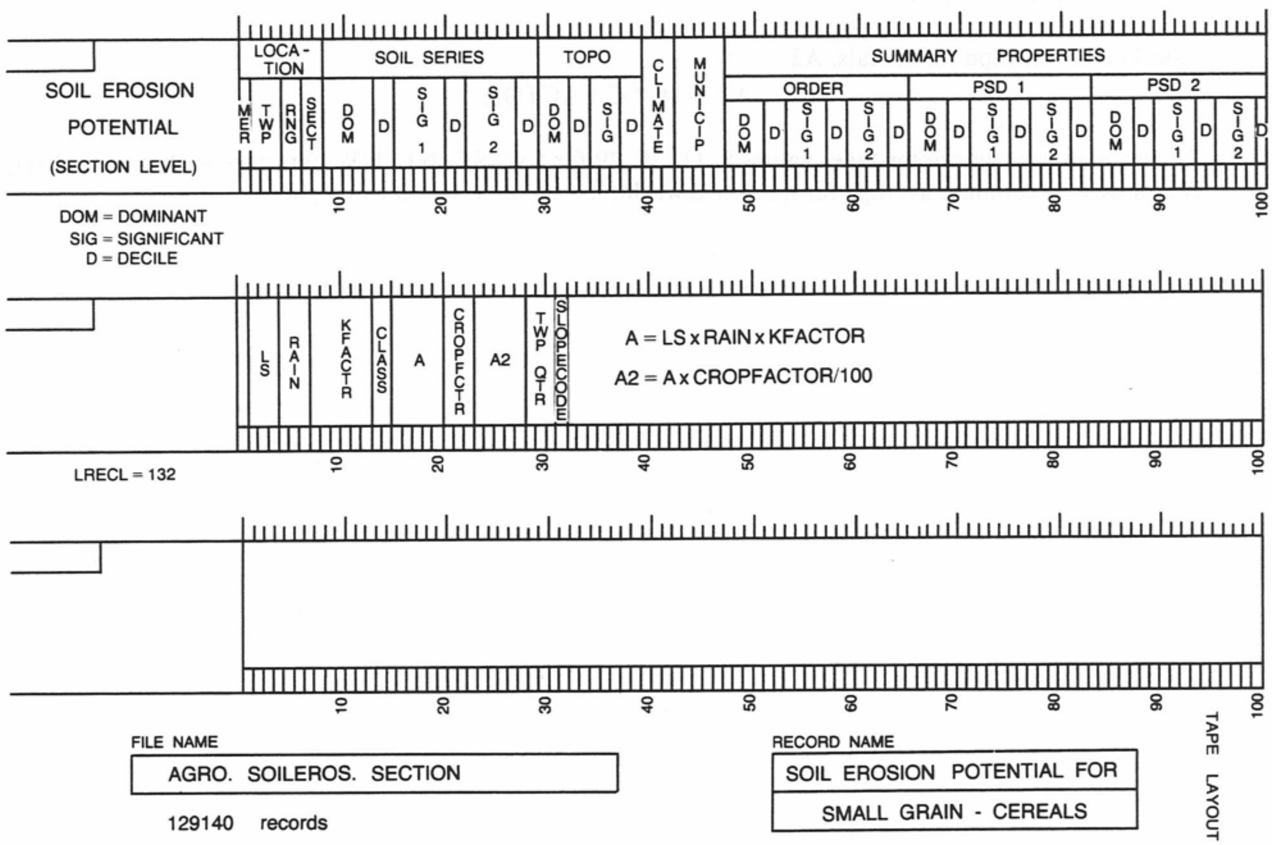

FIG. 13. TAPE LAYOUT FOR SOILEROS FILE 1 AND 2

The **SOILEROS 2** database has the same organization and data as **SOILEROS 1** but is generalized to 1/4 township (about 2300 ha) cells. The generalization assumed that if >75% of the sections in each cell had the same erosion class, they were considered as pure units. Otherwise, the average soil loss for the cell was calculated and the class assessed. Only sections with computed soil loss values were used in the final calculation. Programs were written for merging new data with the **SOILEROS** database, for computation of soil loss and for generalization of data.The following sequence was followed:

1. Select fields from **SIDMAP** section database

   LOCATION, SOIL SERIES, TOPOGRAPHY, CLIMATE, MUNICIPALITY, SOIL ORDER, PARTICLE SIZE 1, PARTICLE SIZE 2

2. Match/Merge process *by location* to add **LS** factor a rainfall factor. The LS and RAIN files were created by an expanding process from compressed codes and using other source maps.

3. Match/Merge process by *dominant soil series* to add **K** FACTOR. This was essentially a SAS table lookup from an in-stream data set. The CLASS variable was also determined by table at this point.

4. Calculate preliminary soil loss variable, **A**.

   A = LS * RAIN * K FACTOR

5. Match/Merge process *by location* to add **C** FACTOR.
   Same method as in step 2. above.

6. Calculate soil erosion for cereals, **A2**

   A2 = A * C FACTOR

7. Township quarter descriptor takes values 8, 11, 26, 29 for SW, SE, NE, NW part of township respectively. This is used to compute average for quarter township based data, and for mapping.

APPENDIX D

Selected P factors values (form USDA Handbook 537)

P values and slope — length limits for contouring

slope %	P value	Maximum length* m
1 to 2	0.60	120
2 to 5	0.50	90
6 to 8	0.60	60
8 to 12	0.70	35
17 to 20	0.80	20
21 to 25	0.90	15

* Limit may be increased by 25 percent if residue cover after crop will regularly exceed 50 percent

P values, maximum strip widths, slope length limits for contour stripcropping

slope	P values[1]			Strip width[2]	Max.length
%	A	B	C	m	m
1 - 2	0.30	0.45	0.60	40	250
3 - 5	0.25	0.38	0.50	30	200
6 - 8	0.25	0.38	0.50	30	120
9 - 12	0.30	0.45	0.60	25	70
13 - 16	0.35	0.52	0.70	25	50
17 - 20	0.40	0.60	0.80	20	35
21 - 25	0.45	0.68	0.90	15	30

1. P values:

   A. For 4-year rotation of row crop, small grain with meadow seeding, and 2 years meadow. A second row crop can replace the small grain if meadow is established in it.

   B. For 4-year rotation of 2 years row crop and small grain.

   C. For alternate strips of row crop and small grain.

2. Adjust strip-width limit, generally downward, to accommodate width of farm equipment

WATER EROSION POTENTIAL OF ALBERTA
1:1,000,000
Kilometres 10 5 0 10 20 30 40 50 60 70 80 90 100 110 Kilometres
1 Millimetre = 1 Kilometre
Statute Miles 10 5 0 10 20 30 40 50 60 70 Statute Miles
1 Inch = 15.78 Statute miles
LEGEND
WATER EROSION POTENTIAL OF SOILS IN ALBERTA*
(under cereal production)
Negligible
Slight
Moderate
Severe
Very severe
Extreme
Organic
Boundary of Reconnaissance Soil Surveys
* To accompany report by J. Tajek, W.W. Pettapiece and K.E. Toogood, 1985.
Map generalized from computer generated data based on a modified USLE equation.
Soil data compiled by the Alberta Institute of Pedology.
Cartography by Land Resource Research Centre, Research Branch, Agriculture Canada, Ottawa, 1986.
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Main highway
Secondary highway
Railway
Boundary, provincial
Boundary, park or reserve
Township boundary
Provincial capital
International airport
Other airfields
Elevation (in metres) 525
WOOD BUFFALO NATIONAL PARK
CARIBOU MOUNTAINS
LAKE ATHABASCA
Lesser Slave Lake
ROCKY MOUNTAINS
BANFF NATIONAL PARK
UNITED STATES OF AMERICA