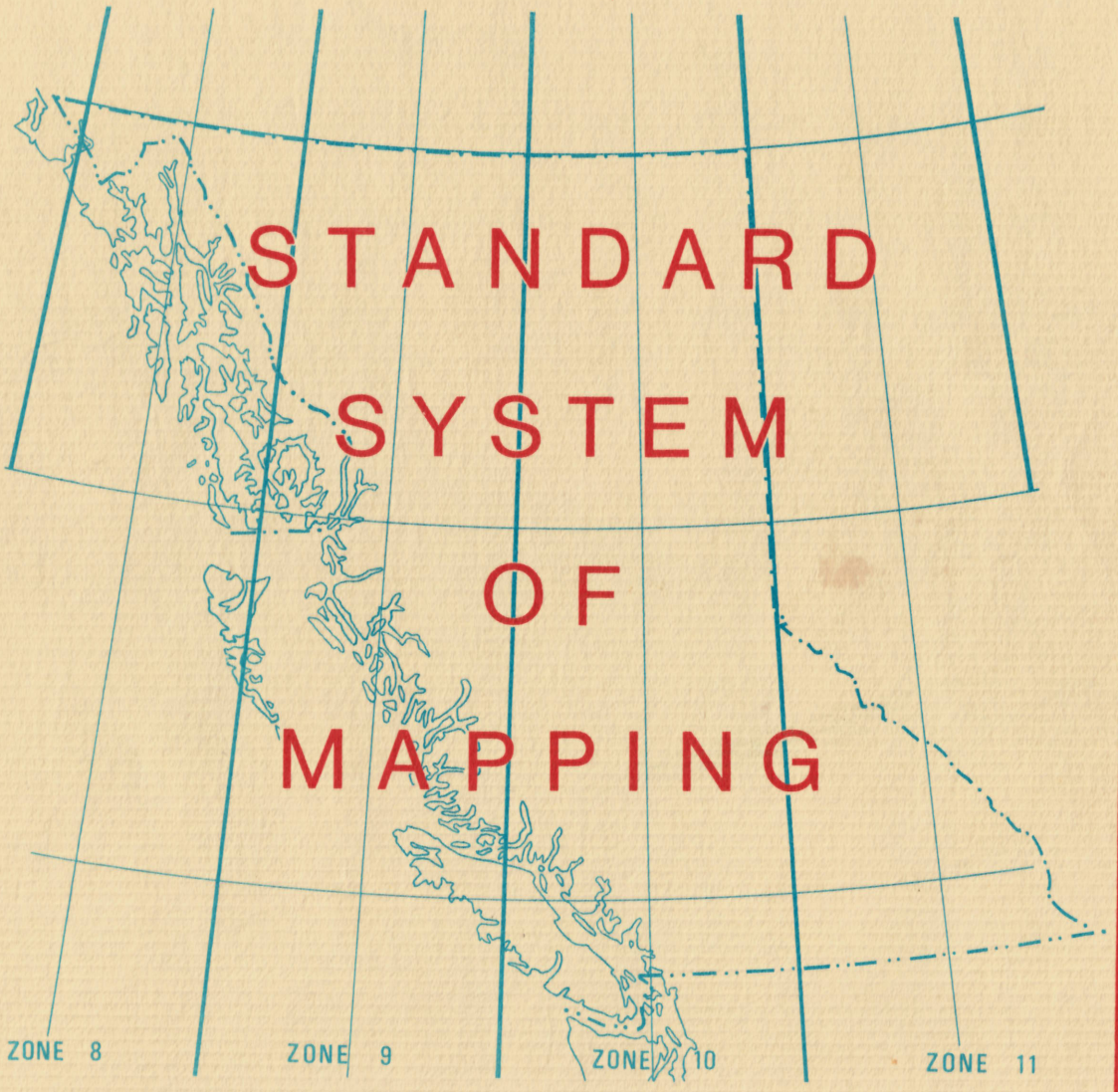
BRITISH COLUMBIA

STANDARD SYSTEM OF MAPPING



STANDARD SYSTEM OF MAPPING FOR BRITISH COLUMBIA

Introduction

This booklet supercedes Order in Council 2884/74, which has been repealed, and describes the Standard System of Mapping for British Columbia which has been adopted by the Department of Environment. A description is included of the Universal Transverse Mercator projection, to be used for all standard mapping, and the U.T.M. Rectangular Grid which the E.L.U.C. Technical Committee has recommended for geo-referencing purposes in connection with the storage and retrieval of data.

It is clearly advantageous for all mapping agencies in British Columbia to adopt a standard system of mapping with common scales, neat lines and numbering systems. Such a system, if accompanied by the free exchange of maps and mapping material between agencies, will assist in avoiding duplication of effort and will enable the comparison and correlation of different mapping themes by the simple process of overlay.

Mapping by the Surveys and Mapping Branch, Lands Service for other government departments and agencies will conform to the standard system.

The Director, Surveys and Mapping Branch, is responsible for the general coordination of Planimetric, Topographic and Thematic mapping in British Columbia and upon request from any agency planning to carry out standard mapping will provide survey control data, technical data and information and any other assistance that circumstances permit.

J. A. Nielsen

Minister, Department of Environment.

July 22, 1976

STANDARD SYSTEM OF MAPPING FOR BRITISH COLUMBIA

DEFINITIONS

1. "Planimetric" mapping means mapping which depicts the natural and man-made features of the earth's surface but does not depict relief.

"Topographic" mapping means mapping which in addition to planimetry, depicts relief represented by contours, spotheights, hachures, shading or other means.

"Thematic" mapping means mapping which displays resource, environmental, cadastral, political and other categories of information in relation to the land as shown on a topographic or planimetric base with an amount of detail appropriate to the theme.

"Neat" line means a line bordering the detail of a map.

"Surround" means the area between the neat lines and the edge of the paper.

"Geographic" system of mapping means a system in which the geographic graticule, or meridians of longitude and parallels of latitude, form the neat lines of the map.

"Rectangular" system of mapping means a system in which the lines of a rectangular grid form the neat lines of the map.

"Director" means the Director, Surveys and Mapping Branch, Department of Environment.

2. GENERAL

2.1 The Standard System of Mapping shall be applicable to planimetric, topographic and thematic mapping.

2.2 The Standard System of Mapping shall not apply to maps or map series:

a) Specifically designed for display, illustrative, graphic, pictorial or advertising purposes,

b) At scales less than 1:250 000 or larger than 1:500

c) Site, engineering, route and other maps or plans for specific projects for which standard neat lines, or the Universal Transverse Mercator projection are unsuitable.

d) When the Director has, on the merits of the case, authorized non-standard mapping.

2.3 In order to avoid duplication of effort any authority proposing to start any new mapping is invited to first consult with the Director.

3. STANDARDS

The Standard System of Mapping shall include the use of:

i) Map neat lines and numbers based upon the National Topographic System, The British Columbia Geographic System or the British Columbia Rectangular System.

ii) Standard Scales

iii) Elevations in metres based upon the Canadian Geodetic Datum.

iv) Standard contour intervals in metres.

v) The Universal Transverse Mercator Map Projection.

vi) Standard conventional symbols, surround information, line weights and other specifications made by the Director from time to time.

STANDARD SCALES

4. Standard Scales and System of Mapping to be used with each.

1:25 000 and smaller - National Topographic System

1:20 000
1:10 000
1: 5 000
1: 2 500
1: 1 250
} British Columbia Geographic System (B.C.G.S.)

1: 2 000
1: 1 000
1: 500
} B.C.G.S. or B.C. Rectangular System

5. National Topographic System

5.1 The National Topographic System (N.T.S.) is a geographic system under which Canada is divided into numbered primary quadrangles each 4° latitude by 8° longitude. Fig. 1 shows the primary quadrangles which cover British Columbia.

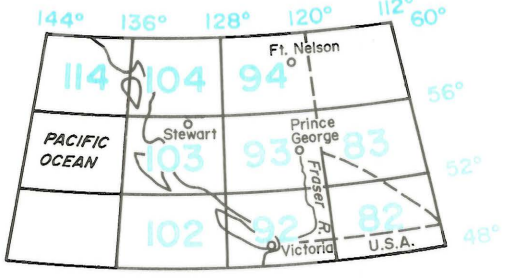


Fig. 1

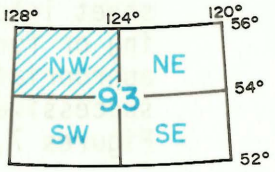
5.2 Neat lines and Map numbers for the scales for which the National Topographic System are applicable are illustrated by example in Figures 2 to 6.

93 N.W.

A quarter of a primary Quadrangle denotes a map at 1:500 000 scale each 2° latitude by 4° longitude

1:500 000

Fig. 2

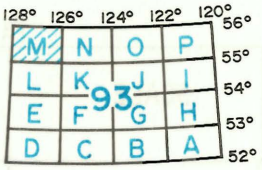


93 M

A sixteenth of a primary quadrangle lettered A through P denotes a map at 1:250 000 scale each 1° latitude by 2° longitude

1:250 000

Fig. 3

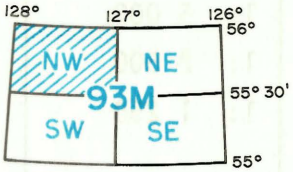


93M/N.W.

A quarter of a lettered quadrangle denotes a map at 1:125 000 scale each 30' latitude by 1° longitude

1:125 000

Fig. 4

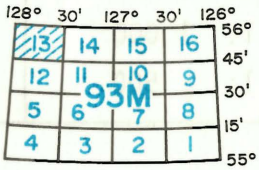


93 M/13

A sixteenth of a lettered quadrangle numbered 1 through 16 denotes a map at 1:50 000 scale each 15' latitude by 30' longitude

1: 50 000

Fig. 5

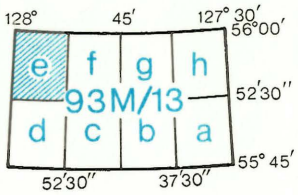


93M/13e

An eighth of a 1: 50 000 sheet lettered "a" through "h" denotes a map at 1:25 000 scale each 7' 30" latitude by 7' 30" longitude

1: 25 000

Fig. 6



5.3 Double sheets in horizontal format, that is ab, cd, ef and gh are sometimes printed for 1:25 000 scale on the N.T. System.

6 British Columbia Geographic System

6.1 The B.C.G. System is a geographic system in which the coverage in minutes and seconds of longitude is double the coverage in minutes and seconds of latitude for sheets at all scales. The smallest scale in the system is 1:20 000 derived from a breakdown of the N.T.S. 1:250 000 sheet into 100 parts. Larger scales are obtained by successive quartering or further division into 100 parts. A map number consists of the appropriate N.T.S. 1:250 000 map number followed by the numbers of each successive breakdown, each separated by a period. See Table 2 and Figures 7, 8 and 9.

Table 2: B.C.G.S. Scales, Map Numbers & Coverage

SCALE	MAP NUMBER	LONGITUDE	LATITUDE
1: 20 000	82F.035	12'	6'
1: 10 000	82F.035.1	6'	3'
1: 5 000	82F.035.2.2	3'	1' 30"
1: 2 500	82F.035.4.4.4	1' 30"	45"
1: 1 250	82F.035.3.3.3.3	45"	22.5"
1: 2 000	82F.035.063	1' 12"	36"
1: 1 000	82F.035.045.1	36"	18"
1: 500	82F.035.045.2.2	18"	9"

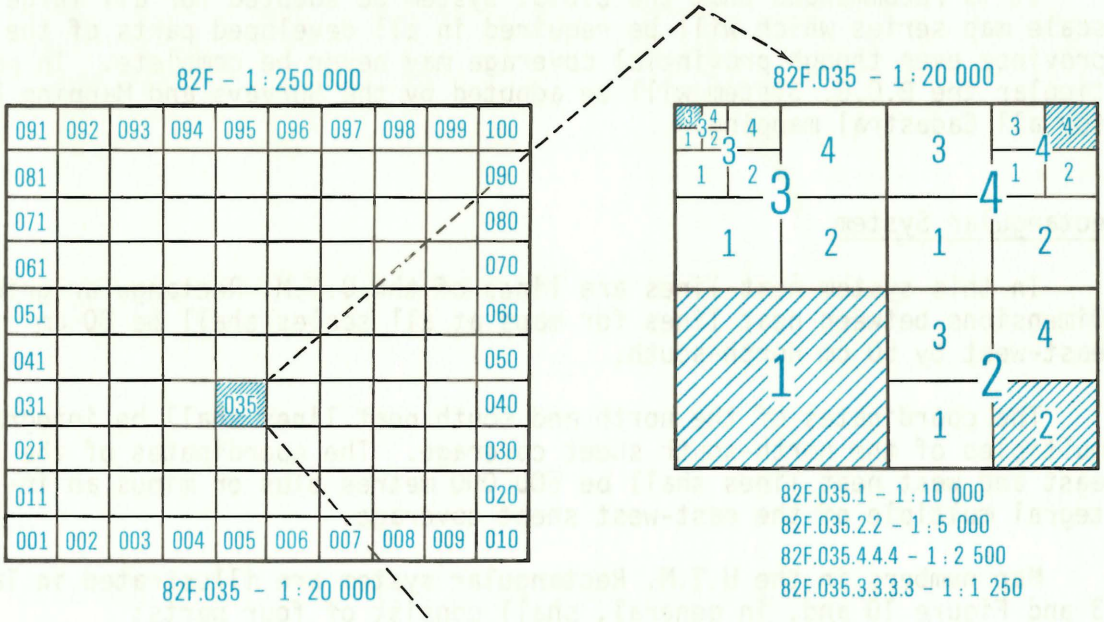


Fig. 7

Fig. 8

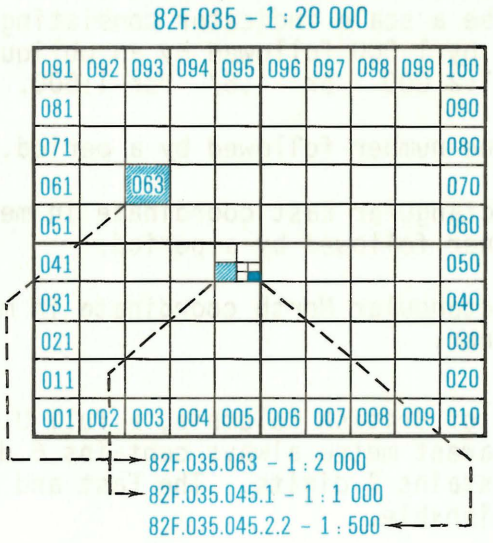


Fig. 9

6.3 In the B.C.G.S. numbering system the format of the number is different for each scale and the scale is therefore implicit in the number.

6.4 It is recommended that the B.C.G. System be adopted for all large scale map series which will be required in all developed parts of the province even though provincial coverage may never be complete. In particular the B.C.G. System will be adopted by the Surveys and Mapping Branch for all Cadastral mapping.

7. B.C. Rectangular System

7.1 In this system neat lines are lines of the U.T.M. Rectangular grid. Dimensions between neat lines for maps at all scales shall be 80 cm east-west by 50 cm north-south.

7.2 The coordinates of the north and south neat lines shall be integral multiples of the north-south sheet coverage. The coordinates of the east and west neat lines shall be 500 000 metres plus or minus an integral multiple of the east-west sheet coverage.

7.3 Map numbers in the U.T.M. Rectangular system are illustrated in Table 3 and Figure 10 and, in general, shall consist of four parts:

7.31 Since the number of digits in a map number is not unique for each scale the first part of the map number shall be a scale indicator consisting of the scale divided by 1 000 followed by an oblique stroke e.g. 2/ for 1:2 000 or .5/ for 1:500.

7.32 The U.T.M. Zone number followed by a period.

7.33 The U.T.M. Rectangular East coordinate in metres of the SW corner followed by a period.

7.34 The U.T.M. Rectangular North coordinate in metres of the SW corner.

In the latitudes of British Columbia, a full U.T.M. rectangular East coordinate to the nearest metre always contains 6 digits and the north coordinate always contains 7 digits. The East and North coordinates are thus easily distinguishable.

7.4 Mapping on the U.T.M. Rectangular System for a particular zone shall normally terminate at the zone boundary and will result in irregular sheets of reduced or extended size. If it is necessary to have a local map series on a single coordinate system straddling a zone boundary then the most appropriate zone must be chosen and extended in width as necessary.

B.C. Rectangular System Sheet Numbers

Scale	Coverage in m E - W	N - S	Sheet Number
1: 2 000	1 600	1 000	2/10.514400.5451000
1: 1 000	800	500	1/10.513600.5451500
1: 500	400	250	.5/10.513200.5451750

Table 3

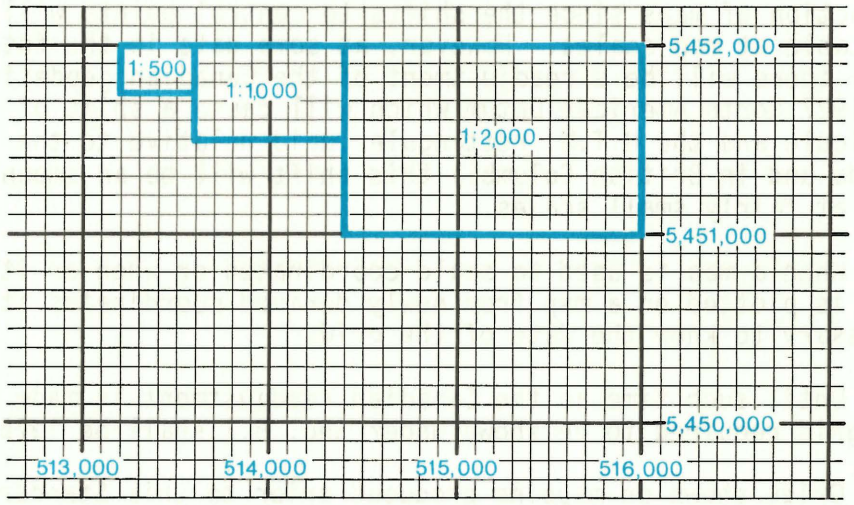


Fig. 10 Map Sheets Listed in Table 3 (above)

8. Projection, Graticule and Rectangular Grid

8.1 The Universal Transverse Mercator Projection shall be used for all mapping.

The values in degrees, minutes and seconds of the latitude and longitude of the neat lines shall be shown at the four corners of the map.

All maps shall show the U.T.M. rectangular grid with coordinate values either by fine full lines across the face of the map or by marginal ticks at map intervals not exceeding 20 cms.

In the surround there shall be a note in the following form: "U.T.M. Grid Zone _____(date)". The date being the date (year only) of the grid as explained in Sec. 8.2.

8.2 Re-adjustment of Control and Grid Dates

From time to time after control surveys of greater accuracy are made the coordinates of control points may be assigned new values relative to the geographic graticule and U.T.M. rectangular grid. Such changes will not, in general, have any impact upon the use or production of maps since the shifts to control points will not be plottable at map scales. However, at some date in the future (probably 1978) there will be a readjustment of the Canadian geodetic network on the 1927 North American Datum which will cause a shift of the geographic graticule and the U.T.M. rectangular grid relative to the land mass of Canada and in British Columbia this shift will be an amount plottable even at fairly small scales.

When a map is used to scale coordinates or when an item of detail is plotted on a map from newly derived coordinates it is therefore necessary to know the date of the grid.

Until such time as the Canadian readjustment is made the date of the grid required to be shown under Sec. 8.1 shall be 1975.

Grids shown on mapping produced prior to this Standard System of Mapping shall also be considered to be 1975 grids. After the new Canadian readjustment, or any subsequent readjustment, mapping based upon that readjustment shall show the appropriate grid date which will be included with coordinate information issued by the Director.

9. Elevations

9.1 The datum for elevations shall be the Canadian Geodetic Datum authorized by Order Number 630 of the Privy Council of Canada dated 11 March 1935. All elevations issued by the Geodetic Survey of Canada and by the Surveys and Mapping Branch of British Columbia are referred to this datum. Agencies committed to other datums should state the equation relating their datum to the Canadian Geodetic Datum on relevant maps and documents and may be maintained until a suitable opportunity to convert to the standard system occurs.

The use of the U.T.M. projection automatically implies that standard mapping be plotted at sea level Canadian Geodetic Datum.

9.2 Standard contour intervals shall be 1, 2 or 5 metres multiplied by integral powers of 10, or any integral multiple of 25 metres.

10.

11. Surround Information

11.1 Map Numbers and Theme

Standard Map numbers shall be shown in the surround at the south-east corner of the sheet. For thematic maps the theme shall be shown adjacent to the map number, e.g. CADASTRAL 92F.014.3.2

For maps of a local series a simple local numbering system, in addition to the standard numbering, may be adopted, and is encouraged.

11.2 Compilation or Revision Date

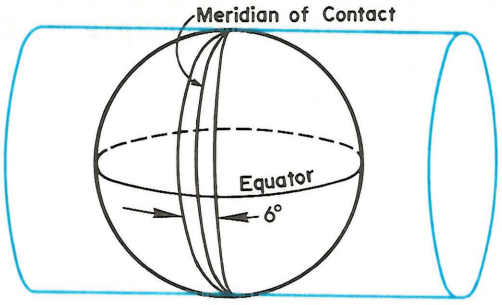
The date of compilation or revision of the map base or the thematic overlay, if any, shall be shown together with date of air photography used.

11.3 All maps shall indicate sufficient data on origin and compilation so that an assessment of quality and reliability can be made.

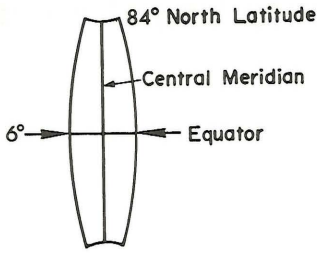
12. Universal Transverse Mercator Projection

12.1 A map projection is the representation of the spheroidal surface of the earth on a flat sheet of paper, and as such must involve distortion. The greater the area represented the greater will be the distortion. A large area such as British Columbia must therefore be divided into strips or zones so that within each zone the distortion may be kept within reasonable limits.

12.2 In its simplest form the Transverse Mercator Projection is the projection of a sphere onto a cylinder wrapped around it with contact along a meridian. The term Transverse denotes the fact that the cylinder is in contact along a meridian instead of along the equator as in the normal Mercator Projection.



U.T.M. Projection
Fig. 11

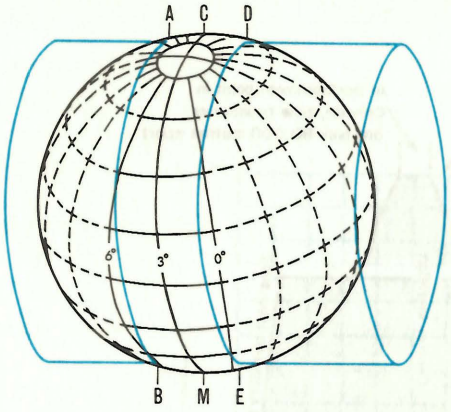


U.T.M. Zone
Fig. 12

12.3 The Universal Transverse Mercator (U.T.M.) projection is a special form of the Transverse Mercator in which the spheroid is divided into 60 zones each 6 degrees of longitude in width. The zones are numbered eastwards starting at the meridian 180° from Greenwich. Four zones numbered 8, 9, 10, and 11 cover British Columbia. A map of British Columbia showing the U.T.M. Rectangular Grid in metres is obtainable from Map Sales Office, Surveys and Mapping Branch.

Each 6° lune on the earth's surface as illustrated in Fig. 11 is flattened into a U.T.M. zone as illustrated in Fig. 12. The projection is unsuitable for the polar regions and, in the northern hemisphere, its use is restricted to south of 84° north latitude. The scale along the central meridian of each zone, where the cylinder makes contact with the spheroid, is everywhere correct. The process of projection or flattening involves distortion or an increase in scale as distance from the central meridian increases.

12.4 The U.T.M. projection is not a "projection" in the true geometrical sense but is rather the mathematical development of the spheroidal lune onto a plane surface done in such a way that the increase in scale in a north-south direction at any point away from the central meridian is matched by a corresponding increase in scale in an east-west direction. The result is a "conformal" or "Orthomorphic" projection in which the scale at all points is equal in all directions, shapes and angles within small areas are correctly preserved and parallels of latitude intersect all meridians at right angles. The central meridian is a straight line. All other meridians are curves concave to the central meridian. The equator is a straight line perpendicular to the central meridian and all other parallels are curves, concave towards the pole, which intersect the central meridian and all other meridians at right angles.



Secant Condition of U.T.M. Projection

Fig. 13

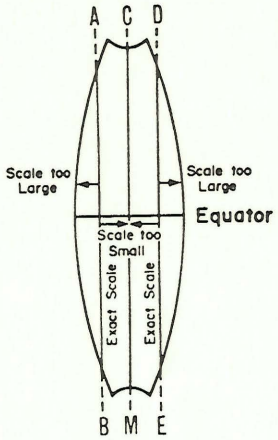
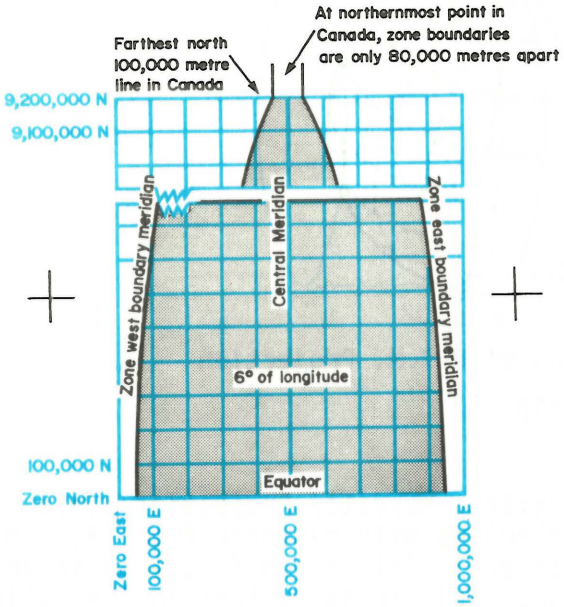


Fig. 14

12.5 In the Transverse Mercator Projection scale is true on the central meridian and increases with distance from it. In the U.T.M. projection a modification is introduced to give a scale reduction on the central meridian. This is equivalent to the cylinder being of smaller radius than the sphere and cutting into the sphere along lines AB and DE parallel to the central meridian in Fig. 13. Along these lines the scale is made true, between them there is a scale reduction and outside them there is a scale increase as shown in Fig. 14. This modification keeps the scale error within tolerable limits and at no place in a zone does the scale differ from true scale by more than 4 parts in 10 000.

U.T.M. Rectangular Grid

12.6 The U.T.M. Rectangular Grid is simply a system of squares superimposed on a map drawn on the U.T.M. projection. The features on the map are distorted by the projection but the rectangular grid is undistorted and consists of straight vertical lines parallel to the central meridian, and at right angles to them, straight horizontal lines parallel to the equator.



U.T.M. Zone with 100 000 metre Grid Superimposed

Fig. 15

Horizontal lines are designated by the distance in metres from the equator which is called the "northings" or Y coordinate. Over British Columbia the values of northings range from approximately 5 350 000 metres at the south end of Vancouver Island to 6 650 000 metres at the 60th parallel. Vertical lines are designated by the distance in metres from an imaginary point or "false origin" 500 000 metres west of each central meridian which is called the "eastings" or X coordinate. In the latitude of British Columbia the values of eastings range from a minimum of 280 000 metres to a maximum of 720 000 metres. The false origin is used so that all eastings are positive. If measured from the central meridian the values would be negative to the west and positive to the east.

U.T.M. Scale Factor

12.7 Since the projection causes distortion, except along the lines AB and DE in Fig. 14, the distance between two points in a local area scaled from the map will be distorted by a factor known as the "Scale Factor". Except where high precision is required the scale factor, which never causes a distortion exceeding 4 parts in 10 000, may be ignored by both map makers and map users. The rectangular grid which overlays the map is undistorted and true to scale and, for example, the side of a 1 km grid square at 1:10 000 scale will measure exactly 10 cm - but the distance between the points on the ground at the corners of the grid square will be 1 km divided by the local scale factor. Thus a distance scaled from a map, or more importantly, calculated from the rectangular coordinates of the end points, is a "grid distance" or "projection distance" and must be divided by the local scale factor to obtain the true distance. Conversely true distances must be multiplied by the local scale factor to convert them to grid distances before they can be plotted onto a map or before they may be used for calculations involving rectangular coordinates.

12.8 The U.T.M. scale factor on the central meridian is 0.9996 and increases in proportion to the square of the distance to the east or west of the central meridian. Tables 4 and 5 give the scale factors at various distances and differences in longitude from the central meridian.

It must be realized that the distortions of the U.T.M. projection, quantified by the scale factor, will exist in all standard mapping irrespective of the system of neat lines adopted.

12.8

Distance in metres From Central Meridian	Scale Factor
0	0.999600
50 000	0.999631
100 000	0.999723
150 000	0.999876
200 000	1.000091
250 000	1.000367

Table 4

Difference in Longitude from Central Meridian and Scale Factor							
Latitude	0° 00'	0° 30'	1° 00'	1° 30'	2° 00'	2° 30'	3° 00'
48	0.999600	0.999617	0.999668	0.999754	0.999874	1.000027	1.000215
50	0.999600	0.999616	0.999663	0.999742	0.999852	0.999994	1.000168
52	0.999600	0.999615	0.999658	0.999730	0.999831	0.999962	1.000121
54	0.999600	0.999613	0.999653	0.999719	0.999811	0.999930	1.000074
56	0.999600	0.999612	0.999648	0.999707	0.999791	0.999898	1.000029
58	0.999600	0.999611	0.999643	0.999696	0.999771	0.999868	0.999985
60	0.999600	0.999610	0.999638	0.999686	0.999753	0.999838	0.999943

Table 5

Sea Level and Combined Factors

12.9 All normal mapping is done at sea level datum and this applies to standard mapping in British Columbia. In the foregoing description the term "true distance" refers to the actual distance between points reduced to the horizontal at sea level. To reduce a measured (horizontal) distance to sea level it must be multiplied by the "Sea Level Factor" which may be calculated with sufficient accuracy for all purposes other than those requiring geodetic precision from the formula:

$$\text{Sea Level Factor} = \frac{6\ 385\ 000}{6\ 385\ 000 + E}$$

where E is the mean elevation in metres above sea level of the distance measured.

The Sea Level Factor may be combined by multiplication with the U.T.M. Scale Factor to produce a Combined Factor.

A measured (horizontal) distance multiplied by the Combined Factor will be the projection distance, grid distance or map distance (terms which are synonymous) at sea level.

So far as plotting on, or scaling distances from, a map are concerned the Sea Level Factor is normally insignificant, but in computations with coordinates where accuracy to a fraction of a metre is required both the Sea Level and U.T.M. Scale Factors - and hence the Combined Factor - may be significant.

Convergence

12.10 The central meridian of each zone is parallel to the Y axis of the rectangular grid. Elsewhere there is an angle between the parallel grid lines and the meridians which converge towards the pole This angle is known as "convergence" and may be calculated from the following approximate formula:

Convergence in seconds = Difference in longitude from central meridian in seconds X sine of the latitude.

Relationship between Geographical & Rectangular Coordinates

12.11 Since the origin of rectangular coordinates is the intersection of the central meridian with the equator there is a direct mathematical relationship between the two systems of coordinates, and the U.T.M. zone and rectangular coordinate constitute a unique reference to a point just as do latitude and longitude. The relationship is, however, a complicated one and conversions between the two systems of coordinates are normally carried out by electronic computer.

Rectangular Coordinate Calculations Limited to Local Areas

12.12 Since the scale factor changes with distance from the central meridian it follows that calculations, made in terms of rectangular coordinates, should be restricted to areas over which the scale factor may be considered to be constant. Over larger areas or distances calculations may still be made but for accuracy require refinements that take into account the changing scale factor. When accuracy is required and electronic computer programs are available it is best to carry out calculations covering large areas or long distances in terms of geographical coordinates which are free from projection distortions.

Zone Boundaries

12.13 A map of one zone on the U.T.M. projection cannot be fitted against a map of an adjoining zone. Fig. 12 shows a single zone which clearly cannot be fitted against an exactly similar adjoining zone due to the boundary meridian on the two maps being represented by lines convex to each other and which can thus only have a "rolling" fit. In the event that a map is required overlapping two zones the single most appropriate zone must be chosen and extended in longitude to the necessary width. This will apply whether the neat lines are geographic or rectangular. On such a map the rectangular grid of the chosen zone will be extended into the adjoining zone. Similarly calculations involving the rectangular coordinates of more than one zone must be preceded by conversion to coordinates of a single most appropriate zone with extended width.

12.14 U.T.M. Rectangular Coordinate References

In order to record a unique reference it is necessary to include the U.T.M. zone, the east coordinate and the north coordinate in that order. Note that this differs from a commonly used surveying practice of recording northings before eastings, or latitude before departure. If the reference is not required to be more precise than 1 metre in both eastings and northings it may be recorded as a single string of characters, as in a B.C. Rectangular System map number, in the form:

Zone period Easting period Northing

e.g. 10.437823.5603104 (precision 1 metre)

If the reference is only required to a lesser precision of 10 metres, 100 metres, 1 kilometre or 10 kilometres then an equal number of non-significant digits may be omitted from both easting and northing.

e.g.	10.43782.560310	(precision 10 metres)
	10.4378.56031	(precision 100 metres)
	10.438.5603	(precision 1 kilometre)
	10.44.560	(precision 10 kilometres)

Note that in all references the number of digits in the northing must exceed the number of digits in the easting by one.
To convert an abbreviated reference to a full reference add an appropriate number of zeros to easting and northing so that the number of digits in each is respectively 6 and 7.

If precision to better than one metre is required then the zone, easting and northing must be recorded separately and not as a single string.

e.g.	Zone	10
	Easting	472 703.900
	Northing	5 362 806.995

which is the coordinate of the tip of the statue of Capt. Vancouver on the Parliament Buildings in Victoria.

12.15 Canadian Military Grid

Some 1:50 000 and 1:250 000 N.T.S. maps published by the Federal government show the Canadian Military Grid. This grid is exactly the same as the U.T.M. grid except that 100 kilometre squares are assigned letters which replace the U.T.M. zone number, the first digit of the easting and the first two digits of the northing in a military grid reference.
An example may be seen on N.T.S. 1:250 000 sheet 104J for Dease Lake Townsite for which the Military grid reference is VQ3980. The U.T.M. reference for the same point is 9.439.6480 and this may also be read from the map since the full numeric values of the grid lines are given in addition to the grid square letters.

Canadian Military Grid References are NOT INTENDED TO BE USED FOR CIVIL PURPOSES OR GEO-CODING in British Columbia and this note is only included as an explanation.

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